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JOHN PHILOPONUS' CRITICISM OF ARISTOTLE'S THEORY OF AETHER

BY

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Für
Otto Kaiser

"Problems occur both in cases of conflicting arguments (for they involve an impasse whether something is so or not, there being persuasive arguments on both sides) and in cases where we have no argument to offer because the issues are so vast and we think it difficult to state the reason, for example, whether the universe is eternal or not; for one might inquire into such questions also."

Aristotle, *Topics* I 11, 104 b 12–17

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Abbreviations

Adv. math.	*Adversus mathematicos*
An. pr.	*Analytica priora*
An. pst.	*Analytica posteriora*
CAG	*Commentaria in Aristotelem Graeca*
Cael.	*De caelo*
Cat.	*Categoriae*
Crat.	*Cratylus*
De an.	*De anima*
DK	Diels-Kranz, *Fragmente der Vorsokratiker*
Gener. an.	*De generatione animalium*
Gener. corr.	*De generatione et corruptione*
Hist. an.	*Historia animalium*
Metaph.	*Metaphysica*
Meteor.	*Meteorologica*
OED	*Oxford English Dictionary*
Parm.	*Parmenides*
Part. an.	*De partibus animalium*
Phys.	*Physica*
Pol.	*Politica*
RE	*Pauly-Wissowa's Realencyclopädie*
Rep.	*Republic*
SVF	*Stoicorum Veterum Fragmenta*
Tim.	*Timaeus*
Top.	*Topica*

1. Introduction

In recent years, the interest of both classicists and historians of philosophy and science in the Christian Neoplatonist John Philoponus has been increasing considerably. Philoponus is now recognised and appreciated not only as an illuminating commentator on Aristotle, but also as a fascinating and remarkably independent thinker in his own right.[1] Modern accounts often view Philoponus' physical theories as a major contribution to the transition from ancient to modern physics. Some of the most important innovations attributed to him are the impetus theory,[2] the theory of matter as an indeterminate three-dimensional substrate,[3] and his critique of Aristotle's 'laws' of falling bodies.[4] The subject-matter of the present study, a further important achievement of Philoponus, is his revision of central doctrines of Aristotelian-Neoplatonic cosmology. The textual basis for this study is formed by the fragments of Philoponus' lost treatise *De aeternitate mundi contra Aristotelem*, a work in which Philoponus extensively criticises Aristotle's theory of aether and his arguments for the eternity of motion and time. The present study deals with the majority of the fragments of that work, i. e. those fragments which are critical of Aristotle's theory of aether. It attempts to show that in the course of rejecting Aristotelian doctrine Philoponus strives to work out a cosmological theory of his own. Although this theory remains indebted to the tradition of Aristotelian-Neoplatonic physics, it is compatible with fundamental doctrines of Christian belief and represents an important stage in Philoponus' doctrinal development.

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[1] A comprehensive assessment may be found in an invaluable collection of new articles on Philoponus edited by Richard Sorabji, see Sorabji (1987 a). The volume also offers an extensive bibliography.

[2] See esp. Cohen–Drabkin (1975), 221–223; G.E.R. Lloyd (1973), 157–160; Sambursky (1962), 70–76; Wolff (1978), 67–160; *id.* (1987); Zimmermann (1987).

[3] See Wolff (1971), 105–148; Jammer (1969), 53–57; Sorabji (1987 b), 18–23 and 34–37; cf. also below 7.2.

[4] See Cohen–Drabkin (1975), 217–221; Grant (1964); *id.* (1965); Wohlwill (1906); Wolff (1971), 11–103; *id.* (1987), 91–95. A summary account of the various contributions of Philoponus to the development of the philosophy of nature can be found in Sorabji (1987 b).

A brief biographical sketch will help to place the *contra Aristotelem* in its historical context.[5] John Philoponus is a figure who illustrates the final stage of ancient philosophy in a period commonly called late antiquity. Little is known about his life. He was born at the end of the fifth century A. D., lived and worked for most of the sixth century in Alexandria, and died not long after 570. As a young man he joined the school of Alexandria – by which time he was possibly already a Christian – and received a thorough education in logic and philosophy under Ammonius, son of Hermeias.[6] The emphasis of the curriculum lay on the writings of Aristotle, and from about 512 onwards Philoponus worked on the editing and publication of his teacher's lectures. Several of the commentaries attributed to Philoponus indicate that they owe much to Ammonius' lectures or seminars,[7] and the extent of Philoponus' original contribution to them cannot be determined with accuracy. In the second, third, and fourth decades of the sixth century Philoponus – who called himself Grammarian[8] – lectured and commented on Aristotle's natural philosophy. However, with apparently growing sympathies for Plato's views, he distanced himself gradually but decisively from the Aristotelian orthodoxy. His disagreement with the school philosophy of his time culminated in the publication of a pair of polemical treatises against two thinkers highly respected at the schools of Athens and Alexandria, Proclus and Aristotle. The first of these treatises, entitled *De aeternitate mundi contra Proclum*,[9] was published in 529/30; the second treatise, entitled *De aeternitate mundi contra Aristotelem*, followed only a few years later.[10] Little is known about Philoponus' activities during the following years. As a Christian he

[5] On the life of Philoponus compare Gudeman–Kroll (1916); Evrard (1953); Saffrey (1954), and Sorabji (1987 b), 1–5.

[6] Philoponus states *In meteor.* 106,9 that Ammonius was his teacher. On the problem see Evrard (1965); Sorabji (1987 b), 3 f.

[7] "ἐκ τῶν συνουσιῶν Ἀμμωνίου τοῦ Ἑρμείου"; see the commentaries on both *Analytics*, on the *De anima*, and the *De Generatione et corruptione*. The remaining commentaries on the *Categories*, the *Physics*, and the *Meteorology* bear no such qualification.

[8] According to Simplicius *In de caelo* 119,7. – From time to time Simplicius refers to Philoponus as 'the Grammarian', usually when he is being ironical rather than malicious, see e. g. *In de caelo* 56,26 f.; *In phys.* 1168,39 f. The epithet 'Grammarian' probably did not possess the modern meaning of being an expert on grammar and related subjects (*pace* Sorabji (1987 b), 5 f.), but, more generally, of being a scholar and a man of letters.

[9] The treatise is edited by Rabe (1899).

[10] On the dates of the two treatises see Wildberg (1987 a), 200–202.

became increasingly involved in the monophysite controversy of his time, defending both theologically and philosophically the position of the monophysites and, what is perhaps less commendable, of the tritheists' faction.[11] Several theological and semi-philosophical treatises which are partly lost, partly extant in Syriac, date from that period.[12] In the later period of his life, Philoponus wrote an exegesis of the biblical account of the creation of the world, the *De opificio mundi*.[13] Significantly, this treatise, which was probably published between 557 and 560,[14] represents a serious attempt to reconcile Christian belief with Aristotelian and Platonic philosophy. The ideas expressed in these writings had a resounding and lasting, though not always adequately acknowledged, impact upon Syriac, Arabic, and Latin mediaeval theology and philosophy, and secured Philoponus palpable influence on the early stages of the scientific revolution during the Renaissance period.

From a philosophical point of view, the most remarkable aspect of Philoponus' development is certainly his open polemic against Proclus and Aristotle. Of the two treatises, the *contra Aristotelem* seems to have received wider recognition in antiquity than the *contra Proclum*, presumably because it tackled fundamental problems in Aristotle's philosophy of nature. Simplicius, for instance, alarmed by the reputation Philoponus had won through writing such a treatise, set out to show by many arguments that the critique of the Alexandrian grammarian was entirely gratuitous and sophistical.[15] It is probable that Philoponus' treatise against Aristotle was translated into Syriac, and some of its central arguments influenced the debate on the eternity of the world in Arabic philosophy.[16] Unfortunately, the treatise has not survived in its entirety. Ironically, it is due to Simplicius' heated opposition to Philoponus that a large number of often quite substantial fragments

[11] In the year 680, just over 100 years after his death, Philoponus was anathematised for his tritheistic doctrines.

[12] See Šanda (1930) and the publications of Furlani. On Philoponus as a monophysite theologian see Hermann (1930) and Chadwick (1987).

[13] The treatise is edited by Reichhardt (1897).

[14] On the problem of the date see Evrard (1953), 299 f. note 3. Wolska (1962), 163–165 proposes an earlier date for the treatise, the years 546–549. On the chronology of Philoponus' writings in general see Sorabji (1987 b), 37–40, and Chadwick (1987), 55.

[15] On the extent and character of Simplicius' invective see Hoffmann (1987), 57–72.

[16] See, e. g., Craig (1979); Davidson (1969); Kraemer (1965); Mahdi (1967); Pines (1972); Steinschneider (1869); Zimmermann (1987).

remains extant. Although modern students of Simplicius' commentaries have recognised their importance, the fragments have never been studied adequately. J. Zahlfleisch first summarised the debate between Simplicius and Philoponus in two articles published around the turn of the century.[17] In 1943, Étienne Evrard produced an important collection of and commentary on the fragments of the first book of the *contra Aristotelem*. However, he covered no more than approximately one fifth of the material, and the work, which has never been published, is accessible only in the University Library in Liège.[18] Fortunately, many of its conclusions are incorporated in a substantial article published by the same author in 1953. Now a collection of the surviving fragments has been made available in English translation,[19] and the present study is the first extended monograph on the *contra Aristotelem*.[20]

The foremost aim of the *contra Aristotelem* is the denial of the thesis that the world is eternal. Apart from his rejection of Aristotle's arguments for the eternity of motion and time,[21] Philoponus' criticism focuses on Aristotle's cosmology, in particular the seminal theory of aether. In books I–V of the original treatise Philoponus cites the arguments put forward in De caelo I 2–4 and attempts to refute them systematically.[22] Due to the fragmentation of the treatise his objections can no longer be considered within their original context, and quite often the significance of particular points against Aristotle is not immediately obvious. In order to do Philoponus' arguments justice, one must analyse Aristotle's theory of aether before one embarks on commenting on Philoponus' critique. Consequently, the present study consists of two major sections. The first part discusses the methodology and arguments of Aristotle's presentation of the theory of aether. Its aim is to understand and evaluate this important episode of ancient science within the framework of Aristotle's general physical theory.

[17] See Zahlfleisch (1897) and *id.* (1902).

[18] I am indebted to Professor Evrard and the staff of the University Library of the Université de Liège for supplying me with a photostat.

[19] See Wildberg (1987 b). The 134 fragments are taken mainly from Simplicius, but also from other Greek, Arabic, and Syriac sources. I have argued that the collection may be regarded as a fair representation of the original treatise, see Wildberg (1987 b), 24–31.

[20] A number of scholars, however, have dealt with isolated arguments, see, e. g., Boehm (1967); Craig (1979); Davidson (1969); Lucchetta (1974/75); Mahdi (1967); Sambursky (1962); Sorabji (1983), 210–231 *passim;* Verbeke (1982); Wieland (1960); Wolff (1971); Wolfson (1966).

[21] See Aristotle *Physics* VIII 1. Philoponus deals with this chapter in book VI of the *contra Aristotelem*, which does not concern us in the present study. The fragments of that book are translated in Wildberg (1987 b), 122–145. Some of the arguments put forward there have been dealt with by other authors, see, e. g., Craig (1979); Davidson (1969); Pines (1972); Sorabji (1982); *id.* (1983), 210–231 *passim;* Verbeke (1982); Wieland (1960); Wolfson (1966).

[22] On the structure of the treatise see Wildberg (1987 b), 26–27.

The second part deals with Philoponus' objections to the postulation of aether. The commentary attempts to evaluate the significance of the fragments of books I–V as a critique of Aristotle and, at the same time, to cast light on their relevance in the context of Philoponus' alternative cosmological theory.

The essay concludes with a summary comparison of Aristotle's and Philoponus' cosmological tenets and a discussion of the importance of the *contra Aristotelem* when viewed as a stage in Philoponus' continuous doctrinal development which culminates in the application of impetus theory to the curvilinear movements of the heavens.

2. The Foundation of Aristotle's Theory of Aether

John Philoponus' lost polemical treatise against Aristotle, the *De aeternitate mundi contra Aristotelem*, attacks two genuinely Aristotelian doctrines. The first doctrine is contained in the idea that the universe – in its present cosmological arrangement – is eternal. Already the title of the treatise makes plain that Philoponus aims, ultimately, at a refutation of this doctrine, whatever his incentive and interest may have been.[1] The second Aristotelian doctrine at stake is the postulate of a fifth kind of element, the 'first body' or aether, which pertains to the celestial region in contrast to the sublunary elements earth, air, fire, and water.[2] Prior to a discussion of Aristotle's arguments leading towards the postulation of aether, i. e. what we may call Aristotle's 'theory of aether', it is necessary to specify what is meant by the two concepts 'aether' and 'eternity'. It is further necessary to justify the initial remark that they are genuinely Aristotelian, and to outline the relation between them. The point of departure of the first part of this essay, therefore, shall be the question of the meaning of and the relation between 'aether' and 'eternity' in Aristotle.

2.1 Aether and Eternity

2.1.1 αἰθήρ and aether

Before Aristotle, the word αἰθήρ denoting a physical body[3] is already used in the *Iliad*, in Presocratic philosophy, and, of course, in

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[1] It is, of course, a truism to say that the concept of an eternal universe conflicts with some of the most fundamental doctrines upheld by the Christian Church. Yet, the mere fact that Philoponus was a Christian will not suffice as an explanation of the extremely detailed and comprehensive criticism expounded in the *contra Aristotelem*.

[2] The major part of the *contra Aristotelem*, books I–V (see frr. 1–107), was exclusively dedicated to this topic. Book VI deals with the proofs for the eternity of motion and time in *Physics* VIII 1. It is not possible to decide what was the exact content of the following books (at least two more, see Wildberg (1987 a), 198–200), nor how many books there may have been altogether.

[3] As opposed to the use of the word in a mythological sense, see Wernicke (1894).

Plato. Before Aristotle, the reference of the word αἰθήρ varies enormously, and it is clearly the case that Aristotle's concept of aether has little in common with the earlier usage.[4] In order to appreciate the genuine Aristotelian sense it is perhaps best to contrast it with the references of αἰθήρ in early Greek thought.

Etymologically, the word αἰθήρ is connected with αἴθω, 'to burn, blaze', but this connection is not at all borne out by the usage in the earliest texts.[5] In the *Iliad*, αἰθήρ is clearly distinguished from ἀήρ.[6] Whereas ἀήρ refers to fog and mist, i. e. those parts of the atmosphere that impair clear vision, αἰθήρ bears the sense of 'clear air'.[7] As Kahn points out, αἰθήρ is not so much a *region* of the skies as a certain condition of the sky, i. e. its brightness and translucence. In the *Iliad*, "the contrast between ἀήρ and αἰθήρ is ... still a question of visibility, and not of relative location".[8] Nevertheless it is clear that the notion of a certain location is not absent. *Iliad* 14, 288 states that the highest fir tree on Mount Ida reaches "through the ἀήρ to the αἰθήρ". Important to the present study is the idea expressed sometimes that αἰθήρ is the abode of Zeus.[9] Aristotle, it seems, is referring to this idea when he attempts to lend support to his own conception of aether by adducing the common opinion of men.[10]

If one can trust the evidence, αἰθήρ in Anaximenes (6th century) is conceived of as thin and dispersed (ἀραιούμενος καὶ διαχεόμενος) air, while fire is still more rarefied air.[11] In Empedocles (5th century), the word αἰθήρ is apparently often used instead of the word ἀήρ,[12] but some fragments seem to distinguish between the two.[13] It has been suggested that αἰθήρ in Empedocles probably refers to a mixture of air

[4] For convenience, 'aether' is used in the following discussion to denote Aristotle's concept (despite the fact that Aristotle himself seems to refrain from adopting the word as a name for his 'first element', see Sandbach 1985), note 98), and 'αἰθήρ' to denote the usage before Aristotle.

[5] On the etymology of αἰθήρ see Chantraine (1968), 32 f. (s. v. αἴθω).

[6] The etymological problem and the meaning of αἰθήρ in the *Iliad* is discussed by Kahn (1960), 140–148. See also Leaf (1902), II, 599–601 and Guthrie (1962) I, 466.

[7] Compare, e. g., *Iliad* 3,381; 5,864; 17,649 (ἀήρ) with 16,300; 17,371 and 646 (αἰθήρ).

[8] Kahn (1960), 145. Hesiod, *Works and Days* 547–556 uses ἀήρ in the same sense.

[9] See *Iliad* 2,412; 4,166; 15,192.

[10] Cf. *Cael.* I 3, 270 b 5–11 and below 4.2.2.

[11] See DK fr. A 8 (I 92, 32 ff.).

[12] Cf. DK frr. B 71 (I 338,3); B 98 (I 346,20); B 109 (I 351,21).

[13] Cf. DK frr. B 38 (I 329,1 f.); A 33 (I 289,17).

and fire.[14] The reference to fire alone is testified in the case of Parmenides[15] and, with better evidence, in Anaxagoras: Aristotle repeatedly accuses the latter of confusing αἰθήρ and fire.[16] In view of this development of the reference of the word αἰθήρ, Kahn suggests that the word is a "literary creation, formed by analogy with ἀήρ and never firmly established in the spoken language." Apparently, only later was it linked up with αἴθω.[17]

In Plato, again, the situation is quite different. Here, αἰθήρ is clearly located between the regions of fire and air.[18] Elsewhere, αἰθήρ is called the purest kind of air.[19] In the *Cratylus*, 408 D–E, one might receive the impression that αἰθήρ is actually a different body, but this is not certain.[20] The Pseudo-Platonic dialogue *Epinomis*,[21] however, states this clearly. αἰθήρ is a separate element and referred to, after fire, water, air, and earth, as the fifth body, 981 C. But its place within the universe has remained unchanged: In 984 A ff. it is stated explicitly that fire and earth are the outer elements, and that the intermediate space is filled by αἰθήρ, air, and water. The author goes on to describe how 'divine spirits' are fashioned from αἰθήρ, and that other creatures are created from the remaining elements. As Taran and Moraux have shown, the concept of a fifth body in the *Epinomis* conflicts with the theory of the *Timaeus* where the four elements are constructed, for good reasons, from regular polyhedra.[22] Although the *Epinomis* seems to take a long

[14] See O'Brien (1969), 287–292.

[15] See DK fr. B 8 (I 240,1).

[16] See Aristotle *Cael.* I 3, 270 b 24 f.; III 3, 302 b 4 f.; *Meteor.* I 3, 339 b 21–23; II 9, 369 b 14 f. Cf. Plato *Phaedo* 98 C.

[17] See Kahn (1960), 141 and 148. Kahn follows A. Meillet (1925). Remarques sur l'étymologie de quelques mots greques. *Bulletin de la société de linguistique de Paris* 26, 17.

[18] See *Crat.* 410 B, where αἰθήρ is said to flow about the air. This agrees with the definition adopted in Hesychius' Lexicon: αἰθήρ is "the place above the clouds."

[19] See *Tim.* 58 D, *Phaedo* 109 B.

[20] αἰθήρ is listed among other "things" such as sun, moon, stars, earth, air, fire, and water. The etymology given in 410 B is identical with Aristotle's, *Cael.* I 3, 270 b 23: αἰθήρ is taken to derive from ἀεὶ θεῖν.

[21] Following the comprehensive study by Taran (1975) it is assumed that the *Epinomis* is spurious. On the problem of αἰθήρ see esp. 36–42. Cf. also Moraux (1963), 1187–1192.

[22] See Taran (1975), 38 f. and Moraux (1963), 1190 f. The objective of *Tim.* 53 C–57 C is the explanation of the transmutation of water, air, and fire. This theory is disturbed by αἰθήρ, which presumably takes the form of a dodecahedron. Secondly, Plato justifies the existence of four elements at *Tim.* 31 B ff. by means of a mathematical theory of proportion. This seems to have been forgotten in the *Epinomis*.

step towards Aristotle's theory of aether, striking differences remain. Aristotle introduced several important innovations and transformed the notion of αἰθήρ completely.

First, aether in Aristotle is not just 'another' element, i. e. a fifth kind of body standing on an equal footing with the other four. It is the 'first' body, and this expression bears a strong axiological connotation: the primary body is more divine and honourable. Also, its place has changed. In Aristotle, aether fills the region above the sphere of fire; it is the sole element of the celestial region. No interaction with the other four, sublunary elements is possible. Unaffected by change and decay, aether revolves by nature in a circle – eternally. The substance of the heavens constitutes the outer, incorruptible shell of an eternal, yet spatially finite universe.[23] The question how this theory relates to Aristotle's early theology and the problem of the soul have proved to be difficult to answer and cannot be dealt with in the present context.[24] It seems unlikely that Aristotle introduced a notion of aether similar to the one argued for in the *De caelo* already in his presumably early dialogue *De philosophia*.[25] The same conclusion may perhaps be inferred from the fact that Philoponus does not seem to have attacked any arguments concerning aether in the *De philosophia*, nor any other arguments for the eternity of the world put forward there.[26]

2.1.2 Eternity in Aristotle

The word 'eternity' in the present context primarily refers to the eternity of the world, and, by implication, the eternity of motion and

[23] On the development of the concept of aether and its use in 18th and 19th century physics, cf. Hesse (1967); Cantor, G. N. and Hodge, J. S. (edd.). 1981. *Conceptions of Ether. Studies in the History of Ether Theories 1740–1900*. Cambridge etc.; and Rosen (1985).

[24] A general summary of the past debate as well as a discussion of the trustworthiness of the doxographical evidence concerning Aristotle's dialogue *De philosophia* can be found in Moraux (1963), 1196–1231. However, Moraux's account at 1213 of the relation between the *De philosophia* and the *De caelo* is probably not justified, see Longrigg (1970), 173. The doxography seems to be largely distorted by Stoic influences. Cf. also Easterling (1964) and Solmsen (1957).

[25] The relevant fragments stem from Cicero's *De natura deorum*, see frr. 21 and 26 (Ross). On the problem see Longrigg (1970), 172 f. and Moraux (1965), li–liv.

[26] The arguments for the eternity of the world in the *De philosophia* are discussed in Chroust (1977); see below 2.1.2.

time. Although 'eternity' is sometimes understood to possess an atemporal sense, for instance, when one speaks of the eternity of timeless logical or mathematical truths and principles, this sense of 'eternity' is not relevant to the present discussion. 'Eternity' in the temporal sense, again, can mean two different things. In the weaker sense, eternal means simply never ceasing to be. In the strict sense, it means never ceasing to be *and* never having to come to be. In order to distinguish the latter from the former sense, it is sometimes referred to as 'eternity *a parte ante* and *a parte post*'.

Speaking generally, natural philosophy before Aristotle may, according to the evidence, be said to have been occupied with an inquiry both into the ontological and the genetic principles of the universe. In Ionian philosophy, in Heraclitus, Empedocles and Anaxagoras, even in Plato's *Timaeus*, cosmology can hardly be separated from cosmogony.[27] Aristotle could maintain, not without justification, that his predecessors thought that at some time in the past the cosmos as it now is came to be.[28] He goes on to categorise his predecessors by distinguishing between those who thought that the universe was everlasting (i. e. eternal in the weaker sense),[29] those who thought it was perishable,[30] and those who believed in cosmic cycles.[31] Aristotle is consciously breaking with these traditions. He claims to show that the universe in its present cosmological arrangement has never been generated in the past, nor will it ever cease to exist in the future.[32] As opposed to the

[27] The case is different in Eleatic philosophy. But then, it is unlikely that the Eleatic One can be validly interpreted as 'universe' or 'world'. – As regards Plato, it remains controversial whether the *Timaeus* gives an account of the actual genesis of the visible world, or whether it is a didactic exposition of the principles of an eternal universe. Aristotle understood the dialogue in the former sense, but since Speusippus and Xenocrates the second interpretation has found many advocates. On the ancient debate see esp. Baltes (1976).

[28] See *Cael.* I 10, 279 b 12 f. Zeller (1878) follows Aristotle in this, but Taran (1974), 140 points out that Heraclitus fr. B 30 (DK) speaks of the eternity of the cosmos as well.

[29] According to Simplicius (following Alexander), *In de caelo* 293,13–16, Orpheus, Hesiod, and Plato.

[30] *Ibid.*, 293,16–18: the atomists. Although the atoms are not perishable, the universe *qua* cosmos is.

[31] Empedocles and Heraclitus. See *ibid.* 293,18–294,6 and *Cael.* I 10, 279 b 16 f.

[32] Accordingly, in Aristotle the study of nature centres entirely on the inquiry into the ontological principles of the world and avoids the pitfalls of cosmogony. On Aristotle's conception of an eternal universe cf. Zeller (1878); Baudry (1931), 155–183; Solmsen (1958); *id.* (1960), 266–274; Behler (1965), 41–45.

universe of his predecessors, Aristotle's world is eternal in the strict sense and always self-identical. The present cosmological arrangement has never been generated and will never cease to exist. When Philoponus contests Aristotle's doctrine he not only rejects this conception of the eternity of the world, but also any account which renders the world eternal *a parte post*.

What kind of evidence did Aristotle produce in support of his doctrine? The most important arguments appear in the *Physics*, where Aristotle argues for the uncreatedness of matter[33] and the eternity of motion and time.[34] Furthermore, there are a number of different arguments in the Aristotelian corpus,[35] but most of them do not entail that the universe in its cosmological arrangement remains unchanged for ever. The possibility, for instance, of an Empedoclean cosmic cycle theory is not always clearly ruled out.[36] Yet, the existence of an eternal and unchanging celestial element constituting the outer spheres of the universe does rule out such a possibility. Systematically, Aristotle's doctrine of the eternity and eternal self-identity of the world relies to a large extent on his theory of aether. At the beginning of the second book of the *De caelo* Aristotle states, II 1, 283 b 26–30:

> "We may convince ourselves ... by the arguments already set forth that the heaven as a whole has neither been generated nor can be destroyed, as some assert, but is one and eternal, with no end or beginning of its total duration, containing and embracing in itself the infinity of time."[37]

Historically, however, it would not be true to say that Aristotle 'deduced' the notion of the eternity of the world from his conception

[33] See *Phys.* I 9, 192 a 27–34: Matter is ungenerated because if it had come to be, something must have existed before as a substratum (for nothing comes to be from nothing) – and this is matter itself.

[34] See *Phys.* VIII 1, 251 a 8–b 10: Motion is the actualisation of the movable *qua* movable. Every movement presupposes a movable which must have been caused to move or to rest (rest being the privation of motion). – See also *Phys.* VIII 1, 251 b 10–28: Time cannot be conceived without the 'now', and the 'now' is the beginning of the future and the end of the past. Since time consists of 'nows', there will always be time before and after the 'now'.

[35] Notably in *De caelo* I 10–12 (that which exists always is incapable of non-existence), III 2 (creation out of nothing presupposes a vacuum, which does not exist), and the arguments in the *De philosophia*, see below. – A summary of Aristotle's arguments for eternity and their influence on later ancient and mediaeval thought has been provided by Sorabji (1983), 232–252; 268–283.

[36] See Zeller (1878), 103; Behler (1965), 50; but cf. *Metaph.* XII 6, 1072 a 8–9.

[37] I. e. the arguments in *De caelo* I, including the theory of aether. – The translation follows Stocks (1930).

of aether. He himself regards the theory of aether merely as a confirmation of the belief in an eternal universe.[38] In his dialogue *De philosophia* he puts forward a number of independent arguments for the eternity of the world. Some of them are preserved in Philo's treatise *De aeternitate mundi*;[39] the gist of these arguments may be summarised as follows:[40]

1. The universe cannot be destroyed from outside nor from inside, because there is nothing outside it to destroy it, and there is nothing powerful enough to destroy it from the inside.

2. Whenever a composite body perishes, its parts, which have been kept together in a counternatural position, return to their natural places. The composition of the universe, however, is harmonious and natural; therefore, the universe cannot perish.

3. [If the universe were created[41]], God himself would never destroy it, not even in order to create a new universe. For the new universe would either be worse than, equal to, or better than the present universe. All three possibilities are incompatible with the idea of an unchanging divine principle.

In discussing these arguments, Chroust arrives at the conclusion "that the doctrine of the uncreatedness and indestructibility of the universe is probably not only one of the most important philosophical innovations introduced by the Stagirite, but also one of the main issues first and elaborately discussed in book III of the *On Philosophy*."[42] It may be pointed out that the above arguments found in Philo warrant only the conclusion that the world is indestructible, i. e. eternal *a parte post*, but it is clear from other evidence that its uncreatedness was maintained by Aristotle as well. In the *contra Aristotelem*, so it seems, Philoponus did not concern himself with refuting the arguments put forward in that dialogue.[43] Instead, he centres his criticism on Aristotle's

[38] See *Cael.* I 3, 270 b 4 f.; II 1, 284 a 35–b 5 and below 4.2.1.

[39] See Philo *De aeternitate mundi* III 10–11 (fr. 18 (Ross)); V 20–24 (fr. 19 a (Ross)); VI 28–VII 34 (fr. 19 b (Ross)); VIII 39–43 (fr. 19 c (Ross)). Cf. also the related arguments in frr. 16–18 and 20 (Ross), and see Sorabji (1983), 281 f.

[40] A translation, summary, and discussion of the following arguments can be found in Chroust (1977).

[41] This argument seems to presuppose hypothetically that God created the universe. See Chroust (1977), 127.

[42] Chroust (1977), 128.

[43] Arguments similar to the ones adduced in the *De philosophia* had, with fresh ingenuity, been put forward against the Christians by the fifth century Neoplatonist Proclus, see Baltes (1978), 134–164. Philoponus repudiated Proclus' 18 arguments in 529 in his famous treatise *De aeternitate mundi contra Proclum*, see Rabe (1899).

theory of aether, which, as has been pointed out, is only one pillar of the doctrine of the eternity of the world. However, more than any other Aristotelian argument, this theory directly implies both the eternity and self-identity of the universe. Hence, Philoponus' critique, if it succeeds, would cast grave doubts on this particular aspect of Aristotle's view of the universe, and this is especially true since Philoponus leaves the basic framework of Aristotelian physics intact. Moreover, Philoponus is well aware of the fact that at least within the context of his repudiation of the theory of aether he cannot produce conclusive evidence to the contrary, i. e. that the world is in fact generated and will be destroyed. The recurrent conclusion of his arguments there is expressed in a phrase like "therefore nothing prevents the world from being generated and destructible." But he complements his critique of Aristotle's theory of aether by a rejection of Aristotle's arguments for the eternity of motion and time in *Physics* VIII 1.[44] And in this context Philoponus indeed produces what he takes to be conclusive proof of the temporal finitude of the universe.[45]

Methodologically, one of the most remarkable features of the *contra Aristotelem* is the fact that Philoponus, who was himself brought up in the tradition of Aristotelian philosophy, often quite effectively turns Aristotle against himself. It may be suggested, therefore, that his historical significance lies not merely in his producing philosophical arguments for the truth of the Christian belief in creation, but also in showing that this belief is not incompatible with fundamental principles of Aristotle's philosophy of nature. Before proceeding to the reconstruction and examination of Philoponus' criticism, it is first necessary to understand the method and argument of Aristotle's theory of aether itself.

2.2 The Prologue: De caelo I 1

According to the evidence the first of Philoponus' objections to Aristotle's theory of aether questions the validity of Aristotle's correlation of simple bodies with simple motions, which forms a vital part

[44] See book VI of the *contra Aristotelem* in Wildberg (1987 b).

[45] These arguments will not be dealt with in the present context; see esp. Sorabji (1982 a); *id.* (1983) 214–231.

of the argument of *De caelo* I 2. We know of no objections to the arguments of the first chapter; which suggests that Philoponus did not deal with this chapter at all. This is not improbable because, as will be seen more clearly later, none of the arguments laid down in chapter 1 contribute materially to the theory of aether. Nevertheless, the chapter possesses considerable importance: even though it is true that it does not establish any premises for later conclusions, it introduces a certain *method* which may be regarded as central to Aristotle's theory of aether. To anticipate, this method may be described as the application of mathematical, in particular geometrical, concepts to the realm of the sensible world. Philoponus is well aware of this, and – according to our evidence – categorically denies that mathematics may at all be applied to physics.[46] In order to understand Aristotle's method as well as Philoponus' criticism, it is necessary to take a closer look at the prologue to Aristotle's theory of aether, *De caelo* I 1.

2.2.1 The subject-matter of natural science: 268 a 1–6

The opening chapter of Aristotle's cosmology begins with the statement that the science of nature deals for the most part with bodies and magnitudes, their attributes and their motions; further, with principles, and in particular how many there are.[47] This indeed very general account of the subject-matter of natural science is justified by an explanation 268 a 4–6 that 'the things constituted by nature' are either (1) body and magnitude (σῶμα καὶ μέγεθος), or (2) what possesses body and magnitude, or (3) the principles (ἀρχαί) of things that possess body and magnitude. For a proper understanding of the chapter it is necessary to clarify what is the exact reference of these three classes. Simplicius, for instance, *In de caelo* 6,33–7,2 offers the following interpretation: (1) comprises things like fire, water, stone, and wood; (2) plants and animals; (3) matter, form and motion. This careless account partially adopted by Stocks (1930) and Guthrie (1939) is almost certainly false. For first, nowhere in Aristotle does the phrase 'bodies and magnitudes' refer to simple bodies or the immediate material of compound substances, as Simplicius seems to suggest. And secondly, motion should

[46] Cf. below 6.2.2.

[47] 'For the most part' because soul, for example, is not explicitly mentioned.

not be included under (3) because motion itself possesses a principle, e. g., nature, and therefore cannot *be* a principle.[48]

The easiest way to proceed is perhaps to find tokens belonging to the second class, i. e. 'what possesses body and magnitude'. On a natural reading of the Greek one could assume that the sum-total of physical objects – animate as well as inanimate – may fall within this class.[49] If this is correct, the third class consists of the principles of these objects, such as matter, form, and privation.[50] The crux is the first class of items. At first sight it is unclear in which way this class differs at all from the second one: On the one hand we have body (σῶμα) and magnitude, on the other what *possesses* (ἔχει) body and magnitude. There is a similar passage at the beginning of *Physics* II 2, when Aristotle sets out to discuss the difference between a physicist and a mathematician; he remarks in 193 b 22–25:

> "Physical bodies possess (ἔχει) planes (ἐπίπεδα) and solids (στερεά) as well as lengths (μήκη) and points (στιγμαί), which are what the mathematician investigates."

In this passage geometrical entities like solids are said to belong to physical bodies.

Now, as is well known, the Greek term τὸ σῶμα is ambiguous, for it can mean both (physical) body and (geometrical) solid.[51] There are instances in the *Corpus Aristotelicum* where τὸ σῶμα is undoubtedly referring to a geometrical solid, and the word there is synonymous with τὸ στερεόν.[52] If this is the case in *De caelo* I 1 as well, one could infer that Aristotle wants the first class to consist of '(geometrical) solids and magnitudes'. An understanding of the sentence in this way is more consistent and attractive, for by magnitude (μέγεθος) Aristotle means mathematical entities as well, like lines, planes, and solids.[53]

[48] "Nature is a principle of motion", an assumption vital to the theory of aether. Cf. below *Cael.* I 2, 268 b 16 and the discussion 3.1.1.

[49] Alternatively, as David Sedley points out to me, a 5 could be read: 'the things which body and magnitude possess (τὰ δ' as object of ἔχει), i. e. πάθη and κινήσεις. On this reading, the second group here corresponds to the second group in a 2 f.

[50] See Aristotle's discussion of principles in *Physics* I 7.

[51] Cf. LSJ s. v. and Bonitz (1870),'742 a 9 ff.

[52] See, e. g., *Top.* V 15, 142 b 24 f. and *Metaph.* V 13, 1020 a 7–14 where Aristotle defines magnitude as measurable quantity divisible into continuous parts, extending in one, two or three dimensions: line, plane, solid (σῶμα).

[53] Mueller (1970), 168 writes: "For in Aristotle 'magnitude' is just a general term referring to lines, planes, and solids." Cf. also the previous note.

Then, taking into account what has been said in the passage cited from *Physics* II 2, one may construe Aristotle's account of the tripartition of the subject-matter of an inquiry into nature as follows:

solids and magnitudes – physical bodies – principles

Unfortunately, in the present chapter Aristotle does not provide a direct hint as to whether or not this interpretation is correct. The following arguments of the chapter, however, suggest indirectly that it is.

This tentative initial interpretation seems to run into serious difficulty *a priori*. Aristotle, more than anyone else in ancient philosophy, advocated a clear separation of the sciences.[54] Why would he include geometrical objects (lines, planes, solids) – which are the subject-matter of mathematics – within the subject-matter of the science of nature? Further, if he really meant to say 'solids and magnitudes', why did he not use the unambiguous term τὸ στερεόν instead of τὸ σῶμα? Is Aristotle deliberately misleading his readers (and auditors)? Or is it possible to account for his procedure? And if so, what is the relevance of these introductory remarks for the theory of aether?

In the following section an attempt will be made to answer these questions. First, however, it is necessary to go through the argument of the chapter and to support the claim that the argument of *De caelo* I 1 indeed involves mathematical objects.

2.2.2 The argument of *De caelo* I 1, 268 a 6–b 10

Having laid down that the subject-matter of physics is threefold, Aristotle confines himself to considering the first class of items labelled 'bodies/solids and magnitudes'. As it seems, the second group comes briefly into play at the end of the chapter, whereas the third group does not receive any consideration at all. Bodies/solids and magnitudes, then, are said to be continuous and in consequence infinitely divisible (268 a 6–8).[55] The first magnitude, the line, is divisible in one direction,

[54] Cf. *An.pst.* I 7, and *Cael.* III 7, 306 a 7–11.

[55] *Cael.* I 1, 268 a 6 f. precisely repeats the view expressed in *Phys.* VI 1, 231 b 15 f. The significance of this is that the sentence is part of Aristotle's maturest definition of the continuous, as has been argued cogently by Waschkies (1977), 353–360; 369–376. The brevity of the remark intimates that the whole discussion of contact, divisibility and continuity in *Physics* V and VI is presupposed.

the second, the plane, in two, and finally the third magnitude, body/solid, is divisible in three directions or dimensions – and that means in all, a 7 f. Clearly, these distinctions intimate what the first class of items really consists of: not fire, water, stone and wood, as Simplicius thought, but lines, planes, and bodies/solids. Aristotle underlines the fact that σώματα are three-dimensional entities. The emphasis, therefore, lies on (geometrical) solid rather than physical body. The claim of line a 7 that a solid/body is divisible in all directions is then supported in a 9 ff. by the additional statement that there is no other magnitude besides these three. This statement precludes points (which Aristotle defines elsewhere as indivisibles possessing position, see *Metaph.* V 6, 1016 b 24–31) as well as some kind of four-dimensional entity. The course of the argument of this chapter suggests that Aristotle wants to exclude the possibility of a fourth dimension in order to support his claim that the three-dimensional solid/body is a μέγεθος τέλειον.

Special significance is attached to the number three: there are *three* types of magnitude, and the solid, the third, is divisible in *three* directions, i. e., it extends continuously in *three* dimensions. According to Aristotle, there is enough evidence to justify the belief in the significance of the triadic structure. For first, the Pythagoreans held that "the All (πᾶν) and everything (πάντα) are determined by the number three; for end, middle, and beginning possess the number of the All, and this is the number three", a 10–13. The remark may be taken as a reference to the characteristically Pythagorean method of identifying physical and non-physical items with numbers. Elsewhere, Aristotle is prone to criticise the Pythagorean number-theory,[56] but here he refers to it in order to that it may serve his own purpose. According to Aristotle's remark, Pythagoreans believed that the All or universe is (or is represented by) the number three, and this number therefore possesses the connotation of τελειότης.[57]

[56] E. g., *Metaph.* XIII 6, 1080 b 16–21; 8, 1083 b 8–19; but cf. also *Metaph.* I 5, 985 b 32 ff.; 6, 987 b 11 f., 27 f.; XIV 3, 1090 a 20 ff. – On the problem of whether the relation between numbers and things is one of identity or rather imitation or representation (μίμησις) see, e. g., Guthrie (1962), 229 ff.

[57] This literal interpretation receives support from *Metaph.* I 8, 990 a 27–29, where Aristotle – in criticising the Pythagoreans – asks whether the number present in the οὐρανός is the same as the number present in opinion (δόξα). Now the number of opinion is reported to have been 3, cf. Ross (1924) I, 144, 184. If one further considers that in the Pythagorean Philolaus (*ca. 470 B. C.) οὐρανός denoted the sum-total of the sublunary region, the realm of becoming and change (see Fr. A 16, *DK* I 403, 22 ff. = *Aëtius* II 7,7) Aristotle's doxographical remark becomes less obscure. – *Contra* Guthrie (1939), 6 f. n. and Moraux (1965), xxxi, [Elders (1966) and Bos (1973) express no opinion on this problem]: Guthrie and Moraux suggest that Aristotle recalls the supposedly Pythagorean notion that numbers represent dimensions in the sense that the point = 1, the line = 2, and so forth. First, this suggestion is self-refuting because it entails that the solid be identified with 4, and not with 3; see also Moraux *ibid.* note 3. – Secondly, the correlation of the first *four* numbers with point, line, plane, solid was part of Plato's unwritten doctrines, cf. Gaiser (1968), *passim*, esp. 360 note 84 with references to Sextus *Adv. math.* X 280; Aristotle *Metaph.* XIV 3, 1090 b 20–24; XIII 8, 1084 a 37 ff.; VII 11, 1036 b 12 f. With Gaiser it may be suggested that this doctrine was not Pythagorean at all, *id.* (1968), 298, but – in the absence of any Pythagorean works – has been attributed to them by later Platonists and Neo-Pythagoreans like Nicomachus (1/2. century A. D.) and Iamblichus (3/4. century A. D.). By analogy, a similar doxographical mistake has been committed in the Neo-Pythagorean claim that already the old Pythagoreans posited the existence of a fifth, celestial element, see Moraux (1963), 1176–1181, and Dreyer (1953), 143.

[58] Cf. Stocks (1930), note *ad loc.*

[59] In doing so men follow not merely human conventions but indeed nature itself, a 19 f. Aristotle says that man is 'induced, led' by nature. The expression ἐπάγειν (to induce) is used in the non-technical sense, cf. Elders (1966), 56 f. and a parallel use in *Metaph.* I 8, 989 a 33; see Ross (1924) *ad loc.* Cf. also *Cael.* III 8, 306 b 15 f.

After this employment of Presocratic authority Aristotle establishes the significance of the number three from two further sides. The number three has its origin supposedly in nature, like one of nature's laws, and accordingly it has found use in religious practice, a 13–15. This is understood as a reference to the fact that in Greek religion, e. g., oaths had to be confirmed by an act of appealing to three Gods.[58] And thirdly, in daily language the expression 'all' is used first whenever one speaks of at least three items, whereas with reference to only two items one speaks of 'both', a 15–19[59]. These three examples or 'phenomena' are apparently taken to produce conclusive evidence that the number three is particularly significant because it suggests comprehensiveness.

So far Aristotle's argument seems to have established the following:

1. There are three kinds of magnitudes: the line, the plane, and the solid/body; the third is divisible and continuous in three directions or dimensions.
2. The number three represents in some sense 'all' and 'everything'.

Aristotle's next move is to infer from these two notions that the solid/body is the μέγεθος τέλειον. For this purpose he introduces a further remarkable premise: The terms 'everything', 'All', and τέλειος do not differ from one another *in respect of form*, but only, if at all, in their matter, a 20–22. Aristotle means that the three terms are formally

synonymous;[60] they are not predicated of the same items, but differently of different material entities. Relying on this formal synonymy of 'all' and τέλειος Aristotle concludes that of all magnitudes the solid/body alone can be considered to be τέλειος, for it is the only magnitude determined by the number three, a 22–25.

At this point it is necessary to consider a further ambiguity in Aristotle's argument. So far the Greek term τέλειος has been left untranslated because it is not clear whether it means 'perfect' or 'complete'. Although these expressions may appear to be very similar, they have to be clearly distinguished. For first, 'perfect' is an axiological expression, whereas 'complete' is not; and secondly, although it is true that everything which is perfect is also complete, it is not the case that everything which is complete is perfect as well.

Hence when Aristotle says a 22 f.: τὸ σῶμα μόνον ἂν εἴη τῶν μεγεθῶν τέλειον, this sentence may be taken to mean four different propositions, given that the subject term τὸ σῶμα is ambiguous as well:

(1) The body is a perfect magnitude.
(2) The solid is a perfect magnitude.
(3) The body is a complete magnitude.
(4) The solid is a complete magnitude.

Most commentators and translators incline to accept the first proposition as the correct meaning of the Greek sentence.[61] But proposition (1) is philosophically absurd. It is simply false to say that any physical body *qua* body is perfect, and I suppose Aristotle never wanted to claim this. More than that, the possible translation of the Greek τέλειον as 'perfect' must be ruled out altogether, for Aristotle argued that 'all', 'everything', and τέλειον are formally synonymous. It is senseless to say that 'all', 'everything', and 'perfect' are synonymous, for they are not, yet it does make sense to say that 'all', 'everything', and 'complete' are, in a way, synonymous. Hence, we are left with the alternative of propositions (3) and (4).

[60] The meaning of formal synonymy can be inferred from *Cael.* I 8, 276 b 2 f., where Aristotle intimates that homonymous expressions are used μὴ κατὰ τὴν αὐτὴν ἰδέαν. – Plato sees a synonymy of ὅλον and πᾶν at *Theaet.* 205 A.

[61] Moraux (1965) xxxii: "Le corps, où se retrouve cette *forme* (ἰδέα), comporte donc une perfection formelle qu'entrave, toutefois, la limitation de sa matière." Similarly Tricot (1949), 2 and Gigon (1952), 118 f.; Bos (1973), 34 writes: "Once it is realized that in his first chapter Aristotle is concerned to maintain the priority of the physical body ..."

Other translators tend to adopt (3), but no one considers the possibility of (4).[62] And yet, the sentence in question seems to be acceptable only if 'body' in (3) has the connotation of 'geometrical solid', as in proposition (4). It is not the case that every physical body is complete *tout court*, for it may be quite incomplete in many respects. Yet, one could say that it is complete *qua* three-dimensional entity, i. e. *qua* geometrical solid, because there are no further spatial dimensions. And, as will be seen, this is precisely what Aristotle sets out to show in the remaining section of the chapter. Let us assume therefore that Aristotle's thesis in this chapter is not the completeness, let alonge the perfection of *physical* bodies, but the dimensional completeness of geometrical solids. With this conclusion chapter I 1 has reached its object: the solid as the complete magnitude has been established. The climax is followed by self-evident and repetitive remarks on the divisibility of lines and planes, a25–28. Then, from a 30 ff. onwards, the argument seizes a fresh starting point, and the tenet of the completeness of the solid is confirmed by a different argument.

The two main sections of the chapter, 268 a 1–28 and a 30–b 10, are connected by a sentence a 28–30 stating that it is clear that divisible magnitudes are continuous, but that it is not at all clear that all continuous magnitudes are also divisible. By cautiously disallowing the immediate conversion of the proposition that everything divisible is also continuous, Aristotle presumably anticipated and averted possible criticism. For a critic of Aristotle could object that the first element (aether) is the *continuous* substrate of the celestial region, that it must therefore be *divisible*, and hence subject to destruction.[63]

[62] See Stocks (1930), *ad loc.*; Guthrie (1939), 7; Elders (1966), 80; Taran (1974), 138.

[63] In a small treatise written after the *contra Aristotelem*, (on the chronology of Philoponus' later, critical treatises see Sorabji (1987 b), 37–40; also Wildberg (1987 a), 202–209), which demonstrated that all limited bodies only possess limited power (δύναμις) – and are therefore perishable – Philoponus in fact raised this objection, although it is likely that an argument of this sort appeared in the *contra Aristotelem* as well; there is, however, no direct evidence for this. Fragments of the treatise are extant in Simplicius at the end of his commentary on Aristotle's *Physics* (1326–1336); he cites Philoponus 1333,4–15: "So if all bodies, ⟨the Grammarian⟩ says, are infinitely divisible, and if the things in heaven are also bodies, then they are without doubt infinitely divisible as well, and this by virtue of their own definition (τῷ ἰδίῳ λόγῳ), according to which they are dimensionally extended (διαστατός); nevertheless, they are in fact never divided, just as matter is formless (ἀνείδειος) by definition, and yet it is never separated from form ... Now, if the things in heaven, which are bodies, are infinitely divisible because they are magnitudes, and if someone divided them in

The additional argument (a 30 ff.) supporting the claim that the solid is a complete magnitude begins with the statement that there is clearly no transition into another genus (μετάβασις εἰς ἄλλο γένος) as there is from line to plane, and from plane to solid, a 30 – b 2. For if there were, the solid would not be complete: "For ἔκβασις necessarily takes place in virtue of deficiency (κατὰ τὴν ἔλλειπσιν), and the complete cannot be deficient", b 2 – 4. The translation of this sentence is unclear because of the word ἔκβασις. This noun seems to be *hapaxlegomenon* in Aristotle and does not occur in Plato.[64] It is perhaps best to understand ἔκβασις as a synonym of μετάβασις,[65] in which case the sentence means that a transition can only take place if the object undergoing transition is deficient in some respect. Thus, transition from plane to solid is possible because the plane lacks the third dimension. Yet, since the solid is complete, i. e. does not lack anything, there is no such transition. In modern terms, these lines may be taken to deny the possibility of a fourth dimension.[66] This denial in itself, of course, is superfluous, for anyone but a modern reader would readily accept that a fourth spatial dimension does not exist. Rather, the argument establishes once more the completeness of the solid, or, in effect, of any physical body in respect of its dimensional extendedness.[67]

theory (τῷ λόγῳ), just as we separate in theory the forms from matter, then the cutting will clearly lead to some magnitude in which the forms of the things in heaven will not be able to exist. In consequence, at the same time as such a division takes place the forms will perish."

64 See Bonitz (1870), 226 b 10 and Brandwood (1976).

65 Following Bonitz and LSJ, s. v. ἔκβασις (3).

66 This is suggested by all commentators and translators except Bos (1973), 35, who regards this interpretation as a modernism. Bos' judgement is correct in the sense that the general problem of a fourth spatial dimension does not occur to Aristotle.

67 'Completeness' is predicated of the solid here in a way familiar from *Metaphysics* V 16. There it says that some things are called 'complete' because they do not lack anything in respect of excellence, or because they cannot be surpassed, or because there is nothing to be found outside them, 1021 b 30 – 32. Cf. also *Phys.* III 6, 207 a 8 f.; *Cael.* II 4, 286 b 18 f.; *Metaph.* X 4, 1055 a 12: "The 'complete' is that which has nothing outside or beyond it." – In later days, Peripatetic philosophers preferred a more attractive but fallacious definition of completeness. The Pythagorean claim at 268 a 10 – 13 that "beginning, middle, and end possess the number of the All" read in conjunction with Aristotle's assertion 268 a 20 f. that "All, everything, and complete are formally synonymous", gave rise to the definition: "To be complete means to possess a beginning, a middle, and an end." Alexander of Aphrodisias, e. g., attempted to prove the completeness of a circle on the basis of this definition, *apud* Simplicium *In de caelo* 39,11 ff. Simplicius appears to have adopted it too, cf. *In de caelo* 48,35 ff. (see *contra Aristotelem* fr. 1/32), and even Thomas Aquinas operates with it in *De caelo*

But what did Aristotle mean by μετάβασις εἰς ἄλλο γένος in magnitudes? If the word σῶμα in line b 2 is understood as *physical* body, the whole inference becomes unintelligible and seems to contradict Aristotle's deepest convictions: he denied vigorously against Plato that it is possible to conceive of a physical world constructed out of (triangular) planes and lines.[68] In order to account for the apparent contradiction it has been suggested that Aristotle was still a Platonist when he wrote the *De caelo*.[69] Bos rejects this view and confidently proposes an even less likely interpretation.[70] According to Bos, Aristotle views lines, planes, and bodies as *irreducible* magnitudes; moreover, the process of ἔκβασις (or μετάβασις) entails on his view a *decrease* of completeness. Since the body is complete, it cannot have been 'generated' by transition from line and plane.[71]

However, if one understands σῶμα as referring to a (geometrical) solid – as has been proposed by our interpretation – all difficulties disappear and the argument becomes perfectly intelligible. The mathematician first constructs a line, then a plane, and then – *in abstracto* or in a model – a three-dimensional solid. This has nothing to do with 'generating' physical objects from lines and planes. And what Aristotle is denying is that the construction of a four-dimensional magnitude is possible. That this interpretation is correct is strongly suggested by a

et mundo I.iv.42. In the first book of the *contra Aristotelem* Philoponus adduces strong objections to it.

68 This view was held by Plato in the middle as well as the late period, cf. *Tim.* 53 C ff. and *Laws* X 894 A. – For Aristotle's criticism see, e.g., *Cael.* III 1, 299 a 1 – 300 a 16; III 7 – 8; or briefly *Metaph.* XIII 2, 1077 a 34 – 36: "Nothing is seen to be capable of being put together out of planes or points, though they would have been seen to be capable of undergoing this, if they were some kind of material reality", (Annas).

69 This is proposed by Elders (1966), 81 f. – Elders follows the mainstream interpretation in supposing that Aristotle speaks of physical bodies rather than mathematical solids.

70 See Bos (1973), 34 – 44.

71 Bos (1973), 37 suggests that the whole passage in question (268 a 30 – b 5) should be translated: "This much is clear: no μετάβασις εἰς ἄλλο γένος is possible, such as (for instance) from line to plane and from plane to body; for the product of such a μετάβασις would no longer be a complete magnitude; for the ἔκβασις necessarily goes hand in hand with a decrease of completeness (thus the body would be incomplete). But the complete (the body) cannot fall short. For it possesses extension in every possible direction." Bos takes this, which bears little resemblance to the Greek, to mean that "derivation of mutually irreducible entities from each other is not permissible." Bos' interpretation is well off the mark because he understands τὸ σῶμα as physical body, and because he has overlooked a parallel passage in *Metaphysics* XIII 2, see below.

passage where Aristotle is indeed considering mathematical constructivism, *Metaph.* XIII 2, 1077 a 24–28:

> "Besides, the point is clear from the way ⟨mathematical magnitudes⟩ are generated. First length is generated, then breadth, finally depth, and then it is complete. So if what is subsequent in generation is prior in reality,[72] solid (σῶμα) should be prior to plane and length. It is complete and more of a whole in the following way also – it becomes animate."[73]

Here Aristotle speaks explicitly of the generation of mathematical magnitudes, but not – like Plato – of the generation of *physical* objects by means of lines and planes.[74] In consequence, it is neither necessary to conclude that Aristotle still adheres to Platonism because he supposedly constructs the physical world out of geometrical entities, nor is it necessary to reinterpret the passage in question elaborately. However, it is characteristic of *Metaphysics* XIII, as it is of *De caelo* I 1, that no clear distinction is drawn between (geometrical) solid and body.[75] The conceptual affinity of both passages – as in fact of many of the arguments in *De caelo* I 1 and *Metaphysics* XIII – is striking and may be taken to support the present interpretation. The initial tripartition of the subject-matter of an inquiry into nature, therefore, comprises lines, planes, and geometrical *solids* as well as physical bodies and their principles. In the *Index Aristotelicus* compiled by Bonitz (1870), 742 a 13–19, all relevant occurrences of σῶμα in this chapter appear, accordingly, under the pleasing entry: σῶμα *mathematice*.

In *De caelo* I 1, the 'confusion' between solid and body becomes most apparent when Aristotle changes subject abruptly; in the last five lines of the chapter he finally speaks of physical bodies and arrives at the notion of the *All* (τὸ πᾶν), the universal body as a whole, which is complete in every respect. The crucial transition is made in line b 5 f.:

> "Now each of those bodies/solids ⟨that appear⟩ in the form of a part is ⟨complete⟩ according to our account; for it possesses all dimensions."

[72] This statement clearly contradicts Bos' interpretation.

[73] The translation follows Annas (1976), 94.

[74] *Metaph.* III 5, 1002 a 15–18 denies that lengths and points constitute physical bodies: "Even if it is agreed that lengths and points are substance rather than bodies, we do not see what sort of bodies they will be substances of (for they cannot be sensible bodies); so there is no substance."

[75] Cf. Annas (1976), commenting on the passage in *Metaphysics* XIII just cited, says 146: Aristotle "confuses the physical object with the mathematical solid, and this emerges forcefully in the appeal to the fact that bodies but not lines, etc. can become animate."

With the phrase "bodies that appear in the form of a part" Aristotle seems to be referring to *physical* bodies, objects as parts of nature and the world as a whole. These parts, too, are said to be complete – but not without qualification: only in virtue of the previous account, i. e., only in so far as they possess all dimensions. Thus, every physical body is in some sense a three-dimensional solid and therefore complete, but it may be incomplete in many other respects. There is, however, one exception. The body of the universal whole is indeed complete in every respect; Aristotle explains this notion by the juxtaposition of the partial bodies and the universe, b 8–10.

> "But the universe, of which these ⟨bodies⟩ are parts, is necessarily complete ... throughout, and not only in some respect and in some other respect not."

In this way Aristotle has introduced the topic of the universe, i. e. the subject-matter of large parts of the *De caelo*.[76] One difficult further point is the statement of b 7 f.: "The partial body is delimited towards the neighbouring body by contact, for which reason each body is in some sense many." At least two interpretations seem possible, neither of which is entirely satisfactory. The standard interpretation, which is vaguely supported by Plato's *Parmenides* 138 A, reads that a body limited by others is touched by them 'in parts'; therefore it possesses parts and is many.[77] Alternatively, one may point to the fact that ἁφή is a central term in Aristotle's theory of continuity which is presupposed at the beginning of the chapter.[78] In *Phys.* IV 5, 212 b 29–213 a 10 the relation of part to whole is assessed in terms of contact: parts form a whole by contact. Along these lines the sentence in question would then indicate that Aristotle wants to express the idea that part and whole are connected organically: any physical body is necessarily in contact with other parts, forms a continuous cluster (i. e. a continuous body that is many) and eventually constitutes the complete whole, which, according to Aristotle, is a continuous plenum, see e. g., *Cael.* I 10, 280 a 19 f.;

[76] At the beginning of chapter 2 Aristotle proposes to inquire into the universe, first into its parts, then taking it as a whole, *Cael.* I 2, 268 b 11–13: "The question as to the nature of the whole, whether it is infinite in size or limited in its total mass, is a matter for subsequent inquiry. We will now speak of those parts of the whole which are specifically distinct." (Stocks).

[77] Cf. Guthrie (1939), 8 note a and Elders (1966), 82 with reference to Simplicius *In De caelo* 10, 18–21.

[78] Cf. e. g., *Phys.* V 3, 227 a 17 ff.; VI 1, 231 a 21 ff.

II 8, 290 a 6 f. and esp. II 4, 287 a 9–11. On this interpretation, therefore, each body would be many not because it has parts, but τρόπον τινά many because it is a part of a continuous plurality.[79]

2.3 Mathematics and Physics in De caelo I 1

After this summary delineation of chapter 1 the overriding questions of its significance as a whole, and in particular its significance in relation to the theory of aether, still remain to be answered. At the same time, the methodology, which becomes apparent in the peculiar absence of a clear distinction between the mathematical solid and the physical body, requires an explanation within the framework of Aristotle's natural philosophy. As it turns out, the two problems cannot be dealt with in separation; our starting-point will be an interpretation of *De caelo* I 1 offered by Paul Moraux.[80]

In his introductory remarks on *De caelo* 1 1 Moraux elegantly construes the main thesis of the chapter by way of a syllogism as follows:

(1) Body is a magnitude determined by the number three.
(2) The number three is the number of perfection.
(3) Therefore, body is a perfect magnitude.

Several objections to this interpretation may be raised. First, unlike some of the major arguments of the following chapters, the line of argument in the present chapter nowhere suggests the formal structure of a syllogism.[81] More importantly, as we have seen, Aristotle does not want to maintain the *perfection of body* – which in this form represents a philosophically absurd proposition – but the *completeness of solids*. One should oppose the tempting interpretation of adopting the connotation 'perfect' in anticipation of the concept of aether: τέλειον is in

[79] A third alternative has been suggested to me by David Sedley: Perhaps Aristotle means that the parts are many because they admit of many predicates in the category of πρός τι; the same part is 'left of x', 'underneath y', etc.

[80] On the following see Moraux (1965), xxix–xxxiv, in particular xxx.

[81] Apart from that, the syllogism as construed by Moraux does not agree with the Aristotelian standard form of a syllogism as it does not observe the proper sequence of major and minor premises. In traditional syllogistic the major premise is supposed to include the predicate term of the conclusion, and the minor the subject term, cf. *An.pr.* I 4, 26 a 21–23; and see Łukasiewicz (1957), 1–3.

fact nowhere predicated of the first substance, and the concept of the superior ontological status of aether has nothing to do with the dimensional completeness of solids.

In contrast to Moraux's interpretation, let it therefore be accepted that Aristotle's argument of the first chapter of the *De caelo* may be summarised in three loosely connected theses as follows:

(1) The (geometrical) solid is dimensionally complete.
(2) Any physical body is complete in so far as it is three-dimensional.
(3) The universe is not only dimensionally complete, but also complete in every other respect.

Supposing that this is the bearing of the chapter, one may ask the question of its significance for the arguments constituting the theory of aether in chapters 2–4, or, on a larger scale, even for the *De caelo* as a whole. The answer is that the above propositions are almost entirely insignificant. Indeed, no argument rests on the premise that the solid is a complete magnitude,[82] and the impression arises that at least the *content* of chapter 1 is surprisingly irrelevant. Once this is recognised it is only natural to assume that the importance of the present chapter – given that it indeed possesses the kind of importance which typically pertains to opening chapters of Aristotelian treatises – must lie in its *method*. In the following discussion, the possibility of understanding the chapter in this way will be explored.

If the argument of *De caelo* I 1 is looked at from a distance, its methodological structure appears to be like this: the study of nature, Aristotle argues, is concerned with geometrical magnitudes, with physical magnitudes, and with the principles of these physical magnitudes. Passing over the third class of items, Aristotle says that geometrical magnitudes extend in one, two, or three dimensions. Then, since tridimensionality is the highest (complete) form of dimensional extension – there exists no four-dimensional geometrical magnitude – he concludes that the same is true of physical magnitudes: there is no physical object 'beyond' the three-dimensional body.

Speaking generally, one could describe this line of argument as an application of geometrical concepts to the realm of nature. True assertions made about geometrical magnitudes are taken to apply equally to

[82] The same is, of course, true of the (absurd) proposition that body is a perfect magnitude. – The general notion of the tri-dimensionality of body is briefly referred to in *Cael.* I 7, 274 b 19 f. and II 2, 284 b 23 f.

physical objects. How does Aristotle justify this line of reasoning? He does not. There simply is no explicit justification of this method, but Aristotle hints at it when he says in 268 a 5 that physical bodies possess (ἔχει) geometrical magnitudes.

Before we follow this hint, it is necessary to point out that the same method underlies some of the most crucial arguments in the following chapters. In fact, one could almost say that the theory of aether depends on this method.

1. In *Cael.* I 2, 268 b 17–20 Aristotle states that there are only two simple natural movements, rectilinear and circular, because there are only two simple (geometrical) magnitudes, the straight line and the circle.
2. In *Cael.* I 2, 269 a 18–21 the axiological priority of circular over rectilinear motion is justified by the assumption that the (geometrical) circle is axiologically prior to the straight line.
3. In the whole chapter *De caelo* I 4 the premise that there is no natural movement contrary to circular movement relies on the hypothesis that in a (geometrical) circle no two points are contrary to one another.[83]

In all these cases geometrical concepts and tenets are projected directly onto the realm of the sensible world. Propositions in the exact science of geometry are taken to bear out assertions made in the science of nature.[84] If Aristotle's methodology is looked at from this point of view, it is indeed surprising that he does not justify it explicitly. For there is no doubt that the application of mathematics to physics was an issue of controversy. Platonists denied categorically that true propositions in the exact sciences represent at all the state of affairs in the sensible world.[85] The ever changing world of sensible objects allows

[83] In chapters I 5–7 further instances of the application of geometrical concepts to physics can be found.

[84] On Aristotle's readiness to apply mathematics to nature cf. also Sorabji (1972 b), 302–304.

[85] Although it is true that in the *Timaeus* Plato makes ample use of mathematics, he disclaims 27 D–29 D that his account of the universe involves truth and certainty, cf. Cornford (1937), 29 f. – It is, however, controversial if Plato's 'real astronomer' of *Republic* VII applies sophisticated mathematics to the data observed in order to 'save the phenomena', or if he is concerned with a purely mathematical science of motion that can afford to denigrate observation. Recently, the second alternative has been reaffirmed by Mourelatos (1980), but cf. the careful opinion expressed by G. E. R. Lloyd (1968), 79–81.

only a probable account (εἰκὼς λόγος): true knowledge (ἐπιστήμη), on the other hand, presupposes a timeless, unchanging, and fully real subject-matter – the realm of intelligible objects. For Plato, of course, the subject-matter of mathematics (arithmetic and geometry) is part of the intelligible world.[86] The question therefore that presents itself is: how would Aristotle have justified the epistemology that underlies the method used in these chapters of the *De caelo*? An answer to this question has to take into account Aristotle's own philosophy of mathematics – if we can suppose that his scattered and unsystematic remarks can at all be united into a coherent system. Since Aristotle's philosophical remarks on mathematics and geometry have been interpreted recently by several expert scholars, we will confine ourselves to a comparison of the main points of the various interpretations offered.[87] Particular priority is given to the following questions:

1. What is the *ontological* status of geometrical[88] objects in Aristotle?
2. What is the *epistemological* relation which, according to Aristotle, exists between geometrical objects and the sensible world?

Interpreters of Aristotle's philosophy of mathematics may be divided into two groups, one of which makes Aristotle's position appear to be more remote from Plato's than suggested by the other account. Let us begin with the latter, 'traditional' view first.

Mueller (1970) starts off with the statement that the fundamental difference between Plato and Aristotle lies in their ontologies. Whereas both philosophers shared the epistemological view that geometrical objects instantiate geometrical properties perfectly and sensible objects do not, Aristotle denied, in contrast to Plato, that geometrical objects are therefore fully real and partake of an ideal existence over and above the realm of the sensible world (156 f.). In Aristotle, geometrical objects are arrived at by 'abstraction' (ἀφαίρησις) from sensible objects. The idea of 'abstraction' lies at the centre of Aristotle's philosophy of mathematics, and Mueller describes it as a (theoretical) elimination of something from consideration (160 f.). The question, however, of what

[86] Plato's philosophy of mathematics is therefore usually termed 'realism'. Cf. the accounts given by Wedberg (1955) and Annas (1976), 3–26.

[87] For the following discussion compare Mueller (1970); Happ (1971), 581–649; Annas (1976), 26–41; and Lear (1982).

[88] The problem presented by the argument of the *De caelo* only requires a clarification of the status of geometrical objects, and we may therefore leave Aristotle's number-theory aside.

exactly is eliminated, and what remains after the process of abstraction has been completed, is not entirely clear. Some say matter is eliminated, but there are good reasons for supposing that what is eliminated are 'properties'. What remains is of course the mathematical object, only in the first case it appears to be a pure, matterless property, i. e. a universal like roundness and triangularity, while in the second case it seems to be a physical object *lacking* certain irrelevant properties. Mueller acknowledges the virtue of the first alternative, which understands Aristotle's mathematical objects as universals, but he himself argues in favour of the second. If one eliminates successively all properties of a sensible object, the notion arrived at, according to Mueller, is the continuous and quantitative in three dimensions.[89] This concept, pure tri-dimensionality, Mueller takes to be the *substratum* of mathematical objects, termed 'intelligible (or noetic) matter' by Aristotle (166). Ordinary geometrical figures are produced if geometrical properties are imposed on indeterminate tri-dimensionality (167). Ordinary geometrical reasoning about these objects gives rise, according to Mueller, to universal mathematical knowledge which can be formulated syllogistically (171).

This account raises several problems. First, Mueller does not make clear what the ontological status of geometrical objects is,[90] and although he asserts that geometrical objects "are intimately connected with sensible reality and in a certain sense underlie it", he does not clarify in virtue of what this intimate connection pertains. And indeed, it is difficult to see why geometrical objects such as circles, triangles, pyramids, and spheres should at all be related to sensible reality. For these objects are 'produced' by geometrical shapes being imposed on *noetic* matter, indeterminate tri-dimensionality. But what are the nature and origin of the geometrical shapes? Mueller does not explain this, but it is clear from his interpretation of Aristotle's epistemological stance that they bear no relation to the sensible world. Certainly, they do not derive from it. What is arrived at by abstraction is the concept

[89] 163 ff. – Mueller supports his view also with a reference to *Metaph.* VII 3, 1029 a 12–18. On the problem of interpreting that passage in his way see Burnyeat *et al.* (1979), 12–14.

[90] He merely rejects at 169 f. the interpretation offered by Proclus according to which particular geometrical objects are construed as mental images, cf. Proclus *In primum Euclidis elementorum librum commentaria* 48,1–56,22. A view similar to Proclus' is expressed by Sorabji (1972 a), 6–8; *id.* (1982 b), 303.

of indeterminate tri-dimensionality. This indeed constitutes a bridge between sensible and geometrical objects, but it hardly warrants Aristotle's methodological supposition that the conclusions of geometrical inferences are true of the objects of the sensible world as well. Mueller states at the beginning that Aristotle shared Plato's epistemology, i. e. that geometrical objects are unlike sensible objects in fulfilling given conditions perfectly. If this is true, how can the study of mathematics result, as Mueller says, in *knowledge about* the sensible world (161)?

Other accounts do not help to resolve this difficulty. Annas (1976), 26–41, is prepared to follow Mueller to a great extent, although she expresses scepticism about the attempt to attribute to Aristotle a uniform theory of geometrical objects (30). Annas suspends final judgement on the nature of 'noetic matter' (33 f.), but endorses the view that according to Aristotle the direct application of mathematics to sensible objects is impossible, 29:

> "Aristotle begins ⟨his argument in *Metaphysics* XIII 3⟩ from the necessity of reconciling two beliefs both of which he firmly holds: mathematics does not directly describe physical objects, for they may fail to instantiate the relevant properties (997 b 3–998 a 6, 1059 b10–12) – but neither does it deal with a separate supersensible range of subject-matter."

A third and similar, though much more elaborate interpretation has been offered by Happ (1971), 581–649. Happ explores and lays great emphasis on the concept of noetic matter. According to him, noetic matter exists 'potentially' in sensible objects and can be actualised by the noetic process of abstraction (583).[91] Noetic matter is pure and indeterminate extension in space and can be abstracted from any sensible body (597). Again, this three-dimensional extension constitutes the substratum for geometrical objects: it is these objects 'potentially', yet does not, as one might expect, function like the matter of sensible objects as the principle of individuation, but as the *genus* of mathematical objects, (639 ff.).[92] Noetic matter, therefore, is both 'potentially' existent in sensible objects and 'potentially' constitutes geometrical objects.[93]

[91] Happ suggests that in Aristotle all intelligible things exist 'potentially' (save the unmoved mover). This sense of 'potential' must not be confused with the potential existence of attributes or substances which may become actual by a process of change, cf. 591–595.

[92] Cf. also Mueller's remark to the same effect (1970), 171.

[93] Happ's final and somewhat contorted definition of noetic matter reads, 609: "'In' den Sinnendingen potentiell vorhanden und noetisch heraushebbar ist die unbe-

But in order to produce such an object, a geometrical form or shape is needed, and Happ argues that Aristotle, although he nowhere explicitly says so, took mathematical properties (forms) as an *a priori* fact, just as Plato did (596–600).[94] Happ denies that Aristotle could have possibly held that mathematical *forms* are abstracted from sensible objects of everyday life such that 'square' is derived from 'window', 'circle' from 'shield', 'sphere' from 'apple', and so forth. Such a theory would be too naive and inadequate for the advanced mathematics practised in the Academy.

As regards Happ's interpretation, again, it must be pointed out that an intimate relation between the sensible and the mathematical realms appears to be impossible. Although one may speak of a 'progression' from sensible objects to indeterminate extension to determinate mathematical object, the latter cannot be said either to have been 'derived from' or to be 'applicable to' sensible objects. On these interpretations it is difficult to see how Aristotle could have categorically denied the 'real' existence of geometrical objects, but at the same time adhered to a Platonic epistemology, which disallows the direct application of mathematics to the natural world.

Because of difficulties of this kind, the 'traditional' interpretations of Aristotle's philosophy of mathematics have come under attack. In a recent article, Jonathan Lear (1982) opposes the view that Aristotle indeed accepted Plato's epistemology. In contrast to previous accounts, Lear describes the process of abstraction as the application of a predicate filter to the irrelevant predicates of the sensible objects (168–175). The result is neither indeterminate tri-dimensionality nor some universal mathematical property, but the same sensible object considered *as* a mathematical object, 168:

> "Generalising, one might say that Aristotle is introducing an *as*-operator, which works as follows. Let *b* be an Aristotelian substance and let "*b qua F*" signify that *b* is being considered *as an F*. Then a property is said to be true of *b qua F* if and only if *b* is an *F* and its having that property follows of necessity from its being an *F*."

stimmte Extensio (ὕλη νοητή), die durch die νόησις aktualisiert wird, aber auch aktualisiert qua (weiterer) Bestimmbarkeit durch die mathematische Form ὕλη und δυνάμει ὄν ist."

[94] Cf. Mueller's remark (1970), 169 that "Aristotle starts from the Platonic notion of geometry as the study of forms."

Lear's interpretation presupposes that sensible objects can indeed be considered *as* mathematical objects, i. e. that they possess – besides other properties irrelevant for the mathematician – the relevant mathematical properties also, 170:

> "Thus, for Aristotle, one can say truly that separable objects and mathematical objects exist, but all this statement amounts to – when properly analysed – is that mathematical properties are truly instantiated in physical objects and, by applying a predicate filter, we can consider these objects as solely instantiating the appropriate properties."

Lear makes a plausible case for the hypothesis that Aristotle believed in the possibility that geometrical forms could be instantiated perfectly in sensible objects (175–183). If his interpretation is correct, Aristotle's epistemological stance on the relation between geometrical objects and the physical world has little in common with Plato's, and it would become clear why Aristotle thought it unproblematic to apply mathematics directly and truly to the sensible world, 181:

> "The important point is that direct links between geometrical practice and the physical world are maintained. Even in the case where the geometer constructs a figure in thought, one which perhaps has never been physically instantiated, that figure is constructed from elements which are direct abstractions from the physical world. Otherwise it will remain a mystery how, for Aristotle, geometry is supposed to be applicable to the physical world."

In consequence of this interpretation of the idea of 'abstraction' in Aristotle, the concept of 'noetic matter' receives an entirely different connotation. Aristotle does not have to postulate 'potentially' existing objects that possess noetic matter; he only has to explain how one thinks about an object that does not exist – as such – in the sensible world. It is true that sensible objects possess noetic matter, not in so far as they are three-dimensionally extended, but rather "in so far as they can be objects of thought rather than perception" (182).

This interpretation renders Aristotle's position as opposed to Plato's more consistent and credible. Aristotle can be said to have denied Plato's ontology as well as his epistemology. Also, Lear's account helps to explain adequately why Aristotle applies geometry to physics without worrying about the misrepresentation of nature possibly involved in such a method. The hypothesis, however, that Aristotle's philosophy of geometrical objects includes the presupposition that geometrical properties are indeed instantiated in sensible objects, remains dubitable.

For this hypothesis suggests that we could not have a precise idea about perfect circles, triangles, spheres, etc., if there were no such objects in the world accessible to the senses. Perhaps it would suffice if the mental act of 'abstraction' were not understood simply as the application of a predicate filter, that is to say as a mere (negative) elimination of irrelevant properties. Suppose a Greek mathematician intended to convey to his students the idea of a perfect sphere: any random, even quite irregular spherical object may have served as a starting point, for along with colour, weight, and materiality one could have 'abstracted from' irregularity and imperfection, and thus acquired the notion of a perfect spherical solid.

We shall now return to the problem of the methodology exemplified in the first chapter of the *De caelo* and ask the question whether or not the text provides us with any evidence confirming the adequacy of either of the two main types of interpretations of Aristotle's philosophy of geometry. Conversely, one may ask the question which of the two types of interpretation represents a better justification for Aristotle's method. An answer to this latter question, clearly, points towards Lear's version. But this is about all one is entitled to concede — for the following reasons: First, Aristotle, according to our interpretation, says that sensible objects *possess* solids and geometrical magnitudes.[95] The text does not indicate whether Aristotle implied — in agreement with Happ's interpretation — that geometrical magnitudes exist 'potentially' in sensible objects, or if he meant — in agreement with Lear's interpretation — that these magnitudes together with their properties are somehow 'instantiated in' sensible objects.

Secondly, one might suppose that the mere fact that Aristotle applies geometry to the realm of nature is a clear sign that Lear's interpretation is closer to the truth than, say, Mueller's or Happ's. But this line of argument is not conclusive. For even if one supposes that Aristotle shared Plato's epistemology, the geometrical concept applied to sensible objects in *De caelo* I 1, i. e. 'three-dimensional solid *qua* three-dimensional', does not present a problem. It is impossible to deny that any physical body is an adequate instantiation of a three-dimensional solid *qua* three-dimensional. Moreover, according to Mueller and Happ the concept of tri-dimensionality, at any rate, is directly arrived at by abstraction from sensible objects, so that it may be directly applied to

[95] See *Cael.* I 1, 268 a 5 and cf. *Phys.* II 2, 193 b 23–35.

them as well. Thus, both the 'traditional' and Lear's interpretation can make room for Aristotle's procedure in the first chapter. But what about the arguments in the following chapters, where Aristotle operates with such concepts as 'straight line' and 'circle'? As will be seen, in those arguments nothing *depends* on the supposition that these geometrical magnitudes must be instantiated perfectly in the physical objects discussed. The derivation of the number of simple movements in nature does not depend on the assumption of perfect, kinetic instantiations of a straight line and a circle. Again, although Aristotle would have held that the movement of the fixed sphere is perfectly circular, his argument for the absence of contrariety in the heavens does not depend on this assumption. Chapter 4 of *De caelo* I attempts to show that on the circumference of a circle there are no points or places contrary to one another. If Aristotle has succeeded in showing this — which he has not — no one would deny that his conclusion is equally true of perfect and approximate circles. More than that, the way in which some of his arguments are designed makes it possible to conclude, with equal stringency, that there are no contrary points in an ellipse, a square, or a triangle.

In consequence, one would have to conclude that the method used in Aristotle's theory of aether can be justified on either interpretation of his philosophy of geometry. It is true, however, that it is better understood on an interpretation which allows for the perfect instantiation of geometrical properties in sensible objects. The geometrical concepts applied to physics in the course of the argument of *De caelo* I 1 are, at any rate, not problematic, and Aristotle's methodology, as it seems unobjectionable, may be regarded as a major factor contributing to the persuasiveness and ingenuity of his theory of aether.

2.4 Conclusion

'Aether' and 'the eternity of the world' are two genuinely Aristotelian concepts. Aristotle's conviction that the universe is eternal *a parte ante* and *a parte post* is borne out by his assumption of a primary, eternal and unalterable celestial element. An analysis of the prologue to the theory of aether has brought out and emphasised the point that in his discussion of the dimensional completeness of solids and physical bodies Aristotle introduces a particular method. According to Aristotle, math-

ematical and in particular geometrical concepts can be used in the course of a physical inquiry into nature. Propositions and arguments devised on the basis of this method involve no falsehood because the objects of mathematics do not exist separately over and above the sensible world, but are, according to Aristotle, somehow arrived at by abstraction from physical objects.

Whereas *De caelo* I 1 merely involves the application of the concept of tri-dimensionality to the realm of the sensible world, the same method will be used – with greater significance – in the following chapters. The force – and weakness – of some of Aristotle's arguments rest on the methodological assumption that it is sound to abstract, for example, from the physical sphericity of the heavens and to speak of the celestial movement in terms of a movement along geometrical circles – but *not*, and this is the important point, in order to arrive at what we should call a *kinematic* theory depicting and explaining stellar motion, but in order to arrive at a *physical* theory about the nature of the celestial bodies itself, given that the first book of the *De caelo* is a cosmological treatise constituting part of Aristotle's ontological account of an eternal yet finite universe.

3. The Existence of Aether: *De caelo* I 2

In the second chapter Aristotle lays down the principles of his arguments and subsequently attempts to prove the existence of a celestial, superior element. Our analysis will follow the natural division of the chapter into four sections: In the first section [A] 268 b 14–269 a 2 the genus 'natural locomotion' is divided into its species and the different types of movements are related to different types of bodies; the second section [B] 269 a 2–18 attempts to prove the existence of a simple body which moves in a circle, and to rule out the possibility that this body is identical to one of the sublunary elements; section three 269 a 18–32 argues for the simplicity and superiority of the celestial body [C]. Finally, in the last section [D] 269 a 32–b 13, Aristotle adduces additional arguments and rejects the Platonic theory that the heavens consist of fire.

3.1 Gathering Premises

In the first main section of this chapter Aristotle gathers the necessary premises for his arguments leading to the postulation of the primary simple body. Nature is defined as a principle of motion, three different types of simple motions in nature are distinguished, and these natural movements are correlated with simple bodies.

3.1.1 Nature as a principle of motion: 268 b 14–16

Aristotle postpones the discussion of the nature of the universe until a later part of the treatise[1] and proposes to inquire first into its specifically distinct parts. He begins his assessment of the substance and essential properties of the celestial region with a statement as follows:

[1] The essential properties of the universal body as a whole, its shape and finitude, are dealt with immediately after the theory of aether, see *De caelo* I 5–7.

A.1 [268 b 14–16]: "Let us make the following beginning: We hold that all natural bodies and magnitudes are movables as such in terms of place; for nature, we say, is a principle of motion for them."[2]

This short sentence is striking for its generality. Marking the beginning of Aristotle's theory of aether it raises several important questions. First, what does it mean to say that all natural bodies are movables as such? What does the expression 'nature is a principle of motion' signify? What kind of causation is involved? And finally, why and in what sense can this sentence be regarded as a principle for an inquiry into the nature of the celestial region?

In order to answer these questions it is necessary to recall some concepts which Aristotle develops in the *Physics*.[3] At the beginning of *Physics* II Aristotle divides all things that exist into those that exist by nature and those that exist by virtue of other causes. The former group comprises such things as animals and their parts, plants, and finally, simple bodies, i. e. the four elements, fire, air, water, and earth. These and bodies of their kind are said to be φύσει, and their distinctive property is the possession of a principle (ἀρχή) of motion and rest within themselves, see *Phys.* II 1, 192 b 8–15. Motion can either be local movement, or quantitative, or qualitative change. Motion and change are, according to Aristotle, the prevalent phenomena within the natural world; importantly, each part of the realm of nature participates in this motion to some extent by virtue of an inherent principle of motion. The different types of natural bodies mentioned by Aristotle are, of course, kinds that belong to entirely different levels or strata within the physical world. In consequence, it cannot be expected that 'nature' functions as a principle of their often very complex and multiple motions in the same way. An account of the complex motions of an animal, for example, cannot disregard the functions of the soul, and the process of growth and development in plants certainly demands a more detailed account that the natural movement of, say, fire and earth. Therefore, if the reference to 'nature' is taken to suffice as a first

[2] Or: "in them" (ἐν αὐτοῖς) supported by Themistius, Simplicius, MS T, and the Arabic MSS; see Taran (1974), 128.

[3] The 'mathematical' approach of *De caelo* I 1 had to be understood in the light of *Physics* II 2 (and *Metaphysics* XIII); the present chapter cannot be understood without reference to *Physics* II 1. In fact, proposition [A.1] is possibly even referring back to that chapter. – *Contra* Elders (1966), who refuses 83–85 to acknowledge any connection of the *De caelo* and the *Physics* in order to protect his thesis that Aristotle was still a Platonist when he wrote the former treatise, cf. *ibid.*, 27–33.

explanation in all cases on all levels, it is clear that the term itself is complex – not to say ambiguous – and in need of further differentiation.

Aristotle continues in 193 a 28 ff. with a distinction of two aspects of nature: matter[4] and form. He already intimated at 193 a 17–23 that the (Presocratic) physicists in particular had used the word 'nature' in the former sense. Their aim had been to reduce all things to their primary constituents, i. e. either to one or some or all of the recognised four elements. According to Aristotle, however, 'nature' should be identified with form rather than matter, 193 a 30–b 8. For there is an analogy between nature and art: The term 'art' is used with reference to what exists by virtue of art and what is a product of art. Similarly, 'nature' is used to denote what exists by virtue of nature and what is a product of nature. In both cases Aristotle emphasises the process of change or motion brought about by art and nature respectively as well as the final product.[5] For the actuality of a product is its form. If one asks what a particular artefact is,[6] one expects an answer which gives a correct description of its form, e. g., a bed, a human statue, etc., and not of its material constituent, e. g., wood or bronze. The latter can only be regarded as being the object in question potentially. The same account applies to the realm of nature: Flesh and bone do not possess their proper nature unless they possess the form of that which is called flesh and bone, 193 a 36–b 3. It becomes clear that nature is both the principle or cause of change *in* nature as well as the actual end achieved, the proper form of the natural body marking the final result of the process of change.[7] Thus, the term 'nature' reveals itself as a complex idea comprising not only the notion of material and formal 'cause',[8] but also, and more importantly, the notion of efficient as well as final

[4] The phrase πρώτη ὑποκειμένη ὕλη in 193 a 29 and τὸ πρῶτον ἐνυπάρχον in a 10 have to be understood as references not to prime but to proximate matter, see Ross (1936), 502 f. and Charlton (1970), 129.

[5] His examples are 'bed' and 'flesh and bones'.

[6] For present purposes the notorious 'artefact' may serve as an example. On its inadequacy see Sprague (1968).

[7] See also the related discussion in *Part.an.* I 1. – The philosophical difficulties involved in the account of 'nature' in *Physics* II 1 are clearly beyond the scope of this essay. A valuable philosophical analysis is provided by Waterlow (1982), esp. 48–68.

[8] The English word 'cause' in this context must not be taken in its familiar sense. Aristotle's four 'causes' (αἰτίαι) provide a complex answer to the question διὰ τί; see Hocutt (1974) and Charlton (1970), 98–104.

'cause'.[9] In Thomistic terminology, Aristotle's 'nature' is both *natura naturans* and *natura naturata*.[10] Despite its complexity the concept of nature has, according to Aristotle, to be agreed to in the sense that it would be ludicrous to *prove* that there is such a thing.[11] Methodologically, the concept that nature is a principle of motion can therefore be used as a starting point for an inquiry into nature, given that the physicist must proceed from what is more familiar and evident to him to what is more obscure though naturally manifest and determinate, cf. *Physics* I 1.[12]

There is a further reason why Aristotle should use proposition [A.1] as the starting point for the present inquiry. The problem of any inquiry into the celestial region is surely this: on what grounds is it possible to arrive at true assertions concerning the nature of the heavens? In the absence of sound 'empirical data' except those obtained by sight[13] any statement can, at the most, rely on plausible arguments by analogy. If certain things known from the sensible world as it is familiar to us appear to pertain similarly to the celestial region, then inferences drawn on the basis of those phenomena may be extrapolated and applied to the celestial region as well. Thus, Plato argued in the *Timaeus* that nothing is visible which does not partake of fire, and he inferred that the heavens, too, must consist mainly of fire, cf. 31 B and 40 A. Aristotle not only wants to repudiate Plato's hypothesis, but also seems to have been concerned with an improvement of method. He bases his arguments for the existence of aether on the phenomenon of motion, which is experienced equally in the celestial and the sublunary regions. The concept of motion as the fundamental phenomenon within

[9] In Aristotle, nature acts for some end: God and nature create nothing in vain, e. g., *Cael.* I 4, 271 a 33. – In *Part.an.* I 1, 641 a 25–27 he says: "'Nature' is used in two senses: in the one sense as matter, in the other as οὐσία; and this means both efficient ⟨cause⟩ as well as end."

[10] In contrast to this it must be pointed out that in the text of the *De caelo* Aristotle sometimes uses the word 'nature' in a less technical and more general sense which could perhaps be paraphrased as 'the creative and regulative physical power ... operating in the material world' (OED). Cf. *Cael.* I 1, 268 a 19; 3, 270 a 20.

[11] Cf. *Phys.* II 1, 193 a 3–6. "That there is such a thing as nature, it would be ridiculous to try to show; for it is plain that many things are of the sort just described. To show what is plain by what is obscure is a sign of inability to discriminate between what is self-evident and what is not ..." (Charlton).

[12] In consequence, Aristotle uses this concept here, as he does elsewhere, as a given fact about natural phenomena. Cf. e. g. *Cael.* III 2, 301 b 17 ff. and 5, 304 b 13 f.

[13] Cf. Aristotle's statements to that effect: *Cael.* II 3, 286 a 5–7 and *Part.an.* I 5, 644 b 22–28.

the whole realm of nature provides the necessary basis for his arguments. Ultimately, these arguments, of course, never cease to be mere analogies, yet Aristotle moulds them into deductive form, and their conclusions claim a great deal of certainty.[14] Aristotle centres his argument on motion, and employs the following strategy: Starting from the fact of the existence and form of the celestial *motion* he attempts to obtain true assertions about the *nature* of the celestial *body*. The connecting concept is the present principle that in natural bodies motion is caused by the nature of that body.

Since the term 'nature' is complex we may ask what is the exact extension of the term here. Aristotle is concerned with simple bodies, i. e. the elements, and it is necessary to clarify what exactly the principle of motion in sublunary elements – and eventually in the heavenly bodies – is. In the whole of chapter 2 of *De caelo* I Aristotle is never explicit about this point. Intuitively, the nature of an element could be taken to be determined by its primary qualities, hot or cold and wet or dry. We say, for example, that heat 'rises'. In Aristotle, however, these primary qualities are held mainly responsible for *qualitative* interaction and the change of the elements into one another. Locomotion upwards and downwards is closely related to a third pair of contraries, weight and lightness. Aristotle says at the beginning of the fourth book of the *De caelo*, 307 b 28–32:

> "It is necessary to inquire about weight and lightness, what they are and what their nature is, and why they possess these powers. For the theory about them is relevant to arguments on motion because we predicate 'heavy' and 'light' of what is capable of moving naturally."

And in the third chapter he continues, 310 a 31–b 1:

> "If, then, that which causes weight and lightness is what causes motion downwards and upwards, and if that which is potentially heavy and light is the movable object, ⟨then⟩ the motion towards its proper place is, for each thing, motion towards its ⟨proper⟩ form."

From these passages it becomes clear that the weight and lightness of a body and its respective motion have the same cause. Aristotle does not say that weight *causes* downward motion, but that the weight of a body and its downward motion possess the same cause. This, of course, is the nature of that body, inherent in matter, initiating motion towards

[14] In the course of the argument of *De caelo* I 2 Aristotle frequently uses the word ἀναγκαῖον, cf. esp. 269 a 5.19.27.

the proper form and end: when air is generated from water, it rises and a potentially light element becomes actually light and is light once it has reached its proper place. The answer, then, to the question of the extension of the term 'nature' in the present context is that even in the case of elementary locomotion the concept of nature cannot be separated from such notions as matter, form, efficient cause, and final cause. Because of its relevance for later discussions I should like to point out that in the present study I assume that Aristotle takes weight and lightness to pertain not only to the partial elementary bodies in counternatural places, but also to the totalities of the elements themselves. That is to say, the earth as a whole is heavy, the firesphere as a whole is light.[15]

The further question of how the nature of the celestial element has to be understood will be left aside until a later stage of this essay. For the present it is necessary to return to the argument of the chapter.

3.1.2 The division of locomotion: 268 b 17–26

In what follows Aristotle proceeds to divide the genus 'locomotion' into different types or species:

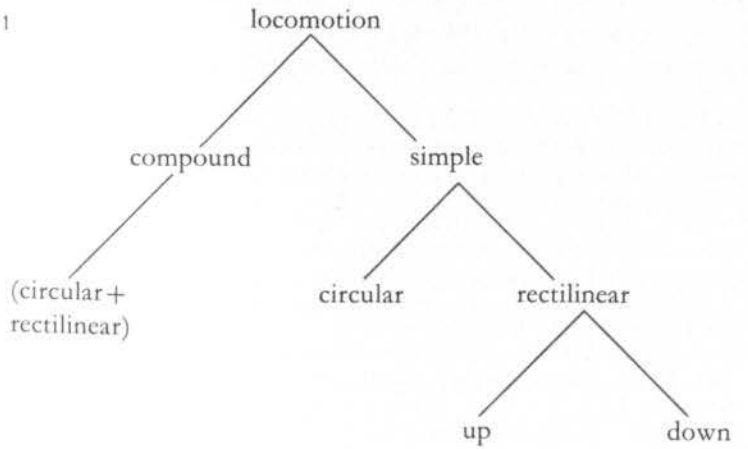
> A.2 [268 b 17–20]: "But all spatial movement – called locomotion – is either rectilinear or circular or a combination of the two, because these are the only simple movements.
> Now the reason for this is that only these magnitudes are also simple: the straight line and the circle."
> A.3 [268 b 20–24]: "'Circular', then, is the movement about the centre, but 'rectilinear' refers to upward and downward motion. By 'upward' I mean the movement away from the centre, by 'downward' the one towards the centre. – In consequence, all simple locomotion necessarily takes place either away from, or towards, or about the centre."

[15] This may be inferred from several passages: In *Cael.* IV 3, 311 a 1–6 Aristotle says: "Now whenever air is generated from water, a light thing from a heavy, it progresses to the upper region. Once arrived, it is light – no longer "becomes", but "is". Clearly then it is moving from potentiality to actuality, and that means attaining the place, quantity and quality proper to its actual state," (Guthrie). See also *Cael.* I 8, 277 a 27–33 where Aristotle argues that speed and weight (or lightness) increase with the proximity of a body to its natural place; cf. also *Phys.* VIII 4, 255 b 11: "The activity of the light thing is to be in a certain place above." See also Simplicius *In de caelo* 21,26 ff.; 264,25 ff.; 698,5–7. – On the general problem of weight and lightness in Aristotle see, e. g., O'Brien (1977).

Proposition [A.2] contains the first two steps of the division: locomotion is either 'simple' or 'composite', and if it is simple it is either rectilinear or circular. Composite movement, on the other hand, is said to be composed of rectilinear and circular movement. The latter are simple because they take place along the only simple magnitudes, the straight line and the circle.[16]

In proposition [A.3] the two kinds of simple movement are further subdivided. The expression 'circular movement' possesses only one meaning referring to the movement about the centre (i. e. of the world). 'Rectilinear movement' on the other hand, may be analysed in terms of the *direction* of movement. It takes place either in an upward direction (i. e. away from the centre), or in a downward direction (i. e. towards the centre). The final sentence of [A.3] states that in this way the types of simple locomotion are exhaustively accounted for. Accordingly, Aristotle's division of locomotion may be described graphically as shown in Fig. 1:

Fig. 1



The result of this division is the complex disjunction that natural locomotion is either a compound of circular and rectilinear movement, or it is simply circular, or simply rectilinear upwards, or simply rectilinear downwards.[17]

[16] Cf. *Physics* VII 4, where Aristotle states that the movement along the perimeter of a circle and along a straight line are not comparable (ἀσύμβλητος), i. e., there is no ratio between them, because the two magnitudes are incomparable, 248 b 4–6; see also 249 a 15 ff.

[17] The method used in this account is the Platonic method of division (διαίρεσις), as

Prima facie, Aristotle's account of the types of locomotion indeed gives the impression that it is exhaustive and borne out by empirical evidence. The fact that Aristotle does not take into account any other rectilinear movements besides 'upward' and 'downward' movement is justifiable because he deals *expressis verbis* with natural locomotion only. However, at least three quite acute objections have to be raised. Taken together, they will render Aristotle's division of locomotion rather doubtful. The first objection concerns the method of the present division itself, for the whole inference seems to consist of a heterogenous application of physical and geometrical criteria.

Beginning with the *phenomenon* of locomotion in nature the first step theoretically divides motion into composite and simple movements, and, in abstracting still further, simple movements are divided in virtue of their geometrical shapes, either rectilinear or circular. (The fact that 'composite movements' are said to consist of two simple movements will find separate consideration below). Finally, in a third step Aristotle imports the criterion of the direction of movement. It is clear that he has left the theoretical realm of geometry, for he defines 'upward' and 'downward' relative to the centre, i. e. the centre of the world.[18]

outlined in the *Sophist* 219 A ff. and the *Politicus* 258 B ff. As a mode of reasoning it is primarily devised for the determination of the definition of a (lowest) species. In order to define, e. g., the species S_i a much wider class S_A is assumed as the starting point of the division. Next, S_A is – usually dichotomously – divided into subclasses S_b and $S_{b'}$; S_b (or $S_{b'}$) is then divided into further subclasses S_c and $S_{c'}$, and so forth. The subclasses on the same level are mutually exclusive because on each level the same predicate is both affirmed and denied. In practice, only one arm of the division is considered and made subject to further division; the other arm is left aside. At some point a species S_i will be found, and the genus S_A in conjunction with all differentiae is taken as the definition of the species S_i; cf., e. g., Taylor (1948); 377. – Different attempts to explain the Platonic method of division can be found in Leisegang (1929), 90–117, A. C. Lloyd (1954), and Gaiser (1962), 125–128. Lloyd (1954), 225 f. distinguishes several principal usages of the method, e. g., (a) to define or understand a genus; (b) to define the lowest species; (c) to show how a genus is both Many and One. – Aristotle criticises the application of this method for the purposes of (a) and (b), see *An.pr.* I 31, 46 a 31 ff.; cf. also *Part.an.* I 3, 643 b 26 ff. He holds that nothing can be proved by it, but here, in *De caelo* I 2, as in other places (see, e. g., *De caelo* III and the schematic analysis in Bos (1972), 50 ff.) he does employ it in order to divide and understand a genus, in this case 'locomotion'. – It has been argued that dihairetic reasoning, which was used in Stoic philosophy in the construction of τετπαλήμματα, played a role in Aristotle's derivation of the qualities of the four elements, cf. Mau (1969), esp. 143–146, and that, under the influence of Plato, it was an important form of reasoning in Aristotle's earlier works, cf. von Fragstein (1967).

[18] Aristotle justifies the cosmological usage of the terms 'up' and 'down' against Plato *Tim.* 62 D–63 A in *Cael.* IV 1, 308 a 17–24.

However, although this application of geometry to physics may be justified in the light of Aristotle's philosophy of mathematics,[19] it is not clear that it is legitimate to apply both geometrical and physical principles within a single inference. One consequence of this heterogeneity surely is that Aristotle overrides the fact that the movements of the stars and planets are far more complex than his idea of a simple motion about the centre suggests.

But even if no objection to his procedure is raised along these lines, one must make the formal criticism that no directional criteria are applied to the arm 'simple circular movements'. The rules of the diairetic method certainly require consistency, and there is nothing that prevents a theoretical division of circular movement into 'clockwise' and 'counterclockwise' motion. Such a division seems to be required also because Aristotle argues in *De caelo* II 2 that the terms 'left and right', 'top and bottom' do pertain to the celestial sphere. However, in the present context Aristotle is mainly concerned with the apparent movement of the spheres, and one could argue that 'circular motion' does not have to be subdivided further because the daily rotation of the heavens is directionally uniform; there are only differences in speed – which Aristotle did not regard as possible differentiae of motion.[20] – At any rate, when at the end of his account Aristotle enumerates the types of simple movements it is clear that the three movements do not belong to the same specific level. The generic difference between circular and directionally determined rectilinear movements will almost automatically lead to the conclusion that circular movement, and therefore the heavens, are fundamentally different from rectilinear movements and bodies which move in a straight line. The generic difference of motions thus prefigures the fundamental dichotomy of the celestial and the sublunary region in Aristotle's universe.[21]

The third objection concerns the concept of composite movements. Although Aristotle only touches upon this concept briefly, it nonetheless possesses a firm place within his system of natural movements and

[19] Cf. the interpretation of *De caelo* I 1 above.

[20] See *Phys.* V 4, 228 b 28–30: "Quickness and slowness are not species and differentiae of motion, because they pertain to all specifically different movements." If speed were a differentia of motion, then, according to Aristotle's theory, the movements of a large and a small lump of earth would be specifically different. – Plato, on the other hand, spoke of counterdirectional movements in the heavens, cf. *Tim.* 36 C,D; 39 B.

[21] On this problem see esp. the interpretation of Seeck (1964), 126 ff.

recurs repeatedly elsewhere.[22] One must ask the question what the term refers to, for there is no immediate empirical evidence for a *natural* movement which is composed of rectilinear and circular motion.[23] A passage from *Physics* V 4 suggests that Aristotle has in mind either some kind of 'deflected' movement or the movement in a spiral. After having defined uniform and non-uniform motion he says, *Phys.* V 4, 228 b 22–25:

> "For it is impossible that the movement along magnitudes which are not uniform is a uniform movement; take for example the deflected movement (ἡ κεκλασμένη κίνησις) or the one along the spiral (ἡ τῆς ἕλικος) or any other magnitude of which any part does not fit on to the other".

It is not clear whether or not Aristotle is speaking of natural movements in these lines. If he does, he probably thinks of the spiral movement of the sun caused by its daily westward movement (the movement of the Same) and the yearly eastward movement along the ecliptic (the movement of the Different) as analysed by Plato.[24] In contrast to this initial suggestion, Alexander of Aphrodisias understood the concept of compound movement as follows:[25]

> "For at the same time when ⟨an elementary body⟩ is carried round it necessarily moves according to its proper momentum (ῥοπή) as well, either upwards if it belongs to the light ⟨bodies⟩, or downwards if it belongs to the heavy ones. Therefore its movement is composed of rectilinear and circular ⟨motion⟩."

Alexander's argument, in fact, only applies to light elements like fire and air. This interpretation of compound movements presupposes that the firesphere, i. e. the outermost natural place of fire, and the sphere of air move about the centre naturally, which, in effect, is incompatible with the gist of Aristotle's subsequent argument. For he is going to show that the four terrestrial elements cannot possibly move in a circle – neither naturally nor counternaturally.[26]

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[22] See *Cael.* I 2, 268 b 30 f.; 269 a 28 f. – The division of locomotion into circular, rectilinear, and composite movements appears also in *Phys.* VIII 8, 261 b 29 ff. and esp. 9, 265 a 13 ff.

[23] I suppose that with 'composite movements' Aristotle is in fact still referring to natural movements. The movements of animate bodies are irrelevant in the present context.

[24] Cf. *Tim.* 39 A and Vlastos (1975), 54–57.

[25] *Apud* Simplicium *In de caelo* 37,13–15 (= Philoponus, *contra Aristotelem*, fr. 1/17).

[26] Cf. 269 a 8 f.: Simple bodies possess only one natural movement; and cf. 269 a 9–18: Circular movement cannot be contrary to the natural movement of one of the elements because they already possess a counternatural movement. In the *Meteorology*, on the other hand, Aristotle seems to allow that the firesphere can move in a circle by the agency of the heavens, cf. *Meteor.* I 7, 344 a 11–13.

Before we turn to the passage which attempts to correlate the different types of movements with bodies, one further proposition remains to be considered. Aristotle uses a rhetorical argument, the analogy, in support of the claim that his account of the types of simple movement is complete:

> A.4 [268 b 24–26]: "And it seems that this followed in agreement with what has been said in the beginning: for the solid/body was completed in three – and so is its movement."

This statement evidently refers back to the argument about the significance of the number three for the concept of completeness in the first chapter.[27]

3.1.3 The 'correlation' of motion and bodies: 268 b 26–269 a 2

In the previous section [A] Aristotle completed a sequential division of the genus 'locomotion' and arrived at a triad of simple movements. Now he returns to the topic of 'body' and develops a similar sequence of division.

> A.5 [268 b 26–269 a 2]: "However, since some bodies are simple but others are composed of these (by 'simple' I mean bodies which possess a principle of motion by nature, such as fire and earth and their kinds as well as their congeners) it is necessary, too, that some movements are simple whereas others are composite in some way; and the movements of simple bodies are simple, whereas the movements of composite bodies are composite – but the latter move according to the prevailing element."

Beginning with the assumption that there are simple bodies (i. e. elements) and compound bodies Aristotle infers that this entails 'with necessity' the existence of simple and composite movements as well, such that certain movements belong to certain bodies. The inference is clearly based on the initial assumption that 'nature' is a principle of motion: 'simple' natures cause simple movements, 'composite' natures, i. e. units that are composed of more than one element, cause composite movements 'in some way'. On the basis of what has been laid down in sections [A.2–4] Aristotle attempts to establish a direct correlation

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[27] Compare his remark in the *Rhetorica* II 20, 1394 a 14 ff.: "If the ⟨analogies⟩ stand before ⟨the argument⟩ you must use many of them, but if put afterwards, one alone is sufficient, for a single witness will serve too, if he is a reliable one." – Cf. G. E. R. Lloyd (1966), 406 f.

between the simplicity and the compoundness of bodies and movements respectively. However, there is no necessity involved, and it can be shown that the attempted correlation merely rests on the homonymous use of the terms 'simple' and 'composite'.

In Aristotle the conception of simple and compound bodies is independent of the conception of the simplicity or compoundness of their movements. In the *De generatione et corruptione* Aristotle speaks of 'simple' bodies because they are the primary constituents of homoiomeries and compound bodies. Similarly, in *De caelo* III 3 an element is defined as the ultimate result of a successive analysis of natural bodies; elements cannot be further analysed.[28] There seem to be no sufficient grounds for presupposing a direct correlation between the simplicity and compoundness of bodies and movements. In fact, the assumption runs into considerable difficulties. First, a body composed of fire and air, for instance, would move upwards with a rectilinear simple movement; more than that, a body composed of fire and earth such that the proportion of fire exceeds the proportion of earth will still move upwards in a straight line. Although the body is composite, the movement is not. As Aristotle says, they move according to the prevailing element.[29] If bodies composite in this manner are examined in respect of the form of their movement alone, they surely remain indistinguishable – both from each other and from the pure substances of fire and air. The possibly resulting differences in speed are not, according to Aristotle himself, differentiae of movement.[30] Importantly, there is therefore no unequivocal one-to-one relation between motion and nature. Although it is true that all simple bodies move with simple movements, it is not true to say, conversely, that all simple movements are the movements of simple bodies, for compound bodies may move with a simple movement as well.

If this points to the problem involved in the correlation of simple bodies and simple movements, a comparable problem is presented by the relation of composite bodies and composite movements. Here especially the homonymy of the terms is very clear. Within the framework of Aristotle's natural philosophy a composite body can only be

[28] Cf. *Cael.* III 3, 302 a 15–18 and esp. Seeck (1964), 63–86.

[29] Cf. *Cael.* I 2, 269 a 1 f. and 28–30.

[30] See *Phys.* V 4, 228 b 28–30. Nevertheless, Aristotle's view on the significance of speed is not always consistent. On the problem see O'Brien (1977), 71 f. and cf. above note 20.

a body composed of two or more sublunary elements. Since all individual movements of these bodies occur in a straight line, the composite body can – as pointed out above – only possess a principle of motion such that the body somehow moves in a straight line. In his division of 'locomotion', however, Aristotle speaks of composite natural movement in terms of *rectilinear* and *circular* movement. The incompatibility is apparent, for if this view is interpreted on the level of body, a composite movement requires an underlying body which is composed of a terrestrial and the celestial element. For the latter, according to Aristotle, naturally revolves in a circle. But this kind of composition is impossible. In the course of his exposition of the theory of aether the association of celestial and sublunary substances is ruled out categorically. The 'ontological difference' strictly separates the sublunary from the celestial region, and one may conclude that a natural composite movement in the sense laid down by Aristotle here does not exist.

As it seems, Aristotle completely ignored these difficulties; in *De caelo* III 3, where he repudiates Anaxagoras' opinion that substances like air and fire are a mixture of homoiomeries, he says 302 b 5–8:

> "But since every natural body possesses a proper motion, and since some motions are simple, others composite, and since composite motions belong to composite bodies and simple motions to simple bodies, it is clear that certain simple bodies exist. For there are simple motions."[31]

Here as well Aristotle assumes that the motions of composite bodies are composite whereas in fact they need not be. The passage cited also suggests that all composite motions are the motions of composite bodies and all simple motions are the motions of simple bodies, which again is a false hypothesis.

3.1.4 The problem of the completeness of the division of motion

In sections [A.2–5] Aristotle took three important steps. First, he divided the genus locomotion into four different species: composite movement, simple circular, simple upward, and simple downward motion. He subsequently classified all natural bodies as simple and composite bodies, and thirdly maintained that necessarily simple movements belong to simple bodies and composite movements to composite bodies.

[31] Cf. also III 4, 303 b 4 f.

Before we turn to the first argument for the existence of aether devised on the basis of this 'correlation', it is necessary to deal with some problems which are relevant for the understanding of Philoponus' criticism of this part of *De caelo* I 2.

It has been pointed out that the assumption of such a 'correlation' is unjustified because simple movements may belong not only to simple but also to composite bodies. In addition to this, the whole passage as represented graphically in Fig. 1 raises a number of other important questions. First of all, it is remarkable that in lines b 27–29 Aristotle mentions only two elements, fire and earth. It is not difficult to see why he should like to do so. His problem is that the number of simple movements is not equal to the number of simple bodies: although there are five bodies with different natures, there are only three different movements. The question therefore arises whether or not the vague sentence πῦρ καὶ γῆν καὶ τὰ τούτων εἴδη καὶ τὰ συγγενῆ τούτοις (b 29) should be taken as including a reference to the remaining elements air and water. Stocks, for example, translates: "Fire and earth with their kinds, and whatever is akin to them". Here it seems as if Aristotle is eager to avoid the issue of the intermediate elements because they are in no way related to or determined by the given division of locomotion. Since natural rectilinear motion is directionally divided into upward and downward motion, no systematic necessity requires the postulation of four rather than just two terrestrial elements. This interpretation receives support from the fact that in various other places Aristotle speaks of three simple bodies only: aether, earth, and the intermediate body.[32]

Alexander of Aphrodisias, however, proposed a different reading, see *apud* Simplicium *In de caelo* 16,21–26. He understands the sentence to mean: "Fire and what is of its species, earth and what is of its species, as well as those bodies that belong to the same genus". The last clause he understands to refer to the elements air and water; the terms 'genus' and 'species' are taken to denote classes which are differentiated in terms of motion. Earth and water, *qua* bodies which move downwards, belong to the same genus, yet – although belonging to the same genus does not entail this – Alexander would

[32] Cf. *Cael.* I 8, 277 b 12–17; also I 3, 270 b 26–31; III 1, 298 b 6–8; on the problem see Joachim (1922), xxxii, note 2, Seeck (1964), 142 ff., and Moraux (1949), 160–162.

have said that their movements are specifically different.[33] If Alexander's interpretation is correct, Aristotle could escape the objection that his division of locomotion is systematically inadequate, i. e., that he only recognised three simple motions whereas there are five simple elementary bodies. Alexander would say that – for the purpose of the present argument for the existence of aether – the division of locomotion has not been fully completed, although this is done elsewhere, i. e. *De caelo* IV. Simplicius adopts Alexander's suggestion. However, its untenability will become apparent once one raises the question of how the commentators thought the division of locomotion can be or has been completed. Simplicius suggests in his commentary that the movements of, say, earth and water are different in species because water, as opposed to earth, does not continue to move to the centre of the world. Its motion terminates at the surface of earth. Similarly, air does not rise upwards in the same way as fire does, for its movement terminates at the concave inner surface of the firesphere, see *In de caelo* 27,11–23. This solution is occasionally proposed even in modern times. Thus, in following Farabi's criticism of Philoponus, Muhsin Mahdi writes, (1967), 241 f.:

> "Upward and downward movements need to be subdivided by taking into account, not merely the direction of the movements, but also its starting point and goal or the place where it terminates. For, while both fire and air move upward, air stops at a place beyond which it will not proceed, while fire will proceed beyond this place to its own place, which is higher; similarly, both earth and water move downward, yet earth proceeds downward beyond the place at which water stops in its downward movement. This analysis of the kinds of simple movements, which is obviously Aristotle's own (and was assumed by him in *On the Heaven* i.2–3, since he refers the reader to *On the Heaven* iv, where it is stated), was schematized by his commentators as follows. Simple circular movement is one generically as well as specifically and individually. Simple rectilinear movement, on the other hand, consists of two "genera" – upward and downward movements – each of which is subdivided into two "species" according to the distance travelled or the place where the movement terminates."

Fortunately, as we shall see, Philoponus can be credited with refusing to accept this kind of scholasticism. In the following discussion it will be shown briefly that this theory is an incorrect representation of Aristotle's account of the natural movement of elementary bodies.

[33] The same he thought to be true in the case of fire and air.

The questions that concern us for this purpose are the following:

(1) Does Aristotle propose a further differentiation of upward and downward movement elsewhere such that the movements of earth and water (fire and air) are understood to fall under the same *genus*, i. e. downward (upward) motion, but are somehow differentiated in *species*? In other words, does Aristotle recognise five as opposed to only three simple movements?

(2) Is Aristotle's division of locomotion in *De caelo* I 2 at all properly understood as an attempt to provide a *derivation* of the number and kinds of simple bodies from the kinds of simple movements? And if this is not the case, how should the whole inference be interpreted?

As regards the first question the answer must clearly be negative. The relevant text, *De caelo* IV, where Aristotle is believed to have completed such a division, does not provide any evidence for this.[34] It is true that in *De caelo* IV Aristotle discusses the motion of the terrestrial elements; he also distinguishes between four terrestrial elements. But it must be emphasised that the derivation of these elements does *not* depend upon a differentiation of simple motions, but rather on Aristotle's theory of natural places. Seeck has been able to show that in book IV both theories – the theory of *four* different natural places and the theory of *two* different natural locomotions – compete with one another to the point of incongruity. For according to the latter theory both earth and water are heavy and tend towards the centre of the universe, whereas both fire and air are light elements and incline towards the circumference.[35] According to the former theory, however, the elementary bodies are arranged in the form of strata around the centre of the world so that each elementary mass occupies its proper natural place. According to this theory all elements except fire possess weight.[36] Aristotle had to introduce the theory of natural place precisely because it allows an unequivocal identification of all four terrestrial elements: they can be determined in virtue of the place they naturally occupy. It is on the other hand impossible to determine and identify these elements in virtue of their natural movements alone. For (i) in a stratified universe

[34] On the following cf. esp. Seeck (1964), 106–121.

[35] Cf. *Cael.* IV 2, 308 b 27; 309 b 7 f.; 310 a 12 f. This theory is also presupposed in *De caelo* I 2, cf. 269 a 17 f.: fire and air move upwards, earth and water downwards.

[36] Cf. *Cael.*, IV 4, 311 b 8 f.; 5, 312 b 2–7.

the intermediate elements air and water sometimes move upwards, sometimes downwards in order to reach their natural places, depending on the starting point of their movement. An identification in terms of motion as such necessarily remains inconclusive. And (ii) within the framework of a purely kinetic theory without the concept of natural place, and assuming that both earth and water (air and fire) possess downward (upward) motion, an identification of elementary bodies is equally impossible. It is not true to say that the movement of, say, earth is distinguishable from the movement of water because the former would continue to the centre whereas the latter would stop at the place of the circumference of the earth.[37] From what has been laid down in the *Physics* Aristotle is committed to the view that the movement of, e. g., water is *identical* in species to the movement of earth – despite the fact that water is impeded by earth and does not reach its goal, the centre of the universe. In *Phys.* V 5, 229 b 14–21 he says:

> "Where there are intermediates between the contrary terms, a movement to an intermediate operates as a contrary in a movement, in whichever direction the change takes place: thus, gray operates as would black in a movement from gray to white or from white to gray ...; for a mean is in a way one of the extremes relatively to the other, as we have said before."[38]

This should make it clear that although water never reaches the goal of its motive tendency, the motion *qua* motion is indistinguishable from the motion of earth. There are, as is explicitly stated in the *Meteorology*, only three simple movements.[39]

Once this is clarified, it is necessary to deal with the second question. It if is true that Aristotle only recognises three simple movements (which means that the division of motion in *De caelo* I 2 is complete), and if he recognised at the same time five elementary bodies, then it is likely that the passage [A.2–5] is not even intended to be a

[37] As is supposed, e. g., by Mahdi (1967), 241 f. According to Mahdi, the division of the genus 'locomotion' in *De caelo* I 2 is incomplete. "Upward and downward movements need to be subdivided by taking into account, not merely the direction of the movements, but also its starting point and goal or the place where it terminates."

[38] Cf. the citation above. I have adopted the translation by Hope (1961), 101. – Cf. also *Phys.* V 1, 224 b 32–35 and esp. 2, 226 b 3–8.

[39] See *Meteor.* I 2, 339 a 11–15: "We have previously laid down that there is one element from which the natural bodies in circular motion are made up, and four other physical bodies produced by the primary qualities, the motion of these bodies being twofold, either away from or towards the centre." (H. D. P. Lee).

general derivation of simple bodies from simple motions. Aristotle's sole interest lies in producing enough evidence to show that a further, extraterrestrial elementary body must be postulated. This end has been achieved. For (i) the natural circular motion of the heavens suggests the existence of a body that possesses a nature which moves it in a circle. And negatively the fact that (ii) the heavens are not possessed of a natural upward and downward tendency suggests that it is not one of the terrestrial elements. We may now proceed to an analysis of the arguments for the existence of aether.

3.2 The Existence, Simplicity and Priority of Aether

Aristotle adduces two major arguments in order to show that the celestial region consists of aether. The first argument, in effect, attempts to demonstrate the necessary existence and simplicity of aether, the second argument emphasises that aether must also be axiologically prior to the sublunary elements. There follow additional, less plausible arguments which mainly serve to repudiate the Platonic doctrine according to which the heavens consist of fire.

3.2.1 The argument for the existence and simplicity of aether: 269 a 2–7

The first argument for the existence of aether runs as follows:

> B.1 [269 a 2–7]: "Supposing, then, that (i) simple motion exists, and that (ii) circular movement is simple, and that (iii) the movement of a simple body is simple and simple movement is the movement of a simple body (...), then (iv) there must necessarily exist some simple body that moves with a circular movement in virtue of its [own][40] nature."

This argument has rightly been interpreted as an analogy.[41] In virtue of the assumption that there are three simple movements and the observed fact that two of these movements belong to certain simple bodies it may be inferred by analogy that the third simple movement

[40] Cf. MS E and Verdenius (1969), 268 *ad loc.*

[41] Cf. Gigon (1952), 125; Seeck (1964), 133 f. with qualification; the most illuminating account is given by Kullmann (1965), 255 f.

must belong to a simple body as well.[42] Kullmann points out that the analogy might well take the form of an exact logical inference. Even if it is devised in the form of a deductive syllogism it remains an analogy as long as one of the premises is a proposition which has been arrived at by *induction*.

The present argument, according to Kullmann, is a *syllogism of fact*.[43] He reconstructs as follows:

> Circular movement is a simple movement.
>
> A simple movement is the natural specific movement of a particular simple body.
>
> ---
>
> Circular movement is the natural specific movement of a particular simple body.
> (= There is a particular simple body that possesses circular movement as its specific natural movement.)

Kullmann states that the second premise – which in its present form represents his own reconstruction and does not exactly resemble Aristotle's text – has been arrived at by induction. Thus, the universal proposition that simple movements are the movements of simple bodies has been inferred, according to Kullmann, from a generalisation of singular instances familiar from the sublunary region. Apart from Kullmann's deviation from the text one could object to this reconstruction that it does not entirely agree with the standard form of an Aristotelian syllogism, for the minor and the major premises have exchanged places.

Moreover, without wanting to question the validity of Kullmann's general interpretation of the argument as a syllogism of fact, it must be pointed out that the actual merits and deficiencies of Aristotle's argument have not been sufficiently recognised. The merit of the argument lies in its form. It can be shown that it possesses in fact an

[42] See Kullmann (1965), 256.

[43] In his article Kullmann shows that inferences of this kind are significant to Aristotle's theory of scientific explanation as *syllogisms of fact* (as opposed to *syllogisms of explanation*), see *id.* (1965), 248–254; *An.pst.* I 13, and Barnes (1975), 148 ff. Syllogisms of fact proceed through a statement of fact as the middle to the reason or cause of the fact. E.g., from the phenomenon that the planets do not twinkle and the induced universal proposition that all lights that do not twinkle are near (the statement of fact), the conclusion can be drawn that the planets are near. A syllogism of explanation would conclude the other way round: if it were known that the planets are near one could *explain* syllogistically the fact that they do not twinkle.

even clearer deductive form than suggested by Kullmann. On the other hand, its deficiency lies in the fact that the conclusion is at least dubitable because the second premise does not represent a proposition which can be arrived at by valid induction.

In order to assess its deductive form, let us first recapitulate the three premises:

(i) Simple motion exists. (269 a 2)
(ii) Circular movement is simple. (a 3)
(iii) The movement of a simple body is simple and a simple movement is the movement of a simple body. (a 3–4)

Since premise (i) merely states the *existence* of simple movements it is possible to merge premises (i) and (ii) into a single premise (P):

(P) Some simple movements are circular movements.

(P) does not state anything else than premises (i) and (ii) taken together because a particular affirmative proposition possesses existential import: if a proposition stating that 'some A's are B's' is true, this entails that there actually *exists* at least one A of which the proposition holds.[44]

Premise (iii), on the other hand, can be rewritten in the form of a universal affirmative statement we may call premise (Q):

(Q) All simple movements are the movements of simple bodies.

(Q) in fact only resembles the second part of premise (iii), but it is this clause which is vital for the stringency of the argument.[45] With logical consequence the conclusion states that

∴ There is a simple body which [naturally] moves in a circle.

As can be shown, the argument represents a valid syllogism of the form **IAI** of the third figure, i. e. *Disamis*:[46]

[44] According to the Boolean interpretation of the traditonal square of opposition the particular **I** and **O** propositions possess existential import whereas the universal **A** and **E** propositions do not. On Aristotelian conventions of logic, however, universal affirmative propositions do possess existential import.

[45] Elsewhere Aristotle uses the first part of (iii), i. e., that the movement of a simple body is simple, cf. *Cael.* I 3, 270 b 28; 6, 274 b 2–3; III 4, 303 b 5. But in III 3, 302 b 7 when Aristotle attempts to show the existence of composite and simple bodies he says: "Composite ⟨movements⟩ belong to composite ⟨bodies⟩, and simple ⟨movements⟩ to simple ⟨bodies⟩."

[46] In what follows I have adopted the formalisation of syllogism as proposed by Patzig (1969). Thus, 'AiB' is read as 'A belongs to some B' or 'Some B's are A'. 'SB' stands for 'simple body', 'SM' for 'simple motion' and 'CM' for 'circular motion'.

CM i SM
SB a SM
CM i SB

In this way, I think, more justice is done to the actual form of Aristotle's argument which attempts to prove the existence and simplicity of a circular moving body.[47] The fact that the conclusion really states more than what has been laid down in the premises, i. e. the naturalness of the movement, is taken into account by Aristotle in an afterthought 269 a 7–9, which will be discussed in due course. First, however, it is necessary to examine each of the premises and assess their truth-value. Premise (P) does not cause any difficulty. Circular movement is manifest to the senses – therefore existent – and it is simple because it takes place along a simple magnitude, the circle. (P) thus rests firmly on what has been laid down by Aristotle in proposition [A.2] above.

In the case of the second premise (Q) the matter is different. Kullmann simply wrote that this general proposition has been arrived at by induction, but he does not say how. Premise (Q) relies on the second series of division [A.5]. Here Aristotle stated that 'there are simple and composite movements and that *the movements of simple bodies are simple*, 268 b 30–269 a 1. The emphasised proposition can indeed be considered to be a valid generalisation. On the assumption that simple bodies like fire, air, water, and earth exist and the experience that they move upwards or downwards in a simple straight line one can reasonably infer that

(R) All simple bodies possess simple movements.

But this is not what is stated in proposition (Q). But (Q) clearly represents the text of premise (iii), for in 269 a 3 f. Aristotle tacitly imports the immediate conversion of (R) as well. He says in premise (iii):

(iii) The movement of a simple body is simple (= R) *and* a simple movement is the movement of a simple body (= Q).

On the basis of the second half of premise (iii), which is indispensible for the argument, premise (Q) was rendered as:

Disamis is discussed by Aristotle in *An.pr.* I 6, 28 b 5–11. Its validity can be proved by conversion into **AII-1** (*Darii*): The major premise CM i SM converts into SM i CM and becomes the minor premise; the conclusion of *Darii* SB i CM validly converts into CM i SB, which is the conclusion of the above syllogism.

[47] Cf. also Simplicius *In de caelo* 18, 17 f. who construes in a very similar way.

(Q) All simple movements are the movements of simple bodies.

However, this proposition is false because a universal affirmative statement does not possess a proper converse, unless one employs limitation from the universal to the particular. I. e. the valid conversion of (R) reads: 'Some simple movements are the movements of simple bodies'. Within the framework of Aristotle's natural philosophy this is perfectly true. But the universal statement is not, for there are simple movements which are not the motions of simple but of composite bodies. Thus, when in his third premise (269 a 3 f.) Aristotle assumes that there is a one-to-one relation between simple bodies and simple movements, his assumption does not only rely on induction but also on invalid logic. From this it is clear that the present deductive argument is an invalid argument by analogy.

3.2.2 The naturalness of the celestial movement: 269 a 7–18

It has been mentioned above that the conclusion of the argument [B.1] which attempted to prove the existence and simplicity of a body moving in a circle includes a notion which has not been laid down in the premises. This is the idea that circular movement belongs to the body in question "in virtue of its *own* nature", 269 a 6 f. It is only in the following set of propositions [B.2–5] that Aristotle sets out to show why this must be so.

For the sake of clarity it must be pointed out that on our interpretation the following section 269 a 7–18 does not contain a second proof for the existence of aether,[48] but belongs systematically to the first proof. The purpose of this appendix is to emphasise the point that the circular motion of the heavens is natural and not forced. This is necessary because Aristotle's strategy is to infer the nature of the celestial body from the kind of movement it has, which is possible only if nature (and not some kind of force) is in fact the principle of its motion. If its movement were forced evidently nothing definite could be said about its nature. The method employed to prove the naturalness of circular motion is indirect, i. e., Aristotle excludes all other possibilities.

[48] So Gigon (1952), 125 ff; Seeck (1964), 135 ff.; Elders (1966), 86.

Accordingly, the general content of the present passage as a whole is best understood in the following manner:
There are four possible ways to look at circular movement; either

(1) it is the natural movement of one of the four elements, or
(2) it is the counternatural movement of one of the four elements; or
(3) it is the counternatural movement of a body other than one of the four elements; or
(4) it is the natural movement of a body other than one of the four elements.

Aristotle attempts to prove the last proposition (4). In the conclusion of the proof in section [B.1] he already asserted that this is the case, cf. 269 a 5–7. Since the quadruple disjunct above is exhaustive, proposition (4) may be proved indirectly by eliminating the three remaining possibilities. Thus, possibility (1) is ruled out in [B.2], possibility (2) is ruled out in [B.4], and finally, possibility (3) is rejected in section [B.5].

> B.2 [269 a 7–9]: "For by force it ⟨sc. a simple body⟩ can move with the movement of another and different body, but by nature this is impossible, given that a single movement belongs to each simple body naturally."

The difficulty of interpreting this passage is the question of the logical subject of the verb ἐνδέχεται. It has, of course, been long recognised that the subject cannot be 'the circular moving body'[49] but must be 'some simple body', see a 5 f.[50] Proposition [B.2] therefore states that, for instance, some element like fire cannot move downwards naturally, this being the natural movement of earth. The reason is given by Aristotle in the form of a further assumption: There is only *one* movement that belongs to each simple body naturally. This assumption is not at all surprising. Given that nature is the principle of motion and that each simple body only possesses *one* nature, it can be expected that each simple body possesses only *one* natural movement, too. Only "by force it can move with the movement of another and different body." Thus, proposition [B.2] excludes the possibility that one of the four elements, the natural movement of which is rectilinear upwards or downwards, moves in a circle by nature.

[49] Gigon (1952), 128, construes this way and acknowledges that it results in "Unsinn".
[50] Cf. Seeck (1964), 134 note 1; Moraux (1965), translation *ad loc.* – Philoponus *contra Aristotelem* fr. 1/10* (*apud* Simplicium *In de caelo* 34,21–24), and Simplicius *ibid.* 18,20 ff. have understood the sentence in the same way.

B.3 [269 a 9–12]: "Further,[51] if 'counternatural movement' is contrary to 'natural movement', and if a single thing has a single contrary, then – given that circular movement is simple – it is necessary that, if it does not belong to the moved body naturally, it belongs to it counternaturally."

In order to reject the two remaining possibilities, i. e. that circular movement is not carried out counternaturally, either by a sublunary element (2), or by a body other than an element (3), Aristotle introduces a further premise. The principle of [B.2] that any simple body possesses only *one* simple movement naturally does not suffice for present purposes. In order to justify his rejection of (2) and (3) he adduces: The elements possess not only *one* natural movement but also only *one* counternatural movement, for a single thing possesses a single contrary.[52]

Now, since 'movement' can be divided into natural and counternatural movement, Aristotle assumes that if it is not natural – as was shown in [B.2] in the case of the four elements – the movement must be counternatural. Hence:

B.4 [269 a 12–15]: "Then, if the body which moves in a circle is fire or some other element, its natural locomotion will be contrary to circular movement. But a single thing has a single contrary, and upward and downward movement are ⟨already⟩ contrary to one another."

On the assumption that the supposedly counternatural circular movement is carried out by fire or some other (terrestrial) element, the natural movement of, e. g., fire would be contrary to circular movement, which is impossible. For there are only two contraries: the natural movement of fire cannot be contrary to both downward and to circular movement. Similarly:

[51] The ἔτι in a 9 answers the εἴπερ in a 8, and not the εἴπερ οὖν of line a 2.

[52] The assumption that a single thing possesses a single contrary is firmly rooted in Aristotle's natural philosophy. The place above is contrary to the place below, upward movement contrary to downward movement, hot contrary to cold as dry is to wet. Generation and destruction take place in virtue of contrariety. The principle is also mentioned in *Metaph.* IV 2, 1004 b 3 and discussed in *Metaph.* X 4, 1055 a 19 ff. There Aristotle defines contrariety as 'complete contrariety' which exists between two absolute extremes, i. e. the maximum difference. Similarly, in the *Physics* 'contrariety of place' is defined as that which is most distant in a straight line, cf. V 3, 226 b 32 ff. – This concept of contrariety – and, by implication, the above principle – is challenged by Philoponus (see *contra Aristotelem* fr. V/88 (*apud* Simplicium *In de caelo* 171,17–32), where he presumably follows Xenarchus' objection *apud* Simplicium *In de caelo* 55,25–31 and 56,8–17) and, similarly, by Thomas Aquinas (see *De caelo et mundo* I.iv.40). – In contrast, see Simplicius *In de caelo* 19,18: Aristotle's principle must be true because "nature is not so unjust as to put many in opposition to one."

B.5 [269 a 15–18]: "But if the body moved counternaturally in a circle is some other body, then some other movement will belong to it naturally. But this is impossible; for if it were upward motion that body would be fire or air, whereas if it were downward motion it would be water or earth."

This possibility assumes that the counternatural circular movement is carried out by a body different from the four elements. Since the movement was assumed to be counternatural, it is implied that there must be a movement which belongs to that body naturally. Since there are only three natural and simple movements the choice is limited to the two different rectilinear movements. But this would render the body in question one of the sublunary elements, and proposition [B.5] results in the paradox that the circular moving body is both a non-element and an element, which is impossible.

In conclusion, the whole argument [B.2–5] may be described schematically in the form of a τετράλημμα,[53] see Fig. 2. The truth-functional disjunctive operator v is used in the exclusive sense.

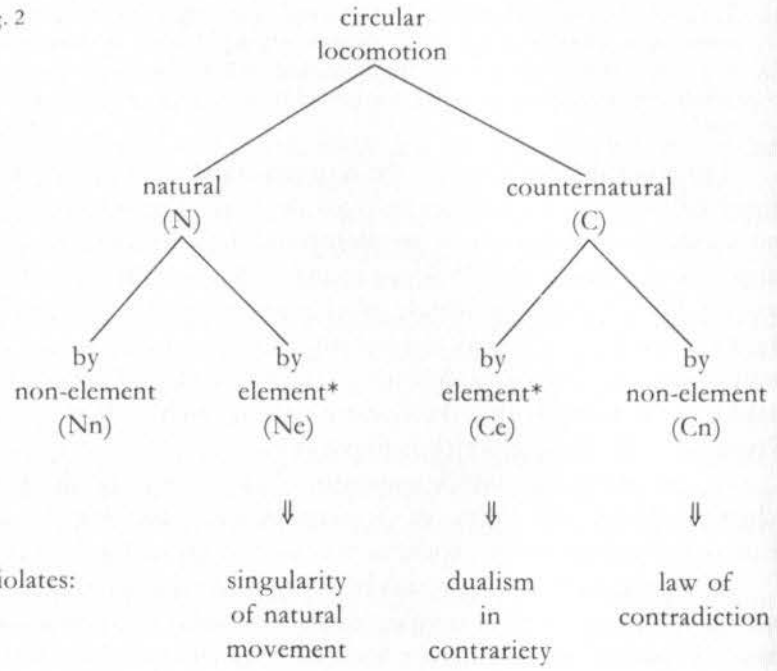
In this argument Aristotle endeavours to prove that circular movement is not in any respect contrary to the rectilinear movements, but rather the natural movement of a body different from the four known elements. The main work within this indirect proof is done by the principle that a single thing possesses a single contrary. If one applies this principle to *three* items, i. e. the three simple natural movements two of which have already been granted to be contraries, then it is inevitable that the third item, i. e. circular movement, cannot be integrated in the same system of contrariety. The impossibility of a uniform system of contrariety for the sublunary and the celestial region thus reflects the fact pointed out above that in Aristotle's division of locomotion rectilinear and circular movements appear on different generic levels.[54]

It is worth mentioning that the argument possesses two functions. The primary function (i) is to show that circular movement is natural; the secondary function (ii) is to prove that the celestial body cannot be

[53] On the significance and method of the τετράλημμα cf. Mau (1969).

[54] Cf. above 3.2.2 and Seeck (1964), 128; 136 f. As Aristotle himself says: things differing generically cannot be related to one another in terms of contrariety, see *Metaph.* X 4, 1055 a 6–10: "For transition into one another does not apply to things that differ in *genus*; for they are at a greater interval and incomparable. But things that differ in *species* are subject to generation from contraries *qua* extremes, since the interval between the extremes is greatest, and so is the interval between contraries."

Fig. 2



1. N v C
2. N → Nn v Ne
3. ¬ Ne
4. C → Ce v Cn
5. ¬ Ce
6. ¬ Cn
7. ¬ C
8. N
9. ¬ Ne (3)
10. Nn

* I.e. sublunary element.

one of the sublunary elements. In virtue of (i) the argument is closely connected to the proof of section [B.1] because it co-establishes its conclusion. In virtue of (ii) it appears to be quite independent. It is for this reason that the present argument is generally understood as an additional and indirect proof of the existence of aether.

3.2.3 The simplicity and priority of the celestial element: 269 a 18–32

Whereas the first proof attempted to establish the existence and simplicity of the circular moving body – and subsequently the natu-

ralness of circular motion – the following argument in section [C] attempts to prove the simplicity and priority of that body. In this proof the initial assumption of the chapter, i.e. that nature is a principle of motion, functions as an implicit principle as well. Whereas the former argument tried to infer the *simplicity* of a body from the simplicity of motion, this argument infers the *priority* of the body in question from the priority of its movement. Just as in the former argument the priority of circular movement is established by a regress to a higher level of abstraction: natural movements are determined in virtue of the geometrical shape of their paths.

> C.1 [269 a 18–23]: "But further, movement of this kind ⟨i.e. circular movement⟩ is necessarily primary. For the complete is by nature prior to the incomplete; the circle, however, is a complete thing, but the straight line is not – neither the unlimited straight line (for otherwise it would possess a limit and an end), nor one of the limited straight lines (for there is always something beyond them: for every limited line can be extended somehow)."

Proposition [C.1] argues for the primacy of circular over rectilinear movement. The argument is preparatory to the main argument [C.2]. The result of [C.1], i.e., that circular motion is indeed prior to rectilinear motion, appears as premise (ii) in the argument for the simplicity (and, by implication, primacy) of the celestial body, see [C.2] below.[55] The whole inference rests on the assumption that the circle is prior to the straight line. 'Priority', of course, is not predicated in a temporal but in an axiological sense: the circle is prior by nature. This statement is rather surprising, for in proposition [A.2] above 'circle' and 'straight line' appeared on the same generic level as two primary and irreducible types of geometrical magnitude. Here the axiological priority of the circle over the straight line is justified by the assumption that the circle is 'complete' and the straight line 'incomplete'. An immediate problem arises because Aristotle does not define what he means by 'complete' and 'incomplete'. Once again, he seems to take for granted that the reader is familiar with basic concepts and definitions of his natural philosophy. He calls unlimited straight lines[56] incomplete because they do not possess a limit and an end; limited straight lines, on the other

[55] Cf. also the analysis of Seeck (1964), 138 and Gigon (1952), 129 f.

[56] The problem that unlimited straight lines do not exist will not be dealt with at the moment. See Philoponus' criticism in frr. 1/27* and 32 and the comments in section 5.5.4. – Cf. now *Phys.* III 7, 207 b 19–21; VIII 9, 265 a 17 f.

hand, are incomplete because they are always extensible so that there is always something beyond them.[57]

The present conception of completeness agrees with the conception implied at the end of the first chapter, cf. *De caelo* I 1, 268 a 30–b 4: the solid is complete because it is not dimensionally deficient. In *Physics* VIII, on the other hand, Aristotle presents a different argument in order to show the priority of circular movement, putting less emphasis on the properties of the circle as geometrical magnitude. Here, circular motion is prior because it is uniform, perpetually continuous, and can be eternal, see *Physics* VIII 8 and 9. It is unclear, however, whether or not the priority of the celestial motion over and above the motions of the sublunary elements actually depends on the perfect instantiation of a circle in the movement of the heavens.

Once the crucial idea of natural priority and posteriority of movements is established, Aristotle lays down the premises for the second main argument of the chapter.

> C.2 [269 a 23–32]: "In consequence, if indeed (i) the prior movement is the movement of a body that is prior by nature, and if (ii) circular movement is prior to rectilinear movement, and if (iii) movement in a straight line is ⟨already⟩ the movement of simple bodies (for fire moves rectilinearly upwards and earthy bodies move downwards to the centre), then it is necessary that (iv) circular movement, too, is the movement of one of the simple bodies."

Proposition [C.2] is an informal argument by analogy: since movement in a straight line belongs to simple bodies, the body moving with a simple circular movement must be simple as well, and this *a fortiori*, because circular movement is not only simple but also prior to rectilinear movement.[58] The first premise relies on the

[57] In Aristotle, two conditions are prerequisite for completeness: limitation and all-inclusiveness. He says in *Phys.* III 6, 207 a 8–15 that the whole and the complete – as opposed to the infinite – mean very much the same: to be all-inclusive and to involve an end or limit. Examples: a 'whole man' or a 'box'. Cf. also *Metaphysics* V 16. In virtue of this definition a circle could indeed be regarded as complete, for it is limited by the perimeter, and there is nothing outside it that would improve its status as a circle. One could in fact argue that if anything were added to the circumference, the figure would not remain a circle but become oblique. Cf. Simplicius *In de caelo* 39,9–11: "Nevertheless, the circle is limited, possesses an end, and has nothing outside it, and it is not possible to increase it while its shape remains."

[58] This interpretation follows the lucid analysis of Seeck (1964), 137 f. *contra* Gigon (1952), 129 f. – Seeck's interpretation has, however, been prefigured by Alexander, see *apud* Simplicium *In de caelo* 40, 21–32.

axiom that nature is the principle of motion. It states that if the body is prior by nature the movement must be prior as well and vice versa. The second premise (ii) rests on what has been established in section [C.1], stating that circular movement is prior to rectilinear movement. Finally, premise (iii) is the proposition in virtue of which the argument has to be classified as an analogy because it is, supposedly, arrived at by induction. Premise (iii) states that all movements in a straight line (i. e. simple movements upwards and downwards) are the movements of simple bodies. This proposition, again, is false. It has been pointed out that composite bodies may move with a simple motion as well. On the observation, e. g., of a rectilinear upward motion it is not possible to decide whether the body in motion is fire, air, or some other, composite body. In this argument, premise (iii) involves the same fallacy as the third premise of the previous argument (269 a 3–4). From the fact that earth and fire etc. move with their peculiar rectilinear motions (cf. 269 a 26 f.) Aristotle can validly infer that all terrestrial elements move with motions in a straight line. But he is not entitled to the converse, i. e., that all movements in a straight line are also the movements of simple bodies, which is what premise (iii) asserts. In consequence, one is entitled to conclude from the premises of the present argument only that the body which moves in a circle is prior to the body which moves in a straight line (on the basis of (i) and (ii)). From here, however, there is no way to infer that this body must also be simple. And just why should it be ruled out that a composite body possesses ontological priority over some other, simple body?

Thus, the general conclusion of the whole inference as stated in [C.3] below is in rather better agreement with the evidence produced in the premises:

> C.3 [269 a 30–32]: "And from all this it is manifest that there naturally exists some bodily substance different from the formations here ⟨i. e. in the terrestrial region⟩, more divine and prior to them all."

This proposition does not assert the simplicity of the celestial body but claims only that the celestial substance is different from and prior to the sublunary elements – if we leave aside, for the time being, its divine nature. Although Aristotle has not been able to prove the simplicity of the celestial body, he has given quite good reasons for believing that the body moving in a circle – whatever it may be – is

indeed different and primary, provided one is prepared to accept the assumptions that nature is the principle of motion, and that circular movement is by nature prior to rectilinear movement.

3.2.4 Additional arguments: 269 a 32 – b 13

The previous sections [A] – [C] in conjunction with the first chapter of the treatise may be considered as a systematic unit. The arguments are carefully prepared and connected; both the language and in particular the method of the arguments display homogeneity. In contrast, the remaining section [D] differs from the earlier parts in many ways. There are not only stylistic differences;[59] the analysis of the passage shows that it is quite independent, for the argument does not presuppose anything that has been laid down previously. Moreover, some of its propositions involve an idea which is even contradictory to a principle introduced and adhered to in the first part of the chapter. Nevertheless, the line of the argument of the present section is consistent in itself, and the whole of the following section [D] has perhaps been added *en bloc* to the rest of the chapter. In passage [D.1] Aristotle once more argues for the naturalness of circular motion. In [D.2] this notion is further developed. The naturalness of circular movement is assumed to entail the existence of a simple and elementary body to which this motion belongs naturally. In addition, it is emphasised that the assumption of circular motion being contrary to the nature of the moving body results in absurd consequences. [D.3] concludes that on the basis of all this the celestial body cannot consist of fire.

> D.1 [269 a 32 – b 2]: "⟨This is manifest⟩ even on the additional assumptions that (i) all movement is either natural or counternatural, and that (ii) the movement which is counternatural for one body is natural to another, as, for instance, upward and downward movement is suffered by fire and earth naturally and counternaturally respectively.
> For in consequence, it necessarily follows that circular movement, too, – given that it is counternatural to these bodies – belongs to some other body by nature."

Aristotle begins with the assumption that all movements are either natural or counternatural. The second assumption (ii) states that in

[59] Cf. Gigon (1952), 131.

sublunary physics any simple movement is natural to one element but counternatural to some other element. Then, by way of analogy, it is possible to infer that the same will be true in celestial physics. Since circular motion is counternatural for the sublunary elements – their movement being in a straight line – it must be natural for some other body.[60] The major difficulty with this argument is that it ignores the metaphysical principle introduced earlier that a single thing possesses only a single contrary, 269 a 10. For Aristotle assumes in 269 b 1 f. that circular motion is contrary to both kinds of sublunary movements.[61]

Once it is established that circular movement is a natural movement, Aristotle draws the conclusion and discourages anyone from assuming that it could be a counternatural, i. e. forced, movement.

> D.2 [269 b 2 – 10]: "In addition to these propositions: if circular locomotion belongs to something naturally, it is evident that it would be one of the simple and primary bodies which, just as fire moves upwards and earth downwards, moves in a circle by nature.
> But if the bodies rotating with curvilinear motion move contrary to nature, it would be remarkable and wholly absurd that this movement alone should be continuous and eternal despite the fact that it is contrary to nature. For it appears in other cases, at any rate, that what is counternatural perishes very quickly."

The first part of the passage [D.2] concludes again by way of analogy that natural movement belongs to a simple and primary (i. e.

[60] See also Kullmann (1965), 256 f.

[61] It has been argued that the expression παρὰ φύσιν in line b 2 does not possess the force of "contrary to the natural" but only of "not according to the nature of the sublunary elements", cf. Guthrie (1939), 17 note a following Simplicius *In de caelo* 51, 28 – 52, 13. See also Elders (1966), 88. – Gigon (1952), 128 f. accepts the full force of the contradiction and concludes that the present chapter represents the combination of two parallel drafts attempting to prove the existence of a fifth element. – Seeck (1964), 130; 136 f., on the other hand, argued that Gigon's solution of the problem is inconclusive, for the lapse of placing both sublunary movements in opposition to the celestial movement occurs also in the passage which *expressis verbis* relies on the principle that one is contrary to one, cf. 269 a 15 – 18 and Seeck (1964), 136 f. Seeck points out that the difficulty pertains as such to Aristotle's system of simple movements. For it is possible either to posit contrariety of the sublunary movements and to isolate the celestial movement (see [B.2 – 5]), or to juxtapose circular and (undirected) rectilinear movement (see [D]). Strictly speaking, the two approaches are incompatible, but they can be reunited if one considers that the respect in which circular and rectilinear motion on the one hand, and upward and downward motion on the other hand are said to be contrary is different: there is a physical contrariety between upward and downward motion, and a geometrical one between circular and rectilinear motion (Düring (1966), 354).

elementary) body. Similarly with the second part: It is absurd to assume that the heavens revolve by the agency of some unnatural force, for in that case they cannot be expected to be viable and eternal.[62]

> D.3 [269 b 10–13]: "In consequence, if the body moving ⟨in a circle⟩ is indeed fire, as some contend, then this movement is just as counternatural to it as downward movement. For we see that the movement of fire is in a straight line away from the centre."

The last proposition reveals that the purpose of section [D] is to repudiate the opinion of certain philosophers who hold that the heavens consist of fire. Presumably, the reference is to Plato and/or Platonists like Xenocrates.[63] For first, it is known that these philosophers held the position under attack.[64] And secondly, the anonymous reference suggests that the philosophers referred to are well-known to the reader or, more likely, the audience. A relevant parallel passage is for example *Cael.* I 10, 279 b 32, a remark which must be interpreted as a reference to leading Platonists.[65] At any rate, Plato said in the *Timaeus* that the universe must consist of fire and earth (plus intermediate elements) because it is solid, visible, and tangible (31 B). The heavens, in particular, consist for the most part of fire (40 A). Statements of this kind are of course as difficult to refute as they are to prove. Aristotle, however, rejects Plato's tenet on the basis of the assumption that a simple movement must belong either naturally or counternaturally to the body in motion, 269 a 32 ff.[66] Once it is conceded that fire possesses upward movement by nature, circular movement can only be counternatural to it, and the aforementioned absurdity of section [D.2] follows. Thus, the heavens cannot consist of fire. Despite the fact that some arguments of section [D] contradict principles central to the argument of the preceding part of the chapter, it is likely that [D] has received

[62] The eternity of the heavens, in fact, as well as their 'divine' nature declared in 269 a 31 have not yet been proved.

[63] *Contra* Gigon (1952), 132, who understands this passage in conjunction with 270 b 24 f. as a reference to Anaxagoras.

[64] Cf. Plato *Tim.* 40 A 2 f. and Xenocrates (396–314 B.C.) fr. 56 (Heinze); further Dillon (1977), 30 f. and Moraux (1963), 1193. – Xenocrates as well postulated the existence of a fifth element which he located beyond the region of the celestial bodies.

[65] Cf. the interpretation of Baltes (1976) I, 18 f. – Anonymous references to Platonists are common in Aristotle, cf. Bonitz (1870), s. v. *Platonici.*

[66] The same assumption recurs time and again in Aristotle's natural philosophy, cf. *Cael.* III 2, 300 a 23 f.; b 18; II 13, 295 a 6; *Phys.* IV 8, 215 a 1; *De an.* I 3, 406 a 26. Cf. also *Phys.* V 6, 230 b 18.

its present place because it contained an effective refutation of Platonic doctrine.

The chapter concludes 269 b 13–17 with an emphatic restatement of a 30–32 asserting the existence of a further elementary body over and above the elements of the sublunary world.

3.3 Conclusion

In the second chapter of the *De caelo* Aristotle postulates the existence of a separate element in the celestial region. He attempts to show that apart from its existence three further predicates belong to this element: it is a simple body, it is axiologically prior to the four sublunary elements, and its motion in a circle is natural. The argument of this chapter establishes the main feature of Aristotle's cosmology. Although the elements of both the sublunary and the celestial regions move by nature, the universe itself is strictly divided into two, materially completely distinct regions.

The whole discussion is firmly based on the assumption that the 'nature' of bodies is a principle of their motion. Theoretically, this assumption entitles Aristotle to draw conclusions about the nature of a body from the kind of motion it exhibits. Aristotle's conclusions rest on two main arguments, both of which involve invalid induction. The first argument attempts to 'demonstrate syllogistically' the existence and simplicity of the celestial body. It involves the premises that there is a simple motion which is circular, and that all natural simple motions are the motions of simple bodies.[67] The second premise is false. Aristotle's correlation of simple/composite motions and simple/composite bodies has no justification. There is no reason for supposing that simple movements always require the existence of a simple body. Thus, there are no theoretical grounds for assuming that the celestial body must be simple, even if its movement – contrary to the evidence – is taken to be simple. In consequence, the postulation of the existence of a further elementary body has not been demonstrated successfully. The assertion that the movement of the heavens is natural is confirmed by an indirect argument. Circular movement cannot be the natural or counternatural movement of any of the four elements, nor the coun-

[67] See I 2, 269 a 2–4.

ternatural movement of a different body. The argument relies on the 'metaphysical' principle that each sublunary element possesses precisely one natural and one counternatural movement.

The second main argument attempts to show that the celestial body is both simple and axiologically prior to the sublunary elements. The argument rests on the same false premise that simple movements are the movements of simple bodies;[68] moreover, it is assumed that the geometrical magnitude 'circle' is prior to the geometrical straight line. Even if the latter premise is granted the argument remains unsound. By way of a largely independent set of arguments at the end of the chapter, Aristotle rejects the idea that the heavens consist of fire.

In conclusion, it may be stated that Aristotle has altogether failed to produce sufficient evidence to warrant the postulation of aether as the element of the celestial region. We may now proceed to Aristotle's discussion of the nature of aether.

[68] See I 2, 269 a 25 f.

4. The Nature of Aether: *De caelo* I 3–4

In *De caelo* I 2 Aristotle attempts to demonstrate that it is necessary to postulate the existence of a fifth (or: first) elementary body which is prior to the four 'traditional' elements and pertains to the celestial region. If the existence of this primary body is thus established, the question arises, What else can be said about it? Fire, water, air, and earth are associated with and characterised by the primary qualities hot, cold, wet, and dry. In Aristotle, a further pair of contraries belong to these elements as objective properties: weight and lightness, and these properties play a vital role in his analysis of natural motion. Given, then, that these three pairs of contraries lie at the centre of Aristotle's physics of the sublunary world, in what sense are they relevant for the newly 'discovered' celestial element? In the following methodologically fascinating but otherwise hopelessly contorted arguments, Aristotle answers this question negatively: None of the just mentioned qualities pertains to the celestial body. There is, he argues, no contrary to the celestial element, implying that it is impossible to attribute a contrary quality to the celestial region. But precisely because of this, certain quite different properties accrue to it, such as unchangeability and incorruptibility.

Aristotle's argument in *De caelo* I 3 affirms in three steps the absence of weight and lightness, 269 b 18–270 a 12, section [E], the absence of a body contrary to aether, and, in consequence, the absence of substantial, quantitative, and qualitative change, 270 a 12–35 [F]. The discussion culminates in the final assessment of the nature of the celestial body, which, again, is supported by three dialectical arguments, 270 b 1–31, section [G]. The whole of chapter 4, 270 b 32–271 a 33, represents an aside to the main argument of section [F] and attempts to justify a crucial premise employed there, namely that no movement is contrary to circular movement.

4.1 Aristotle's Negative Celestial Physics

In the first part of *De caelo* I 3 Aristotle sets out to assess the nature of the celestial element. His theory may tentatively be described

as 'negative celestial physics'. Aristotle's starting point is what has been established in the previous chapter: that a distinct celestial element exists, and that it revolves in a circle by nature. Relying mainly on those suppositions, Aristotle attempts to infer that the concepts the physicist applies to the natural bodies of the sublunary world in order to explain natural phenomena are by no means applicable to the celestial region as well. Rather than giving an account of what aether is and the terms in which it may be described, Aristotle shows what it is not.

4.1.1 The denial of 'weight and lightness': 269 b 18–270 a 12

His first argument denies that the celestial body possesses weight and lightness:

> E.1 [269 b 18–26]: "In view of what has been said – either by hypothetical assumption or by proper demonstration – it is clear that not every body possesses lightness and weight. It is first necessary, however, to set out what we mean by 'heavy and light', at the moment only as far as is sufficient for the present purpose; later, when we come to investigate their real nature (οὐσία), we will do so with more accuracy.
> Let 'heavy', then, be that which naturally moves towards the centre, and 'light' that which moves away from the centre: 'the heaviest' that which sinks below all things that move downwards, 'the lightest' that which rises to the top of all things that move upwards."

The first sentence, in a typical vein, anticipates the conclusion of the argument. Moreover, Aristotle makes clear that he relies on what has been said in the preceding chapter,[1] partly by way of assumption, partly by way of demonstration. Simplicius' summary *In de caelo* 59,31–60,4 has it that the following propositions have been assumed:

1. that there are two simple lines, the straight and the circular;
2. that upward motion takes place in the direction away from the centre, downward motion towards, and circular motion about it;
3. that a single thing possesses a single contrary; and
4. that each simple body only possesses one natural motion.

He further comments 60,4–22 that the following propositions have been demonstrated:

[1] The syntax of the first sentence has been considered corrupt by Moraux (1949), 163, but his emendation has not found general acceptance; see, e. g., Elders (1966), 90.

5. that there are two simple movements (rectilinear and circular);
6. that the movements of simple bodies are simple, and that simple movements are the movements of simple bodies;[2]
7. that a fifth simple body, moving in a circle by nature, exists and is more complete (τελειότερος), prior (πρότερος), and more honourable (τιμιώτερος) in nature than the sublunary elements.

Before providing the actual argument that is supposed to prove the anticipated conclusion Aristotle defines briefly what he means by 'heavy and light', referring the reader (or: auditor) to a more detailed account elsewhere, i. e. *De caelo* IV.[3] Here, 'heavy and light' are defined in kinetic terms. Bodies are called heavy and light if they move naturally in a certain, objective direction, either away from or towards the centre. It is not clear why Aristotle thought it necessary to define the superlatives 'heaviest' and 'lightest' as well, for these concepts play no part in the later argument. Nevertheless, it is necessary to discuss these definitions because there seems to be an ambiguity involved. The heaviest is defined as τὸ πᾶσιν ὑφιστάμενον τοῖς κάτω φερόμενοι, the lightest as τὸ πᾶσιν ἐπιπολάζον τοῖς ἄνω φερόμενοι.[4] Both verbs, ὑφίστασθαι and ἐπιπολάζειν, can possess a static as well as a kinetic sense. It is therefore not immediately clear whether, e. g., the lightest is that which 'floats on top of everything', or that which 'rises to the top of everything'.[5] The immediate context does not speak of places but of movements, thus suggesting that indeed the kinetic sense is employed here. This impression can be confirmed by a reference to *De caelo* IV 4, where it is most apparent that the definition involves the kinetic sense, e. g., 312 a 2–5:

> "Since that which sinks to the bottom of everything (τὸ πᾶσιν ὑφιστάμενον) moves (φέρεται) towards the centre, it is necessary that that which rises to

[2] It has been argued above 3.2.1 that the second half of this proposition has neither been proved by Aristotle nor can it be proved, since it is false.

[3] This reference, in conjunction with the rather elliptical definitions given, strongly suggests that the account of *De caelo* IV is presupposed and was already hammered out by the time this passage was composed. Cf., e. g., the definitions given in IV 1, 308 a 29–31. – On the problem of the relative chronology of the two main sections of the *De caelo* (i. e. books I–II and III–IV) cf. Moraux (1949), 157 ff.; *id.* (1965), xxxviii f. note 4; Solmsen (1960), 293–303; Elders (1966), 59–63, 90 f.

[4] Cf. also the definitions in *Cael.* IV 4, 311 a 16–18.

[5] Commentators are divided over this problem. Stocks (1930) and Guthrie (1939) *ad loc.* accept the kinetic sense, but Thomas Aquinas (1952), Tricot (1949), and Moraux (1965) *ad loc.* adopt the static sense. The ambiguity is exploited by Philoponus in fr. II/38 (*apud* Simplicium *In de caelo* 66,17–24).

the top of everything (τὸ πᾶσιν ἐπιπολάζον) moves towards the extremity of space."[6]

Aristotle's argument for the claim that the heavens are not possessed of lightness or weight runs as follows:

> E.2 [269 b 26–270 a 3]: "Thus, it is necessary that everything moving either upwards or downwards possesses either lightness or weight or both, albeit not in relation to the same body; for bodies are heavy and light relative to one another, for example, air is light relative to water, and water is light relative to earth.
> But the body which moves in a circle cannot possible posses weight or lightness. For it cannot move either naturally or counternaturally towards or away from the centre. For first, locomotion in a straight line does not belong to it naturally because there was one movement for each simple body, and it would in consequence be identical to one of the bodies moving in this way.
> Suppose, secondly, that it moves contrary to nature; then, if the counternatural movement is downwards, upward motion will be natural; but if the counternatural movement is upwards, downward motion will be natural. For we have laid down that in the case of contrary movements, if one is counternatural, the other is natural."

The gist of this argument appears to be the following: if the body that moves in a circle were able to move in a straight line, the movement would either be (a) natural or (b) counternatural.

(a) The movement cannot be natural because natural rectilinear movements are already the movements of the sublunary elements. Given that nature is a principle of motion, the celestial body would be identical in nature to one of the sublunary elements, which is impossible. — This argument is fallacious. Aristotle suggests that the fact that two bodies move in the same direction is a sufficient reason for supposing that they are identical in nature. This is not the case, for if it were true, fire would be identical to air, and water to earth.[7] Aristotle consistently

[6] Cf. also *Cael.* IV 4, 311 b 13–20. — Had Aristotle defined 'the heaviest' and 'the lightest' in static terms, he could have hardly saved himself from the embarrassment of assigning lightness to the celestial body. For since the heavens are no doubt located 'on top of everything', they ought to be the lightest body of all, which is precisely what Aristotle wants to deny.

[7] As has been pointed out in the previous chapter, differences of speed do not, as is sometimes contended, provide criteria towards a differentiation of the *natures* of elementary bodies, cf. above 3.1.4. The present argument confirms this view: for if it were the case that moving bodies can be distinguished in nature on the basis of the speed of their motion, aether would remain distinct from the sublunary elements *even if* it could move in a straight line, as it would, no doubt, move with a different speed.

ignores the difficulty that in his system a single rectilinear movement is the natural movement of two sublunary elements.[8]

(b) The movement, according to Aristotle, cannot be counternatural either because every counternatural motion is matched by and corresponds to a natural movement in the opposite direction. And so, if the primary body could move upwards (or downwards) contrary to its nature, the corresponding opposite movement would necessarily be natural for it, in which case the same consequence as in the case of (a) follows. It is clear that the present argument represents a mere adaptation of an inference employed in the second chapter, see *Cael.* I 2, 269 a 7–18. There, Aristotle attempted to show that circular motion cannot be the natural or counternatural motion of any of the sublunary elements.[9] It is, according to Aristotle, conversely true that rectilinear motion cannot be the natural or counternatural motion of the celestial element. The present argument of chapter 3 is elliptical in the sense that it does not explicitly state all the premises it relies on. Although it is stated that there is only one natural movement for each simple body, Aristotle does not indicate that he also presupposes the ἓν ἑνὶ ἐναντίον-rule of *Cael.* I 2, 269 a 14. For unless this principle is applied it does not follow that, say, downward motion could not possibly be 'contrary' to both natural upward and natural circular motion.[10]

If it be granted that Aristotle has in fact shown that the celestial body cannot move in a straight line at all — which, of course, he has not — one might ask how Aristotle further concludes that the heavens are not possessed of lightness and weight. Evidently, Aristotle cannot argue:

(P) All bodies moving upwards or downwards possess lightness or weight (269 b 26 f.).
(Q) The heavens cannot move upwards or downwards (b 31 f.)
∴ Therefore, the heavens cannot possess (ἀδύνατον ἔχειν) lightness and weight (b 30 f.).

[8] Philoponus readily exploits this difficulty in fr. I/1* (*apud* Simplicium *In de caelo* 26,31–27,4).

[9] Cf. above section 3.2.2.

[10] In his paraphrase Themistius therefore supplies the ἓν ἑνὶ ἐναντίον-rule, cf. *In de caelo paraphrasis* 11,17 and Simplicius *In de caelo* 63,19–23.

This argument is fallacious because the predicate term in (P) is undistributed. The assertion in (Q) that the celestial bodies do not belong to the class of bodies that move upwards and downwards therefore does not allow the conclusion that they are also devoid of lightness and weight. What Aristotle needs is something like this:

(R) All bodies that possess lightness and weight move in a straight line upwards or downwards.
(Q) The heavens cannot move upwards or downwards.
∴ Therefore, the heavens cannot possess lightness and weight.

But this latter argument, though logically valid, is not conclusive because premise (R) is false. Logically, (P) cannot simply be converted into (R), and besides, according to Aristotle himself, the elements in their proper places *do* possess lightness and weight *in actu*, yet they *no longer* move in a straight line.[11] For instance, the sphere of fire as a whole is light because it consists of light bodies. Nevertheless, it does not move in a straight line. As it seems, Aristotle has to resort to a more sophisticated argument. Hence he states:

> E.3 [270 a 3–12]: "But since the whole and the part move by nature towards the same place, as, for example, all the earth and a small clod, it follows first that this body possesses no lightness or weight at all (for otherwise it would move locally towards or away from the centre by virtue of its own nature).
> It follows secondly, that it cannot possibly move with a local movement such that it is either pulled upwards or drawn downwards. For it cannot move either naturally or counternaturally with a movement other than its own, neither itself nor any part of it. For the same argument applies to the whole as to a part."

Prima facie, the significance of the part-whole distinction at this stage is not clear. Commentators, ancient and modern, have generally interpreted this passage as an additional point to the argument that the heavens are neither heavy nor light.[12] But on that interpretation Aristotle's distinction remains redundant. Does it really serve no immediate purpose? It is noteworthy that the distinction between part and whole is drawn *before* the actual conclusion of the argument is finally repeated. Aristotle says in [E.3]: "Since (ἐπεί) the whole and the part move by nature towards the same place ..., it follows (συμβαίνει) that the heavens

[11] See above 3.1.1.
[12] See, e. g., Simplicius *In de caelo* 63,24 ff.; Thomas Aquinas *In de caelo* I. v. 56; Elders (1966), 91.

do not possess lightness and weight." In addition, it is clear that Aristotle's argument for the absence of weight and lightness in the heavens cannot be construed as above, because (P) and (Q) alone do not make an argument and (R) is a false proposition. In consequence, one must suppose that Aristotle's argument depends on three rather than two premises:

(P) All bodies moving upwards or downwards possess lightness and weight (269 b 26 f.).
(Q) The heavens cannot move upwards or downwards (b 31 f.).
(S) The whole and the part move to the same place by nature (270 a 4 f.).
∴ Therefore, the heavens cannot possess lightness and weight.

Evidently, if this is an argument at all, it must be highly elliptical. Is it possible to supply additional premises which render the argument valid? It may be suggested that Aristotle has perhaps the following inference in mind: The proposition that the whole and the part move towards the same place could be taken to imply that an elementary body which has reached its proper place does *not* actually cease to move *of its own accord*. It is merely prevented from moving because, having reached its proper place, it cannot move any further since the place of the totality of that element is strictly defined and encompassed by the two neighbouring spheres of sublunary bodies. In the same way, the whole never loses its *inclination* to move according to its nature, yet it has ceased to move because, being in its proper place, it obeys the superior principle of universal order and arrangement. Now, if this is true premise (P) can be rephrased as

(P′) All bodies that possess an inclination to move upwards or downwards possess lightness and weight (but they do not actually have to be in motion).

This proposition can be converted into a proposition very similar to (R), which Aristotle needs for his argument. For, no doubt, the term 'possession of an inclination to move upwards or downwards' is coextensive with the term 'possession of lightness and weight'. Therefore, (P′) converts to

(R′) All bodies that possess lightness and weight possess an inclination to move upwards and downwards.

(Q) The heavens cannot move upwards or downwards (nor do they have the inclination to do so because they pursue circular motion by nature).

∴ The heavens cannot possess lightness and weight.

Admittedly, it is not at all obvious that someone who asserts (P) could actually mean (R′). The interpretation just proposed assumes that Aristotle's argument is highly elliptical and in need of additional premises. This seems to be the only way to make sense of it; if this interpretation is taken to represent the gist of the argument, it becomes clear, however, that Aristotle's point concerning the identity of movements of the part and the whole is an integral, indeed, indispensable and vital part of the argument – and not, as the commentaries generally suggest, a somewhat redundant appendix.

4.1.2 The denial of generation, increase, and alteration: 270 a 12–35

The following passages constitute a sequence of three arguments which – brief and elliptical as they may be – lie at the centre of Aristotle's cosmological theory. The first argument [F.1+2] denies that the celestial body can possibly be subject to generation and destruction. Once this is established, Aristotle infers that aether is not subject to increase and diminution either [F.3]. Finally, on the basis of that argument he confidently concludes that it is unalterable as well [F.4].

> F.1 [270 a 12–18]: "It is equally reasonable to assume, too, that this body is ungenerated and indestructible, and neither subject to growth nor alteration, because everything that is generated is generated out of a contrary and some substrate, and perishes in the same way in some substrate and both by the agency of a contrary and into a contrary, as has been stated in our first discussions."[13]
>
> F.2 [270 a 18–22]: "However, the local movements of contraries are contrary. If, then, nothing can be contrary to this body because there is no movement contrary to circular locomotion, nature seems to have justly[14] exempted from contraries that body which was to be ungenerated and indestructible. For generation and destruction take place among contraries."

The problems presented by these two passages are considerable. It seems to be generally accepted that Aristotle argues that the celestial

[13] This remark may be taken as a reference to *Physics* I 7.

[14] ὀρθῶς ties in with the εὔλογον of line 12; see Le Blond (1938), 90.

body has no contrary, and that it is therefore not subject to generation and destruction. However, it is necessary to ask what it means that the celestial body has no contrary. *Prima facie*, the sentence is ambiguous, for one could take it to mean (a) that aether does not possess any kind of attribute which possesses a contrary correlate, i. e., the heavens are neither hot, nor dry, nor light, and so forth. Or, the sentence could be taken to mean (b) that there is no *body* contrary to the celestial body. In other words, ἐναντίον could either refer to an attribute (e. g. a quality), or to a substance. Now, given that the celestial body is a substance, and given that, according to Aristotle, there is no contrary to substance,[15] a reading of the sentence in the second sense seems to be ruled out *a priori*. The problem, however, of the passage consists precisely in the fact that it seems to prohibit this *a priori* exclusion. Some sentences clearly speak of contrary bodies. Let us go through the argument in order to clarify what the term ἐναντίον in each case refers to.

For a start, it is noteworthy that in the previous chapter *De caelo* I 2 Aristotle uses ἐναντίον in two ways. First, and above all, he speaks of 'contrary movements', as in upward and downward movement. In this sense he uses the term also in chapter 4 when he is trying to show that circular motion does not have a contrary. Secondly, he uses the term ἐναντίον in a rather vague and unspecified way in the principle that a single thing possesses a single contrary (ἓν ἑνὶ ἐναντίον).

In *De caelo* I 3 the word occurs for the first time at 270 a 2 [E.2], and here it clearly possesses the former sense, i. e. contrary movements. We may now turn to passage [F.1]. Aristotle outlines in a very compressed way his analysis of generation as put forward in the first book of the *Physics*. In the difficult chapter *Physics* I 7 he distinguishes between two different usages of the concept of generation. There is generation proper (γίγνεσθαι ἁπλῶς), and generation of attributes (τόδε γίγνεσθαι τι).[16] In the first case a particular individual thing is said to come to be as this individual thing, but in the second case something is said to become something, i. e., to become hot, large, red, in a place, etc. Aristotle points out that in the second case the particular thing clearly remains identical while one or several of its attributes change. The

[15] See *Phys.* I 5, 189 a 32 f.; *Cat.* 3 b 24–32.

[16] See *Phys.* I 7, 190 a 31–b 10. – Cf. the related discussion in *Gener.corr.* I 3, and the comments by Williams (1982), 80 ff. See also Bostock (1982).

particular thing therefore underlies (ὑποκεῖσθαι) the change of attributes.[17] The changing attributes are described as ἀντικείμενα καὶ μὴ ὑπομένοντα,[18] and the underlying subject of change as ὑποκείμενον.[19] The gist of the following argument[20] is that the same account applies in the case of generation proper. Here, too, one must recognise an underlying subject without which generation proper is impossible: nothing comes to be from nothing. Although the change is dramatic, the seed, e. g., must be recognised as the ὑποκείμενον of the plant or the animal. There are several processes that may lead to generation proper (either one alone or several in combination): change of shape, addition, subtraction, combination, or other qualitative changes. Aristotle maintains that in any case both processes of generation must be analysed in terms of the ὑποκείμενον and two somehow opposed terms (τὰ ἀντικείμενα)[21]. The question is: What type of contrariety does the term τὰ ἀντικείμενα refer to in this context? In order to answer this question a further distinction has to be drawn. Consider the following two cases:

(1) Air is generated from water when the latter is heated up, i. e., when the ὑποκείμενον changes qualitatively from cold to hot.
(2) A statue comes to be from a block of marble if the unspecific form of the material 'marble' is changed into the form of a (human) statue.

In the former case generation proper takes place by virtue of a different type of ἀντικείμενα than in the latter case. Let the first type of ἀντικείμενα be called 'contraries proper'; examples are: hot-cold, wet-dry, black-white, and so forth. In the latter case one cannot say directly that the form of the finished statue is 'contrary' to the formlessness of the material. Aristotle's own distinction, therefore, is the one between form (μορφή) and privation (στέρησις).[22] The question therefore arises, which kind of contrariety does the term ἀντικείμενα refer to? Already in antiquity there seem to have been variant opinions on this question. Philoponus is reported to have pointed out in the *contra Aristotelem*, fr. IV/64*: *apud* Simplicium *In de caelo* 121,11–14:

[17] See *Phys.* I 7, 190 a 13–21 and a 34–b 1.
[18] See, e. g., 190 a 26 f.
[19] See 190 a 35 ff.
[20] See 190 b 1–10.
[21] See 190 b 10–17.
[22] Aristotle introduces these terms in *Phys.* I 7, 190 b 17 ff.

> "Aristotle and his commentator Alexander want the hypothesis that 'contraries are generated from contraries'[23] to be true of contraries in the proper sense (ἐπὶ τῶν κυρίως ἐναντίων), but others say that the hypothesis is sound for privation (στέρησις) and form (εἶδος)."

The argument of *Physics* I 7, at any rate, and the examples adduced there suggest that Aristotle is indeed speaking of form and privation, rather than of contraries proper or both. His example for generation of attributes is a man becoming cultured (μουσικός) from being uncultured; the attribute 'uncultured' may naturally be taken as the privation of 'culture', rather than its contrary proper. And his examples of generation proper also involve form and privation: a statue being made from a 'shapeless' material, a plant or an animal coming to be from a seed.[24] But if it is the case that in that chapter Aristotle analyses generation in terms of privation and form only, he himself gives rise to considerable confusion. For at the beginning of the chapter he uses the preliminary term ἀντικείμενα, as has been pointed out, and it is perhaps not entirely unjustifiable to refer to 'form and privation' as 'opposites'.[25] But later, when he actually introduces the terms form and privation, he goes on to refer to them as ἐναντία, contraries.[26] At one point, στέρησις is even called the contrary (ἐναντίον) of the positive descriptive term (λόγος) of the object in question.[27] In consequence, it seems that one has to be extremely careful. Whenever Aristotle defines generation in terms of ἐναντία, it is not at all clear that he actually means 'contraries', i. e. contraries in the proper sense. In a sentence already mentioned, *Gener.corr.* II 4, 331 a 14, where he says that generation takes place out of contraries and into contraries, the context demands that here contraries in the proper sense are meant, namely hot, cold, wet, and dry. But this – and we may now return to the *De caelo* – is not at all clear in the present argument [F.1.2] where Aristotle wants to show that the heavens are not subject to generation. In fact, it seems quite impossible to decide definitely in which sense ἐναντίον may have been used in [F.1]:

[23] I. e. Aristotle's account of generation. Aristotle claims this in *Gener.corr.* II 4, 331 a 14–16; *Gener.an.* IV 1, 766 a 14, and virtually also in *Cael.* I 3, 270 a 14–17 [F.1], in which passage Aristotle refers to *Physics* I 7.
[24] Simplicius too points out, in my opinion correctly, that in *Physics* I 7 Aristotle does not speak of contraries in the proper sense, cf. *In de caelo* 121, 14–25.
[25] See I 7, 190 a 13–b 17.
[26] See I 7, 190 b 17–191 a 22.
[27] See I 7, 191 a 14.

> "⟨The heavens⟩ are neither subject to generation nor growth and alteration because everything that is generated is generated out of a contrary and some substrate, and perishes in the same way in some substrate and both by the agency of a contrary and into a contrary, as has been stated in our first discussions."

Indeed, the situation seems hopeless. If Aristotle is, after all, referring to *Physics* I 7, we should assume that he means contrariety in terms of form and privation. This fits in well with his emphasis on the ὑποκείμενον. But doubts arise if one considers that the context is a theory of elements, and that he says that generation and destruction is brought about "by the agency of a contrary" (270 a 16). It does not make any sense to say that form and privation 'bring about' generation,[28] but it does make sense to say that contraries proper are the agents of generation.[29] But this is not the end of the problem. For regardless of which of the two senses of ἐναντίον one is inclined to adopt in [F.1], it is certain that neither of them will be suitable for construing the argument of [F.2]. When Aristotle says that "the local movements of contraries are contrary" (270 a 17 f.), it is nonsense to say either that the local movements of form and privation or that the local movements of 'hot and cold',[30] and 'wet and dry' are contrary. Clearly, here Aristotle must be speaking of *bodies*, and so he does in the following sentence, 270 a 18–21:

> "If, therefore, nothing (i. e. no body or element) can be contrary to the celestial body (τούτῳ) because there is no movement contrary to circular motion, nature seems to have justly exempted from (ἐξελέσθαι ἐκ) contraries that body which was to be ungenerated and indestructible."

The last occurrence of 'contraries' is, again, entirely ambiguous. Does Aristotle want to say that the celestial body is exempted from contrary qualities, or does he claim that the heavens are removed from (taking ἐξελέσθαι ἐκ in a more literal sense[31]) those bodies that are, by

[28] And there is nothing in *Physics* I 7 that suggests this.

[29] In *Gener.corr.* II 2, 329 b 24–32 action and passion is attributed to the primary qualities.

[30] Heat, of course, is said to 'rise', but this is only a derivative action somehow linked to the property of heat; the primary action of heat is qualitative and not local change.

[31] According to Bonitz's index, ἐξαιρέω constructed with ἐκ does not occur very often in Aristotle. But when it occurs, its meaning is quite literal, i. e., something is *spatially* removed from something else, rather than something being exempted from a property; cf. *Hist.an* I 17, 496 b 5 f. (lungs are removed from a dissected animal); VI 18, 572 a 13 f. (in Crete stallions are not kept apart from the mares), *Gener.corr.* II 8, 335 a 2 f. (water is removed from earth).

virtue of their contraries, contrary to one another?[32] When he continues in line a 22 that generation and destruction take place ἐν τοῖς ἐναντίοις, this does not clarify the problem either. Again, what does this phrase mean?[33] Is it that Aristotle wants to say that generation and destruction takes place 'between contraries' (i. e. between contraries proper, or, perhaps, between form and privation), or that these processes take place 'among those bodies that are contraries' (i. e. by virtue of contrary qualities they possess). Now, it seems clear enough that the argument will never yield its precise meaning if scrutinised in this way. The best one can do, presumably, is to recognise that Aristotle uses the word ἐναντίον homonymously, and he probably would have denied that any one of the possible senses should be ruled out categorically. Thus, the argument may be taken to claim that aether possesses neither a contrary proper, nor a contrary in terms of form and privation, nor is there a body that can be said to be in any way contrary to the celestial body. Only from the following argument concerning alteration does it become clear that the last alternative is particularly relevant.

But is it possible to regard this argument involving a considerable homonymy as sound? Let us rush to its defence and attempt to reconstruct the inference on the supposition that Aristotle is speaking of simple bodies (elements) only. The argument may roughly be construed as follows:

(1) All ⟨simple⟩ bodies generated are generated out of a contrary ⟨quality⟩ and some underlying substrate, 270 a 14 f.
(2) Simple bodies that possess contrary qualities are bodies contrary in nature (supplied).
(3) Nature is a principle of motion (supplied).
(4) The local movements of contraries ⟨i. e. simple bodies contrary in nature⟩ are contrary, 270 a 17 f.
(5) There is no movement contrary to local movement in a circle, 270 a 19 f.
(6) The celestial body is both simple and moves in a circle (supplied).

[32] Note that in *Gener.corr.* II 3, 331 a 1–3 water is said to be contrary to fire, and earth contrary to air. The literal, spatial reading of ἐξελέσθαι ἐκ could be confirmed by a reference to *Cael.* I 2, 269 b 15 where the primary element is said to be separated (κεχωρισμένον) from the sublunary elements.

[33] Elders (1966), 92 f. criticises Longo (1961), 301 for supposing that generation takes place *between* contraries (Longo presumably follows Thomas' 'inter contraria'), and suggests the translation 'in the region (domain) of contraries'.

(7) There can be no ⟨simple body⟩ contrary ⟨in nature⟩ to the celestial body, 270 a 18 f.
(8) Generation and destruction take place among ⟨simple bodies⟩ that are contrary ⟨in nature⟩, 270 a 22.
(9) Therefore, the celestial body is not subject to generation and destruction, 270 a 20 f.

It is evident that the conclusion of this inference relies heavily on premise (7), which in turn is established by premises (4) and (5). Premise (4), which may be restated as a conditional: 'If the bodies are contrary, then the movements are contrary', seems to be plainly false. Water and earth are contrary bodies in respect of possessing partly contrary qualities – otherwise they would not be able to change into one another. Yet their natural local motions are not contrary but the same. Why does Aristotle need premise (4)? In order to infer by contraposition that 'if the movements are not contrary, then the bodies are not contrary'. If it is true that circular motion has no contrary (see premise (5)), it follows that the celestial body has no contrary either. Premise (5), however, seems to be highly suspect as well, and Aristotle is at great pains to justify it in an appendix to the theory of aether, *De caelo* I 4. The arguments brought forward there will be discussed in due course. For the present it is necessary to consider the following passage:

> F.3 [270 a 22–25]: "But further, everything that increases increases through a kindred body being added, and what diminishes diminishes[34] by being resolved into matter. Yet, in the case of the ⟨celestial body⟩ there is nothing out of which it has been generated."[35]

If the conclusion of the previous inference has been granted, the present argument is straightforward. It assumes that increase presupposes generation. In order for a body to increase, something of the same kind has to be added to it from outside.[36] For example, the firesphere 'increases' whenever the hot exhalations of the earth arrive at their natural place, but first these exhalations have to be generated in the lower region.[37] In the case of the celestial body, however, there

[34] The emendation of MSS H and M: καὶ τὸ φθῖνον φθίνει in line a 23 is read in line a 24.
[35] Differently Guthrie (1939), 29: "but this body has no such matter"; but cf. Stocks (1930) *ad loc.*: "But there is nothing out of which this body can have been generated."
[36] Cf. Aristotle's account of nutrition in *De anima* II 4, 416 b 3 ff.
[37] Cf. Aristotle's own example of air increasing in volume after it has been generated by way of ἀλλοίωσις from water, *Phys.* IV 7, 214 b 1 f. – The discussion of increase in *Gener.corr.* I 5 does not seem to illuminate the present argument.

is nothing out of which aether can be generated such that the celestial sphere is subsequently increased.

Next Aristotle denies that alteration (ἀλλοίωσις) occurs in the celestial region:

> F.4 [270 a 25–35]: "But if it is subject neither to increase nor diminution,[38] one can assume by the same reasoning that it is unalterable as well. For alteration is motion in respect of quality, and qualitative states and dispositions do not occur without change of properties (πάθη); for example: health and disease. But we experience that all physical bodies that change their properties are subject to increase and diminution, such as the bodies of animals and their parts as well as the bodies of plants. The same applies to the bodies of elements.
> In consequence, if indeed the body that moves in a circle cannot admit of increase and diminution, it is reasonable that it is also unalterable."

First of all, it is noteworthy that Aristotle seems to become increasingly careful about claiming necessity for his conclusions. It is merely "reasonable"[39] that the heavens are unalterable. But how can this be? If he has already demonstrated that the heavens do not possess any contrary qualities, and if alteration is change of contrary qualities,[40] then it is surely necessary that the heavens cannot be subject to alteration. Yet, Aristotle does not argue along these lines, and because of this we may confirm our earlier conjecture that the point to be proved in [F.1+2] is not that aether possesses no contrary qualities, but rather that it is physically removed from those bodies that are contrary to one another.

Whatever the case may be, Aristotle rules out alteration by means of an unimpressive argument by analogy. Alteration is a change of quality (κίνησις κατὰ τὸ ποιόν). He then (270 a 28 f.) relates qualitative change to change of property (μεταβολὴ κατὰ παθή), and continues to speak about animals and plants. His argument is that all physical bodies subject to alteration κατὰ πάθος also increase and diminish. Since the same account applies to the elements[41] it is reasonable to infer, according to Aristotle, that the celestial body, not being subject to increase, is not subject to alteration either. The

[38] All MSS except H read ἄφθαρτον, but cf. 270 a 30 f. and 33 f.
[39] εὔλογος. The word appeared once already in 270 a 12. On the significance and usage of εὔλογος in Aristotle, see Le Blond (1938).
[40] Cf. *Phys.* VI 10, 241 a 30–33; *Gener.corr.* I 4, 319 b 10–12.31–33.
[41] See 270 a 32 f., perhaps because the same account always applies to the whole and to the part; cf. above 270 a 11 f.

analogy between living beings and elements as well as the antecedent of the argument are hard to justify. Is it really the case that everything that changes qualitatively always increases or diminishes as well? In *Phys.* VIII 7, 260 a 29–34, at any rate, Aristotle expresses the converse opinion, i. e., that increase cannot take place without (prior) alteration.

Despite the fact that it would be worthwhile to examine these arguments further, and to relate them to doctrines propounded in other treatises, we will terminate the discussion here. There is, after all, no evidence that Philoponus scrutinised to any extent Aristotle's arguments for the absence of increase, diminution, and alteration from the celestial region, for he himself believes that the heavens, although not indestructible, are nevertheless unalterable for as long as they exist.

It remains to turn to the general conclusion and to outline the evidence adduced in support of it.

4.2 The Conclusion of the Argument and Additional Evidence

The final part of the exposition of the theory of aether summarises the preceding discussion. Aristotle asserts that the celestial body is ἀΐδιος, eternal, and qualitatively and quantitatively unalterable. This conclusion, based on theoretical grounds, is further warranted by additional evidence taken from popular beliefs, empirical astronomy, and etymology.

4.2.1 The eternal existence of aether

The concluding sentence of *De caelo* I 2 states that there exists some simple body which is different (ἕτερος) and separate (κεχωρισμένος) from the bodies of the world around us.[42] There, Aristotle already suggested that its nature is τιμιώτερα, more honourable than the nature of the sublunary bodies. Here, at the end of the discussion of chapter 3, Aristotle is in a position to specify more precisely:

[42] Cf. 269 b 13–17.

> G.1 [270 b 1–4]: "So that the primary body is eternal and does not admit of increase and diminution, but is unaging, unalterable, and impassive, is clear from what has been said, if our assumptions can be trusted."

Almost all predicates assigned to the primary body are negative. 'Eternal' (ἀΐδος) is merely the positive shorthand term for 'ungenerated and indestructible'. Aristotle does not restate that aether is neither heavy nor light. It is surprising that, in addition to his denial of increase, diminution, and alteration, Aristotle also says that it is unaging (ἀγήρατος) and impassive (ἀπαθής). These are predicates one would not readily expect in a cosmological treatise concerning a physical element. These expressions[43] do not necessarily imply that Aristotle thought the celestial body to be alive, but they suggest this at least to some extent.[44]

More important in our context is that, for the first time, Aristotle says that the heavens are eternal, i. e., they have never been generated

[43] The predicate ἀπαθής ties in with Aristotle's claim that the celestial body is indestructible. By ἀγήρατος he presumably means that aether, being eternal, is not worn out in the course of time, cf. *Phys.* IV 12, 221 a 26–b 7.

[44] This remark leads to a much disputed problem in the study of Aristotle's natural philosophy. The problem is generally believed to arise if the theory of aether of *De caelo* I 1–4 is contrasted with other passages in *De caelo*. For in the former chapters, Aristotle is taken to explain circular motion almost 'mechanistically': the heavens move by virtue of their own (bodily) nature; cf. also *Cael.* II 1, 284 a 18–35. Elsewhere, however, Aristotle explicitly says that the heavens are alive; cf. II 2, 285 a 29 f.; II 12, 292 a 18–21; 292 b 1 f. On the problem see Ross (1936), 96–98; Guthrie (1939), xxix–xxxvi; Cherniss (1944), 581–602; Moraux (1963), 1198–1200 with further references. A consideration of all the passages and the literature concerning this problem lies beyond the scope of the present inquiry. This much, however, ought to be said: Although it may *prima facie* appear that Aristotle explains the circular movement of the heavens in the same way as the rectilinear motion of the sublunary elements, i. e., as being caused by their nature alone, and although it is true that the sublunary elements are certainly not animate, Aristotle does not refrain from stating also in *De caelo* I 2 and 3 that the primary element is more divine, more honourable, unaging, and impassive. These expressions can neither be excluded from the argument of these chapters, nor can they be reconciled well with an interpretation of Aristotle's theory of aether as 'mechanistic'. The apparent contradiction between 'mechanism' and 'animism' in Aristotle's explanation of celestial motion, therefore, can be found in the theory of aether itself, and not only if that theory is compared with other remarks in the *De caelo*. In consequence, it may be suggested that Aristotle would not have hesitated to qualify the impression he gave that the celestial body moves *only* in virtue of precisely the same principle which is the cause of the movements of the inanimate sublunary elements. When he speaks of circular motion by nature, this locution does not as such preclude the presence of a soul, for 'movement by nature' and 'movement by soul' are not mutually exclusive concepts. – On the related problem of the prime mover compare v. Arnim (1931); Guthrie (1939), xv–xxix; Cherniss (1944), *passim*, and more recently Waterlow (1982), 204 ff.

and will never be destroyed.[45] It is slightly surprising that he does not elaborate this point, that he does not explicitly link up his theory of aether with his doctrine of the eternity of the world. It is true that the eternity of the heavens is again discussed in *De caelo* I 10–12 and finally confirmed in II 1. But the fact that the significance of aether for the doctrine of the eternity of the world is not underlined here suggests that the theory is not solely devised *in order* to prove eternity. In other words, proving the eternity of the world is not the real issue; to Aristotle, it seems, the theory of aether merely agrees well with his conviction of the eternity of the world, rather than establishes it.[46] This suggestion is confirmed by the fact that Aristotle emphasises repeatedly that his theory agrees with reputable popular beliefs, rather than that it is *establishing* anything new, cf. *Cael.* II 1, 284 a 35–b 5:

> "If, then, as we said, the view already stated of the first motion is a possible one, it is not only more appropriate so to conceive of its eternity, but also on this hypothesis alone we are able to advance a theory consistent with popular divinations of the divine nature." (Stocks)

And in the present chapter Aristotle is prone to point out not only that his theory is confirmed by the phenomena, but also, and apparently more importantly, that it in fact *confirms* the phenomena,[47] 270 b 4 f.:

> "Our account seems to confirm the phenomena, and the phenomena, in turn, confirm our account."

4.2.2 Additional evidence: 270 b 5–25

1. The first phenomenon Aristotle refers to (270 b 5–11) stems from a context we would call natural theology: All men have some conception of gods, and they invariably allot the highest place, heaven,

[45] Aether is eternal *a parte ante* and *a parte post*.

[46] According to the evidence of the fragments of his exoteric writings Aristotle had argued for the eternity of the world, e. g., in the *De philosophia*, on independent grounds. See above 2.1.2.

[47] The following examples indicate that the term 'phenomena' refers to appearances and common experience in the widest sense, in particular ἔνδοξα; on the problem of Aristotle's φαινόμενα cf. Owen (1961) and Nussbaum (1982) who objects to Owen's judgement that in Aristotle φαινόμενον is used ambiguously in referring sometimes to 'observed data' and sometimes merely to 'common beliefs' (ἔνδοξα). Nussbaum emphasises that Aristotle's phenomena arise consistently from the basic patterns of human experience, discourse, and behaviour.

to the deity. They are thus (intuitively) combining the immortal with the immortal.[48] Aristotle is possibly alluding to the *Iliad* where αἰθήρ is said to be the abode of Zeus.[49]

2. The second phenomenon (270 b 11–16) could be said to involve ancient observational astronomy: During the whole past until Aristotle's times no change seems to have taken place in the outermost heavens nor in any part of it. Aristotle supports this evidence by a vague reference to ancient records (κατὰ τὴν παραδεδομένην ἀλλήλοις μνήμην)[50]

3. The third phenomenon (270 b 16–25) consists of an etymological point: Aristotle supposes that the name αἰθήρ had been assigned to the highest region so that it be distinguished from the things in the world below. According to his – erroneous – opinion, αἰθήρ derives from ἀεὶ θεῖν, 'to run always',[51] (which agrees only too well with his idea that the movement of the heavens is continuous and eternal), and he criticises Anaxagoras' more appropriate derivation of αἰθήρ from αἴθειν, 'to burn'.[52] Why did Aristotle think that this etymological point echoing the premonitions of his forefathers strengthens his case? Partly because there is, according to Aristotle, no real progress and development in the history of the ideas of men. The world is eternal, and whole cultures are periodically eradicated by natural catastrophes, but the same ideas and beliefs (δόξαι) of man recur at intervals over and over again.[53] Ironically, Thomas Aquinas, after having given a masterly outline and defence[54] of Aristotle's fallacy-ridden theory of aether, comments in *In de caelo et mundo* I.vii.77 as follows:

[48] See also *Meteor.* I 3, 339 b 19–21 and cf. *Metaph.* XII 8, 1074 a 38–b 14. – On the significance of common opinions of this kind for Aristotle's philosophy see Nussbaum (1982), esp. 291.

[49] Cf. *Iliad* 2,412; 4,166; 15,192 and see Leaf (1902) II, 599–601.

[50] Simplicius *In de caelo* 117,24–27 claims to have heard that the Egyptian records covered 630 000 years, and the Babylonian records even 1 440 000 years. According to Neugebauer (1975) II, 559, the Egyptian contribution to astronomy is insignificant. On the achievement of Babylonian astronomy see, e. g., *id.* I, 347 ff.

[51] The same etymological derivation can be found in Plato, *Crat.* 410 B.

[52] Cf. DK fr. B 15; Aristotle *Meteor.* I 3, 339 b 21–25. On the etymological problem cf. above 2.1.1.

[53] See *Cael.* I 3, 270 b 16–20; *Meteor.* I 3, 339 b 27–30; also *Pol.* VII 9, 1329 b 25–27. The same view that human cultures are destroyed by floods and heatwaves is expressed in Plato, *Tim.* 22 C–23 C. On the problem of history in Aristotle, cf. Behler (1965), 55–60.

[54] Defended for example against the criticism of Philoponus whose arguments he was well acquainted with through Simplicius' commentary *In de caelo*.

"Destruuntur enim studia veritatis per diversas mutationes in his inferioribus accidentes: sed quia mentes hominum naturaliter inclinantur ad veritatem, cessantibus impedimentis, renovantur studia, et homines tandem perveniunt ad opiniones veras quae prius fuerant: opiniones autem falsas non necesse est renovari."

The final passage of chapter 3, 270 b 26–31, represents a difficult problem because it is not possible to incorporate it into a systematic account of Aristotle's theory of aether. Aristotle appears to maintain that there are as many simple bodies as there are simple motions, namely three, a statement impossible to reconcile with the doctrine of five elements. This discrepancy raises the fascinating problem of the genesis of the text of the *De caelo* as a whole, which, regrettably, cannot be discussed in the present context.[55] In his critique, Philoponus seems to have passed over this passage in silence; we may be allowed to do the same.

4.3 Contrariety and Circular Motion: De caelo I 4

In the central argument of *De caelo* I 3 Aristotle attempted to show that aether is not subject to generation and destruction. Roughly, the argument relied on two main premises, first that everything generated is generated out of a contrary, and secondly that there is no contrary to circular motion. In the context of the first premise Aristotle referred to earlier discussions of generation, but he did not justify his second premise. Its justification is the purpose of chapter 4 which begins 270 b 32 f.:

"That no other locomotion is contrary to circular locomotion may be argued for in many ways."

The sentence is obviously ambiguous since it can mean two quite different things. On the one hand, Aristotle could be taken to say (a) that there exists no movement which is contrary to circular movement. That is to say, if the movement of the celestial sphere takes place from east to west, then it is impossible that a movement in the heavens from west to east exists. The movement of the heavens is uniform and one. Or, on the other hand, he could be taken to argue (b) that although circular movements in different directions do indeed exist, i. e., what

[55] On the problem cf., e. g., Moraux (1949).

we would call clockwise and counterclockwise motion, it is wrong to suppose that these different movements are actually contrary to one another. Proposition (b) is a much more reasonable claim to make because it does not blatantly contradict the phenomena. Aristotle first discusses the relation between rectilinear and circular motion.

4.3.1 Circular and rectilinear motion: 270 b 33–271 a 5

H.1 [270 b 33–271 a 5]: "In the first place, we are most inclined to regard the straight line to be opposed to the circumference. For the concave and the convex line seem to be not only opposed to one another, but also, when they are taken together as a unity, to be opposed to the straight line. In consequence, if there is indeed some contrary to circular motion, motion in a straight line, above all, must be contrary to it. However, the movements in a straight line are opposed to one another because of the ⟨opposite⟩ places. For up and down constitute a difference of place and a contrariety."

The problem raised in this passage is whether or not it is possible to regard 'the straight' as contrary to 'the curved'. Formulated in the abstract like this, the issue almost seems to be a geometrical one. Aristotle denies that there is any contrariety involved, but his argument is elliptical and unconvincing. Without justification he confines the issue to a comparison of (physical) upward/downward motion and circular motion. The former two movements are already contrary to one another (because the places from which they commence are contrary places), and therefore cannot be contrary to circular motion as well; for – and Aristotle does not state this – a single thing has only a single contrary, given that it possesses a contrary at all. It is necessary to underline the strategy of this argument, because it is used in the whole chapter. Aristotle reduces the question of contrariety in motion to the question of contrariety of places. A movement is determined by its termini and its direction, either from A to B or vice versa. The shape of the movement is entirely irrelevant. On this account it is, of course, impossible to integrate circular movement into a system of contrary motions, for in circular motion (a) the direction changes permanently, and (b) the movement possesses no termini because it always returns to the same point. As Aristotle is going to say further down, 271 a 20–22:

> "Circular motion takes places from the same to the same, but contrary movement is defined as locomotion from one contrary to the other contrary."

In 270 b 35 Aristotle says that 'concave' and 'convex' seem to be opposed to one another (ἀντικεῖσθαι ἀλλήλοις). To him, this remark raises the more general question of whether or not different circular movements may be regarded as contrary to one another, which is discussed in the rest of the chapter. The particular problem of the relation of concave and convex is not dealt with to any further extent, and we may instead adduce Alexander's explanation why the contrariety of 'concave' and 'convex' is only apparent. Alexander said that if 'concave' is conceived of as contrary to 'convex' in the case of a single line, then the line would be contrary to itself, which is impossible.[56]

4.3.2 Contrariety in a circle: 271 a 5–33

There follow four arguments by which Aristotle attempts to exclude the possibility of contrariety in circular motion. In his commentary, Simplicius defends Aristotle against the objections raised by Philoponus, and he lists four presuppositions which he thinks support the arguments substantially, *In de caelo* 176,15–20:

> "Now, on the grounds of what has been laid down before, Aristotle held that (i) the movements from contrary places are contrary movements of place, and that (ii) the places at the greatest distance are contrary places, and that (iii) the greatest distance is determinate, just as the smallest distance, and that (iv) every distance possessing a determinate length is measured by the straight line between the distances."

These propositions seem to play indeed some part in the logic behind Aristotle's reasoning. The first supposition has already been mentioned, and the remaining ones are no less important. For, again, if contrary places are places that are furthest apart (ii), and if this distance must be determinate (iii), and if every distance between two places is determined by the shortest connection between them (i. e. the straight line), then it is clear that circular movements can never take place between contrary places, simply because *qua* points on a circumference any distance between them is indeterminate.[57] The arguments run as follows:

[56] *Apud* Simplicium *In de caelo* 174,11–13.

1. 271 a 5–10: The movement from A to B along the circumference of a circle is not contrary to the movement from B to A because there may be an infinite number of circumferences between the two points. That is to say, the movements would indeed be contrary if they were rectilinear and bounded by points A and B, but since the movement is curved it could take place on an infinite number of circumferences which all pass through points A and B. Because they are infinite in number they may not be called contrary movements.

2. 271 a 10–13: This argument assumes that there is only one circumference, a semicircle with distance CD as its diameter and base. Aristotle argues that the movements from C to D and from D to C (e. g., the movements of a pendulum) are not contrary as such, for the following reason, 271 a 13: "For we always determine how far away something is by means of the straight line." If we accept Simplicius' explanatory remarks, Aristotle can be taken to say that, since the distance along the circumference is indeterminate, points C and D cannot be said to be at a determinate distance; C and D therefore are not contrary places, nor are the movements between them contrary movements.

3. 271 a 13–19: Assume two semicircles H and O which, if joined together, constitute a circle bisected by the diameter at points E and Z. Aristotle's argument that the movement from E to Z along semicircle H is not contrary to the movement from Z to E along semicircle O is self-evident and redundant. That any circular movement is not contrary to itself needs hardly be demonstrated.

4. 271 a 19–33: The fourth and final argument is the most crucial one. Anyone would concede that counterclockwise movement is contrary to clockwise movement. Aristotle himself says this in the *Physics*.[58] But here Aristotle argues that, given that there are three points B, A,

[57] Presumably because the circumference and the straight line are incommensurable; cf. Aristotle *Phys.* VII 4, 248 b 4–6.

[58] Though of course not in the same terms, see *Phys.* VIII 8, 262 a 6–12: "Moreover, we have an indication that motion from A to B is contrary to motion from B to A in the fact that, if they occur at the same time, they arrest and stop each other. And the same is true in the case of a circle: the motion from A towards B is the contrary of the motion from A towards C: for even if they are continuous and there is no turning back they arrest each other, because contraries annihilate or obstruct one another." (Hardie and Gaye).

and C on a circle, the movement from A to B is not contrary to the movement from A to C. This time he gives two reasons. The first reason, a 20–22, is that both movements eventually return to point A, i. e., to the same place rather than to the contrary place. Therefore the movements cannot be contrary. The reason is merely nominal and depends entirely on the definition of contrary movements, which have to occur, according to Aristotle, between contrary places. Aristotle's point is that circular movements in different directions are not contrary movements. So far he treats the problem almost entirely as a geometrical one. The last argument, in contrast, leaves the level of geometry and imports physical, even metaphysical premises.

Aristotle states 271 a 22 f. + 31–33 that if there were a movement contrary to circular movement, one movement would be useless (μάτην). If they were equal, they would cancel each other out; if one was stronger (ἐκράτει), the other would be rendered inoperative (ἡ ἑτέρα οὐκ ἂν ἦν). But God and nature create nothing that is useless, therefore (and this seems to be the implicit conclusion) it is not possible that a movement contrary to circular movement exists. *Prima facie*, this argument seems to contradict the appearances, for the movements of the celestial bodies are complex. Does Aristotle want to deny on metaphysical grounds the existence of the movement of the moon, the retrograde movement of the planets, and the movement of the sun through the zodiac? The argument does not have to be read in this way. When Aristotle claims that contrary circular movements would cancel each other, or else the stronger movement would prevail, he may indeed want to account for the phenomena. That is to say, the complexity of the movements of the spheres itself demonstrates that the movements are not contrary movements. For if they were, the celestial movement would either be entirely uniform or even non-existent. Of course there are, Aristotle would say, many different movements observable in the heavens, but precisely because they co-exist, forming a complex motion, they may not be regarded as contrary movements.

The four arguments just set out put Aristotle's theory of aether in a rather advantageous position. For if Aristotle is right, it would be impossible to object to his concept of aether on the grounds that the movements of the heavens are complex and irregular. Aristotle, or any later Peripatetic cosmologist, need not have been concerned about the growing complexity of astronomical theories attempting to save the

phenomena. As far as Aristotle is concerned, any kind of movement may be observed in the celestial region: it would confirm his view that no movement is contrary to circular motion. And Aristotle himself points out that the movement of the heavens is not uniform and one, for which reason there is generation and decay in the sublunary world.[59]

Nevertheless, it seems doubtful that Aristotle's position can be saved entirely. Are his claims not incompatible with his proposal of a physical variant of Eudoxus' theory of homocentric spheres as worked out by Aristotle in *Metaphysics* XII 8? This theory presupposes the interaction and mutual cancellation of the movements of spheres revolving in contrary directions,[60] a fact which seems to be explicitly ruled out in *De caelo* I 4. It is important to recognise that in Aristotle the theory of aether and the physical theory of homocentric spheres are incongruous.[61]

Most striking and remarkable is certainly the quasi-mathematical approach these arguments exhibit. In order to 'demonstrate' the eternity of the heavens, Aristotle abstracts from physical data and concepts. One could almost say that he introduces a geometrical model which he takes to behave essentially in the same way as the physical counterpart. No part of these arguments, however, seems to require that the geometrical figure of the model is actually instantiated perfectly in the movement of the celestial spheres. The revolutions of the celestial spheres are simply reduced to hypothetical movements along chords, semicircles, and circles, and the natural movements of simple bodies between cosmological regions are looked at as movements between mere points. In Aristotle's theory of aether, mathematical and physical reasoning are intimately connected, so intimately that some of the most decisive arguments seem to rely exclusively on geometry in the widest sense – rather than physics.

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[59] See *De caelo* II 3; *Gener.corr.* II 10.

[60] See *Metaph.* XII 8, 1073 b 38–1074 a 14. Aristotle introduces so-called ἀνελλίττουσαι σφαῖραι in order to explain the variations in the planets' motion by means of a mechanical interaction of the spheres. He avoids, however, more explicit language of contrariety.

[61] Significantly, in *Metaphysics* XII 8 aether is not mentioned, and Easterling (1961) has shown that the theory of homocentric spheres is alien to the main body of the *De caelo* (with the exception of II 12, which is presumably a later addition).

4.4 Conclusion

In the third section of the theory of aether, *De caelo* I 3–4, Aristotle aims at a theoretical assessment of the nature of the celestial element. The discussion results in the assignment of a number of negative predicates to aether: it is neither heavy nor light, not subject to generation and destruction, not subject to increase, diminution, or alteration. The striking feature of the arguments is that they rely on and operate with only one empirical datum: the circular movement of the heavens as opposed to the rectilinear movements of earth, air, fire, and water. The remaining premises of the arguments are either constituted by or deduced from physical, metaphysical, or geometrical assumptions, e. g., that nature is a principle of motion, that generation takes place between contraries, that one thing possesses only a single contrary, and that there are no contraries on the circumference of a circle. One of the most objectionable premises employed is the ambiguous proposition that no movement is contrary to circular motion, a vital premise for the argument showing that aether is eternal *a parte ante* and *a parte post*. Aristotle attempts to establish the truth of that premise in a separate chapter, *De caelo* I 4, and it was here that his readiness to apply geometry to the realm of physics became most apparent. Aristotle introduces a geometrical model of hypothetical movements of points along the circumference of semi-circles and circles. He evidently assumed that there exists an intimate connection between the geometrical model and the physical world. In virtue of this connection it is valid to infer that the conclusion "no movement is contrary to circular movement" is true both of the geometrical model and the physical world. Aristotle does not explicitly justify his methodology, and his arguments do not seem to depend on the supposition that the movements of the heavens represent *perfect* physical instantiations of a geometrical circle.

Concluding the analysis of Aristotle's theory of aether, there remains the final question of the nature of the celestial element. Aristotle, no doubt, would have answered that aether is a simple body, that it is eternal, unchangeable in every way except spatially, and that it is prior to the sublunary elements, more honourable and divine. More important than this, however, seems to be the fact that aether lacks certain properties which essentially belong to and constitute a physical body. In Aristotle's universe, physical bodies are heavy or light, hot and cold, wet and dry – in almost any kind of combination with an infinite number of intermediates between the extremes. According to Aristotle, *per se* none of these properties can be assigned to the celestial body. But what is this pure substance, devoid of all the qualities of ordinary physical bodies? The existence of such a 'body' is problematic, and almost impossible to conceive. In the same way it would be impossible to conceive of, say, an atmosphere without 'weather'. Aristotle's aether is unlike any physical body ever encountered. In postulating the physical existence of such a semi-body, he clearly transcends the boundaries of the science of physics as an inquiry into the sensible world.[62]

Looking back at the arguments of Aristotle's theory of aether, the fallacies and weaknesses need not be pointed out once again. It has become sufficiently clear that – even on the assumption of an Aristotelian universe – the postulation of a primary celestial element which is eternal and unalterable is indefensible. The fact that the concept of aether is hardly referred to in Aristotle's later writings may perhaps be taken to indicate Aristotle's own dissatisfaction with that theory. Some of its suppositions are incompatible with a theory of homocentric spheres. On the other hand, the fact that the theory of aether has been so vigorously defended and reiterated by philosophers like Alexander of Aphrodisias, Simplicius, Thomas Aquinas, and Cesare Cremonini, may perhaps be regarded as a scandal in the history of philosophy. It is not entirely clear why the Aristotelian concept of aether found recurrent approval over a period of nearly 2000 years and was eventually abandoned only in the course of the revolution of science in the 16th and 17th centuries.[63] One reason is presumably that it benefited from the general belief in the geocentricity of the universe and the widely accepted plausibility of Aristotle's theory of natural locomotion in the sublunary region. The postulation of a fifth element is the natural consequence of Aristotle's theory of rectilinear movements in earth, air, fire, and water. The theory of sublunary motion represents a closed system which cannot account for the circular movement of the heavens.

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[62] Cf. the criticism made in the second century A. D. by the Platonist Atticus, *apud* Eusebium *Praeparatio evangelica* XV 7. – The fact that aether transcends the realm of the physical comes to light too in Aristotle's revealing description of it as τι παρὰ τὰ σώματα τὰ δεῦρο (269 b 14 f.); in the *Metaphysics* τὰ δεῦρο are frequently contrasted in a similar way to Platonic entities.

[63] On the fate of the Aristotelian concept of aether see Hesse (1967); Rosen (1985); Westfall (1969).

Since nature is a principle of motion, the body which moves in a circle ought to be different from the elements which move in a straight line. Both theories go together, and critics of Aristotle's theory of aether, like Philoponus, have found it necessary too to introduce substantial changes in Aristotle's theory of sublunary motion and the function of nature in it.

Part II

5. Philoponus' Rejection of Aether: Book I

5.1 Introduction

> Has philosophi demonstrationes persequunti sunt posteriorum nonnulli, Ioannes Grammaticus acerrime omnium.
>
> Cesare Cremonini (1616)

The observation that Philoponus attacked Aristotle's arguments for the existence and the qualities of a fifth element "acerrime omnium", as Cesare Cremonini puts it, appears to be correct enough.[1] Not that Philoponus' objections give the impression of being particularly polemical; rather, they are pertinent and often valid and detrimental because they rest on a deep understanding of Aristotelian philosophy. Philoponus' critique may rightly be regarded as more thorough than anything previous critics had brought forward against Aristotle's cosmology both because of the attention he pays to detail and because of the general strategy and structure of the *contra Aristotelem*. Formally, Philoponus' major strategy consists in disclosing inconsistencies, contradictions, and absurd consequences, but above all in turning well-founded Aristotelian tenets against Aristotle himself. As regards the content, one could divide Philoponus' treatise into three major parts. The first part, consisting of books I–V (now fragments 1–107), contains a detailed critique of Aristotle's theory of aether. In the second part, book VI (fragments 108–133), Philoponus not only rejects Aristotle's arguments for the eternity of motion and time as developed in *Physics* VIII, but also, and more importantly, devises a number of celebrated proofs of their finitude. The third section, which consisted of at least two further books of which we possess almost no evidence whatever (fragment 134), was presumably more theological in character and dealt with the eschatological problems of the world's end and the

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[1] Witness the 134 extant fragments of the *contra Aristotelem* which are now translated into English with introductions and notes; see Wildberg (1987 b).

creation of a new world.[2] Most probably, the *contra Aristotelem* was written between 530 and 533/4, i. e. only a few years after the *contra Proclum* (529). More important than this is the likely relative date. Considerable evidence suggests that the open polemic against Aristotle was either entirely or almost completed when Philoponus was still lecturing on Aristotle's *Meteorology*.[3] If books VII and VIII were indeed as theological in character as Simplicius' remarks in fr. VI/132 and the Syriac fragment VIII/134[4] suggest (see note 2), then the *contra Aristotelem*, as a treatise which is both philosophical and theological, would indicate the gradual shift of its author's intellectual interests.[5]

This second part of the present essay concerns itself with those fragments of the *contra Aristotelem* which are critical of Aristotle's theory of aether. As has been pointed out in the general introduction (chapter 1), Philoponus' critique aims to cast doubt upon Aristotle's conception of an eternal and self-identical universe, and to pave the way for a philosophical justification of the Christian doctrine of the creation of the world. It is thus the first and crucial step towards a full refutation of the concept of an eternal world in so far as it removes the physical theory supporting this conception. Although Philoponus' critique is treated here as a self-contained piece of philosophical criticism

[2] This at least is discussed in the eighth book; see the Syriac fragment fr. VIII/134 (Brit. Mus. MS 17 214, fol. 72vb,36–73ra,19): "The title of the second chapter of the eighth book of John the Grammarian's *contra Aristotelem*: 'Our argument affirms that that which is subject to resolution into not-being is not wicked on its own and by itself, and that that into which the world will be resolved is not not-being.' – From the second chapter: 'However, the world will not be resolved into not-being, because the words of God are not resolved into not-being either, and we clearly speak of new heavens and a new earth.'"
This fragment ties in with Simplicius' remark fr. VI/132: *In phys.* 1178,2–5: "〈The Grammarian〉 declares that this world changes into another world which is more divine – a 〈proposition〉 he elaborates in the following books (ἐν τοῖς ἑξῆς βιβλίοις) – not realising that this is not a destruction of the world but a perfection." – On the problem of the precise allocation of the fragments to certain books see Wildberg (1987 b), 26–28.

[3] On the absolute and relative dates of the treatises see Wildberg (1987 a). É. Evrard (1953) proposes the variant relative chronology: *contra Proclum* – *In meteor.* – *contra Aristotelem*.

[4] The roman numeral assigned to a fragment refers to the book of the *contra Aristotelem* to which the passage originally belonged; on the structure of the treatise and the allocation of the fragments to the various books see Wildberg (1987 b), 26–28. The source of each fragment is generally specified in the text of this commentary; in addition, a list of the extant fragments of the *contra Aristotelem* can be found in the appendix.

[5] Cf. the brief biographical sketch in chapter 1.

in its own right, it may well be regarded as preparatory for the final arguments of the sixth book proving the temporal finitude of the world, and for the following eschatological speculations.

The primary aim of the second part of this commentary is the reconstruction of the strategy and content of Philoponus' criticism of Aristotle's theory of aether. A first reading of the fragments shows that Philoponus seems to have followed the structure of the theory as set out by Aristotle in *De caelo* I 2–4 very closely, except for the third book, where he discusses an argument from the *Meteorology*. His procedure is reflected in the arrangement of the fragments extant in the commentary of Simplicius, who seems to have followed in parallel the outline of the *De caelo* and of the *contra Aristotelem*. Philoponus' detailed scrutiny of the arguments of the first chapters of the *De caelo* enables him to refute systematically as many explicit or implicit assumptions and logical inferences as he possibly can. In view of this fact the extant fragments represent, as such, an impressive example of philosophical invective. But there can be no doubt that in spite of the often incompatible ramifications of his objections in the *contra Aristotelem*, Philoponus is indeed striving to outline an alternative cosmological theory. In the course of his dealings with Aristotle's theory of aether, Philoponus worked hard on the development of a cosmology which combines Platonic, Aristotelian, and Christian elements. The theory, as we find it in the *contra Aristotelem*, differs in important respects from ideas expressed in earlier treatises, e. g., the *contra Proclum*, and is by no means his final conception of the structure of the universe. Writing the *contra Aristotelem*, Philoponus seems to have developed ideas which led him, ultimately, to the negation of a world-soul and the application of impetus theory to the movement of the celestial bodies, which are the most striking features of his cosmology in the *De opificio mundi*.[6] The *contra Aristotelem* may be adequately described as an important step in this development, and excursuses in chapters 6 and 7 as well as the final chapter will discuss certain aspects of the development of his views and their transformation at later stages.

Reading the extant fragments of the *contra Aristotelem*, it is important to bear in mind that the polemical nature of the treatise allows Philoponus to assume certain positions merely for the sake of argument. In other words, although all fragments contain arguments against

[6] See the discussion below in chapter 8.3.

Aristotle, not every fragment reflects Philoponus' own conviction. In order to discover not only the dialectical route of his objections, but also Philoponus' own views, it is almost always necessary to consider a whole sequence of arguments related to one particular problem. The following commentary is therefore subdivided into sections which discuss sets of fragments dealing with the same topic. Only in this way can justice be done both to the argument of each fragment and to the general strategy of the *contra Aristotelem* as a whole.

In the first book against Aristotle, Philoponus discusses three major issues arising from Aristotle's arguments in *De caelo* I 2. Beginning with a critique of Aristotle's problematic correlation of bodies and movements in elements, he attempts to show that one is not entitled to infer from the circularity of the celestial motion that the body of the spheres must be different in nature from the sublunary bodies. Moreover, Philoponus questions the validity of Aristotle's theoretical division of natural locomotion, thus undermining the foundations of his first attempt to prove the existence of aether. That proof stated in its conclusion that the celestial body must be simple and able to revolve in a circle by virtue of its own nature, for the movement of the heavens is both simple and natural. Philoponus rejects this conclusion in an important set of arguments aiming to show that the movement of the sublunary firesphere is both natural and simple. Next, Philoponus attacks Aristotle's second proof in *De caelo* I 2. He denies that this argument actually demonstrates the ontological primacy of the celestial body over the sublunary world. On the basis of premises conceded for polemical purposes he disowns Aristotle's and Alexander's supposition regarding the completeness of the circle and circular motion: Their belief in the primacy of circular over rectilinear motion is arbitrary. The first book of the *contra Aristotelem* concludes with an excursus, which did not remain extant, on earlier philosophers who also rejected Aristotle's postulation of aether.

5.2 The Correlation of Natures and Motions

The first five fragments I/1–5 contain three different arguments, the first of which has been preserved by three different and presumably independent sources: Simplicius, the Byzantine scholar Symeon Seth, and Farabi. The arguments form a systematic unit in so far as they are

directed against Aristotle's division of locomotion and his problematic 'correlation' of movements and bodies. It is significant that Simplicius, who does not mention any objections raised by Philoponus against *De caelo* I 1, does not give any evidence that Philoponus directly attacked Aristotle's fundamental assumption that nature is a principle of motion. This can be taken as a first indication, to be confirmed later, that in the *contra Aristotelem* Philoponus himself accepts this Aristotelian tenet.

5.2.1 Fragments I/1–3

In chapter 3 above, sections 1.2–4, the problems arising from Aristotle's division of the genera 'locomotion' and 'body' have been discussed to some extent. In order to understand the following arguments it may be helpful to recall the main difficulty of those passages. Aristotle's theses in *De caelo* I 2, 268 b 17–269 a 2 can be summarised in the following way:

(1) All natural bodies are movables in space; their nature is a principle of their motion.
(2) On the level of elementary bodies five different bodies with different natures may be distinguished: aether, fire, air, water, and earth.
(3) Elementary bodies are simple, and simple bodies move with a simple motion.
(4) There are three specifically distinct simple motions in space: upwards, downwards, and in a circle.

If one attempts, as Aristotle does, to correlate bodies and motions, the primary difficulty lies in the fact that the existence of five elementary bodies with well defined natures seems to require the existence of five different simple motions in space, if indeed nature is a principle of their motion. Yet the number of simple movements is merely three. This systematic difficulty arises because the concept of nature is complex. In proposition (2) the nature of the five elements is determined by virtue of their possession of primary qualities such as hot, cold, moist, and dry, or, in the case of aether, by virtue of the absence of these qualities. *These* 'aspects' of nature, however, do not function as principles of *local* movement, but of chemical change as well as of generation and corruption. The locomotion of elements, on the other hand, is closely

related to their possession of weight and lightness. According to Aristotle's theory, bodies possessing the property of lightness move upwards to the circumference, heavy bodies downwards to the centre. Accordingly, since aether is neither heavy nor light, it moves neither upwards nor downwards but in a circle. Speaking of the nature of a body therefore is necessarily ambiguous unless these two quite different senses of 'nature' are clearly distinguished. Aristotle himself has to be censured for not doing so in the present context.

A theorist following Aristotle in his failure to clear up the ambiguity may find it desirable to streamline the system so that the number of movements does correspond to the number of simple bodies. There is a choice between two options. One may say that the present division of motion is incomplete, so that upward and downward motion ought to be subdivided into two further species such that the number of simple movements increases to five. Historically, this was the line of argument taken by orthodox Peripatetics like Alexander and Simplicius. It has been shown above that their solution is untenable in view of the textual evidence, in particular of *De caelo* IV.[7]

The other option is to identify terrestrial elements which share the same movement, thereby assimilating water and earth, and fire and air respectively, and reducing the number of the elements to three. This option, however, is equally unacceptable on account of the neglected ambiguity of nature. Philoponus effectively exploits the ambiguity in his first objection to Aristotle in the following manner, fr. I/1*: *In de caelo* 26,31–27,4:

> "The first objection, then against the aforementioned hypotheses of Aristotle ⟨the Grammarian⟩ has taken in debased form from the arguments of Xenarchus as follows: If different movements are generated by different natures, it would be arbitrary if the nature generating the same movements is not one and the same. Therefore, since both earth and water move towards the centre, they should be of the same nature and the same species, and similarly fire and air, moving towards the upper region. And accordingly, a syllogism is formed by ⟨the Grammarian⟩ as follows:
> If earth and water are simple bodies and both move towards the centre, they should be moved, according to Aristotle, by the same nature; but bodies moved by the same nature *are* of the same nature and of the same species; therefore, as a consequence of this, earth and water are of the same species, which ⟨the Grammarian⟩ says to be evidently absurd, if indeed the one is dry and the other moist."[8]

[7] Cf. above section 3.1.4.

The consequence of determining the nature of an elementary body by its movement alone leads to the absurdity that the number of the terrestrial elements is reduced to two, making fire and water identical to air and earth respectively. Cornering Aristotle in this way, Philoponus is of course aware of the criticism to be expected from Peripatetic orthodoxy. Orthodox commentators would object that the assumption that all upward and all downward movements are one in species is false. Philoponus anticipates this objection. In the Arabic fragment I/3 sections (11) and (12) he gives two reasons why he thinks that Aristotle's division of motion is complete: There are only three simple movements, first because movement in a straight line can only be of two kinds since there are no more than two directions and two termini (11). Secondly, differences in speed do not result in a differentation of motion; even if water moves slower than earth the movement is specifically the same (12). For otherwise a large portion of earth which moves, according to the Aristotelian 'laws' of natural motion, faster than a small portion, would be specifically different from a smaller portion of the same earth.[9]

The gist of Philoponus' argument may therefore be summarised as follows: If nature is the principle of elementary motion, and if there are five specifically distinct elementary bodies but only three simple motions, then it is evident that different natures are able to cause the same motions. Although Philoponus does not directly reject Aristotle's assumption that nature is a principle of motion, he refuses to concede that the motion of body is unequivocally determined by its nature. Since there are more 'natures' than simple motions, it is not possible to acquire knowledge of the nature of a body solely on the basis of the form of its motion.

In the introduction to the first argument just outlined Simplicius says that Philoponus took the present objection from the arguments of Xenarchus, who was a 'Peripatetic' philosopher of the first century B. C. As Paul Moraux has shown, Xenarchus greatly sympathised with

[8] See also the rendition of the same argument by Symeon Seth, fr. I/2*: Delatte (1939), 41,1–14, and by Farabi, fr. I/3, sections 9–10+13: Mahdi (1967), 257–9.

[9] Both reasons are fundamentally in agreement with Aristotle, cf. above section 3.1.4, and see *Phys.* V 4, 228 b 28–30; *Cael.* IV 4, 311 a 21: "The heavier body moves faster in the same way".

certain tenets of Stoic philosophy.[10] Not long after the Aristotelian corpus was edited by Andronicus, Xenarchus revived the study of Aristotle with a very close and critical examination of Aristotle's natural philosophy. His main work was entitled "Πρὸς τὴν πέμπτην οὐσίαν", a treatise in which he repudiated Aristotle's arguments for the existence of aether. The work itself is lost, but Simplicius quotes it frequently enough to allow a fairly good reconstruction of the main arguments.[11] In the present context it is not possible to compare all the arguments of Xenarchus with the ones of Philoponus. Simplicius' remark, however, raises the general problem of the relation between Xenarchus and Philoponus. Simplicius no doubt intended to accuse Philoponus of plagiarising other philosophers. But to what extent can this be true? The fact that neither the fragments of the *contra Aristotelem* nor any other work by Philoponus mention Xenarchus explicitly may suggest that he never uses Xenarchus' polemic directly. Nevertheless, it is certain that the arguments were known to him at least through Alexander's commentary on the *De caelo*.[12] In the last fragment of book I (fr. I/36) Simplicius says that Philoponus "considers himself to have won an important point in showing that other (philosophers) as well have argued against the fifth substance."[13] It seems that Philoponus, just as in the *contra Proclum*, supported his own arguments by references to earlier thinkers who had already argued along similar lines, and it may well be possible that Philoponus did acknowledge his indebtedness to Xenarchus here.

However the case may be, the present argument (frr. I/1–3) attempts an improvement on Xenarchus' fourth argument.[14] Xenarchus held that it does not follow from the fact that the heavens move with a different movement that they are also different in nature; for one can see that the parts of air (or water) move with different movements towards their proper place, depending upon the starting point of their motion, but their nature no doubt remains identical. What this objection amounts to seems to be merely that Aristotle's line of argument is not

[10] Cf. esp. Moraux (1973), 197–214; further Moraux (1967).
[11] Cf. the lucid summary given by Moraux (1967), 1423 ff. and *id.* (1973), 198 ff.
[12] Simplicius reports that Alexander refuted Xenarchus' objections; see, e. g., *In de caelo* 22,18; 23,26; 24,20 f. It is clear from numerous passages that Philoponus consulted Alexander's commentary.
[13] See *In de caelo* 59,6–10.
[14] Cf. *apud* Simplicium *In de caelo* 23,31–24,7.

probative. Philoponus, on the other hand, suggests that it leads to absurd consequences. For if it is true that different movements are caused by different natures, then it should also be true, according to Philoponus, that the same movements are caused by the same natures, which reduces the number of elements to three rather than five, and this is an untenable consequence.

Strictly speaking, Philoponus' argument is logically invalid because it involves the fallacy of denying the antecedent. Philoponus himself must have been aware of this; his point seems to be a dialectical one, aiming primarily to question Aristotle's correlation of simple bodies and simple movements.

5.2.2 Fragment I/4

In approaching the intricate argument of fr. I/4 (*In de caelo* 28,1–11) we may begin by outlining the general relation pertaining between the nature and the motion of elementary bodies in Aristotle. Different aspects of this relation can be described as follows:

(1) Bodies different in nature move with different movements.
(2) Bodies of the same nature move with the same movements.
(3) Bodies different in nature move with the same movements.

Philoponus states propositions (1) and (2) at the beginning of fr. I/1*: *In de caelo* 26,33–35, and the purpose of that argument was to show that proposition (3) is true as well. It is clear, however, that proposition (3) contradicts (1), but both statements can be made compatible once it is realised that they are true of different kinds of elementary bodies. Proposition (1) is true of fire and water, or fire and earth, or air and earth. Proposition (3), on the other hand, is true of earth and water, or air and fire. In consequence, propositions (1) and (3) are not universally true. In order to make them compatible they may be reformulated in the form of particular affirmatives.

(1′) Some bodies that are different in nature move with different movements.
(3′) Some bodies that are different in nature move with the same movements.

Equally, proposition (2) does not seem to admit the universal quantifier either. Xenarchus showed in his fourth argument[15] that in Aristotle's universe it is not true to say that 'all bodies of the same nature move with the same movements', for water and air sometimes move downwards, sometimes upwards. Nevertheless, if natural movement is understood as the movement to the natural place, irrespective of whether this movement occurs upwards or downwards, then proposition (2) will be universally true.

There is another universal proposition Aristotle wants to be true in his universe:

(4) All movements that are different in species are the movements of bodies different in nature.

This statement represents the central idea behind Aristotle's arguments for the existence of aether. For if proposition (4) is true, it will indubitably follow that the celestial body possesses a nature which is different from the nature of the sublunary bodies because its natural motion is fundamentally different as well. If it were shown that proposition (4) is in fact not universally true, Aristotle's arguments for the existence of aether would become baseless.

Precisely this, I take it, is Philoponus' intention in the second argument as put forward in fr. I/4 (*In de caelo* 28,1–11). What he attempts to show is that

(5) Some movements that are different in species are the movements of bodies of the same nature.

Before we cite the argument it is necessary to point out a certain peculiarity. The argument does not involve particular affirmative propositions of the type just set out but what appear to be modal propositions. Philoponus evidently thinks that proposition

(3′) Some bodies that are different in nature move with the same movements

is equivalent to or at least implies the modal proposition

(3*) Bodies that are different in nature can (ἐνδέχεται) move with the same movements.

[15] See *apud* Simplicium *In de caelo* 23,31–24,7.

The probable reason why Philoponus chose (3*), rather than (3′), as premise for his argument will become apparent later; the argument relies, at any rate, solely on this proposition and an immediate inference he calls 'conversion with negation',[16] fr. I/4: *In de caelo* 28,6–11:

> "If (3*) bodies that are different in nature like earth and water can (ἐνδέχεται) move with the same movement, then, converting with negation you will say:
> There is nothing to prevent (οὐδὲν κωλύει) bodies which move with a different and not the same movement from being of the same nature, so that, even if the heavens move in a circle but the bodies below the moon move in a straight line, still there is nothing to prevent the heavens from being of the same nature as the sublunary bodies and perishable like them."

The argument runs as follows:

(3*) Bodies that are different in nature can move with the same movements.

Philoponus thinks to infer directly

(5*) Different movements can be the movements of bodies of the same nature.[17]

Philoponus indicates at line 28,8 that his argument relies on a logical figure called σὺν ἀντιθέσει ἀντιστροφή, the conversion with (or by) negation. This is a *terminus technicus* which originated in the context of the Stoic logic, and it is necessary first to clarify what it means. In his work on inferential forms Chryssipus distinguished five different modi of elementary inferences. These are such that their validity need not be demonstrated by a formal proof: they are ἀναπόδεικτοι.[18] The first two modi are as follows:[19]

(i) If p, then q; p; therefore q.
(ii) If p, then q; not q; therefore not p.

In the present context we are primarily concerned with the second modus, for Ammonius Hermeiou, the Alexandrian teacher of both

[16] σὺν ἀντιθέσει ἀντιστροφή. A slight variation of the following argument appears in lines 28,16–18. Cf. also Farabi's rendition of it: fr. I/3 section 14 (Mahdi (1967), 258 f.).

[17] Just as in the case of propositions (3′) and (3*), Philoponus apparently takes the modal proposition (5*) to be equivalent to or to imply proposition (5) above.

[18] See Sextus Empiricus *Adv. math.* 8.223, and cf. Frede (1974), 127 ff.

[19] These modi are distinguished and exemplified by Philoponus in his commentary *In an.pr.* 244,3–31.

Simplicius and Philoponus, calls this modus the 'conversion with negation'.[20] Simplicius gives a clear formal definition at *In de caelo* 29,3 f.:

> "The contradictory of the antecedent follows from the contradictory of the consequent."

These remarks clarify that the term 'conversion with negation' signifies an inference within the system of hypothetical syllogisms which is equivalent to *modus tollens* or, in modern propositional calculus, to the law of transposition:

$$(p \rightarrow q) \leftrightarrow (\neg q \rightarrow \neg p)$$

Returning to the argument of fr. I/4 the second problem arising is the fact that Philoponus' immediate inference does not resemble the form of the second hypothetical syllogism. Rather, it seems to consist of two propositions (3*) and (5*), whereby the second could be regarded as the contrapositive of the first.[21] Also, as has been pointed out, both propositions are not straightforwardly categorical but problematic: the connectives ἐνδέχεται (28,7) and οὐδὲν κωλύει (28,8) indicate that the modal category of possibility is involved.

Philoponus' inference is fallacious because he commits a formal error; for convenience and clarity let the argument be reformulated in terms of the propositional calculus.

For this purpose let 'different' be equivalent to 'not the same', and 'same' be equivalent to 'not different'. Further let

p = the nature is the same
$\neg p$ = the nature is not the same, i. e., is different
q = the movement is the same
$\neg q$ = the movement is not the same, i. e., is different.

Then Philoponus' argument may be formalised as follows:

$$(\neg p \rightarrow Mq) \rightarrow (\neg q \rightarrow Mp)$$

This, however, is more than the law of transposition entitles one to conclude; the rules of transposition only legitimise the following inference:

[20] Cf. Ammonius *In an.pr.* 68,28. See also Galen *Institutio logica* 14,17–21; Frede (1974), 150, and Lee (1984), 86 f.

[21] Lee (1984), 86 points out that the term σὺν ἀντιθέσει ἀντιστροφή was used also to denote contraposition in predicate logic, e. g., $AaB \rightarrow \neg Ba \neg A$.

$$(\neg p \rightarrow Mq) \rightarrow (\neg Mq \rightarrow p)$$

Simplicius perceives this error clearly. He complains *In de caelo* 28, 18–27 that Philoponus is ignorant of the conversion by negation because he does not place the negation particle in the proper place. For the proper negation of the consequent of the conditional premise 'the movement can be the same' is 'the movement cannot be the same', and not 'the movement is not the same'. Simplicius' point is that in negating Mq Philoponus did not write $\neg Mq$ but simply $\neg q$.

It is not possible to save the argument. Philoponus does not indicate how he thinks he can infer after transposition:

$$(\neg Mq \rightarrow p) \rightarrow (\neg q \rightarrow Mp).$$

This inference is invalid unless additional assumptions are imported. There is a choice between two assumptions:[22]

Either (1) $\neg q \rightarrow p$
or (2) $\neg q \rightarrow \neg Mq$

The first assumption begs the question; it reads: 'If the movement is not the same, then the nature is the same'. But it is precisely the possibility of this thesis which the argument intends to establish.

The second alternative is to assume: 'If the movement is not the same, then it cannot possibly be the same'. That is to say, if the movement of two elementary bodies is different in species, it is impossible that it ever be the same. E. g., since the parts of fire and the parts of the celestial sphere move with different movements, it is not possible that these parts move at any time with the same movement. Although this assumption would save Philoponus' argument, it contradicts the position he would like to demonstrate. In the following arguments Philoponus defends the Platonic and Stoic opinion that the heavens too consist of some sort of fire, and he asserts that both fire and air possess two natural movements: upwards and circular.[23] In consequence, he must suppose that it is possible for parts of fire to move both with different as well as the same movements.

The question may be asked, Why did Philoponus choose to use the modal premise (3*) rather than the more straightforward particular

[22] *Ad* (1): If it is true that $\neg q$ implies p, then it is valid to infer that $\neg q$ implies Mp as well.
Ad (2): If it is true that $\neg q$ implies $\neg Mq$, and if $\neg Mq$ implies p [Transp], and if p implies Mp, then it would also be true that $\neg q$ implies Mp.

[23] Cf. below frr. I/11*–13*; 17*.

affirmative proposition (3′) 'Some bodies that are different in nature move with the same movement'? The answer is presumably that Philoponus wanted to disguise the formal invalidity of his inference. σὺν ἀντιθέσει ἀντιστροφή, or rather contraposition, of particular affirmative statements is generally not a valid immediate inference.

Simplicius' further criticism at *In de caelo* 28,29–32, I take it, leads in this direction. He says that in the case of problematic statements, i. e., statements in which the affirmation and its opposite possess equal possiblity, the conversion with negation does not possess the force of necessity, οὐκ ἔχει τὸ ἀναγκαῖον. He claims 28,32–29,7 that in Philoponus' argument the antecedent itself, rather than the negation of the antecedent, follows from the negation of the consequent.[24] He supports his point that in some cases of problematic propositions conversion with negation is invalid with two examples as follows, *In de caelo* 29,10–20:

(1) "If it is a man, then it is possible for it to be literate; if it is not possible for it to be literate, then it is not a man."

(2) "If it is an animal, then it is possible for it to move the upper jaw; if it is not possible for it to move the upper jaw, then it is not an animal."

Whereas the conclusion of the former inference is true, the conclusion of the latter is false. Most animals are in fact incapable of moving the upper jaw, yet there are some species that possess the ability to do so, notably reptiles, e. g., the crocodile, cf. Simplicius' example 29,16.[25] The reason Simplicius gives is that in the first example the possibility of being literate applies universally to all mankind, whereas in the second example the possibility of moving the upper jaw applies only to some animals, *In de caelo* 29,9.14.19 f. Simplicius suggests that Philoponus' argument is just like his second example and is therefore invalid. The law of transposition does not apply in these cases, he would argue, because the antecedent itself, rather than the negation of the antecedent, follows from the negation of the consequent. If it is

[24] I. e., if the movements of two bodies are different, then the bodies in motion are different in nature rather than of the same nature.

[25] In modern biology this ability is called 'kinesis'. Most reptiles as well as sharks possess kinesis, see, e. g., J. Z. Young. 1962. *The Life of Vertebrates*. 2nd ed. New York and Oxford, 377. – Cf. also Aristotle, *Hist.an.* I 11, 492 b 23 f.

not possible for something to move the upper jaw, then it may still very well be an animal, for most animals possess a fixed upper jaw.

In addition to these two points Simplicius criticises Philoponus' terminology in order to cast doubt upon and ridicule his ability as a logician.[26] Both Stoic and Peripatetic logicians used to call the conditional premise of a hypothetical syllogism (if p, then q) συνημμένον, comprising the antecedent (if p; ἡγούμενον) and the consequent (then q; ἑπόμενον).[27] The additional assumption (p) was called μετάληψις in Peripatetic and πρόσληψις in Stoic logic, the conclusion (then q) συμπέρασμα and ἐπιφορά respectively.[28] Neither school used a single term to denote the additional assumption (p) together with the conclusion (then q). At *In de caelo* 30,15–19 Simplicius points out that Philoponus invented the term δεύτερον συνημμένον for this purpose, which is entirely unusual.[29] It is not difficult to see the reason why Philoponus used this term. It has been pointed out above that his argument does not represent the second standard form hypothetical syllogism but the immediate transformation of one hypothetical and problematic proposition into another. If the first proposition is called συνημμένον, one understands why he would call the second one δεύτερον συνημμένον.

5.2.3 Fragment I/5

Although Philoponus has failed so far to show that the celestial body may well be regarded as the same kind of substance as the sublunary bodies, he has succeeded in showing that the movement of a body does not supply significant information for the determination of the nature of a body. In Aristotle's universe bodies of different natures can move with the same motion, and Philoponus insists that it should be equally possible that bodies of the same nature move with different movements. In the following fragment (fr. I/5: *In de caelo* 30,26–34) Philoponus elaborates this point. He attempts to show that even if it is possible to infer the existence of certain qualities of a body from its natural motion, viz. weight and lightness, it will nevertheless

[26] See *In de caelo* 30,15–19.

[27] Cf. Philoponus *In an.pr.* 242,24–34 and Frede (1974), 80 note 18.

[28] Cf. Philoponus *In an.pr.* 242,34–243,10 and Frede (1974), 118 note 2.

[29] Read πρόσληψις instead of πρόληψις in Simplicius *In de caelo* 30,18.

be impossible to infer, without additional information, the character of the other qualities constituting its nature. For the sake of the argument Philoponus agrees in fr. I/5 that the heavens possess neither weight nor lightness because they naturally move in a circle, and heavy and light elements move upwards and downwards respectively. He then argues that this concession does not entail the conclusion that the heavens are also devoid of heat and cold, fr. I/5: *In de caelo* 30,29–34:

> "For even if light bodies always happen to be hot, and equally, if heavy ones are always cold, it will not necessarily follow that those bodies which are neither light nor heavy are devoid of coldness and heat. For the conversion from the antecedent (ἡ ἐκ τοῦ ἡγουμένου ἀντιστροφή) is not sound. Look: if someone is a man, he is also always an animal; but it is not true to say that if someone is not a man, then he is also not an animal."

From a purely logical point of view this argument rests on the avoidance of the fallacy of denying the antecedent. However, the question presents itself, Why did Philoponus find it necessary to attack this fallacious argument? One answer would perhaps be that he took it to represent the general strategy of *De caelo* I 3. For in I 3, 269 b 18–270 a 12 Aristotle lays down that the heavens are neither heavy nor light, and continues 270 a 12–14:

> "It is equally reasonable to assume, too, that this body is ungenerated and indestructible, and neither subject to growth nor alteration."

Aristotle first establishes the absence of weight and lightness and then shows indeed that no contrary at all pertains to the heavens. But the two steps are not linked with each other directly such that the latter is taken to follow from the former. Rather, the circularity of the celestial motion provides in both cases the reason why Aristotle postulates the absence of any kind of contrariety. It is therefore not entirely clear whether Philoponus indeed intended to attack this passage in *De caelo* I 3, or whether he had some other argument in mind. It is clear, however, that fr. I/5 supports the claim made at the end of fr. I/4 that nothing prevents the heavens from being of the same nature as the sublunary elements, and from being perishable like them.[30] For if it is true that the absence of weight and lightness does not entail the absence of the other primary qualities (e. g., hot and cold), then it is still possible that the heavens are perishable because of this. Philoponus could have

[30] Simplicius remarks at *In de caelo* 28,11 that Philoponus is eager to draw this conclusion in virtually every argument.

supported his claim by pointing out that some celestial bodies are evidently hot.[31]

Simplicius' swift rebuttal of this argument is worth mentioning. Philoponus has made the logical point that the following argument is invalid:

> If p, then q; not p, therefore not q.
> (Fallacy of denying the antecedent)

At *In de caelo* 30,34–31,6 Simplicius argues that there are cases in which the above argument may be valid, 31,1 f.:

> "If the ⟨propositions; terms⟩ are co-extensive (ἐξισάζειν), then there is nothing to prevent the conversion (ἀντιστροφή) to be formed from the antecedent,"

rather than from the consequent of the conditional premise, as required in *modus tollens*. He gives the following example:

> If it is a man, then it is capable of smiling.

One may infer both that:

> It is not capable of smiling; therefore it is not a man.

and

> It is not a man; therefore it is not capable of smiling.

In this example the terms 'man' and 'capable of smiling' are co-extensive, for being capable of smiling is a proprium of man. Simplicius further maintains that Philoponus' argument fr. I/5 is not sound in the context of primary qualities because the terms 'hot' and 'light' as well as 'cold' and 'heavy' are co-extensive. In defence of Philoponus one could reply that co-extensiveness breaks down in the case of the primary qualities 'wet' and 'dry'. I. e., although it may be true to say that an elementary body moving, e. g., upwards is hot, it remains uncertain whether the body in motion is fire or air.

[31] It can only be conjectured that Philoponus adduced an empirical argument in the present context. He did so elsewhere, as is clear from fr. III/59: *In de caelo* 89,20–22: "Yet ⟨the Grammarian⟩ is arguing on the assumption that the celestial bodies are also tangible to us; this is clear from his frequent appeal to the heat of the sun ..." – Aristotle, who refuses to acknowledge any kind of quality in the heavens, has to explain the heat of the sun as a sublunary phenomenon, cf. *Meteor.* I 3, 341 a 12 ff. and Gilbert (1967), 481 ff.

5.3 *Against the Division of Locomotion*

In his refutation of Aristotle's line of argument in *De caelo* I 2 Philoponus follows the text very closely. Having attempted first to unsettle Aristotle's conception of the relation between nature and movement, he continues with an attack on Aristotle's division of locomotion.[32] He aims to show first that the given διαίρεσις is inconsistent, fr. I/6 (*In de caelo* 31,6–16), that the theoretical distinction of rectilinear and circular motion is an inadequate representation of the actual movements in nature, fr. I/7 (*In de caelo* 32,1–11), and finally, that a juxtaposition of rectilinear and circular motions *qua* physical motions is unwarranted because the bodies in motion, i. e. the celestial whole on the one hand and the sublunary parts on the other, are not on an equal footing, fr. I/8 (*In de caelo* 33,17–20). Philoponus denies in these arguments that Aristotle is justified in theoretically dividing the genus 'locomotion' into species, and in assuming subsequently that this theoretical division corresponds to and represents the types of simple locomotions encountered in nature.[33]

5.3.1 Fragment I/6

Philoponus attempts to show that the Peripatetic derivation of the number of kinds of simple bodies from the number of simple motions leads to absurdities. First Philoponus grants his opponents that the natures of fire and earth are different *because* their movements are different in species. He then argues by analogy that if this is the case in the sublunary region the same must be true in the case of the movements in the heavens, fr. I/6: *In de caelo* 31,7–14:

> "Just as in the case of the four elements: even if rectilinear movement is one in genus, there still exists, since the movement away from the centre is different in species from the movement towards the centre, a difference in species between fire and earth because of this. In the same way, since there is a difference in species between westward and eastward movement, the moving bodies will also be different. And the planets, if they indeed differ naturally in speed from one another, as earth and water do although they possess the same downward momentum, differ in species because of being faster and slower."

[32] Cf. above 3.1.2.

[33] As pointed out above in section 3.1.2 Aristotle sets out to distinguish theoretically between circularity and straightness, and then continues to speak without qualms of motion about, towards, and away from the centre (of the universe).

Philoponus calls for consistency. Circular motion must be divided at least into eastward and westward motion. In addition, if one is prepared to differentiate the downward movement of water and earth,[34] it is equally necessary to differentiate between the different movements of the planets. However, if this kind of consistency is adhered to, the consequences are disastrous, fr. I/6: *In de caelo* 31,14–16:

> "Therefore he says that the simple bodies are not five only but equal in number to the spheres plus the four elements."

Since each celestial sphere must be regarded as consisting of a specifically different body, the absurdity follows that one must assume – at any rate in Aristotle's own system as proposed in *Metaphysics* XII 8 – no less than 49 different celestial bodies in addition to the four terrestrial elements.[35]

5.3.2 Fragment I/7

In the following fragment, Philoponus continues the polemic on a different level. He attacks Aristotle's assumption that the celestial motion is circular. For this purpose he relies on the Aristotelian definition of kinetic circularity[36] as formulated more precisely by Alexander of Aphrodisias, fr. I/7: *In de caelo* 32,1–11:

> "If Alexander was correct in pointing out that Aristotle defined that kind of motion as circular in the proper sense which takes place around the centre of the universe, but if those kinds of motions which do not take place around the centre of the universe are neither strictly circular nor simple, and if the stars too – which move with their own movement along the spheres, as the astronomers hold – revolve around distinct centres of their own which do not coincide with the centre of the universe, then it is evident that neither the stars themselves nor their epicycles nor the so-called eccentric spheres carry out a proper circular or simple

[34] As was thought to be necessary by some commentators, cf. above 3.1.4.

[35] On the problem of the correct number of spheres cf. Easterling (1961), 138 ff., and Hanson (1963). – Simplicius' reply at *In de caelo* 31,16 ff. is remarkably timid: although the spheres differ in species kinetically, they do not differ in matter.

[36] In *Cael.* I 2, 268 b 20 f. Aristotle says that circular motion takes place about the centre.

movement, because both downward and upward movement are observed. For even if this conflicts with Aristotle's hypotheses, the stars are clearly seen to reach a perigee and an apogee."

Philoponus relies on Alexander's rather than Aristotle's version of the definition of circularity because the precise formulation is more open to criticism. Alexander adds that any movement which does not take place around the centre of the universe, i. e. any eccentric motion, is not circular nor simple in the strict sense. If Alexander's version of the definition is accurate and in agreement with Aristotle's intentions, the conflict between Aristotle's assumption that the heavens move in a circle and the astronomical theories based on observation is clearly inevitable. For observation shows, as Philoponus points out correctly, that some celestial bodies are sometimes at apogee and sometimes at perigee.[37] In order to account for these variations astronomers since the third century B. C. had attempted to devise systems to replace Eudoxus' theory of homocentric spheres. Whereas Callippus and Aristotle sought to save the phenomena by mere modifications of Eudoxus' theory, Autolycus of Pitane (2nd half of the fourth century B. C.) was the first to realise that the variation of the size of the moon contradicted the theory of homocentrics. It was clear that no modification allowed for the variation of the distance of the planets from the earth.[38] Apollonius of Perga (262–190 B. C.) is credited with having produced the theoretical framework for the more successful theory of eccentrics and epicycles as worked out by Hipparchus (190–126 B. C.) and later Ptolemy (*fl. ca.* A. D. 127–148).[39] Irrespective of the mathematical exactitude of these theories, they presented the problem of the physical counterparts of the contrived eccentrics, epicycles, and their deferents. Aristotle, for that matter, may have been a realist in the sense that he may have regarded his theory of aether as compatible with the astronomical theories of his time.[40] Yet, the reconciliation of more advanced mathematical theories of epicycles with a physical theory

[37] E. g., the moon; in antiquity, the variation of the brightness of Venus, which is due to its phases, was wrongly supposed to have the same explanation.

[38] Cf. Simplicius *In de caelo* 504,20–24 and see Pedersen, Pihl (1974), 80 f.

[39] See Pedersen, Pihl (1974), 81 ff. and Dreyer (1953), 149–170.

[40] The theory of aether is in fact compatible with the theory of homocentrics only in so far as the proper circularity of the celestial motion is concerned. Incompatibility arises because the latter theory, unless it be regarded merely as a mathematical model, requires contrariety in celestial motion (i. e. counteracting spheres); this was ruled out by Aristotle in his theory of aether, but not in *Metaphysics* XII 8; cf. above 4.3.2.

postulating the existence of a homogeneous celestial aether was no doubt recognised as a problem.[41] Theon of Smyrna (*fl. ca.* A. D. 115–140), for example, assumed that the epicycle is the equator of a solid sphere which moves freely along the deferent inside a hollow sphere. The planet itself is attached to the equator of this solid sphere.[42] And Ptolemy, who at the beginning of his *Almagest* argues that the heavens are spherical because they consists of aether,[43] "composed a thoroughly cosmological work, the *Hypotheses of the Planets*, which includes a rather unsatisfactory physical mechanism for epicyclic motions."[44]

In contrast to these attempts Philoponus approaches the difficulty radically, bringing the theory of aether into conflict with Hellenistic astronomy. In fr. I/7 (*In de caelo* 32, 1–11) he points out that Aristotle's hypotheses clearly contradict the phenomena. The movements of the things in the heavens are not circular and simple, but eccentric and complex. In consequence, Aristotle's theoretical method of dividing 'locomotion' into simple circular and simple rectilinear motion in the context of a cosmological treatise can no longer be justified. According to Philoponus, the physical theory of aether is already refuted by the successful astronomical theory of epicycles.

5.3.3 Fragment I/8

In addition, Philoponus continues in fr. I/8, even if the theoretical division were sound and the heavens moved indeed with a simple and circular motion, it might nevertheless be objected that a comparison of celestial and sublunary motion is not possible, fr. I/8: *In de caelo* 33,17–20:

"Aristotle did not make the comparison between the elements and the heavens on the same assumptions, because in one case he took the whole

[41] Historians of science generally follow Duhem in their opinion that most ancient astronomers were not concerned with the physical implication of their systems. That Greek astronomy was in fact deeply rooted in physics has been shown by G. E. R. Lloyd (1978). – Cf. the remark made by Kuhn (1957), 105: "The Hellenistic astronomers who measured the universe, catalogued the stars, and grappled with the problem of the planets were clearly not indifferent to the cosmology developed by their Hellenic predecessors." On the problem see also Rosen (1985).

[42] Cf. Dreyer (1953), 160.

[43] Cf. *Almagest* I 3. See the translation by Toomer (1984), 40.

[44] Kuhn (1957), 105. Rosen (1985), 18 concludes: "Ptolemy accepted Aristotle's aither, but not his interlocking spheres transmitting motion from planet to planet."

as moving in its proper place, but in the other case he took a part as having abandoned its proper place and to have come to be in its counter-natural place."

Whereas the movement of the heavens is the movement of a whole, the movements of the elements are movements of parts. Modern commentators see the difficulty in the fact that in the one case the movement is *in* the proper place, whereas in the other it is movement *towards* the proper place.[45] In introducing the part-whole distinction Philoponus has made a far stronger point. It may be conjectured that this distinction has led him to the suggestion that the movement of the heavens ought to be compared to the movement of the totalities of the elementary bodies. In fr. I/9: *In de caelo* 34,7–9 he says that

"both the firesphere and the air move in a circle, and they possess this movement by virtue of their own nature – just like the heavens."

Philoponus argues that the movement of the totalities of fire and the adjacent sphere of air move with a movement that is identical in kind to the movement of the heavens. However, since a movement is determined not only by its shape (circular, rectilinear, simple or composite), but also by its origin (nature or an external force), one may speak of identity of motions if and only if both factors are identical. Hence, Philoponus assumes for the sake of the argument that the movement of these spheres is simple and circular. Subsequently, he attempts to show that it is also caused by nature, just as the movement of the heavens, fr. I/9: *In de caelo* 34,10. For this purpose he borrows an argument from Aristotle:

"It is better (κάλλιον) not to be at all than always to be in a state contrary to nature."[46]

The argument could be continued as follows: Since the firesphere does exist, and since it cannot be in a state of permanent frustration, its motion must be natural. Importantly, in the attempt to show that the movement of the heavens is not unique Philoponus argues that some totalities of the sublunary elements move in a circle naturally. In the course of a methodological criticism of Aristotle's division of

[45] Already Theophrastus asked in the *Metaphysics* why the heavens, given that they are in their proper place, are not enjoying rest rather than pursuing eternal motion; cf. *Metaph.* II 5 a 23–25.

[46] Aristotle uses a similiar argument when he attempts to show that the heavens cannot consist of fire, cf. *Cael.* I 2, 269 b 5–10.

motion[47] Philoponus arrives at a notion of extreme importance in his development of a theory of cosmological dynamics. At the centre of the first book of the *contra Aristotelem* lie the exposition of the theory of the naturalness of sublunar circular motion and its defence against Alexander's earlier interpretation. Moreover, as will be seen, the theory contrasts sharply with the current Peripatetic-Neoplatonic orthodoxy in late antiquity. The controversy and Philoponus' position in it are the subject-matter of the following section.

5.4 The Movement of the Firesphere

It is first necessary to outline the various theories on the movement of the outer sphere of the sublunary world. Subsequently, the relevant fragments I/9–17* will be commented on.

5.4.1 The movement of the firesphere in Aristotle's *Meteorology*

In *De caelo* IV Aristotle summarises his theory of natural motion and place of elementary bodies. According to him the sublunary universe is stratified in concentric layers of the elementary masses: the spheres of earth, water, air, and fire. The loci of these spheres are the natural places of the elementary bodies constituting the spheres, and the displaced elemental parts, if unobstructed, move to the appropriate loci by virtue of a natural principle. The concept of natural motion is closely connected with the concepts of 'weight' and 'lightness',[48] and fire, the lightest element, rises to the top of the other elements until it ceases to rise and comes to rest at the circumference of the sublunary world.[49]

In the *Meteorology*, which presupposes this theory, the stratum of fire is said to consist not of what we are accustomed to call fire but

[47] I.e., that Aristotle illicitly juxtaposes rectilinear and circular motion because the one belongs to parts whereas the other belongs to a whole.

[48] Cf. *Cael.* IV 3, 310 b 19–26. Weight and lightness as such are not the principles of natural motion; rather, whatever causes upward (downward) motion also causes lightness (weight), 310 a 29–b 1, and the motion is the actualisation of the respective quality, 311 a 1–8. Cf. above 3.1.1.

[49] *Cael.* IV 4, 311 b 21 ff.

rather of the hot and dry exhalations (ἀναθυμιάσεις) from the earth.[50] This quasi-fiery substance is highly inflammable but only potentially fire since it is not actually alight. In the following discussion it is referred to as 'fuel', ὑπέκκαυμα, a word which for the ancient commentators became the *terminus technicus* for the outer stratum of the sublunary world: the 'firesphere'.[51] The firesphere is bounded by the celestial region;[52] in order to explain various meteorological phenomena Aristotle supposes that the sphere is carried round in a circle by the agency of the heavens.[53] Since this is stated unambiguously, the problem arises how this theory is to be aligned with the equally unambiguous statement in *De caelo* I 2 which says that is impossible for any one of the sublunary bodies to move in a circle – either naturally or by force.[54] The explanation of this straightforward contradiction caused the ancient commentators considerable difficulty. The whole doctrine of the existence of aether seemed to be at stake. Whereas Platonists as well as Stoics seized the opportunity to attack Aristotle on the issue, the Peripatetic camp had to resort to modifications of Aristotle's theory in order to save it.

5.4.2 Solutions to the problem of the firesphere

In general, the question of whether or not the firesphere is in fact moving does not seem to have been disputed in Antiquity. Persuaded by the evidence of meteorological phenomena, all thinkers agreed that the totality of fire moves in a circle. Disagreement, however, arose over the question of the origin of this movement. Is it a natural or a counternatural movement, or of a still different kind?

Depending on what stance natural philosophers took on the issue of the substance of the heavens, they interpreted the movement of the firesphere in correspondingly different ways. The philosopher Xenarchus (first century B. C.), who sympathised with Stoic thought and denied the existence of aether,[55] proposed a theory according to which

[50] *Meteor.* I 3, 340 b 21–29.
[51] *Meteor.* I 4, 341 b 12 ff. and LSJ s. v.
[52] *Meteor.* I 3, 340 b 4 ff.; 4, 341 b 2 ff.
[53] See *Meteor.* I 3, 340 b 32–341 a 3; I 4, 341 b 22–24; b 35 f.; I 7, 344 a 11–13.
[54] Cf. *Cael.* I 2, 269 a 7–18. Nevertheless, the text of *De caelo* I 2 is not entirely consistent on this point either, see above 3.2.4.
[55] See Moraux (1967) and esp. *id.* (1973), 197–214.

the rectilinear movements of the elementary parts towards their natural places are not regarded as natural movements. For, Xenarchus argues, the element is still in a counternatural place while it is in motion. Xenarchus spoke of natural movements only when the body is already in its proper place, for only there has the element achieved its full actualisation. Once they are in their natural places the elements either pursue rest, or move in a circle. The natural state of earth, water, and the lower air is rest, whereas it is natural circular motion for the upper air and fire. The circular motion of fire is identical to the movement of the heavens, and the heavens thus consist of fire as well.[56]

This theory is not only influenced by the Platonic and Stoic tenets that the heavens consist of a particular, pure kind of fire but also by Plato's refusal to attribute the qualities 'heavy' and 'light' to elementary bodies without qualification: According to Plato, only elements in their counternatural places possess these properties and the corresponding movements.[57] Simplicius mentions *In de caelo* 20,10–12 that the theory just set out was not only held by Xenarchus but also by Ptolemy in his books *On Elements* and the *Optics* as well as by Plotinus.[58] Incidentally, Philoponus describes the same theory in his commentaries on the *Meteorology* and the *De anima*, and in a general manner he refers to it as the theory of the Platonists.[59]

As it seems, in his commentary on the *De caelo* Alexander of Aphrodisias had attempted to refute Xenarchus' objections to Aristotle;[60] subsequently, he developed a different theory designed to save Aristotle's arguments for the existence of aether. Simplicius first reports *In de caelo* 22,18 ff. that Alexander denied that the rectilinear movements of the elementary parts are not natural movements. The upward motion of fire, for instance, is not a movement towards the full actualisation of that fire, but a movement of fire proper towards its natural place, *In de caelo* 22,23–25. Alexander thus retains Aristotle's theory of natural rectilinear movement. As regards the circular movement of the fire-

[56] Cf. Simplicius *In de caelo* 21,33–22,17 and Moraux (1973), 199.
[57] See *Tim.* 62 C–63 E; also *Aët.* I 12,2. As opposed to this Aristotle's theory in *De caelo* IV presupposes 'absolute' weight and lightness.
[58] Cf. *In de caelo* 20,10 ff.; 37,33 ff. and Plotinus *Enn.* II 1.3 and 8.
[59] Cf. *In meteor.* 37,18–22; 97,4–9 and *In de anima* 65,32–66,14. Proclus operates with the same theory in his arguments against the Christians, see *apud* Philoponum *contra Proclum* 380,23–381,1.
[60] Cf. Simplicius *In de caelo* 22,18; 24,21. Alexander's commentary on the *Meteorology* does not raise this problem at all.

sphere, he defends Aristotle with an argument which takes its movement to be composite instead of simple. For, Alexander says, inside the sphere of fire some of its parts move upwards, others downwards; at the same time the whole sphere moves in a circle. Hence, the movement of fire in its natural place is a composite movement, and in this way Alexander evades the question of whether simple circular movement in the case of fire is possible.[61] Since according to Alexander it is not simple, Aristotle cannot be accused of self-contradiction.

It is evident that this solution to the problem is far from satisfactory, and in late antiquity Peripatetic philosophers had second thoughts about it. In his commentary, Simplicius outlines a quite different theory.[62] According to him, Aristotle did not flatly deny that any of the four sublunary elements can move in a circle. He only said that circular motion belongs to them neither naturally nor counternaturally.[63] Therefore, given that fire indeed moves in a circle, its movement is neither natural nor counternatural.[64] Simplicius compares the movement of the firesphere to the movements of the planets which are carried round by the agency of the fixed sphere. He claims that both movements are not natural; but they cannot be counternatural either, for in that case they would certainly be harmful (βλαβερός) and not permanent (οὐ μόνιμος, 21,21 f.). In consequence, the movements must be due to a useful force (βία ἐπωφελής) and should be described as ὑπὲρ φύσιν, 'supernatural'. He explains that this supernatural movement is added to the firesphere naturally or imparted (ἐνδιδόναι) to it as a living motion by a superior being.[65]

É. Evrard suggests that the originator of this theory may have been Ammonius, since all his major pupils accepted it: Damascius, Simplicius, Olympiodorus, and even Philoponus in his *Physics* commentary and in the *contra Proclum*.[66] Although this hypothesis may not

[61] See *apud* Simplicium *In de caelo* 35,20 ff.
[62] See *In de caelo* 21,1–25; 35,12–20 and 51,5–28.
[63] Cf. Aristotle's argument *Cael.* I 2, 269 a 7–18.
[64] Though Simplicius seems to accept Alexander's point that the movement is composite, he still finds it necessary to account for the circularity of that motion, cf. *In de caelo* 21,10 ff.; 35,13 f.; 36,3–6 and esp. 37,29–33.
[65] Cf. *In de caelo* 37,34–38,2; 51,22–26. Note that in accordance with Aristotelian dynamics Simplicius speaks of imparted *motions*. Towards the end of his life, the impetus theorist Philoponus will speak of the celestial motions as being due to imparted *forces*. Cf. below the brief final discussion in 8.3.
[66] See Evrard (1953), 305 f.; 309–314. Cf. Philoponus *In phys.* 198,12–19; 198, 32–199,12; 378,21–31; *contra Proclum* 240,28–241,10; 278,19–28.

be incorrect, there is no good evidence to support it, and Ammonius' name is never mentioned in context.[67] On the other hand, a passage in Philoponus' commentary on the *Meteorology* – his last commentary on Aristotle[68] – suggests that Damascius had, if not originated, at least proposed this theory in one of his works. Philoponus says *In meteor.* 97,20 f.:

> "From this it is clear that the motion does not belong to (the comets) supernaturally, as Damascius says somewhere else, and which we have refuted."

It is not impossible that Damascius, rather than Ammonius, invented the theory, probably whilst he was teaching in Alexandria,[69] and that it subsequently found wide acceptance among Peripatetics in late antiquity. Philoponus, when he wrote the commentary on the *Physics* around 517, still accepted the theory of supernatural motion. At *In phys.* 378,21 ff. he first denies that any of the things moving in a straight line by nature can move in a circle, and then continues 25–29:

> "For even though the firesphere and the continuous air move along together with the whole, (this movement) is not according to nature but supernatural, just as the bodies of living beings – which are heavy by nature – are not moved with a transverse motion by nature but by soul. So it is impossible that one and the same thing which moves in a straight line naturally also moves along a circumference."

It is noteworthy that the movement of the firesphere is compared, by an analogy, to the movements of living beings moved by a soul.[70] According to Philoponus' *Physics* commentary, another tenet belongs to this theory: the totalities of the elements in their proper places do not possess any natural movement at all. Though this is evident in the case of water and earth, it is also true of air and fire; nevertheless, the latter are moved by the agency of the heavens supernaturally.[71]

According to Simplicius the case is slightly different. No element ever loses its inclination (ῥοπή) upwards or downwards respectively.

[67] It is, e. g., remarkable that no traces of the theory can be found in those of Philoponus' commentaries which are said to be based on Ammonius' lectures.
[68] See Evrard (1953); Wildberg (1987 a).
[69] Damascius is believed to have been born in 458 – thus being about 30 years senior to Philoponus and Simplicius – and to have taught at the school in Alexandria before he became diadochus at Athens, cf. Kroll (1901), 2039–2042.
[70] The same analogy is drawn by Olympiodorus in his commentary on the *Meteorology* 2,21–29.
[71] Cf. *In phys.* 198,12–19; 198,32–199,12.

Accordingly, the whole of fire always inclines towards the heavens, and the whole of earth always inclines towards the centre. But whereas earth necessarily comes to a rest, fire is supernaturally moved in a circle.[72]

It is possible to summarise the orthodox theory of natural cosmological motion in the Athenian and Alexandrian schools as follows: The elementary bodies possess a natural movement towards their natural place. There they either come to a rest or move in a circle supernaturally. The cause of this supernatural movement is the motion of the celestial body. The rival 'Platonistic' theory vigorously denies the existence of aether. The heavens and the upper fire are not theoretically distinguished in the sense that the former is regarded as the cause of the movement of the latter. Since fire is the substance of the celestial bodies it possesses circular motion by nature, and so does the upper air, in contrast to the lower air, water, and earth, which are at rest. The rectilinear movements of the parts of elements towards their appropriate places are not regarded as natural movements because an element in its counternatural place is not fully actualised.

5.4.3 Philoponus on the movement of the firesphere: Fragments I/9–17*

We may now turn to Philoponus' novel solution to the problem of the movement of the firesphere as developed in his polemic against Aristotle. His primary interest is to show that the circular movement of fire is both natural and simple so that its movement cannot be said to be different from the motion of the heavens in any respect.

The following fragments I/9–17* may be divided into two groups: fragments I/9–13* put forward arguments for the movement being natural, fragments I/14–17* arguments for its being simple. If the movement of the firesphere is both natural and simple, it must be identical to the movement of the celestial spheres. The conclusions of these arguments constitute part of a new theory of cosmological motion which incorporates ideas of both the 'Platonistic' and the 'Peripatetic' theories.

[72] Cf. Simplicius *In de caelo* 21,29–31; 65,7 f.; 67,7–14.

In fr. I/9 (*In de caelo* 34,5–11) Philoponus expresses the opinion that the movement of the firesphere must be natural because it is impossible that something permanently move contrary to its nature.[73] In consequence of this Philoponus asserts fr. I/12*: *ibid.* 35,14–18:

> "Fire has two natural movements, the one in an upward direction which belongs to the parts of fire which have become detached from the totality, the other, a circular one, which belongs to the totality itself, so that there is nothing to prevent the revolving heaven itself from consisting of fire, and the movement will not be contrary to its nature."

This theory of the two natural movements of fire manifestly contradicts Aristotle's dictum at *Cael.* I 2, 269 a 7–9 that each sublunary body possesses only one natural movement. In fr. I/10* (*In de caelo* 34,21–24) Philoponus remarks that this cannot be considered as a valid objection to his theory because the dictum is not even observed in Aristotle's own theory of cosmological motion, a point which is elaborated later in frr. I/33–35; in fr. I/10* he merely says that water and earth both incline towards the centre of the universe, and it is therefore true to say that water moves with the movement of earth, and vice versa. The argument relies on the supposition proved earlier that the movements of the elements water and earth are in fact identical in species.[74]

In fr. I/11* Philoponus uses a part of Aristotle's proof in *Cael.* I 2, 269 a 9–18[75] for his own purposes, fr. I/11*: *In de caelo* 35,5–8:

> "For if a single thing possesses a single contrary, and if the movement downwards is contrary to the natural movement of fire, then circular movement will not be contrary to it as well. In consequence, circular movement is not counternatural for fire. For the counternatural is the contrary. Therefore, circular movement belongs to fire naturally when it is in its proper place."

The general conclusion drawn from all this, of course, is that since the movement of the firesphere is natural nothing prevents the heavens from consisting of fire, which in turn implies that the heavens are perishable just like the things of the sublunary world; cf. fr. I/13* (*In de caelo* 35,28–33). Two aspects of these arguments are noteworthy. First, in the *contra Aristotelem* Philoponus accepts the 'Platonistic' position that the movements of the totalities of the elements are natural,

[73] See fr. I/9: *In de caelo* 34,10 f.
[74] Cf. the Arabic fr. I/3, section 12 (Farabi; Mahdi (1967), 259).
[75] Cf. above 3.2.2.

although his reasons are not the same as, e. g., the ones adduced by Xenarchus. However, at the same time Philoponus does not disown the 'Peripatetic' notion that the movement *towards* the natural place is a natural movement. At least in the case of fire and air he assumes two natural movements,[76] and by synthetically combining notions from two rival theories of cosmological motion he arrives at a yet distinct, third theory of his own. Secondly, the question may be asked to what extent Philoponus attacks the current theory of supernatural motion. Since he develops his new theory in the course of his critique of Aristotle, it is almost impossible to assume that he did not defend it, e. g., against Damascius' theory. Simplicius does not cite any polemic of this kind, but he does say that Philoponus debases (παραχαράττει) the idea of supernatural motion and departs from it; see fr. I/12*: *In de caelo* 35,14–20.[77]

For the time being it is necessary to return to fragments I/14–17* where Philoponus defends his claim that the heavens consist of fire against Alexander who said that the movement of the firesphere is not simple but composite. The implication of Alexander's point is clear: The firesphere and the heavens would remain kinetically distinct, and therefore distinct in substance. Plotinus, who must have known Alexander's theory,[78] holds that once fire has reached its proper place it strives to rest, moving neither upwards nor downwards.[79] It only remains for it to be carried along by the soul by virtue of natural attraction.[80] Its movement is evidently meant to be simple, although this is not explicitly stated. It seems clear that Plotinus would deny, against Alexander, that inside the outer sphere of fire the parts move upwards and downwards. In contrast to Plotinus, Philoponus concedes that these parts do indeed rise and descend, and are rarefied and condensed, but he does not agree that the movement of the whole

[76] Philoponus would probably have argued consistently that both movement downwards as well as rest belong to water and earth naturally, cf. fr. I/18: *In de caelo* 42,20–22.

[77] For a further discussion of this problem and its implications for the chronology of Philoponus' later writings see Wildberg (1987 a), 202–209.

[78] See Merlan (1943) who draws the conclusion that "... it seems that Plotinus is indebted very much to Greek philosophy as it existed in the second and third centuries. Perhaps, even as far as Plato and Aristotle are concerned, it is more important to know how they were interpreted in Plotinus' time, than what they 'really' had said", 191.

[79] See *Enn.* II 1.3,13–18. Cf. also II 1.8,1–5.

[80] κατὰ φυσικὴν ὁλκὴν ἑλκομένῳ ὑπὸ ψυχῆς, *Enn.* II 1.3,18 f. Although induced by soul its movement is κατὰ φύσιν, II 1.8,15 ff.

sphere is not simple *because of this*. He defends his point as follows, fr. I/14: *In de caelo* 36,15–18:

> "For it is possible that, when fire is carried upwards and water downwards, some of its parts are hurled here, others there, by the agency of some kind of wind, but the whole nevertheless moves with a simple movement away from and towards the middle."

Moreover, he argues by analogy, irregularities are observed in the movements of the planets: Venus is sometimes more apogee, and sometimes more perigee, but the whole movement of the heavens is nevertheless simple, fr. I/15 (*In de caelo* 36,21–25). Further, rarefaction and condensation do not, as Alexander asserted,[81] render the local movment of the whole non-simple. For the former are changes of quality, but the latter is a spatial movement, fr. I/16 (*In de caelo* 37,3–12). Whereas the arguments of frr. I/14 and 15 rely on the part-whole distinction, fr. I/16 distinguishes between qualitative and local change. Philoponus attempts to show that whatever changes may occur in the parts of the elements, the movements of the totalities of the elements are simple all the same. Fr. I/17* (*In de caelo* 37,12–29) contains an argument in which, as it seems, Philoponus deliberately misreads Alexander, for he supposes that according to Alexander's argument the totalities move not only in a circle but also upwards and downwards as a whole, fr. I/17*: *In de caelo* 37,16–18:

> "⟨The Grammarian⟩ mischievously distorts the passage ⟨in Alexander⟩ because he understands 'upwards' and 'downwards' to refer to the whole, and he tries to show that the firesphere can move neither upwards because it touches the lunary sphere, nor downwards by nature."[82]

At the end of fr. I/17* Simplicius once more repeats the main argument for the naturalness of the circular motion of the firesphere, *In de caelo* 37,26–29:

> "Yet ⟨the Grammarian⟩ frequently brings in the argument that if circular movement did not belong to the firesphere and the air by nature, they would not last for a long time because the movement would be contrary to nature. For also Aristotle says that what is contrary to nature is destroyed very quickly."[83]

From all this it is clear what Philoponus' own theory amounts to. The elementary bodies possess two natural movements and a counter-

[81] Cf. *apud* Simplicium *In de caelo* 35,20 ff.

[82] A similar argument occurs in Plotinus, see *Enn.* II 1.3,13–17.

[83] Cf. also fr. I/9 (*In de caelo* 34,5–11). On Aristotle see *Cael.* I 2, 269 b 9 f.

natural one. In particular, fire and air move both upwards *and* in a circle by nature. The movement of the firesphere is both natural and simple, and it in no way differs from the movement of the heavens. It is therefore not necessary to postulate the existence of aether; rather, one must conclude that the heavens consist of fire and are perishable as well.

The question may be asked why Philoponus does not simply adopt the 'Platonistic' theory of cosmological movement, i. e., that fire possesses only one natural movement, which is circular. The answer may be that the theory of the 'Platonists' does not exclude the possibility that the world does not come to an end. For if one assumes that simple circular motion is the *only* natural movement of the fire and belongs essentially to the celestial fire, then one could still infer that the upper fire is unalterable, imperishable, and entirely separate from the realm of generation and destruction. For it moves with a movement that does not occur naturally in the sublunary world. Plotinus, for instance, who rejected Aristotle's notion of aether, nevertheless maintained that the universe is eternal.[84] And in the course of his argument Plotinus postulates two kinds of fire, the one of the sublunary region, the flame (φλόξ), and the upper fire or light (φῶς).[85] Plotinus' celestial fire is a very close analogue of Aristotle's aether, since Plotinus says that it is unalterable and moves in a circle according to its nature.[86] When Philoponus on the other hand claims that fire possesses two natural movements, he no doubt wants to imply that the sublunary fire is identical in nature to the fire which resides in and constitutes the celestial region. For only on the assumption of one kind of fire will it follow that the heavens are perishable too. Although Philoponus, as will be seen later, allows certain distinctions between celestial and sublunary varieties, he nevertheless maintains that they are types of a single fiery nature. In a sense it may be said that Philoponus' project amounts to a reinstatement of the four traditional Empedoclean elements.

[84] See *Enn.* II 1.

[85] See *Enn.* II 1.7,33–49. Graeser (1972), 22–24 suggests that in his defence of Plato's cosmology Plotinus is influenced by Zeno's doctrine of the existence of two kinds of fire, the πῦρ τεχνικόν and the πῦρ ἄτεχνον, see, e. g.; *SVF* I 120.

[86] *Enn.* II 1.8,15–19. It is important to recognise that for Plotinus the natural movement of this fire is also caused by the world-soul, II 1.3,13–25. Later in the *contra Aristotelem* Philoponus proposes the same theory.

5.5 Against the Priority of the Heavens

In the following set of fragments I/18–32 Philoponus examines Aristotle's second main proof of *Cael.* I 2, 269 a 18–32. Here Aristotle attempts to show that the celestial body must consist of a simple elementary body which is essentially different from the elements of the sublunary world because the movement of the heavens is not only different from but also prior to the natural movements of the four elements. Although Aristotle's proof failed to provide conclusive evidence for the simplicity of the celestial element, it provided some justification for the conclusion that the heavens must be prior to – and therefore different from – the substances prevailing in the sublunary world.[87] If Aristotle has indeed succeeded in showing this, the doctrine of the eternity of the world would receive a relatively secure basis. One could no doubt infer that the heavens never cease to exist by virtue of their ontological primacy over the sublunary world. Naturally, Philoponus must be interested in a thorough repudiation of this argument as well, for according to his own conviction the Aristotelian dichotomy between the heavens and the sublunary region does not exist.

It has been shown that Aristotle's proof relies on a quasi-geometrical premise: the circle is complete while the straight line is incomplete. In his refutation Philoponus not only questions the truth of this premise, but also scrutinises other concepts and assumptions which play a role in the argument. Having first denied the existence of any essential difference between the heavens and sublunary region (fr. I/18), Philoponus argues against the primacy of circular motion (frr. I/19–22), against the completeness of the celestial body (frr. I/23–24), against the completeness of the circle (frr. I/25–28), and finally against Alexander's definition of completeness in particular (frr. I/29–32). The character of all these arguments is robustly dialectical, and apart from rebutting Aristotle's arguments of the *De caelo* they represent a witty exposure of certain arbitrary aspects of Peripatetic-Neoplatonic school philosophy of late antiquity.

Philoponus completes his critique in the first book of the *contra Aristotelem* by pointing out a notorious internal difficulty in Aristotle's text (frr. I/33–35).

[87] Cf. above 3.2.3.

5.5.1 Fragment I/18

At the end of his proof in *Cael.* I 2, 269 a 18–32 Aristotle concludes that the celestial motion is prior to the rectilinear movements of the four elements; the celestial body must therefore be different (ἄλλος) and more divine (θειότερος).[88] Philoponus replies fr. I/18: *In de caelo* 42,20–22:

> "Even if the body moving in a circle may be primary, it does not follow that it is different from the four elements, as in fact rest and circular movement belong to these as well when they are complete ⟨i. e. in their proper places⟩."

The argument virtually contains the sum of Philoponus' discussion of the movement of the firesphere. Simplicius does not quote this objection without first taking the opportunity to vent his hatred against his critical contemporary. Like a young crow or jackdaw Philoponus "chatters in vain against the sacred bird of Zeus", i. e. Aristotle.[89] Simplicius also points out that Philoponus merely relies on Xenarchus' third argument which he already quoted *In de caelo* 42,10–14:

> "Even if there is something that moves in a circle, it is not different from the four elements, if indeed some of the elements too are at rest while others move in a circle when they are complete; above all, this applies to fire. For the parts which are still incomplete move with a movement in a straight line, which – as Aristotle thought as well – is an incomplete movement."[90]

Again the question presents itself whether Philoponus explicitly stated that his argument derives from Xenarchus' book *Against the Fifth Body*. Whatever the case may be, it should be noted that Simplicius in either case cannot be entirely justified in suggesting that Philoponus has plagiarised Xenarchus. As we have seen, Philoponus' theory of natural cosmological motion supporting the present argument is quite different from Xenarchus': whereas the latter assumed that the circular motion of the totality of fire is the only natural motion of fire, Philoponus argues that fire possesses in fact two natural movements.

[88] Cf. 269 a 30–32. The argument relies on the premise that the nature of the celestial substance is the principle of its motion.
[89] Simplicius cites Pindar's *Olympian Odes* II 87 f. On Simplicius' invective against Philoponus in general see Hoffmann (1987), 57–72.
[90] Cf. also the argument cited by Simplicius *In de caelo* 21,33–22,17.

5.5.2 Fragments I/19–22

Aristotle's second main argument of *De caelo* I 2 includes a deduction of the primacy of the celestial motion from the premise that the circle is prior to the straight line. Aristotle takes the circle to be complete but the straight line to be incomplete.[91] The concept of completeness operating in this deduction comprises the notions of all-inclusiveness and limitation.[92] In his lost commentary on the *De caelo* Alexander of Aphrodisias attempted to explain the assumption of the priority of the circle over the straight line differently, *apud* Simplicium *In de caelo* 39,11–14:

> "But Alexander shows the circle to be complete on the grounds that it possesses a beginning, a middle, and an end; if, at any rate, he says, the centre is its beginning, the external line ⟨i. e. the circumference⟩ the limit (πέρας), and the plane between these the middle."

Here Alexander uses a peculiar definition of completeness, claiming that the complete must possess a beginning, a middle, and an end. Simplicius tells us that Alexander devised (συνελογίσατο) this definition from two remarks made by Aristotle in *De caelo* I 1.[93] Aristotle said 268 a 11–13 that the Pythagoreans held that "end and middle and beginning possess the number of the All", and continued at a 20 f.: "All things, the All, and the complete do not differ from one another in kind (ἰδέα)".[94] These remarks apparently induced Alexander to come up with his own, quite arbitrary definition of completeness. Nevertheless, despite its inadequacy Alexander's authority ensured that it became widely accepted. Simplicius has no objection to it[95] and even Thomas Aquinas uses it in his *De caelo et mundo*.[96] Philoponus rejects it decisively,[97] but adopts it here for the sake of the argument. He attempts to show that Alexander's definition makes nonsense out of the Peripatetic belief in the eternity of the world, fr. I/19: *In de caelo* 42,27–31:

> "Then, in conceding for the time being that a circle is complete because it has a beginning, a middle, and an end, ⟨the Grammarian⟩ says: What

[91] See *Cael.* I 2, 269 a 18–25.
[92] Cf. above 3.2.3.
[93] Simplicius *In de caelo* 8,27–33.
[94] On the problem see above 2.2.2.
[95] Cf. *In de caelo* 8,33. See also *ibid.* 48,35–49,2 (fr. I/32).
[96] See Thomas Aquinas (1952), I iv, 42.
[97] See below frr. I/29*–32.

necessitates that the *movement* taking place in a circle is complete as well? If it is for the reason that it has a beginning, a middle, and an end, as Alexander said but not Aristotle, then the movement in a limited straight line possesses the same properties."

That is to say, if the circle is indeed complete in the sense of Alexander's definition, then the movement in a circle, which is supposedly complete, must have a beginning and end, and therefore be limited. Philoponus exploits the ambiguity involved in the terms 'beginning', 'middle', and 'end', which may either refer to parts of things or to parts of processes, like motion, and time. In fr. I/20: *ibid.* 43,8–10 he adds:

"Precisely because they suppose circular movement, which possesses neither a beginning nor a limit, to be eternal, it is evident that it should be incomplete because it is unlimited, whereas the movement in a limited straight line ought to be complete."

Philoponus suggests that any movement in a straight line is a proper instance of complete motion. Aristotle argues *Cael.* I 2, 269 a 22 f. that rectilinear movements are not complete because a straight line can always be increased: it always has something outside it. Philoponus objects that an unlimited straight line does not exist; Aristotle's assumption is therefore not universally true. For since the sphere of the universe is limited, the longest straight line will be its diameter.[98] In a second move Philoponus entangles the Peripatetics in an even greater difficulty, fr. I/22: *In de caelo* 44,15–18:

"Furthermore, if the movement of the heavens and the time capable of measuring it are complete, then they possess a beginning, a middle, and an end, and they will not be unlimited or unceasing, as Aristotle believes. But if unceasing, then they are not complete. For they do not have a beginning, a middle, and an end."

Consequently, if the completeness of the celestial motion is assumed it follows, according to Alexander's 'definition', that time and motion are not eternal. Or, if they are to be eternal, they are not complete. Although Philoponus' attack relies on the ambiguity of the terms beginning, middle, and end, he seems to have detected a weakness in

[98] Cf. fr. I/21: *In de caelo* 43,22–25 and Simplicius' remark *ibid.* 44,3 f. The salient point of Philoponus' objection is that it agrees with Aristotle, see *Phys.* III 7, 207 b 19–21 and VIII 9, 265 a 17 f.

Peripatetic thought. On the basis of their own tenets and definitions he has arrived at the conclusion that infinity, (and therefore eternity,) and completeness are mutually exclusive concepts.

5.5.3 Fragments I/23–24

In these fragments Philoponus raises a problem not directly related to Aristotle's argument in *De caelo* I 2. He censures Aristotle for concluding, without justification, that the celestial body is complete, fr. I/23 (*In de caelo* 45,2–7). Aristotle in fact does not conclude this, but Philoponus thought perhaps that the idea is implied in the final assertion of *Cael.* I 2, 269 a 30–32 that the heavens are more divine and prior to the sublunary elements.[99] His accusation is that Aristotle is employing a circular argument, fr. I/23: *In de caelo* 45,3–7:

"For if it is because the circle is complete that Aristotle also took the movement in it to be complete, and if the movement takes place in a physical circle, and if this physical circle is the celestial body, and again, if it is because circular movement is complete that he also took the body moving with this movement, i. e. the heavens, to be complete, then the argument is circular and not a proof."

Philoponus claims that when Aristotle assumes that the movement in a circle is complete, he does not speak of any circle in the abstract, i. e. the geometrical figure, but of a physical circle which is, according to Philoponus, the celestial circle (sphere) itself. Hence, Philoponus wants to summarise the gist of Aristotle's argument as follows: Since the celestial body is complete, the movement along the circumference of the celestial body is complete, and since the movement is complete, the celestial body is complete. But this is an unfair misrepresentation of Aristotle's argument, and Simplicius rightly rushes to its defence.[100] Philoponus seems to maintain that Aristotle only *pretends* to speak of a circle as such, but never considers the geometrical shape of the paths of the movements. To Philoponus' mind, Aristotle's talk of circles really signifies physical entities such as the celestial body.[101] But if the interpretation of *De caelo* I 1 put forward in Part One is correct, it is clear that, on the contrary, Aristotle's method precisely consists in the

[99] Cf. also *Cael.* I 1, 268 b 8–10 where Aristotle says that the universe is complete.
[100] See *In de caelo* 45,19–26.
[101] Cf., e. g., frr. I/2 (*In de caelo* 43,22–25) and 27 (*ibid.* 46,29–47,3).

application of mathematical-geometrical concepts to the realm of physics. Philoponus does not accept this method; later in the *contra Aristotelem* he seems to have attacked it directly.[102] In fr. I/24 Philoponous rebuts a further argument for the completeness of the heavens which equally does not appear in the present chapter of the *De caelo*. Fr. I/24: *In de caelo* 45,27–29:

> "But if the celestial body is complete because it is spherical, then in this respect, at any rate, it will not be different from the other elements, the totalities of which Aristotle himself wants to be spherical."

It is not clear why Philoponus adduces this objection here since the sphericity of the heavens is not discussed until *De caelo* II 4. And there, Aristotle himself points out that the totalities of the sublunary elements are spherical as well.[103] The difference between the two regions lies in the greater smoothness and accuracy with which the spherical shape is instantiated in the heavens.[104] There is no indication that Philoponus recognises this as a significant difference.

5.5.4 Fragments I/25–28

Earlier, in fr. I/19, Philoponus made the explicit concession that the circle is a complete geometrical figure. On the assumption of Alexander's definition of completeness he showed subsequently that it does not follow that the celestial motion too is complete because of this. Now Philoponus proceeds to repudiate the more fundamental idea of the completeness of the circle itself, fr. I/25: *In de caelo* 46,4–11:

> "But again, as if he regrets that he has conceded that the circle is complete rather than the straight line, he attempts to prove the opposite: For if, he says, the circle were assumed to be a plane surface, as Alexander thinks, then it would not have a centre in actuality, in order that it may escape being divided there and so losing its continuity. In consequence, it does not have a beginning. The limited line, however, whether natural or mathematical, does have actual extremes. Then, in so far as the actual is

[102] Cf. fr. V/93: *In de caelo* 178,13–16, where Simplicius says that Philoponus "speaks arrant nonsense as he finds fault with the attempt to demonstrate things of nature from geometrical principles." – Before Philoponus, Xenarchus had raised similar objections to the application of mathematics to physics, see *apud* Simplicium *In de caelo* 25,11–13; 42,6–8 and Moraux (1973), 200 f.

[103] See *Cael.* II 4, 286 b 10–26 and 287 a 5–11.

[104] See *Cael.* II 4, 287 b 14–18.

> complete rather than the potential, the straight line will be complete rather than the circle."

Parts of this argument may be understood in the light of Alexander's interpretation of Aristotle's argument; cf. *apud* Simplicium *In de caelo* 39,11–14. Alexander said that the plane circle possesses a beginning (the centre), a limit or end (the circumference), and the area between as the middle. In opposition to this Philoponus holds that the geometrical circle does not possess an actual centre. There is nothing more to the circle than the line of the perimeter. He uses the word 'circle' in a sense which is different from Alexander's. For Alexander the circle is a *plane figure* bounded by a line that is equidistant from one point in that plane, the centre. In Greek mathematics, this last conception of 'circle' is fairly common and accords with Plato, Aristotle, and Euclid.[105] Although Philoponus' idea that the circle is simply constituted by the circumference[106] is unusual, it is not entirely unknown. In book III, Prop. 10 Euclid says that two circles do not cut each other in more than two points – and hence uses 'circle' in this second sense as well. In any case, it must be conceded that *movement* in a circle is better represented by Philoponus' conception of 'circle' than by Alexander's.[107]

As regards Philoponus, the force of his objection is not entirely clear. In fr. I/25: *In de caelo* 46,6–8 he argues that if one assumes, with Alexander, that the circle is a plane surface, it will follow that it does not possess an actual centre. For circles are continuous figures which do not possess an actual centre; according to Philoponus, the possession of a centre entails that the continuity may be disrupted, *In de caelo* 46,7 f.; fr. I/26: *ibid.* 46,18 f. And so, since a circle does not possess a centre, it does not possess a beginning either and is therefore incom-

[105] See Heath (1926), I 183 ff. (*ad* Def. 15). For Plato cf. *Parm.* 137 E; Aristotle: *Cael.* II 4, 286 b 13–16; *Rhet.* III 6, 1407 b 27; Euclid: Book I, Def. 15 and 16. See also Mugler (1958), 260 f.

[106] The sense of circle as 'perimeter' is also presupposed in the argument of fr. I/26 where Philoponus says that such a circle possesses neither an actual centre nor an actual area; see fr. I/26: *In de caelo* 46,23–25.

[107] Even Simplicius concedes *In de caelo* 39,14 f. that Aristotle is certainly not speaking of a circle as a plane figure. He therefore cannot entirely accept Alexander's interpretation and thinks instead that the circle is complete because it is limited (πεπερασμένος) and has nothing outside it (οὐδὲν ἐκτὸς ἔχει), 39,5–11. Later, however, when he defends Alexander in view of Philoponus' criticism, Simplicius notes feebly 43,13–15: "It is worth knowing that the circle is also completely complete (τέλειος τελείως) because every part of it possesses a beginning, a middle, and an end."

plete. Fr. I/26 (*In de caelo* 46,17–25) seems to make the same point for the case of purely geometrical circles, which equally do not possess a centre, nor a middle, i. e., no actual area which is circumscribed by the perimeter. But just why circles do not possess an *actual* centre, and why possessing a centre entails discontinuity, remains obscure. Thus, the elenctic force of the argument is uncertain.

Having supposedly shown that the circle is an incomplete figure, Philoponus proceeds to the corresponding argument for the completeness of the straight line. Any straight line possesses a beginning, a middle, and an end, regardless of whether it is a geometrical or a physical line; see fr. I/25: *In de caelo* 46,8–11. In fr. I/27*: *ibid.* 47,1–3, and fr. I/28 (*ibid.* 47,10–13), Philoponus first claims that it is not true to say that every limited straight line may be increased.[108] For a straight line possessing the length of the diameter of the universe can evidently not be increased, fr. I/27: *In de caelo* 46,29–33. He then provides an obscure argument which is supposed to show that a circle is in fact not all-inclusive, i. e., it can be increased from outside without its perfect shape being affected in any way, fr. I/27: *In de caelo* 47,1-3:[109]

> "For ⟨the Grammarian⟩ also says that in the case of a circle, if it should be a body, or in the case of a sphere, a body poured around it equally from all directions and attached to it will make ⟨the circle or sphere⟩ larger."

And in fr. I/28: *ibid.* 47,10–13 he adds:

> "But many circular and spherical things in living bodies increase by food taken in, like the head of a human being and the circle of the cornea of the eye."

The last argument in particular is a rather crude attempt to refute a theoretical mathematical proposition by a physical counterexample, and again, more than anything else, it casts light upon Philoponus' refusal to allow purely mathematical considerations to be imported into the discussion of physical problems.[110]

[108] Against Aristotle *Cael.* I 2, 269 a 22 f.

[109] Simplicius *In de caelo* 39,9–11 argued to the contrary: "Nevertheless, the circle is limited, possesses an end, and has nothing outside it; and it is not possible to increase it without altering its shape." The properties of a circle are taken from Aristotle *Cael.* I 2, 269 a 21–23.

[110] Philoponus explicitly rejects the application of mathematics to physics in fr. V/93: *In de caelo* 178,13–16.

5.5.5 Fragments I/29*–32

Finally, Philoponus attacks Alexander's definition of completeness directly, fr. I/29*: *In de caelo* 47,27–30:

> "But because he finds fault with the given definition of 'complete', he also says that one wastes one's labour when one tries to divide a hand or a tongue or earth or fire or any other part into a beginning, a middle, and a last."

In this argument Philoponus takes full advantage of the inadequacy of Alexander's definition, for it is not readily applicable to items which may well be regarded as complete in their own right. Philoponus' examples, however, may appear peculiar, but they suffice to make the point that beginning, middle, and end cannot possibly be adequate criteria for judgements about the completeness of things. Fr. I/30* (*In de caelo* 48,5–11) shows that Philoponus provoked his Peripatetic contemporaries with the question which of the three spatial extensions corresponds to beginning, middle, and end – given the three-dimensional body is complete in the sense that is comprises all spatial dimensions.[111] Curiously enough, Simplicius accepts the point, but does not puzzle very long over the question how the three equal dimensions of a cube ought to be allocated, *In de caelo* 48,7–9: it simply makes no difference.

Philoponus briefly returns to the problem of the completeness of the circle in order to confront his readers with a further aporia following from Alexander's definition, fr. I/31 (*In de caelo* 48,14–22). Above all, the fragment may serve to exemplify an important aspect of the methodology of the *contra Aristotelem*, which becomes apparent time and again. After having shown that Alexander's definition is virtually futile, Philoponus accepts his opponent's definition and shows that further absurdities follow all the same. His argument runs as follows: If a three-dimensional body is complete because it possesses all dimensions, then the circle is evidently not complete in this sense. But if one assumes with Alexander that the circle is complete in respect of his definition of 'completeness', then it will follow that the circle is both incomplete and complete, fr. I/31: *In de caelo* 48,15–17.

[111] As Aristotle argued in *De caelo* I 1. – Ptolemy seems to have written a treatise in one book called *On dimensions* in which he proved that there are not more than three spatial dimensions, cf. Simplicius *In de caelo* 9,21–29.

It is not certain whether Simplicius has cited all arguments adduced by Philoponus against the definition of completeness. Nevertheless, the arguments suffice to show that the definition in question cannot be adequate, because a) it is not applicable to all kinds of complete things, and b) it does not take into account all the different respects in which things may be said to be complete. This, however, is precisely what Philoponus himself expects from a proper definition: rigorous universality, fr. I/31: *In de caelo* 48,19–22:

> "So if Aristotle intended to demonstrate from the premise that circular motion is complete that it is also prior to rectilinear movement, he should have defined the notion (ἔννοια) of 'completeness' universally, and should have shown that the definition applies to every circle, but does not apply to any straight line."[112]

Philoponus rightly criticises Aristotle for operating with terms that have not been defined prior to their usage in the argument. Aristotle's argument for the priority of circular motion therefore necessarily remains unclear and objectionable on formal grounds.[113]

It is perhaps worth pointing out that the dispute between Alexander and Philoponus may serve to illustrate a recurring problem in the exegesis of Aristotelian texts. Alexander apparently chose to interpret the passage in the *De caelo* without looking beyond the immediate context wherein it occurs. In order to explain why Aristotle thought that the circle is complete he looked back at the most proximate arguments in *De caelo* I 1, combined two quite different propositions into a definition – and completely missed the point. Philoponus shows successfully that Alexander's exegesis is untenable. A criticism of this kind may naturally have two different consequences. Either a commentator attempts to find better explanations elsewhere in the Aristotelian corpus – or even the history of philosophy at large (which is roughly Simplicius' method of exegesis), or one becomes, like Philoponus, increasingly alienated from the Aristotelian text itself. The utter disagreement between Philoponus and Simplicius seems to be linked, at least to a certain extent, to these diverging attitudes.

[112] Cf. also fr. I/32: *In de caelo* 49,4–7.

[113] Philoponus' last argument concerning completeness consists of a rhetorical question, fr. I/32: *In de caelo* 49,7–10: "Just why is that which possesses a beginning and a limit and something between these complete, and not rather that which neither has a beginning nor a limit, like the infinite line? For the infinite line does not admit of theoretical addition and increase." The question is rhetorical because Philoponus himself does not believe in the existence of an infinite line, cf. fr. I/27* (*In de caelo* 46,26–47,3).

5.5.6 Fragments I/33–36*

In the final part of the first book of the *contra Aristotelem* Philoponus has – according to Simplicius' evidence – done no more than to point to the notorious contradiction in Aristotle's chapter *De caelo* I 2. For in the first main argument[114] Aristotle assumes that a single thing can only possess a single contrary. But at the end of the chapter he indicates that the two rectilinear movements are in fact contrary to circular motion.[115] The analytical clarity of Philoponus' criticism in fr. I/33 (*In de caelo* 56,28–57,8) is remarkable and quite unparalleled in any extant ancient commentary. He concludes his analysis fr. I/33: *ibid.* 57,3–8:

> "So either ⟨Aristotle⟩ made a false assumption in the former passage – i. e., that the heavens cannot be one of the four elements moving in a circle contrary to nature – or he wrongly supposed now that circular movement is counternatural for the four elements. For what he said would be an absurd consequence of the former hypothesis, namely that two are contrary to one, is precisely what has been shown to result from the hypothesis laid down now."

Finally, as has been pointed out earlier, fr. I/36*: *In de caelo* 59,6–10 indicates that Philoponus supported his arguments against aether by references to philosophers before him who had raised similar objections. In this context, Xenarchus may have been mentioned, together with the Stoics and perhaps Plotinus. If this is true, Simplicius' remark in fr. I/36* would support the view that the *contra Aristotelem* was structured in a vein similar to the *contra Proclum*. There, too, the main body of argument is frequently followed by references to other authorities in philosophy.[116]

5.6 Conclusion

In the first book of the *contra Aristotelem* Philoponus rejects Aristotle's two main arguments for the existence of aether in *De caelo* I 2. Philoponus claims that Aristotle's assumption of an intimate correlation between the natures of physical bodies and their natural movements is

[114] I. e. *Cael.* I 2, 269 a 2–18.

[115] Cf. *Cael.* I 2, 269 a 32–b 6 and above 3.2.4.

[116] Cf., e. g., *contra Proclum* VI 8; XI 14; XIII 15.

unwarranted. He attempts to show, largely by invalid logic, that on Aristotle's own assumptions one ought to recognise that the connection between nature and motion is much less specific than assumed in the *De caelo*. The nature of a body does not strictly determine its local motion. Philoponus attempts to show that it is not in fact impossible that bodies of the same nature move with different movements.

Moreover, Aristotle's theoretical division of natural locomotions is artificial: it does not do justice to the actual movements encountered in nature. Is it at all possible to speak of the simple motion of the celestial spheres? And how is it possible to compare, without qualification, the movements of a whole (i. e. the heavens) to the movements of parts (i. e. the dislocated elementary bodies)?

Philopohus suggests that the movement of the heavens ought to be compared to the movement of the *totality* of a sublunary elementary body. In this context Philoponus argues that there exists no difference between the movement of the celestial body and the movement of the sublunary firesphere. He proposes the novel theory that fire and air possess two natural movements, rectilinear upward motion *and* circular motion, thus defying both Aristotle's theory and the current Neoplatonic theory of the supernatural origin of these movements.

Philoponus' solution to the problem of the firesphere results in a theoretical assimilation of the celestial and sublunary regions. Since fire moves in a circle by nature, there are no reasons for disowning Plato's venerable theory that the heavens consist for the most part of fire, nor are there any reasons for believing in the divinity of the heavens. Philoponus attempts to increase the plausibility of his theses by pointing out that other philosophers before him had rejected Aristotle's concept of aether on similar grounds.

6. On the Nature of the Celestial Region: Books II and III

In the first part of the third chapter of *De caelo* I, before Aristotle proceeds to show that there is no contrariety and therefore no generation and corruption in the heavens, he argues that the celestial body is not possessed of weight and lightness because it does not move with a rectilinear motion by nature.[1] In the second book of his treatise against Aristotle, Philoponus sets out to refute this argument. He claims, in particular, that 'heavy and light' are not, as Aristotle supposes, absolute qualities, that the totalities of the sublunary spheres do not possess these properties (although their parts do), and that it is not impossible that the heavens too consist of heavy and light bodies which move in a circle both by nature and by the agency of a soul.

The third book of the *contra Aristotelem* may be viewed as a digression from the direct discussion of the argument in the *De caelo*. It deals largely with an argument brought forward by Aristotle in the *Meteorology*. There, Aristotle attempts to show that the heavens cannot consist of fire because this would lead to the destruction of the universe. Philoponus thoroughly rejects this theory and argues, with Plato, that the heavens consist of all elements, though of a particular kind of fire for the most part. He supports his position by a number of arguments from 'sense-perception'.

Because of the topical connection of books II and III – both books discuss the substance and attributes of the celestial region – they will be commented on together in the present chapter.

6.1. The Structure and Argument of Book II

6.1.1 Fragments II/37–39

Having commented on the first argument of *De caelo* I 3 ('weight' and 'lightness'), Simplicius, with assumed reluctance, continues his polemic against the Alexandrian Grammarian, fr. II/37: *In de caelo* 66,8–10:

[1] Cf. *Cael.* I 3, 269 b 18–270 a 12.

"But since – regardless of whether one falls into the open sea or into a bath, but especially if one falls into a filthy puddle – it is necessary to swim,[2] let us turn aside again in order to look at the words of the Telchin.[3]"

According to Simplicius' evidence, the second book began with Philoponus remarking self-confidently that in view of his objections put forward in the first book a refutation of Aristotle's theory that the heavens are neither heavy nor light is quite superfluous, fr. II/37: *In de caelo* 66,11–14:

"If Aristotle demonstrated that the celestial body is neither heavy nor light by using the argument that it is none of the four elements, and if the arguments that proved this have been refuted, then it is evident that the point proved by them, namely that it is neither heavy nor light, is refuted as well."

From a logical point of view, this swift dismissal is of course not valid,[4] and in what follows Philoponus provides his refutation proper. The first attack is a dialectical argument which attempts to turn Aristotle against himself. In *Cael.* I 3, 269 b 23–26 Aristotle defines not only 'heavy and light', but also 'the heaviest' and 'the lightest'. According to this definition the lightest is that which 'rises to the top of all things that move upwards'. The crucial word is ἐπιπολάζειν, which possesses the ambiguous meaning of 'floating to the top' and 'floating (i. e. being) on top'. The context makes it plain that Aristotle uses the word in the former, kinetic sense,[5] but Philoponus, when he accepts the definition in fr. II/38 (*In de caelo* 66,17–24), takes advantage of the ambiguity. He claims 66,17–19 that the heavens undoubtedly float on top of everything and concludes that they must therefore be the lightest body of all. It is clear that he uses ἐπιπολάζειν in the second, static sense. In order to cover up his trick he adduces an analogy which suggests that it does not matter in which sense the word is used, fr. II/38: *In de caelo* 66,23 f.:

[2] Simplicius is alluding to Plato *Rep.* V 453 D 5–7.

[3] Simplicius uses the word Τελχίν with reference to Philoponus also elsewhere, cf. *In phys.* 1117,15 ff. In late antiquity, this derogatory term denoted malicious and envious people; hence, in the passage of the *Physics* commentary mentioned, Simplicius continues to speak of Philoponus' βασκανία. On the complex origin and meanings of the word see H. Herter. 1934. Art. 'Telchinen'. In: *RE* V^A^, 197–224, esp. 206–211. It may be added that 'Telchin' may possibly have also been a sobriquet for 'Christian'. On Simplicius' polemic against Philoponus see Hoffmann (1987).

[4] According to Philoponus, Aristotle argued that 'if the heavens do not consist of the four elements, then they are not heavy or light'. The negation of the consequent does, of course, not follow from the negation of the antecedent.

[5] Cf. above the discussion of this definition in 4.1.1.

"For olive oil too floats on top of water after it has relinquished the place below to water."

It is hard to believe that Philoponus took this argument very seriously, though apparently he did, for in fr. II/39 we get another argument which equally confounds the kinetic theory of natural motion with the static theory of natural place, fr. II/39: *In de caelo* 70,34–71,6:

"But since there are, according to Aristotle, only two differences and oppositions of place, above and below,[6] each body therefore is – because it exists in a place – either in the upper or in the lower region. Then, since the spheres of the heavens, with the exception of the fixed,[7] each have as their place the boundary of the surrounding sphere – the lunary sphere having as its place the boundary of the sphere of Venus, and this sphere the boundary of the sphere of Mercury, and so forth – then these spheres are necessarily in the upper region and certainly not in the lower. In consequence, they partake of lightness."

As will become clear from the following fragments, the conclusion of this dialectical argument (i. e. that the celestial body is light) does not represent Philoponus' true opinion. In the course of the second book of the treatise Philoponus proposes and defends a Platonistic theory according to which the totalities of the elements earth, water, air, and fire, *qua* wholes, do not partake of weight and lightness. The same, of course, is true of the heavens, and Philoponus in fact agrees with Aristotle on this point, albeit for different reasons.

6.1.2 Fragments II/40–46

Whereas the properties 'heavy' and 'light' are directly manifest to the senses in the case of distinct portions of an elementary body which have become detached from the whole (the lump of earth drops down, the flame rises), it is not as easy to determine what happens to these properties once the element has reached its proper place. In Aristotle

[6] Cf., e. g., *Cael.* I 8, 277 a 22 f.

[7] According to Aristotle, the place of a body is the inner surface of the container. Since the fixed sphere is not surrounded by anything, it follows that it is not in a place, cf. *Phys.* IV 5, 212 b 13–20. Here Philoponus accepts the Aristotelian definition of place for the sake of the argument. In the *Corollarium de loco* in his *Physics* commentary 557–585 he had already rejected the Aristotelian definition and analysed 'place' by means of a rehabilitation of the notion of 'vacuum'. According to Philoponus, place is an empty extension always filled with a body. On the problem see Wieland (1967) and Sedley (1987). Furley (1987) has given a summary translation of the corollaries on place and void in Philoponus' *Physics* commentary.

the case seems to be clear enough. The nature of an element accounts both for its movement and for its respective property of weight or lightness, and if a portion of an element reaches its proper place it ceases to move, but this does not mean that it loses its weight or lightness as well. Accordingly, Aristotle argues in *De caelo* IV that weight and lightness ought to be understood in an absolute sense: Fire and earth are said to be simply (ἁπλῶς) light or heavy, and that means everywhere.[8] Only water and air possess these properties in a relative sense, i.e. with respect to the former two elements, but they are absolutely heavy and light with respect to one another. Plato, on the other hand, suggested in a famous passage in the *Timaeus* that 'heavy' and 'light' belong to bodies only when they have been separated from their like, and that these qualities primarily depend on the quantity or mass separated.[9] Simplicius credits Ptolemy, Plotinus, and Xenarchus with a theory according to which 'heavy' and 'light' are the qualities of elementary bodies in their counternatural places. The totalities of the sublunary spheres are neither heavy nor light, and therefore enjoy a state of rest or move in a circle.[10] Philoponus seems to endorse precisely this 'Platonistic' theory, for Simplicius says fr. II/40*: *In de caelo* 67,5–7:

> "⟨The Grammarian⟩ prolongs many an argument as he is trying to show that the totalities of the elements do not move in a straight line."

This, of course, need not be argued explicitly. What Philoponus is aiming at is the denial of 'heavy' and 'light' in the case of the totalities of the elements. Since movement in a straight line is a characteristic feature of heavy and light bodies, Philoponus apparently argued that since the sublunary spheres as a whole do not move in a straight line, they do not possess weight and lightness either. Fr. II/41* (*In de caelo* 68,6–10) and 42* (*ibid.* 70,2–8) indicate that he supported his position

[8] See *Cael.* IV 4, 311 b 6 ff. Cf. also Aristotle's statement *Cael.* I 3, 270 a 3–5; 7, 276 a 2–4 that the whole and the part move to the same place by nature, thus implying that the whole does not lose its tendency to move, which would be surprising if it indeed lost its weight or lightness. See finally Simplicius *In de caelo* 72,18–24.

[9] See *Tim.* 62 C 1–63 E 7. In Plato, heavy and light are parameters indicating the effort needed to dislocate a quantity of an element from the congeneric totality. On the problem cf. Müller (1965), 88 f.; on the problem of weight and lightness in antiquity see the preliminary study by O'Brien (1977); on Democritus *id.* (1981).

[10] See *In de caelo* 20,10–15 and the explicit arguments brought forward by Xenarchus *apud* Simplicium *In de caelo* 21,33–22,17. On Xenarchus see Moraux (1967) and *id.* (1973), 197–214.

by a reference to Themistius who said, as Simplicius reports fr. II/42*: *In de caelo* 70,5–7:

> "It would be more reasonable and in agreement with the phenomena concerning these matters if the inclinations (ῥοπαί) were rather assigned to the elements which are in places foreign to them."[11]

Simplicius continues at *In de caelo* 71,19–25 (fr. II/43):

> "And yet, ⟨the Grammarian⟩ spins out many words, thinking that Themistius bears witness in his support that when the elements are in their proper places they do not partake of weight or lightness, but that these properties accrue to them through their removal (θέσις) to a counternatural place; and he further thinks to infer from this that the totality of fire – though, he would say, of the other elements as well – does not partake of weight or lightness any more than the heavens, so that it (i.e. the firesphere) ought to be of the same nature."

Although it is not difficult to imagine that someone held that the firesphere as a whole does not possess 'lightness', it is more demanding to accept the point that the whole earth too does not possess any weight. But precisely this proposition is part of the theory, and Philoponus is consistent enough to attempt to justify it by means of a highly speculative argument,[12] fr. II/43: *In de caelo* 71,25–33:

> "But because the earth, if it were hypothetically removed from its proper place and released, would return to that place, one must not think because of this that the whole earth possesses weight. For if under a similar hypothesis someone removed the whole world (κόσμος), it would also return to its own place once it is released. And yet, the whole world cannot possess weight or lightness because it embraces all things inside itself. But perhaps nothing prevents the world from moving according to the prevalence of the things inside it, but there is no one to say whether it is carried upwards or downwards because 'up' and 'down' are inside it."

In order to lend some plausibility to his bizarre statement that the whole earth does not possess any weight, Philoponus adduces an analogy: the whole world cannot be said to possess either weight or lightness, yet if one removed it from its place it would return to that place once it is released. In consequence, the mere fact of there being a rectilinear movement does not allow the conclusion that the body in

[11] Cf. Themistius *In de caelo* 221,28–30 and the preceding discussion of heavy and light.

[12] The following thought-experiment seems to be an adaptation of Aristotle's argument in *Cael.* IV 3, 310 b 3–5, in which the earth is assumed to be removed from the centre.

motion is heavy or light. The main problem with this argument is that it is incoherent, as Philoponus himself seems to have admitted, *apud* Simplicium *In de caelo* 72,12 (see below). How can a natural philosopher in the Aristotelian tradition assume, even hypothetically, that the whole world be removed from its place? *Prima facie* it is tempting to suggest that in the above thought experiment Philoponus may presuppose a notion of infinite space, something like the Stoic 'infinite void' surrounding the world.[13] However, this suggestion is not borne out by any further evidence in Philoponus. On the contrary, Philoponus adhered to the Aristotelian doctrine that there is no place or void outside this κόσμος.[14]

The argument just cited is supplemented by a second argument, which seems to betray Stoic influence.[15] Philoponus says that perhaps nothing prevents the world from moving according to the prevalence of the things inside it, yet this movement could not be categorised as upward or downward motion because 'up' and 'down' are themselves determined as internal regions of the world. In fact, a great deal seems to prevent such a motion, and not only because there is no space outside the universe. Philoponus' assumption that the whole world, given that it is a compound body, could move in a straight line according to the prevalent element, is faulty. For if the elementary bodies inside it are heavy and light and strive towards the lower and upper regions, and if these are themselves regions inside the universe, then a translatory movement of the whole due to the inclination of an internal elementary body is clearly impossible.

The two arguments just set out are extremely weak because they involve the assumption of a conceptual impossibility. The next argument in fr. II/44* (*In de caelo* 72,10–16), which Philoponus apparently took from Themistius, rests on an assumption which is merely physically impossible.

> "⟨The Grammarian⟩ has provided himself from ⟨Themistius⟩ with this support which he puts to a worse use. He says that even if one does not allow that the world is hypothetically asssumed to be removed, still, what prevents one from assuming stars falling down from their proper abode towards the inner region? If this star is imagined returning again to its natural place, it would move in a straight line. But Aristotle nevertheless wants none of the things in heaven to partake of weight or lightness."

[13] Cf. *SVF* II 524; 535; 538; 539 and 543. The view that the κόσμος does not possess weight is ascribed to Zeno, see *SVF* I 99. – On the problem of the interpretation of the Stoic void, cf. Lapidge (1978), 176 f. and Sambursky (1959), 110.

[14] Cf. fr. II/47: 76,1–5. In fr. II/39: 71,2–4 he says that the fixed sphere is not in a place (cf. above note 7); cf. also *In phys.* 569,7–17; 572,17–573,17; *De opificio mundi* 128,3–5.

[15] A similar argument is attributed to Chrysippus, see *SVF* II 555 and cf. Sambursky (1959), 110.

The argument is remarkable for its counterfactual character, for Philoponus was of course well aware of the fact that anything like this would be physically impossible – unless the whole universe were to be destroyed.[16] Importantly, however, the arguments of fr. II/43* and 44* reveal certain aspects of Philoponus' own theory of weight and lightness. He suggests that of all elements only the parts which become detached from the whole possess weight and lightness; the totalities of the elements do not possess these qualities, and this is true of the sublunary as well as the celestial regions. That is to say, Philoponus agrees with Aristotle that the heavens do not possess weight or lightness, but he also affirms that the totalities of the sublunary elements – even the earth as a whole – lack these properties. Consequently, he claims that there is no difference between the heavens and earth in this respect. But the cost of this claim is high. The idea that the whole earth does not possess weight seems to be utterly implausible. Why would Philoponus accept such a view? Not, it seems, because he regards the alternative option of attributing weight and lightness to the celestial region as even less plausible,[17] but probably because this account is essentially in agreement with the Platonic theory of weight and lightness.[18]

In contrast it is worth-while to consider Simplicius' views on this subject. Simplicius, of course, recognises that the totalities of the sublunary elements do not move up or down, but he emphasises, in agreement with Aristotle, that they still retain the same inclination (ῥοπή) as their parts, *In de caelo* 67,7–14:

> "Now, above all it ought to be understood that something which desires (τὸ ἐφιέμενον)[19] inclines in all circumstances towards the desired object

[16] The inspiration for this argument seems to be the Gospel of Mark, Mk 13,25: "... and the stars will be falling from the heavens, and the powers of the heavens will be shaken."

[17] For he proposes this view at least for the sake of the argument in frr. II/38 (*In de caelo* 66,17–24) and 39 (*ibid.* 70,34–71,6).

[18] Cf., e. g., Plato *Tim.* 62 D 12–63 A 1. A body at the centre of the universe is in a state of equilibrium.

[19] The 'desire' of an elementary body is of course neither conscious nor in any way psychological.

(τὸ ἐφετόν) and, given that both are bodies, the inclination they have remains even though they may have contact with each other, as a consequence of which they are not simply contiguous but are contiguous while holding on to the desired objects and approaching them as much as possible. So equally, the totality of the firesphere, which strives to approach the heavens even more than any part of it, always retains its inclination towards them, so that it would follow if someone – let this be supposed for the sake of the argument – removed the heavens."

Although not every detail of the idea behind this argument is clear, one can see that according to Simplicius the totalities retain their inclination towards the place or object of their natural striving and 'desire'. He too adduces a thought-experiment in which he assumes the removal of the heavens. A weakness of his argument is that he would have to concede that in the case of the firesphere the parts incline towards a different place than the whole, which he takes to incline towards the heavens rather than its proper place.

Returning to Philoponus, it has become clear that he rejects the distinction between the sublunary and the celestial regions in so far as the properties 'heavy' and 'light' are concerned. In both regions, weight and lightness pertain to the parts only, but not to the whole. One may question the strength of Philoponus' endorsement of the statement of similarity between the two regions. It will be remembered that in the first book, when he stated that the heavens consist of fire, he clearly committed himself to the concession that the celestial fire is a special and pure sort of fire, unlike the one to be found in the sublunary region, though not different in nature. And here, in the second book, one finds a further indication that Philoponus is in fact not willing or able to abolish the distinction between both regions in every aspect. In fr. II/45* (*In de caelo* 73,4–15) Simplicius reports that Philoponus anticipated and met an obvious objection to the attempt to assimilate the regions:

"The dissimilarity deriving from the parts is an obvious objection to those who say that the heavens are of the same nature as the sublunary elements, given that the parts of the elements clearly become detached from the whole and are generated and destroyed, but according to true reports handed down to us in the whole past no part of the heavens seems to have become detached or to have changed. In order to refute, as he believes, this objection, the Grammarian says that the more important and principal parts in living beings are less affected, like the heart, and nevertheless they consist of the same elements. And as he agrees that the heavens are more important than the other bodies inside the world he says that above all they are affected to the least degree of all, and because of this their parts evidently do not suffer in the same way as the parts of the elements."

In consequence of this argument, there still remains, according to Philoponus, a considerable difference between the heavens and the sublunary region, even if it is only one of degree: the heavens are more important than all other bodies. It is noteworthy that Plotinus argues in a very similar way when he says that the heavens are imperishable because (i) they move by the agency of a soul, and (ii) because they consist of the best parts accumulated in the most important organ.[20]

Later in the second book, Philoponus attempts to specify the nature of this difference between the two regions more clearly. Importantly, in contrast to Aristotle, the difference between the heavens and the sublunary world, according to Philoponus, does not lie in the presence or absence of weight and lightness or any other actual physical properties of the respective substances, but in their relative importance as parts of the universe. In the fourth book, when Philoponus returns to this subject, he indicates that the heavens are more important than any other substance or region because they guide all things inside the universe naturally.[21]

For the time being, Philoponus concerns himself with lending further support to his relative assimilation of the heavens and the sublunary region. For this purpose he disowns the Aristotelian notion that 'heavy and light' are absolute properties, arguing for their strictly relative character, fr. II/46: *In de caelo* 74,16–26:

"⟨The Grammarian⟩ also quotes Aristotle who says in the fourth book of this treatise[22] that fire is light everywhere and earth is heavy everywhere, but that water is heavy in other elements and light when it is in earth, and that air is light in water and earth, but when it is outside these it is heavy, which he makes plain by the example that an inflated bladder weighs more than an empty one. And from this ⟨the Grammarian⟩ infers that weight and lightness do not belong to the elements as such.
For otherwise it would not be the case, he says, that the same elements endowed with the same capacities (δυνάμεις) and having received nothing

[20] Cf. *Enn.* II 1, 4.6–11.
[21] See fr. IV/75: *In de caelo* 138,32–34: "It has been agreed that the heavens as a whole as well as in their parts are the most important and essential parts of the world. For by their movement all bodies inside it are guided naturally." Cf. also fr. IV/80: *In de caelo* 142,7–25.
[22] Cf. *Cael.* IV 4, 311 b 6 ff.

in addition from outside, are in fact light in one place and heavy in another only because of their relation towards each other, and that they are light in relation to one, but heavy in relation to another element. White, at least, and black, and hot are not displaced in their arrangement, regardless of how they relate to other things."

The gist of this argument is that Philoponus denies that 'heavy and light' can belong to some elements ἁπλῶς and to other elements πρός τι. This, Philoponus argues, is not paralleled in the case of any other qualities of physical bodies, which never change into their opposites depending on their relation to other things. According to him, the relative aspect of 'heavy and light' rules out the absolute one.

In defence of Aristotle it must be pointed out that the supposed disanalogy detected by Philoponus between contrariety in colours and in weight and lightness does not exist. If black and white correspond to absolute weight and absolute lightness, relative weight and lightness possess their analogues in the different shades of grey. And the intermediate colour 'grey' operates as a relative contrary, just as bodies that are relatively heavy and light.[23]

6.1.3 Fragments II/47 and 48

In *De caelo* I 3 Aristotle argues that the heavens are not possessed of lightness or weight (q), because they do not move in a straight line (p). Philoponus has so far denied that the absence of weight and lightness distinguishes the heavens in any way from the sublunary elements, for according to him, the totalities of the elementary bodies do not possess weight and lightness either. In the following discussion Philoponus sets out to refute Aristotle on his own assumptions. He now grants Aristotle the supposition that weight and lightness do pertain to the totalities of the sublunary elements, and subsequently shows that Aristotle's conclusion q, i. e., the absence of weight and lightness from the heavens, still does not follow from p, i. e., the absence of celestial rectilinear motion. He proceeds as follows: If Aristotle argued $p \rightarrow q$, then, by modus tollens, $\neg q \rightarrow \neg p$; but it can be shown that $\neg q \,.\, p$; therefore p is not a sufficient condition necessarily implying q, i. e., the fact that the heavens do not move in a straight line does not as such allow the conclusion that they are devoid of lightness and weight. Fr. II/47: *In de caelo* 75,17–30 reads:

[23] See *Phys.* V 1, 224 b 32–35; 2, 226 b 3–8; 5, 229 b 14–21.

"But let it be agreed that the elements do possess weight or lightness not only in places foreign to them, but that they are characterised by capacities (δυνάμεις) of this kind even when they are in their proper places. For not even in this way, I (sc. Philoponus) think, will there be any argument which is able to show that the celestial body alone is devoid of these capacities, seeing that Aristotle inferred that the heavens do not partake of weight or lightness from the fact that they do not move in a straight line naturally. For in order to prove that the heavens do not move in a straight line naturally he assumed that the heavens are different from the substance of the bodies which move in a straight line; and from the proposition that they do not move in a straight line he then inferred that they do not partake of weight or lightness. Therefore, if there were some argument to show that even if the heavens partook of weight or lightness ($\neg q$), or were a compound of heavy and light bodies, it would nevertheless be impossible for them to move in a straight line (p), then it would surely be evident that they are not necessarily devoid of weight and lightness simply because they do not move in a straight line. Let this be the starting point of the proof."

In order to show that the celestial body *as a whole* cannot move upwards or downwards, even if it possessed the qualities heavy and light (i. e., $p \,.\, \neg q$), Philoponus makes the following assumption, *In de caelo* 75,30–76,1:

"⟨The Grammarian⟩ assumes that the heavens are a rigid and solid body which cannot give way like water and air, and that, if any part of them becomes detached, they do not remain continuous by closing up[24] as air and water do, and he says that the spherical shape is the cause of the solidity."

The assumption is that the heavens are solid, i. e. hard, but at the same time fragile. The following argument relying on this assumption is straightforward. Heaven cannot move upwards because it already occupies the extremity, *In de caelo* 76.1–3. Conversely, it cannot move downwards because (i) it already occupies its natural place, and (ii) because there exists no space to accommodate the celestial body. The spherical form ensures that the heavens are solid and difficult to divide, *ibid.* 76,4–9, but the fragility of the heavens entails that they would perish as a whole if only a part of them became separated, fr. II/47: *In de caelo* 76,13–16:

"But in the case of solids and substances that are difficult to divide, if any part of these becomes detached the shape of the whole will perish. Thence, as along as it is necessary that the heavens remain in their natural shape

[24] Literally: "by replacing reciprocally" (ἀντιπεριιστάμενον).

and the whole world exist, it is impossible that any one of the parts of the heavens become deprived of the continuity of the whole."

And Philoponus concludes the argument, *In de caelo* 76,21–26:

"Consequently, as long as the heavens and the universe must be preserved no part of them may become detached.[25] The fact that the heavens behave in this way demonstrates that they have received some other form that is different from the simple forms,[26] but it does not demonstrate that the heavens are also different from the elements in nature. For equally, when water freezes it may turn into hail or snowflakes, but they are not because of this considered to be a fifth nature of body."

The point of this argument is on the one hand to show that Aristotle was wrong in supposing that the vertical immobility of both the heavens as a whole and in its parts implies the absence of weight and lightness. The apparent phenomenon is explainable by other facts, notably that the heavens cannot possibly move downwards because of the lack of space, and that no part of them may become detached for as long as the whole universe shall remain in existence.

On the other hand, the argument informs us about certain cosmological beliefs held by Philoponus. He bases his argument that no part of the heavens can become detached on the assumption that the celestial body is ἀντίτυπον καὶ δυσδιαίρετον. In contrast to the conception of the heavens as incorruptible crystal spheres made of aether, Philoponus seems to contend that the spheres are not at all incorruptible, but rather hard and very difficult to shatter in consequence of a stable configuration. The assumption of 'hardness' is, to say the least, surprising in view of what Philoponus said in the first book, namely that the celestial region consists for the most part of fire. How can the form of 'fire' be actualised in a quantity of matter which is organised so very stably? The difficulty is perhaps partly removed if one considers that 'hardness' is merely the result of something else, i. e. the spherical shape, and nothing prevents the actualisation of the shape of a sphere in a fiery substrate. But Philoponus never explains why 'sphericity' should be an exceptionally stable configuration, a claim Simplicius, at any rate, finds θαυμαστός.[27] Elsewhere, Philoponus argues in a very similar vein, *In meteor.* 42,1–5:

[25] The preservation of the universe depends, in turn, on the will of God, cf. below fr. IV/80: 142,14–17.
[26] Or: "bodies".
[27] See fr. II/48 (*In de caelo* 77,23–27).

"If each of the spheres and each of the stars is circumscribed by its own spherical shape, then it is clear that each of the things in heaven is necessarily solid (στερεόν) and resistant (ἀντίτυπον). For they are all spherical. For if they were not, they would not preserve their own shape in the course of such a rapid motion."

This passage could perhaps be interpreted as making not the strong claim that 'sphericity' *causes* rigidity, but simply that it *presupposes* solidity. Anything which is spherical must necessarily be rigid and solid, otherwise it would not be able to retain its shape, especially under the strain of motion. However, this leaves open the question *why* the heavens are indeed rigid and solid.[28]

In any case, the objective of the argument is to show that Aristotle's argument for the absence of weight and lightness in the heavens is not sound. On the sole assumption that the heavens are a solid, rigid body – an assumption Aristotle would not have denied – Philoponus shows that they cannot possibly move in a straight line, so that they may still be heavy and/or light; see fr. II/47: *In de caelo* 76,26–29:

"Surely then, if even on the assumption that the heavens partake of weight and lightness, we discovered that rectilinear movement cannot possibly belong to them, it follows that it is not correct to infer that they are free from lightness and weight merely because they do not move in a straight line."

6.1.4 Fragments II/49–51*

The primary aim of this second book of the *contra Aristotelem* is the refutation of Aristotle's tenet of the absence of weight and lightness in the heavens. Philoponus thinks that this aim has been achieved, and in what follows, until the end of book II, he is – as Simplicius *In de caelo* 78,12–15 writes – eager to entangle (περιβάλειν) Aristotle in further contradictions. Apart from some rather acute observations concerning Aristotelian doctrine, the two last fragments of this book contain an important part of Philoponus' own theory of cosmological

[28] In *In meteor.* 41,25 ff. Philoponus seems to incline towards a suggestion he attributes to Plato that the heavens are solid because they consist partly of earth. But this would not necessarily warrant the conclusion that the detachment of a part would destroy the continuity of the whole ('fragility'), because earth does not behave in this way, as Simplicius points out at *In de caelo* 77,27 (see fr. II/48).

motion. The general subject-matter is the problem of the origin of the celestial motion.

Philoponus begins by pointing out that Aristotle's statements in *De caelo* and the *Physics* are contradictory, fr. II/49: *In de caelo* 78,17–28.

> "First ⟨the Grammarian⟩ shows by means of many arguments which, as he says, are in agreement with Plato, that the circular movement of the heavens is natural *and* imparted by a soul, because the heavens are a living being, and although he says this in more words than necessary, I ⟨sc. Simplicius⟩ still think this is said correctly. But then he finds fault with Aristotle for supposedly rejecting in the second book of this treatise[29] the claim that circular movement is imparted by a soul, as Plato held, and for saying that on this account the movement would be contrary to nature and in need of rest and resistance, as are other living beings.
> Yet, the same Aristotle, he continues, said on this subject:[30] 'The heavens are animate and contain a principle of motion', and as regards the stars he says that they should not be conceived as mere bodies and monads which possess an arrangement but are entirely inanimate, but that it is necessary to assume that they participate in activity and life."[31]

One noteworthy point about this passage is that Philoponus seems to argue for and endorse the tenet of a world-soul. Then he proceeds to entangle Aristotle in contradictions by raising the well-known problem of how to understand Aristotle's physical theory of the movements of the spheres. Does Aristotle endorse the view that the heavens are animate, or does he reject it? It may be agreed that in *Cael.* II 1, 284 a 27–35 Aristotle clearly rejects Plato's tenet of the *Timaeus* that the circular motion of the heavens is imparted by the world-soul,[32] and this position may be aligned with his theory of aether, *De caelo* I 1–4, where he emphasises that nature is a principle of motion, and that aether moves in a circle *by nature*. However, in II 2, 285 a 29 f. Aristotle says that the heavens are animate (ἔμψυχος) and contain a – supposedly psychical – principle of motion.[33]

[29] See *Cael.* II 1, 284 a 27–35.
[30] See *Cael.* II 2, 285 a 29 f.
[31] See *Cael.* II 12, 292 a 18–21.
[32] Cf. *Tim.* 33 D f.; 36 D–37 C. – Aristotle objects: "Such a life as the soul would have to lead could not possibly be painless or blessed. The motion must be enforced, if it moves the first body in one way when its natural motion is in another, and moves it continuously, and therefore it must be restless, a stranger to leisure and reason, since it has no relief granted to the soul of mortal creatures by the relaxation of the body in sleep." (Guthrie). See also Guthrie (1939), xxxi f. On the problem of Aristotle's prime mover see Waterlow (1982), 204–257.
[33] Cf. also *Cael.* II 12, 292 a 18–21. The problem plays a significant role in the modern discussion on the development of Aristotle's theology; cf. in general Guthrie (1939), xi ff., esp. xxxi–xxxvi, and more recently *id.* (1981), 243–276.

Philoponus turns to the eighth book of the *Physics* to show that Aristotle's cosmological theory in fact requires the postulation of a world-soul, or at least of some kind of superior motive cause, fr. II/49: *In de caelo* 79,2–8:

> "And if Aristotle proved in the eighth book of the *Physics* that the heavens are a limited body,[34] and that a limited body has limited capacity (δύναμις),[35] and that circular motion is unlimited,[36] then it is necessary that the rotation be provided by a cause of unlimited capacity. However, the nature of a limited substrate is limited itself. According to Aristotle, therefore, that which moves the heavens with a circular movement is something essentially different. So how can he think it right to explain the motion as deriving merely from nature?"

According to Philoponus' interpretation of the arguments of the eighth book of the *Physics*, the heavens cannot possibly move eternally of their own accord, for an infinite force or capability (δύναμις) cannot reside in a finite body. Therefore, the heavens must be moved by something else which is essentially different. Here Philoponus, like his teacher Ammonius,[37] interprets Aristotle's prime mover as an efficient cause, and he indicates that the argument of the *Physics* requires the postulate of a motor, the world-soul. Importantly, this last argument is not at all a dialectical one. Philoponus in fact believed in the general validity of Aristotle's argument in *Physics* VIII,[38] and he believed too that it necessarily leads to the postulate of a world-soul. In the *contra Aristotelem*, therefore, Philoponus draws the consequences which, to his mind, Aristotle should have drawn. Simplicius continues fr. II/49: *In de caelo* 79,8–14:

> "Then, having made the above accusations in these arguments ⟨the Grammarian⟩ says that it is not impossible for the same movement to be caused by a soul and by nature at the same time. For example, if one imagined one of the birds making a straight flight towards the centre: the impulse of the soul thus coincides with the natural inclination (ῥοπή) of the body."

[34] This is in fact demonstrated in *Physics* III 5 and *De caelo* I 5–7.
[35] Cf. *Phys.* VIII 10, 266 a 23–b 6.
[36] Cf. *Phys.* VIII 8, 261 b 27 ff.
[37] Cf. *apud* Simplicium *In de caelo* 271,18–21.
[38] This is made plain by the fact that he exploits it for his own purposes in a separate treatise which claims to show that an infinite δύναμις cannot reside in a finite body, from which Philoponus concludes that the universe must have been generated and will be destroyed. Fragments of the treatise survive in Simplicius *In phys.* 1326–1336.

This is perhaps one of the most important passages of the text because it indicates how Philoponus himself sought to solve the problem of the circular motion of the heavens. Philoponus' solution, however, that the heavens are moved (just like a bird flying towards the centre) both by nature and by soul, is far from being satisfactory. In order to explain this it is necessary to recall what he stated in the first book. There, when he attempted to account for the circular motion of the firesphere, he argued that this motion belongs to fire κατὰ φύσιν. This phrase is significant in the sense that it indicates that Philoponus explains sublunar circular motion in terms of the *natural* principle of motion in fire. Circular motion is brought about by the nature of fire itself. Here, in the second book, Philoponus deals with the separate problem of the circular movement of the celestial body. He finds it necessary, as fr. II/49 shows, to introduce a second principle of motion, soul, and he lets both nature and soul account for the movement of the spheres. The obvious question arises, Why does Philoponus argue along these lines – given that he believed that the heavens too consist for the most part of fire, that fire moves in a circle by virtue of its own nature, and that he did not accept the tenet of the eternity of the world?

Prima facie one may be tempted to suggest that in Philoponus the notion of φύσις has undergone a change. It may no longer possess the status of a sufficient efficient cause, but has been demoted to the level of a mere συναίτια, so that there is need of the activity of the soul in order to fully actualise the natural predisposition.[39] But this cannot be the case in the present treatise, for there is no indication in the writings preceding the *De opificio mundi* that Philoponus modified or discarded the Aristotelian notion of 'nature'. Secondly, his explanation of the movement of the firesphere in book I suggests the contrary. Philoponus follows Aristotelian lines in the sense that he retains the assumption of

[39] On the supposition that by the time of the *contra Aristotelem* Philoponus had already developed certain aspects of his impetus theory, the hypothesis under consideration seems to receive greater plausibility. For if imparted forces are taken to account universally for all kinds of motions (natural movements, i. e. movements ultimately caused by the creator, as well as forced movements), the Aristotelian idea of 'nature' as a principle of motion loses much of its significance. However, this step towards the universal application of impetus theory was not taken by Philoponus before the *De opificio mundi*. – Interestingly, the subordination of 'nature' to an external principle of motion is part of Simplicius' theory of celestial dynamics; see the passage *In de caelo* 387,12–19, which is translated below.

'nature as a principle of motion'.[40] In consequence, there seems to be no reason to believe that the two causes of the celestial motion, nature and soul, are hierarchically structured. Both causes possess equal rank *qua* being efficient causes, and nothing prevents either of them from being able to account for the phenomenon independently. In view of this fact one may appropriately speak of Philoponus' assumption of *double causation*.

Significantly, the polemic against Aristotle is the only treatise in which Philoponus proposes this thesis of double causation in celestial motion. In his earlier writings, up to the treatise against Proclus,[41] Philoponus had not yet worked out the idea that circular motion may well be caused by the nature of fire itself, and he therefore endorsed the view current in his day that the soul moves the heavens (and the heavens in turn the firesphere) *supernaturally*.[42] The situation is unclear in the *Meteorology* commentary, in which the notion of a world soul does not seem to play a significant role at all; in the *De opificio mundi* the existence and activity of soul is finally rejected in favour of universally imparted forces.[43] The thesis of double causation, therefore, clearly represents an awkward interim stage in Philoponus' development of a cosmological theory. Nevertheless, one wonders why Philoponus was either unable or reluctant to suspend the notion of a world soul by the time of his treatise against Aristotle. Certainly, given that he believed that Aristotle rejected the Platonic idea of a world soul, the retention of this idea could be used effectively against Aristotle, as fr. II/49 shows. However, this is not to say that Philoponus retains the psychical principle merely in a combative spirit. In a later passage Simplicius clearly states, fr. III/61*: *In de caelo* 91,17–19:

> "Yet, it is worth knowing that in contrast to others, his comrades,[44] ⟨the Grammarian⟩ wants the heavens to be animate as well, but he nevertheless

[40] Cf. also Philoponus' commentary on Aristotle *Physics* II 1, where this assumption is not criticised. The fact that in the *contra Aristotelem* Philoponus does not reject Aristotle's point of departure for the aether theory, *Cael.* I 2, 268 b 14–16, may be taken as a further indication.

[41] That treatise was written only a few years before the *contra Aristotelem*, cf. above 5.1 and Wildberg (1987 b) 200–202.

[42] See *In phys.* 198,15. For further references see Evrard (1953), 305 f., 309–314.

[43] See *De opificio mundi* VI 2.

[44] I. e. other Christians. Basil, for example, denied that the heavens are animate; see his *Hexaemeron* III 9.

appears to be no less impious towards the heavens than the greatest fools among them."

Given that Philoponus genuinely accepted the world soul, the absence of a systematic reason for this is puzzling. The thesis of double causation not only seems to be uneconomical, but also gives the impression that it may even harm his project of rejecting the eternity of the world. His present cosmological theory comes dangerously close to the ones proposed by Alexander, Plotinus, and Simplicius, all of whom firmly believe in the eternity of the world.

The individual positions of Alexander, Plotinus, and Simplicius differ in certain respects. Although Alexander does not deny the existence of aether (see Moraux (1963), 1238 f.), he seems to have been the first Peripatetic to state explicitly that the celestial rotation is caused by both nature and soul. Significantly, Alexander denies any difference between natural and psychical motion in the case of the heavens (see *apud* Simplicium *In de caelo* 380,29–381,2; *In phys.* 1219,1–7; cf. Merlan (1943), 181) and he is rebuked for this by Simplicius, *In de caelo* 387,12–19:

"In consequence, if one asks in which way does 'nature' move the heavens, and in which way does 'soul', one must not answer, as Alexander did, that there nature and soul are the same. For how could they be the same, if nature is the passive capability (δύναμις παθητική) to be moved, which is the movable in the substrate, but the soul is the external mover? Therefore, one must not say that in the case of the heavens soul and nature are the same, despite the fact that the motion brought about by either of them is identical, but on the one hand the soul moves actively from outside, and on the other hand nature inheres as the principle of being moved."

Simplicius has departed further from Aristotle than Alexander in the sense that he subordinates natural (passive) movement to the activity of the soul.

His theory has probably been influenced by Plotinus who rejects aether but nonetheless defends the eternity of the world; see *Enneads* II 1. In *Enneads* II 2, where he states that the heavenly body (fire or light, cf. Graeser (1972), 22–24) moves in a circle whereby it imitates the νοῦς, he first explains that the mobile nature of fire results in circular motion (*Enn.* II 2,1.20–37) and then continues at II 2,1.37–39: "But if the soul causes circular motion, it will not labour (οὐ καμεῖται); for it does not pull (οὐ γὰρ ἕλκει) the celestial body because the movement is not contrary to its nature. For nature is that which has been arranged by the soul of the universe." In Plotinus, it seems, circular motion is ultimately caused by the world soul, but thanks to the nature of fire the actual process of motion involves no effort.

In the light of the history of the concept of the world soul, the question arises, How could Philoponus accept a world soul in the *contra Aristotelem* and nevertheless reject the idea of the eternity of the world? In his view, there simply is no contradiction because the assumption of a world soul as kinetic principle of the celestial body does not decide the issue one way or the other, fr. II/50*: 199,27–30:

"But he added an argument of the following kind too, that if the celestial body moves with a circular locomotion not by nature but by the agency of a soul, as in the case of living beings, or by the agency of some other superior force, it is not possible to infer from its motion either that heaven is generated or that it is ungenerated."

Nevertheless, it would seem to have been much more sensible for Philoponus not to introduce the thesis of double causation, and to dispense with the idea of a world soul on the grounds that the very nature of fire already accounts for circular motion. It only remains to conclude that at the time of the *contra Aristotelem* the existence of the world soul was still an unquestioned and apparently unquestionable assumption, borne out, above all, by the authority of the Platonic *Timaeus*; see fr. II/50* (*In de caelo* 80,13–23).

6.2 The Structure and Argument of Book III

Only ten fragments survive of the third book. It is convenient to subdivide these fragments into two groups. In the first group (frr. III/52–56) Philoponus objects to an argument put forward by Aristotle in the *Meteorology* stating that the heavens cannot possibly consist of fire. Then, in the second group, (frr. III/57–61*), Philoponus adduces several arguments from sense perception in support of his own theory concerning the substance of the celestial body.

If the *contra Aristotelem* were to be viewed as a step by step refutation of Aristotle's theory of aether as expounded in the *De caelo*, the present book would represent a digression from the arguments there. It is clear, however, that the *contra Aristotelem* is at the same time an exposition of Philoponus' own cosmology. Since he has discussed such topics as the nature and cause of circular motion, and the problem of weight and lightness, it is only consistent that he now uses an argument in the *Meteorology* as a point of departure for an outline of his own theory of the substance and attributes of the celestial region.

6.2.1 Fragments III/52–56

At the beginning of *Meteorology* I 3 Aristotle briefly summarises his theory of the elements constituting the universe. According to him the world does not consist of four, but of five simple bodies, the primary element, aether, filling the celestial region. Although Aristotle says that he has dealt with these matters sufficiently elsewhere,[45] he nevertheless adduces two arguments in support of the claim. They show that neither fire nor air can possibly fill the space between the sublunary world and the ultimate sphere of the fixed stars. Only the first argument is of interest in the present context, *Meteor.* I 3, 339 b 30–340 a 3:

> "But those who say that not only the bodies in motion but also that which surrounds them consists of pure fire, and that the space between the earth and the stars consists of air, would perhaps have abandoned this childish opinion if they had considered what has now been sufficiently demonstrated by mathematics. For it is too simple to believe that each of the moving bodies is small in size because it so appears to us upon observation from here. Now, this has already been stated before in our considerations of the upper region,[46] but let us repeat the same argument here as well. For if both the intervals were full of fire and the bodies composed of fire, each of the other elements would have perished long ago."

There are two obvious reasons why Philoponus must take critical interest in this passage. First, Aristotle's argument seems to entail that the postulation of a fifth elementary body is inevitable. Secondly, and more importantly, Aristotle rules out explicitly the Platonic theory that fire is the celestial substance, which is precisely the stance Philoponus is adopting himself. In his universe the heavens consist for the most part of fire. It is not surprising to find that his refutation formed a whole separate book and must have been quite elaborate. Simplicius says in fr. III/52: *In de caelo* 80,23–28:

> "But since it is his aim, as he himself admits, to defy the propositions on the eternity of the heavens, he has not been content with objecting to what has been written in the treatise *On the Heavens*, but has in addition spent his third book objecting to what has been said by Aristotle in the *Meteorology*, i. e. that the heavens are not fiery."

In total, one may distinguish at least five different objections. Philoponus first replies *ad hominem* that in Aristotle the firesphere causes

[45] See *Meteor.* I 3, 339 b 16–19.
[46] The following argument in fact does not appear in the text of the *De caelo*.

the same difficulty because it is larger than the things surrounded by it (fr. III/52: *In de caelo* 81,5–7). Unfortunately, the force of this objection is negligible precisely because Aristotle presupposes the equilibrium of the powers of the four elements, a reply which is of course less plausible if one supposes the whole celestial region to consist of fire. He could simply answer that the firesphere possesses a certain 'thickness' such that the sum total of its mass and power is not able to overcome and destroy the other elements. Here, Philoponus does not give a reason why one should think that the firesphere is indeed larger, but in the *contra Proclum*, where the same argument appears,[47] he states generally that "that which surrounds is larger than the surrounded", but this remark is plainly unsatisfactory. There is a further objection to Aristotle in the same fragment. Philoponus attempts to turn Aristotle against himself, fr. III/52: *In de caelo* 81,7–9:

> "But neither the fire of the firesphere nor the celestial fire are capable of burning, but what is capable of burning is the fire in our region, which is excess of fire, according to Aristotle."

Aristotle indeed argued in the *Meteorology* that the so-called 'firesphere' has the unactualised capability of burning (πέφυκε ἐκκαίεσθαι); it is not a burning flame (φλόξ) but a quasi-fire or fuel (ὑπέκκαυμα).[48] Hence, if one assumes with Philoponus that the heavens consist of this kind of fire, no difficulty arises. And it is indeed a weakness in the argument of the *Meteorology* cited above that Aristotle does not take into account that he himself assumes different kinds or forms of fire.

Philoponus' definition of τὸ καυστικόν (i. e. the 'burning' fire or flame) as an excess of fire,[49] is not, as he claims, Aristotelian. It is true that Aristotle says once that fire is an excess of heat,[50] but the flame is defined as the "boiling up of a dry current of air"[51] or, more generally, burning smoke.[52] Like Plato, and later Theophrastus, Aristotle recognises several different kinds of fire (εἴδη πυρός), namely φλόξ, ἄνθραξ, and φῶς.[53] Philoponus, too, distinguishes between different appearances

[47] Cf. *contra Proclum* XIII 14, 517,24–518,4 (ed. Rabe).
[48] See *Meteor.* I 3, 340 b 21–29; 4, 341 b 13–24.
[49] Philoponus uses the same definition elsewhere, see *contra Proclum* XIII 11, 507,2 f.; 14, 518,5 f. 21; *In meteor.* 23,14–17; 34,5 f.
[50] See *Gener.corr.* II 3, 330 b 25 f. – Cf. also Philoponus *In gener.corr.* 228,26–229,4.
[51] *Meteor.* I 4, 341 b 21 f.
[52] *Meteor.* IV 9, 388 a 2; cf. also Gilbert (1907), 198.
[53] *Topics* V 5, 134 b 28–30; Plato *Tim.* 57 C; Theophrastus *De igne* 3. – Cf. also the Stoic distinction between ἄνθραξ, φλόξ, and αὐγή, e. g., *SVF* II 612.

of fire[54] but more important than this distinction is the generic distinction he draws between πῦρ φυσικόν (also called πῦρ στοιχειῶδες or πῦρ ζωτικόν) and the πῦρ καυστικόν (or πῦρ διακονικόν).[55] The former is the lightest and purest kind of fire or heat; it not only pertains to the upper region but also generates and maintains the life and warmth in living beings. The latter appears in different 'grades' as flame or glowing fire, depending on the fuel being burned. However, he does not regard light as a kind of fire.[56]

The main difference between Philoponus and Aristotle on this subject is that the fire Aristotle regards as fuel (ὑπέκκαυμα) is taken to be the natural and elementary fire in Philoponus. The burning flame is just a derivative of this fire, namely its excess. Philoponus' distinction between πῦρ φυσικόν and πῦρ καυστικόν no doubt shows influence of the Stoic distinction between πῦρ τεχνικόν and πῦρ ἄτεχνον.[57] However, in the Stoics, as in Plotinus, the relation between the two genera of fire is not entirely clear.[58] On the other hand, although Philoponus too assumes two different types of fire, he states explicitly that this difference is constituted by a difference in quantity, or rather intensity. There can be no doubt that both types of fire are merely instances of one and the same element.

In the third objection (fr. III/53*: *In de caelo* 81,22–26) Philoponus attempts to show that even if it is assumed that there exists a disproportionate quantity of fire in the upper region, nevertheless this will not threaten the permanence of the whole universe, as Aristotle supposes. For the qualities of the elements do not increase in proportion to the mass of the bodies in which they exist. For example: ten thousand times more water is not ten thousand times colder, but a measure of seawater is as cold as the whole sea. The argument must be understood in the light of what has been said with regard to the relation between fire and flame. If one distinguishes between the intensity (degree) of a quality, the quantity of a quality, and the quantity of the underlying substratum, Philoponus argues that the intensity of a quality does not

[54] See, e. g., *contra Proclum* XIII 14, 518,24–519,10.
[55] See *contra Proclum* XIII 14, 518,5 ff.; *In meteor.* 23,14–17.
[56] Light is not a kind of fire but the colour of fire; see, e. g., fr. IV/67: *In de caelo* 124,8 f.; also *ibid.* 130,31.
[57] See, e. g., *SVF* I 120 and Gilbert (1907), 248 f. Cf. Aristotle drawing an analogy between the heat inside the semen and the substance of the stars in *Gener.an.* II 3, 736 b 29–737 a 1.
[58] Cf. Graeser (1972), 22–24 with references.

depend on the quantity of the substratum. Although there is quantitatively 'more' cold in the whole sea, the water does not freeze because the intensity or degree of coldness stays the same. Similarly, the universe is not burned up because there exists quantitatively more fire. It is the intensity of fire which causes the burning, for fire is an excess of (natural) fire.

As has been pointed out, in Philoponus the two 'genera' of fire are not merely juxtaposed. Philoponus recognises only one kind of fire, possessing the same nature, in the whole universe. Simplicius, who is well aware of this, quite rightly points out a difficulty which, to his mind, seems insurmountable, *In de caelo* 81,11–15:

> "If the things below the moon by nature act upon, suffer from, and change into one another, then it is clear that the heavens, too, if they consist either of fire or of anything else of the same nature, necessarily suffer from the things below the moon and act upon them and are, compared with them, (only) of equal strength (ἰσοσθενές)."

This is indeed a major difficulty Philoponus' theory has to face, for the heavens do not seem to suffer anything from the things here but apparently remain unaltered. The objection is so obvious that it had been anticipated by Philoponus. His standard reply is that the heavens are the most important parts of the universe; they will, by virtue of a special form, remain unaltered as long as the universe itself exists.[59] In the present context, where the problems of the fiery nature of the heavens and the heat of the spheres are discussed, he argues as follows, fr. III/54: *In de caelo* 82,14–26:

> "The remoteness of the things in heaven and especially of the stars, which the more ancient philosophers thought to consist mainly of the substance of fire, reduces the heat generated by them for the things here; this the sun clearly shows because it warms those things most to which it has come nearer.
> And so, what kind of qualitative effect would the heat inside the fixed sphere, supposing that it is of a thermal nature, have on the spheres surrounding the earth, which are so far away? For the ultimate sphere could not possibly act qualitatively upon the subsequent spheres because they are like it, nor could these act upon the firesphere. For like is not naturally affected by like.
> The firesphere, therefore, would retain its own nature because it does not admit any of the heat within the spheres, and the firesphere itself would

[59] See fr. II/45*: *In de caelo* 73,4–15; fr. IV/75: *ibid.* 138,32–34: fr. IV/80: *ibid.* 142,7–25.

not have any greater effect on the things inside than it does have now, even if all things around it were fiery, and this is especially true since this kind of fire is not assumed to be a burning flame, as we have pointed out frequently."

Philoponus' rebuttal of the objection mentioned by Simplicius is twofold. First he says that the distance of the stars and the spheres in general prevents them from affecting and being affected by the sublunary things qualitatively. Secondly, the heat inside any one of the celestial spheres cannot possibly affect the things here because it does not even affect the subsequent and proximate sphere. Like is not affected by like, and fire does not act upon fire.[60] In consequence, Philoponus confidently concludes that the firesphere will not turn into a firestorm; it will always retain its moderate nature because it does not admit the heat inside the spheres above it. Philoponus' theory, although it removes the distinction between the sublunary and the celestial regions, is nevertheless able to account for the apparent phenomenon of the unchangeability of the heavens and the stability of the universe at large. This, of course, does not mean that the heavens are unalterable and indestructible *per se*. His theory only claims to account for the facts while the universe exists; its existence itself depends exclusively on the will of God.[61]

In this context it is noteworthy that Philoponus, like Aristotle, does not regard shooting stars, comets, and other 'meteorological' phenomena as a sure sign of the changeability or destructibility of the things in heaven. He too interprets and misunderstands them as sublunar events.[62] But in his favour it must be pointed out that as regards their exact origin and explanation he is sceptical enough to recognise the urgent need for further and close observation, *In meteor.* 98,3–8:

> "Thus, since the philosophers mentioned[63] neither accounted for the phenomena nor were at all able to find some explanation for this ⟨i. e. the movements of the comets⟩, I think it is necessary to make observations of all these things frequently ⟨in order to find out⟩ if what Aristotle said is true, and if it seems to be true to look again, lest the result ⟨of the observation⟩ is mere opinion and an optical illusion – and not the truth."[64]

[60] The principle that like is not affected by like is stated by Aristotle *Gener.corr.* I 7, 323 b 18–24.
[61] See fr. II/47: *In de caelo* 76,14–16 and esp. fr. IV/80: *ibid.* 142,14–20.
[62] See his commentary on Aristotle's *Meteorology* I 4–7.
[63] Philoponus refers to Aristotle's predecessors as criticised in *Meteorology* I 6.
[64] It should be noted that Aristotle would not have disagreed, see, e. g., *Meteor.* I 7, 344 a 5–8.

Importantly, Philoponus not only argues that the celestial region consists of fire, but also that this thesis does not conflict with the phenomena even if one supposes this fire to be actively hot and burning rather than moderate. The reason is that the firesphere shields off, so to speak, the heat in the celestial region. But what about the phenomenon of the heat of the sun? Simplicius is quick to point out an apparent contradiction in Philoponus' argument, fr. III/54: *In de caelo* 83,16–19:

> "And it is clear that although the heat of the heavens is something vital (ζωτική τις), as this man claims, it does not transmit the heat to the things below the moon. But how can he who assumes that the fixed heaven is hot, say on the one hand that it is entirely inactive, and on the other hand that the sun warms us?"

Simplicius raises the problem of the generation of heat by the sun, or, more generally, the problem of the physical relation (action and passion) between the celestial and the sublunary regions. Since Philoponus, as has been shown, transforms Aristotle's cosmology on a large scale by abandoning the strict dichotomy between the heavens and the sublunary region, his consequent conception of the physical relation between the two regions thus united must be of paramount interest, and it is necessary to deal with this subject, in particular the problem of the sun, in a separate section.[65]

The following fragment III/55: *In de caelo* 83,30–84,4 shows, again, that Philoponus not only attacked Aristotle but other Peripatetic philosophers as well, in particular Alexander of Aphrodisias. The issue seems to be Alexander's interpretation of Aristotle's argument in the *Meteorology* that the space between the earth and the heavens cannot consist of air either.[66] Philoponus argues apparently along the same lines as in fr. III/53* that the active qualitative power of an element does not depend on the quantity of the element but on the intensity of the quality. He supports his point by the argument that a small quantity of air may possess a more intense heat than a large quantity.

Philoponus' fifth attack on Aristotle's argument that the heavens cannot consist of fire possesses considerable importance. On the surface, the argument seems to be a simple 'Plato vs. Aristotle', fr. III/56: *In de caelo* 84,15–22:

[65] See below 6.2.2.
[66] Cf. *Meteor.* I 3, 340 a 3–18. This argument follows Aristotle's denial of fire in the celestial region.

> "Plato, ⟨the Grammarian⟩ says, held that the heavenly bodies are not composed of fire alone, but that they partake above all of that sort of fire which produces a better mixture of the other elements. All the fine and purest substance of the elements which possess also the relation of form to the other elements has been chosen for the composition of the celestial bodies, while the more material and so to speak sludgy portion of these elements exists here below. This ⟨i.e. the former⟩ is the sort of fire Plato wants the stars and the sun to be composed of."

A common trait of the *contra Aristotelem* is that, wherever possible, Aristotle is brought into conflict with Plato. Philoponus frequently invokes the authority of Plato in order to lend additional support to his criticisms of Aristotle. Usually, he entirely agrees with Plato. The present fragment is a peculiar instance of this. First, although Philoponus has so far emphasised the supposition that the heavens consist of fire, he now adduces Plato who said that the three remaining elements too must be present in the celestial region, although in much smaller quantities. One must suppose that Philoponus follows Plato in this assumption, for otherwise the succeeding fragments of the third book (see frr. III/57*–61) are incoherent: for in these fragments Philoponus attributes all kinds of familiar corporeal qualities to the celestial body. The remarkable feature of the just cited fr. III/56 is that Philoponus interprets Plato's cosmology, in this particular instance his hypotheses on the substance of the heavens, in a Neoplatonic fashion. Plato's remarks do not seem to include the hypothesis that the universe is stratified so that the purest and finest grades of the elementary polyhedra belong to the upper region and the coarser, more material grades to the world below. The textual evidence of the *Timaeus* merely warrants the supposition that Plato believes the whole universe, including the heavens, to be composed of the four elements, without making the distinction between pure and 'sludgy' grades.[67] Plotinus, in his treatise Περὶ οὐρανοῦ, discusses the substance of the celestial region at length. In order to defend the notion of the eternity of the world without the Aristotelian assumption of aether, he presupposes that the celestial bodies are καθαρὰ καὶ πάντως ἀμείνονα,[68] and although he recognises a number of problems he does not reject the idea that all four elements are present and thoroughly mixed in the celestial region, fire being the

[67] See *Tim.* 31 B 4–33 B 1; also *Aët.* II 6,4; II 13,12. But cf. *Tim.* 58 D 1–4 which may be taken in support of the Neoplatonic interpretation for the case of air.
[68] See Plotinus *Enn.* II 1,4.6–11.

predominant element.[69] Proclus, in an early and now lost treatise entitled "Examination of Aristotle's objections to Plato's *Timaeus*",[70] argues in a similar way:[71]

> "For the celestial fire is not capable of burning (οὐ καυστικόν) but, as I at any rate would say, is life-producing (ζωοποιόν), like the innate heat in us. And ⟨Aristotle⟩ himself says in the *On the Generation of Animals* that there is some 'illumination'[72] whereby each of the mortal animals lives when it is present. The whole heavens, then, consist of a fire of this kind, and the stars possess this element for the most part, but they also possess the perfect (kinds) of the other elements (ἀκροτήτας τῶν ἀλλῶν)."

Philoponus accepts this Neoplatonic interpretation of Plato's cosmology, but in both the *contra Proclum* and, in a more outspoken manner, the *contra Aristotelem* he departs from it in one important respect. As the remaining fragments of book III will show, the assumption of pure grades of the elements does not prevent Philoponus from asserting that the substances there possess exactly the same corporeal qualities as the bodies below the moon. Since the assumption of pure grades seems to have been adopted precisely in order to avoid the attribution of the common qualities to the heavenly bodies,[73] it is particularly remarkable that Philoponus, again, was not able or willing to break with this aspect of Neoplatonic cosmology completely, and to deny, on the evidence to be found in Plato, that there are no different grades of elements.

Before we proceed to the discussion of the remaining fragments of the third book, a final point may be raised in this section. As has been shown, fragments III/52–56 contain important material and argument conveying certain insights into Philoponus' own cosmological views as well as his development; yet, these arguments were primarily designed by Philoponus to repudiate Aristotle's claim in *Meteor.* I 3, 340 a 1–3 that the celestial region cannot consist of fire. Since Philoponus has dealt with this passage in some of his other works as well,

[69] See *Enn.* II 1,6–7; esp. II 1,7.1–19. On the problem of the complete mixture of elements in Plotinus and the possible Stoic influence on him see Graeser (1972), 37 f.
[70] On the date and contents of that treatise see Beutler (1957), 193.
[71] The passage is cited by Philoponus *contra Proclum* XIII 15, 523,11–18.
[72] Proclus must have cited from memory. The word ἔλλαμψις occurs apparently only once in Ps. Arist. *On Plants* I 1, 815 b 33. Nevertheless, in *Gener.an.* Aristotle indeed draws an analogy between the heat in living beings and the substance of the stars, see II 3, 736 b 29–737 a 1.
[73] Cf., e.g., Plotinus *Enn.* II 1, 7.1–33.

it may perhaps be worth-while to compare the arguments brought forward there with the ones just discussed.

In his treatise against Proclus, Philoponus rejects Aristotle's argument in one section (XIII 14) by means of four objections. It is not true that the heavens cannot consist of fire because –

1. the firesphere causes the same difficulty, *contra Proclum* 517,24–518,4;
2. the fire of the firesphere is not capable of burning, *ibid.* 518,5–14;
3. a) Plato says that the heavens consist of a mixture of fire and the other elements;
   b) due to this mixture the excellence of fire is impaired, *ibid.* 518,14–18;
4. fire burns with different intensities; the celestial fire must not be assumed to be a destructive flame but life-producing heat, *ibid.* 518,18–519,17.

The affinity of these arguments to the ones in the *contra Aristotelem* is evident. Arguments 1 and 2 reappear in fr. III/52; argument 3 a) in fr. III/56, and argument 4 seems to be a more explicit version of 2. There is no evidence that argument 3 b) occurred also in the *contra Aristotelem*, despite the fact that this argument would have been able to explain the corruptibility of the heavens rather well. However, the arguments of frr. III/53*, 54, and 55 do not appear in the *contra Proclum*, and this may be taken as an indication that the *contra Aristotelem*, on this point, was more refined and developed. In view of this fact it is tempting to suppose that Philoponus profited from writing his commentary on Aristotle's *Meteorology*,[74] where the argument in question, after all, appears. But one is surprised to find that in the relevant passages of that commentary Philoponus avoids the confrontation with Aristotle.[75] Why? Towards the end of the discussion of the passages *Meteor.* I 3, 339 b 30–340 a 13 he explains, *In meteor.* 24,34–25,2:

> "But the volume of the earth and water stand in practically no proportion to the surrounding ⟨universe⟩. Therefore, the whole distance beyond the earth cannot be filled by one element or even by two alone; from which it apparently remains to infer that the space to the moon is filled by air and fire, but the space beyond it by some third element. However, our own opinions on all these things have been stated elsewhere, and lie ready for those willing to become acquainted with them, in order that we may not repeat ourselves now."

[74] According to the relative chronology proposed by Evrard (1953) the *Meteorology* commentary was written before the *contra Aristotelem* but after the *contra Proclum*. A different relative chronology (*contra Proclum* – *contra Aristotelem* – *Meteorology* commentary) is proposed by Wildberg (1987 a), 202–209.

[75] Conspicuously, Philoponus does not even cite the argument *Meteor.* I 3, 340 a 1–3 as a lemma; see *In meteor.* 18,17–25,2.

This last remark is best understood as a reference to the *contra Aristotelem*.[76] Aristotle's claim in the *Meteorology* that the heavens cannot consist of fire does not receive any further discussion. Philoponus' noticeable reluctance, in his *Meteorology* commentary, to be critical of Aristotle's doctrines may be explained by the conjecture that he evidently thought he had dealt with the matter sufficiently elsewhere and therefore regarded it as inappropriate now to mix oral exegesis and philosophical polemic.[77]

6.2.2 Excursus on fr. III/54: Philoponus on light and heat

Aristotle's remarks on the nature of the sun, the generation and transmission of light and heat from the sun to the sublunary region, and the generation of the seasons, are often notoriously vague. His basic assumption is of course that the sun, like any celestial body, consists of aether. In a passage in the *Meteorology* he accordingly says that it cannot itself be hot, and that the heat of the sun is a mere by-product of its motion and the friction involved.[78] It remains unclear how the heat is transmitted to the lower air. As regards the question of the seasons Aristotle states that the differences are caused by the variation of the distance of the sun throughout the year.[79] His remarks on the generation and nature of light are equally problematic. In the *De anima* he defines light as "the actuality (ἐνέργεια) of the transparent *qua* transparent", and he intimates that it may be generated by fire "or something of that kind, like the upper body."[80] He denies both that

[76] As I have argued elsewhere, see Wildberg (1987 a), 202–209.

[77] Overt criticism is suspended more than once, see e. g. *In meteor.* 16,30–32; 24,38–25,2; 37,18–23; 91,18–20.

[78] See *Meteor.* I 3, 341 a 12–35 and *Cael.* II 7, 289 a 19–35.

[79] See *Meteor.* I 3, 341 a 23–27; 9, 346 b 20–23; *Gener.corr.* II 10, 336 b 2 ff.

[80] Cf. *De anima* II 7, 418 b 9–13.

light is corporeal and that it is at all connected with motion, for which reason the problem of the propagation of light does not arise.[81]

Turning to Philoponus we witness a radical change of view. S. Sambursky has shown in what way Philoponus, in his *De anima* commentary, transformed Aristotle's passage on light into an original theory, and how he sought to solve the problem of the generation of heat in the sublunary region by the sun.[82] Sambursky shows that Philoponus understands light as a kinetic phenomenon,[83] and the meaning of Aristotle's definiens ἐνέργεια is shifted from 'actuality' to 'activity'. The main point of that theory, in the present context, is the fact that Philoponus follows Aristotle in the opinions that the sun, though it is the primary originator of light, is not itself hot, and that light is an incorporeal entity.[84] Having laid this down he presents himself with the following problem, *In de anima* 331,33–36:

> "How, then, is heat generated in air, if the sun, at any rate, is not hot, and the rays of the sun are incorporeal? For if they are incorporeal, there will be no friction (παράτριψις). But if there is no friction, how will the air get warm?"

The problem of how an incorporeal ἐνέργεια produces heat in something corporeal is tackled in the following way,[85] *In de anima* 332,7–22:

> "In view of this problem I reply: in the same way as the soul, not being warm itself, generates some vital ἐνέργεια which sets in motion the innate heat (τὸ ἔμφυτον θερμόν) and thus brings the living being to life (yet when the soul parts the innate heat vanishes immediately), so, I say, there comes into being from the sun some vital ἐνέργεια through the light in air, and this ἐνέργεια sets in motion the innate heat of the air and thus warms it. And just as the passionate faculty (ἡ θυμοειδὴς δύναμις) of the soul which is not warm itself, whenever it is moved warms the blood around the heart, and just as anxiety, being an incorporeal ἐνέργεια of the soul, creates heat, in the same way, one may reasonably suppose, the sun, not being warm itself, moves the heat contained in the air through its vital ἐνέργεια, i. e. light, and thus warms it.
> But if the ἐνέργεια is heat-generating, then if there is more ἐνέργεια in one place there will necessarily be more generation of heat. So that, probably, in the case of reflections (ἀνακλάσεις) the ἐνέργεια is duplicated and contains a smaller amount of air inside, such that ⟨relatively⟩ less air is warmed by a larger amount of ἐνέργεια, not, however, through friction but in the way described by setting in motion its innate heat, which results in the kindling of flames."

[81] See *De anima* II 7, 418 b 13–26; *De sensu* II 6, 446 b 28 ff. and cf. Sambursky (1958), 114.

[82] See Sambursky (1958), esp. 117 ff., but cf. Sorabji (1987 b), 26–30 who points out, against Sambursky, that in the *De anima* commentary Philoponus merely improves Aristotle's own theory insofar as he aligns *De anima*'s treatment of the action of light with the idea of the directionality of colour.

[83] Philoponus' theory of the propagation of light in the *De anima* commentary, which is not relevant to the present context, has been discussed by de Groot (1983).

[84] See *In de anima* 330,19–24; 331,33 f.

[85] Cf. also Sambursky (1958), 124, who suspects Stoic influences. The translation follows Sambursky's with modifications.

In this passage from the *De anima* commentary Philoponus' solution to the problem relies on an analogy with the psychosomatic relation in living beings. Just as the soul affects the body, in the same way light generates the corporeal quality of heat.[86] Importantly, Philoponus states explicitly that the heat is not generated by friction.

In the treatise against Proclus Philoponus does not seem to have changed his views considerably. Although here too he puts forward the thesis that the celestial region consists for the most part of fire which is moderate, non-kaustic and generating life,[87] the sun is still viewed primarily as a source of *light*. It does not seem to be connected with fire, for Philoponus distinguishes clearly between the generation of light by the sun and the generation of heat by fire.[88]

But when we turn to the *contra Aristotelem* and the *Meteorology* commentary, the situation is entirely different. In fr. III/54 he produces an argument which shows that the assumption of a strictly non-kaustic fire in the celestial region is not necessary; the universe would not

[86] A general criticism has to be brought against Sambursky (1958), who attributes the theory to Philoponus, and, to a certain extent, against de Groot (1983). Both authors do not consider the fact that Philoponus, as will be shown in the following discussion, abandons this theory in later treatises. – Furthermore, it ought to be pointed out that the theory of the *De anima* commentary appears, in a slightly modified form, also in Simplicius, *In de caelo* 88,14–22: "But neither does the sun warm because it is fire as it is generally understood, nor does Saturn cool because it is watery; rather, generally, all ⟨celestial bodies⟩ alter the bodies in this world towards their specific nature (ἰδιότης) through their incorporeal δυνάμεις, just like the incorporeal ἐνέργεια of the soul being ashamed or planning something makes the body blush at times, or ⟨the eyebrows⟩ frown. The sun, of course, warms the air through the same δύναμις, and by the friction of the rays, and through the air it warms the other bodies." The similarity of the analogy used to explain the activity of the celestial bodies, i. e., by comparison with the activity of the soul, is striking. Since Simplicius is hardly influenced by Philoponus it is plausible to presume that both men were influenced by a common source, perhaps Ammonius.

[87] See *contra Proclum* XIII 14, 517,24–519,17.

[88] See *contra Proclum* IV 9, 78,12 f.; 11, 84,11–13.

come to an end even if one assumed that all things in the upper region were fiery.[89] If this is true, what prevents one from assuming that the sun is in fact for the most part fire? And indeed, the speculative argument seems to underpin an argument from sense preception which would be unthinkable in a strictly Aristotelian or Neoplatonic cosmological framework, fr. III/58*: *In de caelo* 88,8–10:

> "But how does ⟨the Grammarian⟩ think to infer from the fact that the sun warms the things here that it is itself qualitatively hot and partakes of much fire (πολλοῦ μετέχοντα πυρός), which he infers from the colour as well?"

Unfortunately, Simplicius does not tell us if and how Philoponus, on the basis of this new cosmological assumption, explained the phenomenon of the generation of heat in the sublunary region[90] and the generation of the seasons. As regards the latter problem Simplicius' remarks suggest that Philoponus simply followed Aristotle in supposing that the seasons are generatd by the relative proximity of the sun.[91]

In the *Meteorology* commentary, however, these problems are dealt with in greater detail. Philoponus offers a theory which is based on the same cosmological assumptions as developed in the *contra Aristotelem*, and which differs dramatically from the theory of light as outlined in the *De anima* commentary. One of the main objectives of the commentary on the first book of Aristotle's *Meteorology* is to show that Aristotle was wrong in supposing that the heat of the sun is generated by its motion through friction with the medium. In *In meteor.* 41,24–44,21 he shows that the heat must be due not to the sun's motion but to its quality (ποιότης). Later in the commentary he says, 49,22–34:

> "So if the rotation of the sun were the cause of the sublunary heat, the fixed sphere or any other sphere moving between the most extreme spheres would (since it carries along with it the spheres below it) generate much more heat in the air. But if this is true, heat should also be generated during the night. For the motion is one, always continuous and identical with itself. But since this is not the case, and since the air is warmed only in the presence of the sun (ἅμα τῷ ἡλίῳ), the motion of the sun or of the spheres is therefore not the cause of the heat; rather, the cause is the sun's natural quality (ἡ φυσικὴ ποιότης), (for this alternative remains), exactly like (καθάπερ) the quality of fire. For if even Aristotle took the things here as sure indications of what happens in the upper region, and if fire does not warm the air through motion but only through its quality, then it is reasonable to think that the same occurs in the case of the sun, but it is unreasonable when Aristotle, in order to save his own hypotheses, supposes that the celestial bodies are impassive, thus contradicting the phenomena and sense perception itself."

Displaying the self-confidence of an 'empiricist'[92] Philoponus suggests that the heat of the sun is caused by its hot quality, as in the case of fire. He leaves no doubt that he regards the sun as being fiery, even though he avoids claiming that the sublunary fire is identical to the fire of the sun.[93]

A consequence of the modified physical theory of the heat of the sun is that the generation of heat in the sublunary region ceases to be a fundamental problem. Philoponus no longer has to explain how an incorporeal entity, light, generates a corporeal quality in the air, but only how the corporeal quality of the sun affects the sublunary bodies. It is no longer the innate heat which is warmed, but heat, just as light, is regarded as a dynamic entity accompanying light, *In meteor.* 53,2–8:

> "But they object: If the sun is fiery and warms the things below the moon by its heat, why does the sun warm more at noon than when it is at the

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[89] See fr. III/54: *In de caelo* 82,22–26 cited above p. 169 f.

[90] As has been pointed out, Simplicius saw an unsolved conflict in Philoponus between the two assumptions that the sun is hot, and that the celestial fire is inactive; see fr. III/54: *In de caelo* 83,16–19.

[91] Cf. Aristotle *Meteor.* I 3, 341 a 23-27; 9, 346 b 20–23; *Gener.corr.* II 10, 336 b 2 ff. with Philoponus fr. III/54: *In de caelo* 82,14–18. – Simplicius replies *In de caelo* 82,27–83,5: "It is evident that this man ⟨sc. the Grammarian⟩ thinks that the sun warms us more during the summer because it is nearer to us then; it is also clear that he thinks that the sun is nearer to us at noon than at the time when it is rising or setting, since it warms us more at noon. And he is ignorant of the fact that the earth in comparison with the sphere of the sun possesses the ratio of a point, so that the parallax of the exact position of the sun in comparison with the position as seen by us is most minute because of this. How then is it possible that the sun approaches us and recedes further away from us over such a distance that thereupon such a difference of heat is generated in the summer as opposed to the winter?" [On the interpretation of these lines see Wildberg (1987 b), 71 notes 59 and 60.] Simplicius' criticism is of course justified, but in this case it applies to Aristotle as much as to Philoponus. – Simplicius' remark may be taken as evidence not that Philoponus was ignorant about these facts but that he did not dwell on them in the *contra Aristotelem*; in the *Meteorology* commentary he suggests an explanation which comes rather close to Simplicius' own theory, see Philoponus *In meteor.* 53,16–21 and cf. Simplicius *In de caelo* 83,5–11 (see fr. III/54).

[92] In the same commentary Philoponus sharply attacks Damascius for his mythological interpretation of physical phenomena, see *In meteor.* 44,21–36; 116,36–117,31. In the passage just cited, Philoponus' criticism of Aristotle is reminiscent of Aristotle's own polemic against his predecessors.

[93] Cf., e. g., *In meteor.* 43,25–33; 47,26 f.; 52,27–35; 53,22 f.: "the fiery nature of the sun".

horizon? For it is not the case that the things by the side of fire are warmed more, but the things above it, e. g., that which is being boiled or melted. Now, many of the things melted, for instance lead, are melted best when they are beneath fire. Therefore, just as light travels everywhere unless something prevents it, in the same way ⟨travels⟩ the heat, which accompanies light."[94]

Since Philoponus nowhere expounds a full theory comparable to the section in the *De anima* commentary, the change of outlook is perhaps best noticeable if one considers the role friction plays in the new theory. When he tries to explain why the movement of the shooting stars is downwards and seldom upwards, he says, *In meteor.* 62,33–37:

"I therefore say that, as has been shown, the upper parts of the air round the earth are rather cooled because the rays reflected (from the earth) disperse in the openness there.[95] But the rays enclosing between them the air near the earth warm it, because of the condensation, by motion and by *friction*."

In a second passage Philoponus seems to pass off his own, not entirely clear explanation as Aristotle's,[96] *In meteor.* 121,35–122,4:

"On the question how heat is generated by the rays ⟨of the sun⟩, ⟨Aristotle⟩ taught that the air enclosed between the reflection of the rays is warmed by the movement deriving from them and by *friction*. The same happens to the air in stones from which fire is kindled, because it is enclosed by them and threshed by the friction deriving from them, and to the air between the rays reflected back from water or from fiery or other smooth and shiny (?)[97] bodies."

Although the details of this theory remain obscure, it is clear that here, in contrast to the *De anima* commentary, Philoponus states explicitly that friction is involved in the production of heat in the air. There is perhaps even enough evidence to warrant the conclusion that Philoponus now prefers to understand light as corporeal.

The discussion of this particular problem of the sun and the generation of and the connection between light and heat shows how

[94] On the intimate connection of light and heat cf. also *In meteor.* 43,22 f.: "Heat by nature occurs together with light (συμπέφυκε τῷ φωτί); for it also occurs in conjunction with fire."

[95] Cf. Aristotle *Meteor.* I 3, 340 a 24–32.

[96] In the passage cited next Philoponus presumably refers to Aristotle's remarks in *Meteor.* I 3, 340 a 24–32. In his comments on that passage Philoponus does not bring in the concept of friction, cf. *In meteor.* 26,15–28,23.

[97] The word στεάτινος seems to be hapaxlegomenon in Philoponus; its precise meaning remains uncertain.

Philoponus, in the context of his critical reception of Aristotelian doctrine, develops and modifies his own cosmological views. It may be pointed out that the doctrines put forward in the *contra Aristotelem* and the *Meteorology* commentary are closely connected, and that the latter work appears to be representing a more developed stage. In order to bring out further aspects of Philoponus' new theory of the celestial region it is necessary to return to the argument of the *contra Aristotelem*.

6.2.3 Fragments III/57*–61*

In the comments on the previous fragment III/56 (*In de caelo* 84,15–22) it has already been pointed out that Philoponus not only rejects Aristotle's verdict that the celestial region cannot possibly consist of fire, but that he further holds that the three remaining elements must be present too. So far Philoponus has lent support to this theory by a reference to Plato, and he now proceeds to justify it in the light of the 'apparent phenomena'.

First of all, fr. III/57* confirms our interpretation that Philoponus indeed postulates the existence of all four elements in the upper region, for Simplicius says fr. III/57*: *In de caelo* 87,29–88,2:

"He attributes heat and coldness, dryness and wetness, softness and hardness as well as the other tangible and sensuous qualities to the heavens."

It is impossible to attribute these properties to a substance which is assumed to consist of pure fire alone. But given that Philoponus adhered to the Neoplatonic distinction of pure and material grades of the elements, why does he see no difficulty in supposing that although the elements differ in purity, their respective qualities are exactly the same? Plotinus, at any rate, stressed the point that the qualities of the elements in the celestial region are of a quite superior nature.[98] From the following fragments the impression arises that in the *contra Aristotelem* Philoponus was perhaps led to this line of reasoning by 'sense perception'. In his earlier treatise against Proclus, however, Plato's *Timaeus* forms the basis for his stance on the question of the attributes of the heavens.[99] In the *contra Proclum*, XIII 16, 527,11–18 he says:

[98] See *Enn.* II 1,7.

[99] Philoponus outlines his interpretation of the *Timaeus* on this subject in *contra Proclum* XIII 16–17.

"But that Plato not only thinks that the celestial body consists of the four elements but also ascribed to the elements there those qualities generally recognised by us – I mean heat and cold, wetness and dryness, lightness and weight – so that nothing distinguishes them in substance from the elements in the sublunary world, with the exception of fineness and purity, this, again, is clearly laid down by Plato in the *Timaeus*".

Philoponus then cites two passages from the dialogue, and it is not unlikely that similar evidence was adduced in the *contra Aristotelem*.[100] Simplicius, however, merely focuses on and expresses his disagreement with the arguments from 'sense perception', fr. III/58*: 88,8–14:

"But how does he think to infer from the fact that tht sun warms the things here that it is qualitatively warm and partakes of much fire, which he infers from the colour as well? Look: although the other stars are said to partake of much fire and to possess a fiery colour, as he says, Saturn is believed to cool and to combine the things down here, and it is evident that by virtue of the same argument it ought to be cold as well, and not fiery, but rather watery."[101]

Here, as in the *Meteorology* commentary, Philoponus concludes that the sun must be fiery, supporting his claim by a simple inference from the effect to the cause. The substantial fragment III/59 (*In de caelo* 88,28–89,26) puts forward further evidence lending support to his theory. Philoponus claims first, *ibid.* 88,31 f., that

"there is perhaps no quality observed in the things there which does not also belong to the terrestrial bodies."

In the following he sets forth six different qualities and properties which he takes to pertain to the heavenly bodies. They may be summarised as follows, fr. III/59: *In de caelo* 89,1 ff.:

1. *Transparency* is found in air, water, glass, and certain stones, *ibid.* 89,1 f.
2. The various *colours* in the heavens are identical to the colours found in the sublunary world. In particular, *brightness* and *light* are found in fire, fire-flies, heads and scales of fish, *ibid.* 89,3–7.
3. The *spherical shape* is common to the spheres of the sublunary elements and to some other compound bodies, *ibid.* 89,9–11.

[100] The passages cited are *Tim.* 32 B 8–33 B 1; 53 D 7–E 8. Philoponus' interpretation is probably justified, although it must be pointed out that the present issue of the physical qualities of the celestial bodies was not Plato's problem and concern.

[101] On the supposed powers of the planets see, e. g., Ptolemy *Tetrabiblos* I 4 and Plotinus *Enneads* II 3,5.

4. *Circular motion* also belongs to fire and air (by nature), *ibid.* 89,11 f.
5. From this Philoponus infers that everything visible must also be tangible, *ibid.* 89,15–19:
   "But after having said other, similar things, he finally adduces that the heavens, being visible at all events, are also tangible, and being tangible they have tactile qualities: hardness, softness, smoothness, roughness, dryness, wetness, and other comparable qualities as well as heat and cold, which include all these."

Thus, the sixth property of the heavens is *tangibility*.[102]

6. Finally, Philoponus claims *In de caelo* 89,22–25:
   "What is *three-dimensional* (τὸ τριχῇ διαστατόν) is identical in the heavenly bodies and in the things in our region. For no three-dimensional thing will differ from another in so far it is three-dimensional, just as no body will differ from another in so far it is a body."

On this last argument, in particular, Philoponus seems to have laid great emphasis. Indirect evidence suggests that he repeated the argument in a more explicit form in the fourth book of the *contra Aristotelem*. Simplicius says *In de caelo* 134,16–19 (see fr. IV/71):

"Perhaps it is superfluous to contradict his arguments, except that he seems to think that because the things in heaven and the things below the moon are both three-dimensional, nothing distinguishes them from one another, and he makes ample use of the ambiguity of words."

In addition, Simplicius reports an argument in a treatise arguing that no limited body may possess unlimited power – a short treatise written after the *contra Aristotelem* and preserved in fragments by Simplicius[103] – as follows, *In phys.* 1329,28–1330,1:

"But ⟨the Grammarian⟩ says that it has been shown by himself in the fourth book against Aristotle that one and the same prime matter underlies the celestial as well as the sublunary bodies."

The way in which Philoponus may have argued can be inferred from a remark which appears somewhat later in the same treatise, where the following argument from abstraction appears, *apud* Simplicium *In phys.* 1331,20–22:

[102] Cf. also fr. III/59: *In de caelo* 89,19–22.

[103] See Simplicius *In phys.* 1326–1336 and cf. Davidson (1969), 358 f. and Pines (1972), 339–346.

"If, he says, one took the forms of all things away, evidently only their extension in three dimensions would remain, in virtue of which nothing distinguishes the celestial bodies from the bodies of our world."

Earlier, the above group of arguments has been referred to as arguments from 'sense perception', and this is what they may *prima facie* appear to be. This is particularly suggested by the argument on the fiery nature of the sun, which is based on the perception of its heat and its colour; see fr. III/58* (*In de caelo* 88,8–14).[104] However, one must question this claim. Did Philoponus concern himself with a 'physical inquiry', based on observation, into the nature of the celestial body, the results of which he used for his arguments against Aristotle? In the case of the six arguments above the answer must surely be negative. For the 'empirical' points raised by Philoponus exemplify to what extent physical science in late antiquity was preoccupied with the study of treatises on nature, rather than with the study of nature itself. Philoponus' first point concerning transparency is taken from Aristotle *De anima* II 7, 418 b 4–7. The second point concerning colour and light in the heavens and the sublunary world clearly derives from Aristotle *De anima* II 7, 419 a 2–7. The shape of the universe as well as the totalities of the sublunary elements being spherical is not a sense datum but a standard tenet of school philosophy; it derives from Aristotle himself.[105] The same is true of the fourth point concerning circular motion in the sublunary bodies.[106] And in the first book Philoponus showed, by means of *a priori* reasoning, that this circular movement must belong to fire and air according to nature.[107] The inference that everything visible must also be tangible derives, of course, from the famous passage in Plato's *Timaeus* 31 B 4–6. Only the last argument that the three-dimensional substrate *qua* three-dimensional is identical in the celestial and the sublunary regions is, though not empirical, at least original and interesting as it involves Philoponus' theory of matter and the three-dimensional.[108] The arguments do not

[104] Sambursky (1962), 130 states: "We will see ... that Philoponus ... went much further in his polemics against Aristotle [than Xenarchus] and attempted to adduce observational material as evidence for the fiery nature of the celestial bodies." The above arguments are partly outlined by Sambursky (158–166), and he seems to suggest (174) that he regards them as "empirical".

[105] Cf., e. g., *Meteor.* I 3, 340 b 19–22; II 2, 354 b 23–25.

[106] Cf. *Meteor.* I 3, 340 b 32–341 a 3; 4, 341 b 22–24; 7, 344 a 11–13.

[107] Cf. above 5.3.3 and frr. I/9–17*.

[108] On this important problem in Philoponus see below 8.2.

reveal Philoponus' readiness to appeal to empirical observation, but rather his cunning ability to turn Aristotelian passages against Aristotle himself. Moreover, it is conspicuous that in Philoponus the majority of arguments referring to 'an experiment' involve, in fact, experiments carried out in thought rather than in practice, and it is perhaps permissible to generalise that the main virtue of a natural philosopher in late antiquity – for the same is true *mutatis mutandis* of Simplicius – was to be a 'grammarian', i. e. a man of letters and learning, rather than to be a keen observer of natural phenomena.[109]

6.3 Conclusion

In conclusion, the main points of the discussion of the second and third book of the *contra Aristotelem* may be summarised as follows.

Beginning with the problem of weight and lightness in the celestial region, Philoponus elaborates the thesis that there is no fundamental difference between the regions above and below the moon. Rectilinear motion is not *per se* excluded from the things in heaven, just as natural circular motion, as has been shown in the first book, is not absent from the sublunary elements. The movement of the heavens is both natural and psychical: natural, in so far as the celestial body consists of fire, psychical, in so far as it is ultimately moved by the world soul.

Philoponus claims in the third book that Aristotle did not prove conclusively that the celestial body cannot consist of fire. The celestial fire does not, as Aristotle supposed, threaten the existence of the universe at large. Even if the fire constituting the region above the moon were assumed to be a burning flame, the world would continue to exist. Philoponus points out that the sun is for the most part fire, and that the substance and properties of the celestial body, although superior in quality in accordance with the importance attached to it, do not differ essentially from the substances and properties of the things in the sublunary world.

[109] This is not to say that deliberate experiments play a negligible role in Philoponus. G. E. R. Lloyd (1973), 158–162 points out that in his refutation of Aristotle's doctrine concerning the behaviour of freely falling bodies Philoponus explicitly refers to actual tests carried out, cf. *In phys.* 683,16 ff.; this, however, must be regarded as an exception rather than the rule.

A comparative study of the fragments of these books and the views expressed in his earlier and later writings has shown that Philoponus' theses on cosmology in the *contra Aristotelem* represent a stage in his development of a theory which accords both with the philosophical tradition and the fundamental Christian assumption of the creation of the universe. Although his cosmology remains Aristotelian in many respects (nature as a principle of motion, stratification of the universe), Philoponus incorporates Platonic and especially Neoplatonic ideas ('heavy and light', celestial movement being caused by the soul, composition of the celestial body). His views are not, by and large, original, but his synthesis of the various positions, arguments, and controversies on cosmological problems is novel. Philoponus radicalises the ideas of his predecessors. One of the most important instances of this tendency is his revision of the Neoplatonic doctrine of the substantial composition of the celestial bodies, which resulted in his development of an independent theory of the generation of heat by the sun.

7. The Celestial Body: Unchangeable but Corruptible

Having dealt with Aristotle's arguments on the absence of weight and lightness in the celestial region, Philoponus turns to Aristotle's attempts to show that the heavens are both incorruptible and unchangeable. Significantly, Philoponus leaves the arguments concerning the qualitative and quantitative unchangeability of the heavens uncriticised.[1] The thrust of his criticism is directed against the argument that the celestial body, since it is removed from the realm of contraries, must be eternal, *Cael.* I 3, 270 a 12–22 and *Cael.* I 4.[2] Philoponus construes Aristotle's argument as follows, fr. IV/64*: *In de caelo* 121,4–9:

> "In order to demonstrate this (i. e. that the heavens are ungenerated and indestructible), ⟨Aristotle⟩ uses two premises, as has been said before, one saying that (i) what is generated is generated out of a contrary and perishes into a contrary, and the other saying that (ii) there is no movement contrary to circular movement. So this man sets out to object to these two premises, and he begins with the former first."[3]

The fragments of the following two books IV and V of the *contra Aristotelem* focus on the refutation of these two premises. In particular, book IV is mainly dedicated to the refutation of premise (i), book V to the refutation of premise (ii).

7.1 The Structure and Argument of Book IV

The title of one of the major sections of the fourth book has been preserved in a fragment in Arabic. Farabi says in his 'refutation' of Philoponus, fr. IV/62: Mahdi (1967), 256:

> "When ⟨the Grammarian⟩ reached the fourth book he said literally as follows, in the chapter in which he stated Aristotle's proof. He said: His proof that the heavens are ungenerated and that they are indestructible.

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[1] I. e. the arguments in *Cael.* I 3, 270 a 22–35.
[2] Commentary on Aristotle's arguments is provided above, 4.1.2. and 4.3.
[3] Cf. *Cael.* I 3, 270 a 14–17 and 18–20. The second premise, from which Aristotle infers that nothing is contrary to the celestial body (cf. *Cael.* I 3, 270 a 18 f. and Philoponus fr. V/81: *In de caelo* 156,28–31), is established separately in *De caelo* I 4.

Then he said: Examining the proofs that he stated and the explanations of some of those who commented on them."

Apart from what must have been one of the most trivial arguments in the fourth book,[4] Farabi discloses no further details on the philosophical content of this part of the *contra Aristotelem*. Simplicius, however, reports a number of important arguments which originally belonged to book IV, and it is necessary to turn to his commentary on the *De caelo*.

7.1.1 Fragment IV/63

The prelude to the refutation of Aristotle's argument that the celestial body is ungenerated and indestructible consists of a dialectical argument which shows, at any rate, how closely Philoponus scrutinised the Aristotelian text. He begins by outlining the senses of the word ἀγένητος laid down by Aristotle in *Cael.* I 11, 280 b 6–11. Acccording to that passage one may distinguish three senses: Something is said to be ungenerated

1. – if it has come to be without a process of generation, e. g., being touched or being moved. Touch and motion themselves are not generated.[5]
2. – if it has not been generated but possibly will be generated.
3. – if it is absolutely impossible that it be generated (ὅλως ἀδύνατον γενέσθαι).

The third sense is ambiguous because it may either refer (a) to something which does not exist at all and never will exist, or (b) to something which has been in existence eternally *a parte ante*. Only in the following chapter, *Cael.* I 12, 282 a 27–29, does Aristotle point out that he wants the term to be understood primarily in the sense of 3 (b). But this is not immediately obvious in *Cael.* I 11. Philoponus takes unfair advantage of this unclarity and suggests that none of the senses of 'ungenerated' outlined in that chapter actually suits the argument in *Cael.* I 3, 270 a 12–22; fr. IV/63: *In de caelo* 119,13–21 and 28–32:

[4] See fr. IV/76 and cf. below 7.1.4.
[5] On the problem of the first instant of change see Sorabji (1976) and Waterlow (1982), 141–148.

"After having initially outlined the Aristotelian distinction of the senses of 'ungenerated' and 'generated' drawn at the end of the book (i. e. *De caelo* I), ⟨the Grammarian⟩ then asks according to which sense Aristotle now proves the heavens to be ungenerated, and he writes as follows: Neither the heavens nor the world would be ungenerated in the sense that they cannot possibly be generated (i. e. sense 3). For they clearly exist and have received the perfection of their nature. Therefore, only one further hypothesis remains, if the heavens cannot have been generated in the sense of having a beginning of existence, not even a beginning which brought them into existence without a process of generation. [...] Therefore, one hypothesis concerning 'ungenerated' remains, if they are not ungenerated as touch, lightning, and in general instantaneous things are. For these have a beginning of existence although they have not been brought into existence by a process of generation. So which of the three senses of 'ungenerated' specified by Aristotle is the one in question now?"

Philoponus deliberately overlooks the ambiguity involved in the third sense and, taking it in the sense of 3 (a), rules it out. Furthermore, he denies that in Aristotle the world is generated at an instant, the first sense of 'ungenerated'. Only the second sense remains, but this is equally impossible, since it is evidently not the case that the heavens and the world will be generated in the future.

7.1.2 Fragments IV/64*–72

We may now turn to Philoponus' criticism proper. Philoponus sets out to refute the first premise of Aristotle's argument, i. e. that everything generated is generated out of a contrary and perishes into a contrary.[6] His refutation of this premise is a masterly example of an effective strategy of philosophical criticism, the dilemma. In the following argument, Philoponus begins by distinguishing between two different senses of contrariety, i. e. contrariety proper and contrariety in terms of form and privation.[7] He then shows in the first horn of the dilemma that if one accepts the former sense of contrariety in the present argument, the premise in question is false and the argument therefore unsound. In the second horn he concedes that the premise may be regarded as true if one accepts the second, more general type

[6] See the passage quoted at the beginning of this chapter, fr. IV/64*: *In de caelo* 121,4–9.
[7] The latter is the more general type of contrariety; see above 4.1.2. and cf. Anton (1957), 61–67.

of contrariety in terms of form and privation. But it then follows that the heavens themselves must be viewed as generated and eventually destructible.

Philoponus' repudiation takes the following point of departure, fr. IV/64*: *In de caelo* 121,11–14:

> "⟨The Grammarian⟩ says, then, that Aristotle and his commentator Alexander ⟨of Aphrodisias⟩ want the hypothesis 'contraries are generated out of contraries' to be true of contraries in the proper sense, but others say that the hypothesis is sound for privation and form."

The first horn of the dilemma: Philoponus sets out to show by an indirect argument that in the *De caelo* Aristotle spoke of contraries proper, because in the second premise, i. e. that the celestial body and its motion do not possess a contrary, he could not have spoken of form and privation, for the celestial body and its motion clearly do possess a corresponding privation, fr. IV/65: *In de caelo* 121,25–122,9:

> "For with a view to showing that Aristotle says that the heavens have no contrary in the proper sense of the word, ⟨the Grammarian⟩ tries to prove this on the assumption that the heavens possess an opposing privation. For he says that Aristotle would not have held that the heavens do not possess any contrary at all, given that he called 'privation' a contrary.[8] Again I ⟨sc. Simplicius⟩ am compelled to cite his words for the sake of those who cannot believe that someone wrote such arrant nonsense.
> For even if it is agreed, he says, that no movement is contrary to the movement of the heavens, it is at least not impossible that there is a privation of this movement. For there is some opposing privation of any natural thing which exists in a substrate. But motion is a natural thing. For the immobility before the movement and after the cessation of the movement is in fact the privation of this movement. Therefore, if it is not impossible that there is a privation opposite to the movement of the heavens, it follows that ⟨Aristotle⟩ did not use the word 'contraries' in the sense of form and privation, but in the sense of contraries in the proper sense."

If, in consequence of this, it is agreed for the sake of the argument that Aristotle is indeed speaking of contraries proper, the first premise is clearly false. For, Philoponus argues, it is not the case that everything generated is generated out of a contrary proper. He adduces no less than seven different processes of generation which falsify Aristotle's assumption; fr. IV/67: *In de caelo* 123,15–124,12:

[8] See, e. g., *Phys.* I 7, 191 a 13 f. and cf. 190 b 26.

1. Not only the attributes of substances but also the substances themselves are generated, and there is no contrary to substance, as Aristotle himself states in the *Categories*,[9] *ibid.* 123,15–17.
2. Since, according to Aristotle, the rational soul alone is eternal,[10] the souls of irrational animals, for instance, must be subject to generation and destruction. But what is the contrary proper of the soul of a horse or a bull? In addition, the same point can be made about the different functions (or forms) of the soul (τὰ εἴδη τῆς ψυχῆς), *ibid.* 123,17–124.
3. Triangles, circles, and other shapes are not generated out of contraries, *ibid.* 123,14–28.
4. Left and right come to be from one another, but they are not contraries but relatives, *ibid.* 123,28 f.
5. In the case of those categories which do not involve contraries, individuals (ἄτομα) falling into one of these categories are not subject to generation out of contraries proper, *ibid.* 123,29–32. Philoponus does not make clear which of the Aristotelian categories he refers to besides the ones already dealt with, i. e., the categories of substance (1), quantity (3), and relation (4). Obvious choices would be place (but only to a limited extent because contrariety of place exists in the vertical direction), time, position, and state.
6. The assumption, Philoponus claims, is not even universally true in the case of the category of quality, which above all involves contraries proper, e. g., hot, cold, moist, and dry; *ibid.* 123,32–124,8. Take for example colour and flavour, 123,34–124,6:

   > "For if air possesses neither colour nor flavour – as is shown by the fact that it is neither visible nor tasteable – and if it changes into water, which possesses both colour and flavour, out of what kind of contraries of colour and flavour in air do colour and flavour in water come to be? And if air changes into earth or into fire, the same must be said. But more than that, by the putrefaction of air living beings are generated with various colours and differences of flavours. Out of what kind of contraries in the air do they come to be, if air does not possess these qualities?"

7. Finally, light does not possess a contrary, because darkness is the privation of light, and not its contrary, which Philoponus claims to have shown elsewhere,[11] *ibid.* 124,8–12.

[9] Cf. *Cat.* 3 b 24–32.
[10] Cf. *De anima* II 2, 413 b 24–29.
[11] This may be taken as a reference to his *De anima* commentary, 341,10–342,16.

Hence, if one supposes that in the first premise Aristotle spoke of contraries proper, the argument for the ungeneratedness and indestructibility of the celestial body is unsound because it relies, according to Philoponus, on a false premise.

The second horn of the dilemma: Simplicius objects to the argument so far that it is not true that the word 'contraries' must be taken in the proper sense. Aristotle's assumption in fact involves the more general type of contrariety in terms of form and privation, and Simplicius demonstrates this by referring to the relevant passages in *Physics* I 7.[12] But Philoponus is only too willing to concede this.[13] Simplicius, who does not seem to have grasped the strategy of the argument of his opponent, says in fr. IV/69: *In de caelo* 131,17–20:

> "But perhaps there was no need for my arguments because ⟨the Grammarian⟩ clearly agrees in his text that the Aristotelian proposition stating that 'what is generated is generated out of contraries' is true of the most generic type of antithesis of form and privation, but by no means true of the remaining contrarieties."

He continues in lines 131,28–132,4 with a considerable amount of indignation:

> "But this man knew he was writing for schoolboys, which is why, I believe, he did not read, or else did not understand the passage on generation in the *Physics* and has spewed out so must arrant nonsense against the word 'contraries', thinking that the length of his arguments suffices to perplex his audience. But he says on the basis of empty opinion rather than research:
> Let it be agreed that Aristotle calls form and privation contraries here, and that everything generated is generated out of the corresponding privation, just as that which perishes relapses (ἀνακάμπτειν) from form into privation, and, in saying these things, he thinks to show from them that according to Aristotle the heavens too will appear to be generated and destructible. Let us look at these remarkable ventures of his as well, to see from what kind of self-evident axioms he derives the propositions he is concerned with."

The second horn of the dilemma seems to cause greater difficulties for the Peripatetics. Philoponus intends to show that if it is true that

[12] See *In de caelo* 124,21–126,5. On the argument of *Physics* I 7 and its relevance for the argument in the *De caelo* see above 4.1.2.

[13] Fr. IV/68: *In de caelo* 126,11–14. He supports his point by a reference to Themistius who interprets Aristotle's argument on the assumption that contrariety of form and privation is involved, cf. fr. IV/69: *ibid.* 131,20–24 with Themistius *In de caelo* 14,9–37.

generation involves contrariety in terms of form and privation, then the heavens themselves are subject to generation and destruction. *Prima facie*, this does not seem to be a straightforward task. Even if it is true that generation in all cases presupposes the appropriate privation, it does not follow that the possible existence of a privation also entails generation and destruction, so that even if the heavens possess a privation, this does not necessarily mean that they will also be subject to destruction. Philoponus therefore has to import as a further premise precisely this, that generation and destruction presuppose privation and that privation entails generation and destruction. In the following argument this assumption is merely implied, yet it is stated explicitly elsewhere in the *contra Aristotelem*.[14] Philoponus' argument runs as follows,[15] fr. IV/69: *In de caelo* 132,5–8:

> (i) "Every natural form which exists in a substrate and in matter always possesses an opposing privation out of which it has been generated and into which it resolves when it perishes. But (ii) both the heavens and the whole world are characterised by a natural form; in consequence (iii), they too will possess a privation out of which they have been generated and into which they will perish."

The conclusion (iii) is supported by a number of analogies, *ibid.* 132,8–12:

> "For because man is generated out of not-man, and house out of not-house and, speaking generally, any natural and artificial form attains generation out of what is not of its kind, therefore also the heavens – for they are a natural form as well – have been generated out of not-heaven, and world out of not-world."

Simplicius says that Philoponus proffers the first premise as evident;[16] it is of course evident only if one presupposes that privation virtually entails generation and destruction. On the other hand, he seems to have supported the second premise by a number of arguments,

[14] See fr. V/91: *In de caelo* 175,13–18 where Philoponus suggests in an argument that this assumption is in fact shared by his opponents: "If they hold that participating in whatever kind of contraries, either in both or in one of them, is universally a proof of the fact that the thing which partakes of these contraries is generated and destructible, then, seeing that the celestial body is a recipient of contrariety in terms of 'concave' and 'convex', and that the 'concave' of the lunary sphere is one of the contrary places, they ought to say that the heavens are generated and destructible as well."

[15] The premises are restated in reverse order in fr. IV/70: *In de caelo* 133,21–27.

[16] See fr. IV/70: *In de caelo* 133,21–24.

although that proposition is, according to Simplicius, not seriously disputed.[17] For that reason, Simplicius does not report Philoponus' argument at length, but one can make out at least three arguments which attempt to show that the heavens are a material body.[18]

1. The heavens are not immaterial (ἄυλος) because they are perceptible (αἰσθητός), fr. IV/70: *In de caelo* 133,28 f.[19]
2. The things in heaven and the things below the moon are both three-dimensional (τριχῇ διαστατά), in virtue of which nothing distinguishes them,[20] fr. IV/71: *ibid.* 134,16–19.
3. Matter possesses the fitness for receiving all forms (ἐπιτηδείως πρὸς πάντα τὰ εἴδη ἔχουσα) of the things in the sublunary region; in the same way matter is recipient of the forms of the things in heaven,[21] fr. IV/71: *ibid.* 134,20–24.

The gist of these arguments is that the celestial body, being perceptible and three-dimensional, is also material. The celestial form and the universal matter constitute the celestial body. Philoponus rejects any kind of ontological distinction *qua* matter between the two regions, and one could say that he is thus positing the material unity of the universe. He argues that even if one agreed that there are two different types of matter in the two regions, one ought to concede that both are compounds of their common nature and the differentiae in that nature, i. e., one ought to assume one common matter.[22] So if the celestial body is indeed a material entity which possesses some kind of privation, and if

[17] See *ibid.* 133,24–27.

[18] See fr. IV/71: *In de caelo* 134,9–12: "It seems that this man regards that body as matter which the Peripatetics called second substrate (δεύτερον ὑποκείμενον), for he spends many arguments seriously showing that the heavens possess a body – and therefore also matter. Yet, who would dispute that the heavens possess a body?"

[19] Cf. Plato *Tim.* 31 B 4–6.

[20] On Philoponus' conception of matter and the three-dimensional see the excursus below 7.2.

[21] Simplicius objects *In de caelo* 134,24 ff. that if this were the case, the things below and above the moon would be seen to change into one another, but this is evidently not the case. Although Simplicius, too, does not accept Aristotle's concept of aether as the stuff of the celestial region, he nevertheless recognises an ontological difference between the two regions: whereas the sublunary matter admits of generation and corruption, the celestial matter merely admits of spatial change (ὕλη κατὰ τόπον κινητική), see *In de caelo* 134,6–9; 135,18–21. Simplicius himself refers to Aristotle *Metaph.* VIII 4, 1044 b 1–8. On the problem of kinetic matter in Aristotle see Happ (1971), 497–503; 691.

[22] Fr. IV/72: *In de caelo* 135,21–23.

form and privation lead inevitably to generation and destruction, then Aristotle's own premise entails that the heavens too are subject to generation and destruction, which is of course a conclusion unacceptable for any Neoplatonist.

The most interesting aspect of this last argument is that Philoponus postulates the existence of a universal matter which he calls τὸ τριχῇ διαστατόν. This term, which may be translated by 'the three-dimensional', does not refer to a trivial idea in the sense that Philoponus postulates this kind of matter *in order* to lend support to his view that the cosmos is a material, three-dimensional unit. It can be shown that Philoponus arrived at this conception of matter by a quite independent route; the importance of the issue requires that his conception of the three-dimensional be dealt with in a separate section of this chapter.[23]

7.1.3 Fragments IV/73–74

In fragments 70–72 it was put forward that the heavens must be conceived as generated and destructible because the celestial body is a compound of 'form' and 'matter'. Philoponus denies, against Aristotle, that the κόσμος, the universal world order, is eternal. Yet the previous arguments do not cast doubt upon the belief in the eternity of something which, in its present state, underlies the ordered form of a universe, i. e. some primordial matter.[24] Did the world and the heavens come to be out of some pre-existing entity, or did they come to be out of nothing? Philoponus proceeds in what follows to justify the Christian doctrine that God 'at some time' created the universe out of nothing, fr. IV/73: *In de caelo* 136,12–16:

> "But so far, as 〈 the Grammarian〉 says, he has refuted the arguments of Aristotle which prove that the world is ungenerated – 'refuted', that is, by writing nonsense of this kind. He agrees however, that by what has been said he has not refuted the proposition that the world is generated

[23] See below 7.2.

[24] Cf. fr. IV/69: *In de caelo* 132,12–17: "But this argument would perhaps require 〈the Grammarian〉 says, that there exist some substrate and matter prior to the generation of the world in which the privation of the heavens and the world existed and out of which, when it changed, the heavens and the world were generated. But the argument does not strictly imply that the heavens are ungenerated and without a beginning of existence, as the Philosopher 〈sc. Aristotle〉 intended to show. On the contrary, it rather implies that the heavens are generated and have a beginning of existence."

out of a pre-existing substrate. Therefore he wants to show that the world came into existence out of not-being."

The notion of *creatio ex nihilo* has been proposed and discussed by Christians since the second century.[25] The doctrine, which maintains that the whole universe was created by God out of nothing, denies at the same time the eternity and self-sufficiency of matter and the Neoplatonic idea that the world is temporally eternal though in all aspects ontologically dependent on God.[26] Some of the first arguments in favour of *creatio ex nihilo* were formulated by Theophilus of Antiochia (2nd century), who wrote in the second book of his work *Ad Autolycum* as follows:[27]

(1) "If God is uncreated and matter is uncreated, then, according to the Platonists, God is not the maker of the universe, and as far as they are concerned the unique sovereignty of God is not demonstrated.
(2) Furthermore, as God is immutable because he is uncreated, if matter is uncreated it must also be immmutable, and equal to God; for what is created is changeable and mutable, while the uncreated is unchangeable and immutable.
(3) What would be remarkable if God made the world out of pre-existent matter? Even a human artisan, when he obtains material from someone, makes whatever he wishes out of it. But the power of God is revealed by his making whatever he wishes out of the non-existent (ἐκ οὐκ ὄντων), just as the ability to give life and motion belongs to no one but God alone."

John Philoponus, more than three centuries later, is sometimes credited with having attempted to put the doctrine of *creatio ex nihilo* on a secure philosophical footing.[28] Many of his arguments against the eternity of the world are well known and have been discussed or referred to by a number of scholars.[29] But which are his arguments

[25] On the origin of the doctrine see May (1978); Sorabji (1983), 203–209 finds the claim of creation *ex nihilo* already in Philo's *De providentia*.
[26] The latter doctrine was developed by Platonists, notably Crantor, Albinus, Taurus, Plotinus, Porphyry, and Iamblichus; see Baltes (1976), 82 ff. and cf. May (1978), 1–5 and Sorabji (1983), 193 ff.
[27] See Grant (1970), 26 f. and cf. May (1978), 159–167.
[28] See, e. g., May (1978), 5 note 22.
[29] See, e. g., Wieland (1960); Davidson (1969); Pines (1972); Sambursky(1972); Sorabji (1982 a); *idem* (1983), 210 ff.

that the world is actually created *out of nothing*? The fragments of the *contra Aristotelem*, regrettably, do not provide us with satisfactory material on this topic, partly because Philoponus himself refers the reader to arguments brought forward in the earlier treatise against Proclus,[30] and partly because Simplicius does not seem to have been greatly interested.[31] Fragment IV/73 of the *contra Aristotelem* seems to be a rejoinder to possible objections to an earlier argument in the *contra Proclum*; the issue is the clarification of the meaning of the words 'nothing' or 'not-being', 136,16–26:

> "⟨The Grammarian⟩ wants to show that the world came into existence out of not-being. And he makes a quick reference to a proof of this in the *contra Proclum*, except that he presents the objection and attempts to invalidate it by saying: For if something were generated out of complete not-being, they[32] say, it would follow that not-being exists. For it has changed into being. Now, if someone argues, ⟨the Grammarian⟩ says, that the things generated are generated out of not-being in the same way as a ship is built from timber – which means that not-being itself underlies the thing generated and changes into it – then it will truly follow that not-being exists. But I do not think that anyone is witless enough to understand generation out of not-being in this way; rather, anything generated is brought into being only in so far as it is generated without existing previously."

Clearly, the gist of this argument is that Philoponus wants to deny that 'not-being' may be understood as a reified 'Nothing', which is supposed to underlie the generation of things in the same way as timber underlies the building of a ship. But what does he affirm? The last lines are difficult. The Greek 136,25 f. reads: ... ἀλλ' ὅτι, καθὸ γίνεται τῶν γινομένων ἕκαστον οὐδαμῶς ὂν πρότερον εἰς τὸ εἶναι παρήχθη. The word καθό may be taken adverbially, 'in so far as', in which case the sentence may be translated as in the last sentence of the above quotation. In that case, the following interpretation is possible: Something may truly be said to be brought into being (i. e. out of nothing) if and only if it is generated and at the same time did not exist in any way (οὐδαμῶς)

[30] Cf. fr. IV/73: *In de caelo* 136,17; fr. VI/115: *apud* Simplicium *In phys.* 1141,9 f.; fr. VI/116: *ibid.* 1142,1 f.
[31] See fr. IV/74*, where Simplicius merely notes 137,16–19: "He attempts to show by means of many arguments that the things immediately generated by God are not generated out of some pre-existing substrate, but the form is generated together with the substrate." – In addition, Simplicius himself had never read the *contra Proclum*, see *In de caelo* 135,30 f.
[32] I. e. anyone who would want to object to the idea of generation out of nothing.

before. The problem with this interpretation is that it does not really seem to be a good answer to the charge of reifying 'not-being'. On the other hand, καθό may be taken as a pronoun, 'that in virtue of which', a reading which is familiar, e. g., from Aristotle *Metaphysics* V 18. There Aristotle discusses the different meanings of καθό, and he points out that it may signify each of the four 'causes': form or essence, substrate, and in addition the final and efficient cause.[33] Simplicius, at any rate, understands the word καθό in Philoponus' sentence as a pronoun, and he takes it to refer to either the material or the formal 'cause', *In de caelo* 137,14–16:

> "... even if that in virtue of which it is generated does not exist (κἂν μὴ καθὸ γίνεται ἔστι) – let it be generated in virtue of the form (κατὰ τὴν μορφήν) – what prevents it nevertheless from existing in virtue of the substrate (κατὰ τὸ ὑποκείμενον), as, e. g., the marble herme does not exist in virtue of the form before it is generated, but it does exist in virtue of the marble?"

If this understanding of καθό is accepted, Philoponus' remark should perhaps be translated as follows, fr. IV/73: *In de caelo* 136,23–26:

> "But I do not think that anyone is witless enough to understand generation out of not-being in this way; rather, that in virtue of which each of the things generated is generated is brought into existence without having existed previously."

On this translation the point is a rather different one. Philoponus seems to say that one may speak of *creatio ex nihilo* if the normally pre-existing 'causes' (in the Aristotelian sense) of generation are brought into existence as well; what is required is the creation of the physical conditions which make generation and corruption possible. Since matter is generally taken to pre-exist any generation, this remark may be understood in the sense that together with the creation of form, matter is generated as well.[34] The simultaneous creation of form and matter is called *concreatio*. This notion is expressly put forward by Philoponus in the following fragment IV/74*: *In de caelo* 137,16–19:

> "⟨The Grammarian⟩ attempts to show by means of many arguments that the things immediately generated by God (τὰ ἀμέσως ὑπὸ Θεοῦ γινόμενα)

[33] See *Metaph.* V 18, 1022 a 14–22. Aristotle also includes the meaning of 'position'. Cf. Ross (1924), 333 f. The word καθό in Bekker's text has been changed consistently into καθ' ὃ in the text edited by Ross.

[34] In Philoponus' context, the word καθό can obviously not be taken to refer to the efficient cause; even in the case of *creatio ex nihilo* the creator must be assumed to pre-exist the act of creation.

> are not generated out of some pre-existing substrate, but the form is generated together with the substrate."

With this Simplicius leaves the subject, giving no indication why Philoponus thought that the concept of *creatio ex nihilo* is philosophically viable. Philoponus returns to the same subject in his sixth book, frr. VI/114–116, where he argues that Aristotle's assumption of motion being eternal can be proved true only if the tenet of the physicists that 'nothing comes to be out of nothing' is in fact true. Philoponus sets out to show that 'the physicists' are wrong. His argument consists of two steps. First, the tenet cannot be universally true because the creation of the world by God is a clear exception. The passage restates Theophilus' third argument for creation out of nothing, fr. VI/115: *apud* Simplicium *In phys.* 1141,11–19:

> "First, ⟨the Grammarian⟩ says, even if nature produces the things it creates out of what already exists because it has its own reality and actualisation in a substrate, and because nature is not able to be or to act in separation from a substrate, it is not necessary that God, who has his reality and actualisation separate from all beings, create out of existing things as well. For otherwise he would not be superior to nature. And yet God not only produces the forms of the things directly generated by him, but he is believed to originate and create even matter itself."

But in the sequel of this argument Philoponus goes on to argue, remarkably, that the Parmenidean dictum is not even true in the case of nature and art. Simplicius says fr. VI/116: *ibid.* 1142,1–4:

> "Next, he reminds us of yet another proof which is stated in the eleventh book of the *contra Proclum*. By means of this proof he has shown, supposedly, that even the things which are generated by nature and by art come into existence out of not-being and perish into not-being."

Simplicius then reproduces an argument where Philoponus shows that the *corporeal forms* of the things generated by nature and art come into being out of nothing, and one misses the corresponding argument that the same is true of their *matter*. Which are Philoponus' grounds for making the remarkably radical claim that virtually everything is generated out of not-being?

It is necessary to turn to the ninth book of the treatise against Proclus.[35] In chapter 11, *contra Proclum* 344–365 (ed. Rabe), Philoponus develops an elaborate argument "that none of the things generated are

[35] Not to the eleventh book, as stated *In phys.* 1142,1 f.; cf. apparatus to the text.

generated out of being".[36] In that argument, a detailed analysis of which would exceed the limits of this essay, Philoponus first reduces the generation and destruction of corporeal substances to the generation and destruction of corporeal forms.[37] Substances which are subject to generation and destruction are compounds of matter and form, but it is only the form which comes to be and perishes. Matter, which Philoponus prefers to call τὸ τριχῇ διαστατόν,[38] is not subject to generation and destruction because it underlies any substantial change without being affected. A compound substance never comes to be and perishes *qua* whole (καθ' ὅλον)[39] but only *qua* form. The corporeal forms, therefore, are the proper subjects of substantial change.[40]

Once matter is shunted out of the analysis of the process of generation and destruction, Philoponus shows next by means of a complicated indirect argument that the corporeal forms must be assumed to be generated out of nothing.[41] He concludes *contra Proclum* 359,2–14:

> "So if the corporeal forms of the bodies that perish do not resolve into matter, nor change into some other substrate, nor dissolve into the most simple elements, nor return to their own totality, nor change into some other form, but neither admit of a separate existence as such over and above bodies, like the intelligible things (τὰ νοητά) ..., and if it is not possible to conceive of any other type of change apart from these, then it remains that all corporeal forms of perishing bodies change into nothing at all (τὸ μηδαμῇ μηδαμῶς ὄν). Accordingly, they have also been generated out of nothing at all."

There follows, finally, a discussion of Aristotle's δύναμις – ἐνέργεια distinction,[42] in which it is argued that although the substrate may change from a state of potentiality to a state of actuality, the incorporeal forms nevertheless come to be out of and perish into nothing.[43]

It is true that in this important chapter of the *contra Proclum* Philoponus attempts to put the concept of *creatio ex nihilo* on a philosophical basis. The degree of sophistication in comparison with the

[36] See *contra Proclum* 316,3.
[37] See *contra Proclum* IX 11, 344,27–347,10.
[38] *Ibid.* 346,4.
[39] *Ibid.* 345,.20 f.; 346,14.
[40] *Ibid.* 346,16–347,2: τὸ γὰρ εἶδός ἐστιν τὸ κυρίως γινόμενον.
[41] *Ibid.* 347,10–359,14.
[42] *Ibid.* 359,14–363,13.
[43] *Ibid.* 361,25–362,3. The argument does not seem to be consistent with the initial point that matter has nothing to do with the process of generation.

arguments of Theophilus is striking. However, it must remain for a future analysis to decide whether his arguments in support of the radical claim that all things are generated out of nothing actually also embody a radically new understanding of the problem of existential change.

7.1.4 Fragments IV/76–80

Fragment IV/76 comes from an Arabic source, Farabi's treatise *Against John the Grammarian.*[44] Since the argument of this fragment has not been dealt with by Simplicius, it may be useful to quote the fragment here although the point made seems to be a trivial one.

> "And ⟨the Grammarian⟩ literally says this: If the Philosopher ⟨sc. Aristotle⟩ wants to demonstrate by these statements, which we stated before, that the *world* is not generated, on what ground did he transfer what he said about the *heavens* to the *world*? Is it because Aristotle applies what he says about the heavens (supposing that they are ungenerated) to the entire world? For according to John ⟨sc. the Grammarian⟩, he ⟨sc. Aristotle⟩ had in mind here only the case of that part of the world which moves with a circular movement. How, then, did he ⟨sc. Aristotle⟩ permit himself to speak of the entire world in place of this part of the world (for what is made evident about certain parts of the world, whether a state or anything else, need not necessarily be true of the entire world), and not distinguish between the two, and this either unintentionally, or intentionally as someone who employs sophistry? For to shift one's ground from the particular to the universal, and from one particular to another is one of the topics of sophistry, as he explained in *Topics* 2 and subsequently in *On Sophistical Refutations.*"

According to Farabi, Philoponus has censured Aristotle for shifting his grounds from one particular, i.e. the celestial body, to another particular, the world as a whole. Philoponus doubts that the specific eternal existence of the sublunary elements is entailed by the individual eternal existence of the things in heaven. The point is trivial because the eternity of the celestial substance, aether, does no doubt imply the eternal existence of the universe. For is it possible to conceive of a universe in which everything below the moon perishes while the celestial spheres remain intact?

[44] The Arabic text has been edited by Mahdi (1972); translation and commentary by the same author (1967), 256.

The final part of the fourth book deals with Aristotle's appeal to the 'phenomena' in *De caelo* I 3. Having concluded his philosophical arguments with the statement that the first body is eternal, not subject to increase and diminution, unaging, unalterable, and impassive,[45] Aristotle argues that his theory is in agreement with sense perception and, more importantly, with the common opinion of men. For first, all men allot the highest place to God.[46] Secondly, the heavens have never been observed to change.[47] And thirdly, etymologically the word αἰθήρ refers to something which is always in motion.[48]

Philoponus rightly rejects this last etymological point in the *Meteorology* commentary,[49] but there is no evidence that he did the same in the *contra Aristotelem* or the *contra Proclum*. Only the first two 'phenomena' are attacked in the following fragments. By coincidence, two different summary accounts of his criticism of the first argument are extant, one in Greek by Simplicius, the other in Arabic in a 12th century anonymous recension of Abû Sulaimân as-Sijistânî's treatise *Ṣiwân al-Ḥikmah*.[50] A comparison of the two texts, which are listed as fr. IV/78 and fr.IV/79 respectively,[51] throws some light on Simplicius' method of citing Philoponus. The Arabic version has probably been contaminated by Arabic theology;[52] Simplicius' version appears to be a streamlined summary of the original passage, dwelling on the main points alone but nevertheless providing an adequate and accurate paraphrase of Philoponus' argument.[53]

Philoponus adduces two arguments against Aristotle's first 'phenomenon'. The fact that all men allot the highest place to God is no proof of the eternity of the heavens. For first, there are people, ancient as well as "people of our time" who do not believe in the eternity of

[45] See *Cael.* I 3, 270 b 1–4 and cf. above 4.2.1.
[46] *Cael.* I 3, 270 b 4–9.
[47] *Cael.* I 3, 270 b 11–16.
[48] *Cael.* I 3, 270 b 20–24.
[49] See *In meteor.* 16,13–32; cf. 17,35–18,6.
[50] The fragment has been published and commented on by Kraemer (1965). The complete text of the recension entitled *Muntakhab Ṣiwân al-Ḥikmah* has been edited by Dunlop (1979). – As-Sijistânî lived ca. 912–985.
[51] See Wildberg (1987 b), 89 f.
[52] Particularly the last sentences using metaphors of light. On the problem see Kraemer (1965), 326 f.
[53] On the problem of the general authenticity of the fragments see Wildberg (1987 b), 29–31.

the world[54] but all the same raise their eyes to heaven when they pray.[55] Secondly, the Greeks and the barbarians believe their temples and idols to be dwellings for the gods, but no one thinks that these temples and idols are imperishable and ungenerated. Rather, they think that these places are more appropriate for the deity than any other place.[56]

Aristotle's second argument, i. e. that the celestial region is clearly immutable, could turn out to be a considerable embarrassment for Philoponus. Simplicius himself raises this point frequently, and Philoponus cannot but agree. Significantly, he too regarded the celestial body as immutable for as long as it exists; comets and meteors and the other appearances in the sky are, just as in Aristotle, sublunary phenomena.[57] But the immutability of the heavens does in fact not pose a problem. First, Philoponus seeks to weaken the strength of this reference to the 'facts' by an analogy: In the sublunary region there are animals that live longer than others, and mountains and diamonds have existed since the beginning of the world itself. Although it is true that there is no record that the heavens have changed, there is no record of Mount Olympus having changed either.[58] Second, there is a perfectly reasonable explanation of the apparent immutability of the celestial body, fr. IV/80: *In de caelo* 142,14–25:

> "And in the case of mortal animals, for the time that they are to be preserved it is necessary that the most important of their parts retain their proper nature, so that as long as God wants the world to exist it is also necessary that the most important of its parts be preserved. But it has been agreed that the heavens as a whole as well as in their parts are the most important and most essential parts of the world. For by their movement all bodies inside are guided naturally. Therefore it is necessary that as long as the world is to be preserved, the heavens will not abandon their proper nature in any respect, neither as a whole nor in their parts. But if it has rightly been shown by Aristotle that all bodies have a limited capacity (δύναμις), and if the heavens, too, are a body, then it is evident that they are also liable to destruction because the term 'destruction'

[54] This may be taken as a clear reference to Christians.
[55] This argument occurs only in the Arabic version fr. IV/79. Kraemer (1965), 326 understands the gist of the objection in a slightly different way: "For we find that the ancients and the people of our time, who clearly assert that they believe the entire world to be generated, raise their eyes to heaven when they pray, and ⟨they are⟩ no less than then those ⟨others⟩."
[56] Cf. fr. IV/78: *In de caelo* 141,16–19 with fr. IV/79 (2): Kraemer (1969), 237.
[57] See his comments on Aristotle's *Meteorology* I 4–7, and cf. above 6.2.1.
[58] See fr. IV/80: *In de caelo* 142,7–14.

applies to them, even though so far they clearly have not been affected by anything leading to destruction."

Philoponus' universe depends entirely on God's will. Only as long as he wants the world to exist will everything necessary for its further preservation remain unaltered. Above all, this is true of the celestial body since it is the most important part of the universe. Nevertheless, the celestial body is destructible, *In de caelo* 144,22–25; that the celestial body must be destructible has been argued by Philoponus in the previous book of the *contra Aristotelem*.[59] The analogy between 'universe' and 'animal' employed by Philoponus in the above argument is unsurprising, for at the time of the *contra Aristotelem* Philoponus still believed in the existence of a world-soul.[60] Significantly, Philoponus once again attempts to turn Aristotle against himself. If the heavens are a limited body, and if Aristotle has shown correctly that a limited body cannot possess an unlimited δύναμις,[61] then it is impossible that the celestial body be eternal. For according to Philoponus, eternal existence of an individual thing presupposes the possession of an unlimited δύναμις. The argument is a precursor of a later, separate treatise which was exclusively dedicated to showing that the world cannot be eternal precisely because it is a limited body, and all limited bodies are subject to destruction.[62]

7.2 Excursus: Philoponus' Conception of 'the Three-dimensional'

One of Philoponus' passages in book IV of the *contra Aristotelem* argued that the matter of the celestial region is not distinct from the matter of the sublunary world.[63] The argument relies on a specific conception of matter, which emphasises the three-dimensional extendedness of the material substrate of the physical world. Simplicius remarks, fr. IV/72: *In de caelo* 135,26–136,1:

> "But since ⟨the Grammarian⟩ is evidently displeased with the concept of incorporeal matter (ἀσώματος ὕλη), he claims that in the eleventh section

[59] See, e. g., fr. IV/69: *In de caelo* 137,7–15.
[60] See above 6.1.4.
[61] See *Phys.* VIII 10, 266 a 23–b 6.
[62] Fragments of the treatise survive in Simplicius' commentary on Aristotle's eighth book of the *Physics*, 1326–1336. Cf. also Davidson (1969), 358 f. and Pines (1972), 339–341.
[63] See fragments IV/70–71 and section 7.1.2 above.

> of his refutation of the writings of Proclus he has proved that it is impossible that the so-called incorporeal and formless matter (ἡ ἀσώματος καὶ ἀνείδεος ὕλη) exists, and that instead the bodies are ultimately reduced to the three-dimensional (τὸ τριχῇ διαστατόν). But neither have I read his boastings there nor would I be pleased to read shallow nonsense, when even now I do not know how my project of expounding the *De caelo* has made me fall into Augeas' dung."

Several things may be inferred from this passage. First, Philoponus rejects the idea of a so-called 'incorporeal and formless matter'. Secondly, he holds that the lowest level of material being is 'the three-dimensional'. And thirdly, these ideas have been laid down in book XI of the treatise against Proclus. In the present section I shall attempt to interpret these remarks in order to arrive at a proper understanding of Philoponus' treatment of the problem of matter.

7.2.1 Different interpretations of 'the three-dimensional'

It is generally accepted that in the eleventh book of the *contra Proclum* Philoponus develops an original idea of the primary substrate of physical change. It is further believed that his views on matter developed there differ widely not only from the Peripatetic-Neoplatonic doctrine of matter, but also from his own views expressed in earlier treatises, in particular the commentary on Aristotle's *Physics*. However, the more specific question of what Philoponus' new conception of matter is proves notoriously difficult to answer. One of the main difficulties is caused by the terminology: the concepts and terms encountered in the relevant passages often betray an unwieldy lack of rigour, a fact which indicates perhaps that Philoponus is attempting to express new ideas within the framework of no longer adequate paradigms. Scholars have thus interpreted Philoponus' new idea in different ways.

Sambursky argued that the new conception of the first substrate in the *contra Proclum* is 'tri-dimensional extension', and that in this respect Philoponus anticipated Descartes.[64] Sambursky's interpretation

[64] See, e. g., Sambursky (1962), 165: "Matter everywhere, ... is nothing but tri-dimensional extension, and, further anticipating Descartes, Philoponus concludes that matter, being a spatial magnitude, must be infinitely divisible."

leaves it open, however, whether matter in Philoponus is a material or in fact a purely spatial magnitude.

In a very sophisticated treatment of the problem, M. Wolff offers a rather complex interpretation according to which Philoponus' 'matter' is taken to be mere incorporeal extension in three dimensions, possessing independent existence. Yet Wolff emphasises that this pure tridimensionality is *not* the *substrate* of physical bodies, but their *constitutive attribute*.[65] In other words, physical bodies do not possess the 'three-dimensional' as their first substrate, but are essentially constituted by the most fundamental and primitive form, three-dimensional extension.[66]

In contrast, Simplicius, who judges from the evidence he finds in the *contra Aristotelem*, thinks that Philoponus "regards the body (σῶμα) as matter which the Peripatetics called 'second substrate'".[67] Whatever he may be referring to exactly by the phrase 'second substrate', it is clear that Simplicius understands Philoponus' 'matter' to be not a purely spatial entity, but an extended, corporeal one.

Most recently, R. Sorabji has argued that Philoponus' matter is corporeal extension,[68] and has both traced the influence Philoponus may have received from earlier thinkers (like Plato, the Stoics, Moderatus, Plotinus)[69] and outlined the possible impact his ideas may have had on later philosophers (notably Buridan, Descartes, and Locke).[70]

[65] Wolff (1971), 109: "Da sie (i. e. three dimensional extension) im Gegensatz zu anderen körperlichen Eigenschaften keines weiteres Substrates bedarf, um existieren zu können, "subsistiert sie sich selbst" (αὐθυπόστατος εἶναι). Obgleich Philoponus die dreidimensionale Ausdehnung als Substanz betrachtet, hält er sie nicht für ein materielles Ding. Zwar gesteht er zu, sie nach Belieben "als erstes Substrat oder als Materie anzuplappern", aber er weigert sich, sie prinzipiell anderen Eigenschaften körperlicher Dinge als solchen entgegenzusetzen. Vielmehr bezeichnet er die Ausdehnung als "Form" (εἶδος), die sich vor anderen "Formen" nur insofern auszeichnet, als sie für den Körper als solchen "konstitutiv" (συμπληρωτικός) oder "wesentlich" (οὐσιώδης) ist." – Cf. also his remarks to the same effect 118 and 135 f.

[66] Incidentally, Wolff (1971), 136 argues that the world, according to Philoponus, has been created out of nothing and will perish into nothing precisely *because* (i) 'matter' is merely a form, and (ii) all forms are generated out of and perish into nothing. Although (ii) was commonly believed in Neoplatonism (including Philoponus, see *ibid.* 132 note 37), (i) depends on Wolff's interpretation, and (i) + (ii) is, to my knowledge, never stated by Philoponus (significantly, Wolff does not provide a reference).

[67] See *In de caelo* 134,9 f. (fr. IV/70).

[68] See Sorabji (1987 b), 20.

[69] *Ibid.*, 34–37.

[70] *Ibid.*, 19–22.

Moreover, Sorabji points out with Wolff that "Philoponus' promotion of three-dimensional extension to *first* subject is accompanied by another promotion of it to being the form, differentia, essence or essential attribute of body."[71]

It is the primary aim of the following sections to offer an independent interpretation of the gradual change and development of Philoponus' views on the problem of matter. It is necessary, first, to look at some relevant passages in the *Physics* commentary, and subsequently to compare his position there with the argument in the *contra Proclum*, book XI. Already at this point it may be stated explicitly that the following account does not so much offer an entirely novel interpretation of Philoponus' conception of 'the three-dimensional' as it attempts to outline the rationale behind Philoponus' assertion that matter is an extended entity.

7.2.2 The fundamental levels of being in the *Physics* commentary

In a famous passage in *Metaphysics* VII 3, Aristotle, discussing the nature of οὐσία, adduces an argument in which physical bodies are theoretically deprived of all their attributes.[72] For if, he argues, all attributes, and, in a second step, (supposedly determinate) length, breadth, and depth are taken away, nothing remains, except perhaps matter, which is bound by these and which is *per se* nothing that could be referred to semantically.[73]

Philoponus, who defends his sound conception of place as a three dimensional empty extension[74] against an imaginary opponent who

[71] *Ibid.*, 19 and note 119.

[72] See *Metaph.* VII 3, 1029 a 10–26. On the problem of the interpretation of this passage see Schofield (1972) and Burnyeat et al. (1979), 12–14. – The following account sometimes speaks of 'Aristotle's prime matter'. Although the status of this concept in Aristotle is highly controversial among modern scholars, ancient commentators had no doubts that Aristotle endorses the view that 'prime matter' is the ultimate substratum of the physical world. For our present purposes it is unnecessary to take the modern discussion into account because the subject-matter is Philoponus' revision of what he took to be 'prime matter' in Aristotelian and Neoplatonic philosophy. – On the modern discussion of Aristotle's conception of prime matter see esp. Charlton (1970), 129–145; Williams (1982), 211–219; Charlton (1983), with further references.

[73] 1029 a 20 f.: "By matter I mean that which *per se* is not described as something or as quantity or as anything else by which being is defined."

[74] One of Philoponus' major achievements in the *Physics* commentary is the revision of

argues that his notion of place entails an identification of void and body (for both are three-dimensional), replies with a similar theoretical elimination of properties. In this passage, he arrives at a result which bears close resemblance to Aristotle's, *In phys.* 687,29–688,2:

> "Also, he wrongly identifies void with body. For not even if you eliminate all the quality of the body will the bodily extension (σωματικὸν διάστημα) in this way be identical with the void. For even if we remove all quality from the body, the quantified matter (ἡ ὀγκωθεῖσα ὕλη)[75] and the unqualified body (τὸ ἄποιον σῶμα) will remain, which is a compound of matter and a quantitative form (τὸ κατὰ ποσὸν εἶδος). But the void is not a compound of matter and form; for it is not a body at all, but incorporeal and immaterial, and only the space (χώρα) of a body. If, then, when the qualities have been removed from a body that which remains is no less a body, and if the void is not a body, it will never follow that a body is in a body, if body is in void as its place (τόπος)."

This passage seems to be clear enough. As in Aristotle, there are three levels of physical being. First there comes matter; then, on a second level, some compound of matter and the form of quantity, which Philoponus refers to as bodily extension (σωματικὸν διάστημα), quantified matter (ὀγκωθεῖσα ὕλη), or unqualified body (ἄποιον σῶμα). The plurality of qualified bodies constitutes the third level, which, of course, is multiply stratified itself. Elsewhere in the commentary, Philoponus describes the levels of being with a different terminology, *In phys.* 244,6–9:

> "For the proximate matter (ἡ προσεχὴς ὕλη) of the statue is bronze, but since something else underlies it too, e. g., water, water is therefore also the matter of the statue; but also the three-dimensional (τὸ τριχῇ διαστατόν), which underlies the water, and prime matter (ἡ πρώτη ὕλη), which immediately underlies the three-dimensional."

In this passage, as in many other places, the second level is referred to as 'the three-dimensional', which may naturally be taken as a further synonym of 'quantified matter', 'corporeal extension', or 'unqualified body'. It is evident that all these terms refer to something material, a corporeal entity being a compound of matter and some basic form of

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the Aristotelian definition of place. In Philoponus, place is not the inner surface of the container, but the empty, three-dimensional space occupied by body, see his *Corollarium de loco, In phys.* 557–585, translated in Furley (1987); cf. Wieland (1967) and Sedley (1987).

[75] I translate ἡ ὀγκωθεῖσα ὕλη with 'quantified matter' because the term is a synonym of ἡ ποσοθεῖσα ὕλη; see *In phys.* 520,18–25; 516,22–26 and compare 515,15–19; cf. also Wieland (1967), 131.

quantity. It is distinguished from other things in so far as it is characterised by the form of quantity alone and does not possess any other qualification. However, there is a problem. Corporeal quantity may either be determinate, i. e., possess a fixed, measurable length, breadth, and depth, or it may be indeterminate, i. e., extend indiscriminately in all three dimensions. So far, it remains unclear whether the second level of being is constituted by a determinate, or an indeterminate corporeal quanity. A more careful analysis of the process of eliminating attributes seems to be required. Philoponus comments on Aristotle's statement in the *Physics* that 'when the limit and the properties of a sphere are taken away, nothing but matter remains',[76] *In phys.* 520,18–25:

> "'The limit' is the surface and the spherical shape; 'the properties' are the sensuous qualities (αἱ παθητικαὶ ποιότητες), colour, weight and so forth. For if these are taken away, there remains some indeterminate and unbounded bulk (ἀόριστός τις ὄγκος καὶ ἀπεράτωτος), which is matter. 'Matter', however, or 'prime matter', or, which is better, 'quantified matter' (ἡ ποσωθεῖσα ὕλη), which is the three-dimensional (τὸ τριχῇ διαστατόν), which is *per se* indeterminate (καθ' αὑτὸ ἀόριστον) and has no shape (for it is not the same as some determinate quantity, e. g., two or three cubits long, nor as anything shaped), which is why it admits of an always different magnitude and shape. There are some who thought that this was prime matter."

Here it is made absolutely plain that the level of the three-dimensional is constituted by matter extending in all three dimensions without determinate boundaries.[77] Elsewhere Philoponus refers to the determinate measures as 'the great and the small', and he describes them as the first differentiae of quantified matter; see *In phys.* 516,18–26. In contrast to the impression received from the passage *In phys.* 687,29–688,2, Philoponus distinguishes in fact between four fundamental levels of being. Whereas Aristotle, when he eliminated length, breadth, and depth, immediately arrived at prime matter, Philoponus arrives first at indeterminate, quantified matter, and then at prime matter.[78]

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[76] See *Phys.* IV 2, 209 b 9–11.

[77] Cf. also *In phys.* 515,15–19; 93,6–8. This, however, does not mean that quantified matter is boundless in the sense of spatially infinite. The largest possible ὄγκος possesses the dimensions of the universe (τὸ κοσμικὸν διάστημα); see *In phys.* 569,15 and cf. esp. *contra Proclum* XI 8, 434,9–15.

[78] It should be noted that Aristotle's concept of ὕλη νοητή, which some scholars take to be the substrate of mathematical objects in Aristotle, see above 2.3, has little in common with Philoponus' quantified matter, which is an unqualified corporeal, i. e. physical, entity.

Two further things are remarkable about the passage just set out. In the last sentence Philoponus points out that some philosophers took the three-dimensional to be prime matter; in the *contra Proclum* Philoponus intimates that these philosophers are the Stoics.[79] Secondly, he himself seems to have doubts about the Aristotelian concept of prime matter: The whole passage aims to point out that one does not arrive at the Aristotelian type of matter, but at the three-dimensional, which — and this he adds as an aside — other philosophers at any rate regarded as 'prime matter'. The impression that Philoponus is rather sceptical about what he took to be Aristotle's prime matter is confirmed by the fact that in the *Physics* commentary the concept of prime matter plays a very marginal role indeed. It is only referred to occasionally as that which underlies the three-dimensional.[80] On the other hand, the concept of quantified matter, i. e. the three-dimensional, features as one of the most prominent ideas in the commentary. It is not only the material correlate to the concept of place,[81] but also, as Philoponus claims to have shown elsewhere, it is the first unchanged substrate of substantial and qualitative change, *In phys.* 156,10–17:

> "In general, the four elements are the substrate of all physical things, I mean the things which are subject to generation and destruction. In respect of these elements being mixed in always different ways the physical forms came to be. However, the three-dimensional, i. e. the unqualified body (τὸ ἄποιον σῶμα), is the substrate of these elements themselves, and in general of all things. With respect to this substrate, which remains unchanged as body (ἀμετάβλητον μένον ὡς σῶμα), the changes take place, for with respect to it the essential qualities act and are acted upon.
> In our Σύμμικτα Θεωρήματα we have shown that the second substrate (δεύτερον ὑποκείμενον) remains unchanged as body."

This is a very significant passage, not just because it refers to the lost, and apparently early, treatise Σύμμικτα Θεωρήματα.[82] Important

[79] See XI 1, 410,1–3; 3, 413,24–414,5. The interpretation of Stoic matter by Baeumker (1890), 326–345 agrees well with Philoponus' remarks, though Sorabji (1987 b), 34–36 argues that the Stoic concept of matter differs in too many important respects from Philoponus' understanding of it as three-dimensional, corporeal extension. Sorabji's view that closer antecedents for Philoponus may be seen in Moderatus (*apud* Simplicium *In phys.* 230,34–231,20) and a small passage in Plotinus (*Enn.* II 4,11.1–13) is, however, not persuasive.

[80] See, e. g., *In phys.* 16,1; 93,7 f.; 145,32; 146,9; 244,6–9; 520,21–25.

[81] As suggested by Wieland (1967), 130–133. See esp. 563,2–6 where it is stated that spatial and corporeal extension accommodate one another (ἐφαρμόζειν ἀλλήλοις), and cf. 505,1–4; 560,27–30.

[82] The problem of this treatise does not concern us in the present context; see Evrard (1953), 340; Wolff (1971), 121 note 27, and Sorabji (1987), 37.

for the present context is, first, that the traditional role of prime matter is virtually taken over by the three-dimensional, which is presented as the unchanged substrate of physical change. Secondly, the term δεύτερον ὑποκείμενον, second substrate, is introduced as a further synonym of 'the three-dimensional'.[83] Philoponus evidently uses the term in the same sense as 'quantified matter' or 'corporeal extension'. In doing so, Philoponus adopts, as Simplicius tells us,[84] the Peripatetic meaning of the term, which can be traced back to Alexander's *De caelo* commentary.[85] Other commentators, like Dexippus (4th century A. D.), take the phrase δεύτερον ὑποκείμενον to be referring to a particular ποιόν, e. g., copper or Socrates.[86] In Philoponus, at any rate, the term 'the three-dimensional' (or 'unqualified body' or 'second substrate') refers to the unchanged subject of all physical change. Although the passage *In phys.* 156,10–17 just cited does not explicitly state that this substrate remains unaffected by *quantitative* change also, this can easily be inferred from other passages.[87]

In summary, in the *Physics* commentary Philoponus modifies Aristotle's ontology as understood by late antiquity commentators by emphasising the importance of the concept of quantified matter. Indeterminate quantified matter, which he more often refers to as the three-dimensional (but also as unqualified body, second substrate, or corporeal extension), is a compound of prime matter and indeterminate extension in three dimensions. Since it is regarded as the unchanged substrate (ὑποκείμενον) of all physical change, it challenges the position of prime matter as the ultimate principle of the physical world.

Before we proceed to examine the argument of the eleventh book of the *contra Proclum*, it is necessary to qualify the account just given

[83] Cf. also *In phys.* 225,14 f.; 579,3–5 where 'second substrate' and 'the three-dimensional' are also identified.

[84] See *In de caelo* 134,10.

[85] Simplicius remarks *In de caelo* 599,5 that Alexander stated (in his comments on *Cael.* III 2, 301 b 31–302 a 9: "the ἄποιον σῶμα as such, which he calls δεύτερον ὑποκείμενον, is ungenerated."

[86] See Dexippus, *In cat.* 23,25 f.. (On Dexippus see Busse (1888), 406–408). His usage depends on Porphyry, cf. *apud* Simplicium *In cat.* 48,11–16. The two different meanings of δεύτερον ὑποκείμενον must not be confused: the 'Peripatetic' meaning seems to have evolved out of a discussion of physical principles, whereas the Neoplatonic meaning belongs to the context of Aristotle's categories. — Simplicius himself is of course well acquainted with the way in which Philoponus uses the term, see *In cat.* 140,27; *In de caelo* 134,10; 599,5; *In phys.* 514,4–9.

[87] See *In phys.* 515,22–24 and 516,22–26: The great and the small form the primary contrariety pertaining to quantified matter.

in one respect. The central term of Philoponus' fundamental ontology, 'the three-dimensional', involves a certain ambiguity. Although it refers in most cases to the indeterminate quantified matter, i. e. a corporeal entity, it may in some cases simply mean 'tri-dimensionality', as in the following passage. Philoponus defends the idea that the extensions of place coincide with the extensions of body, *In phys.* 561,3–12:

> "Now, it has been shown sufficiently that even if the fact that place is three-dimensional entailed that several extensions are in one and the same body, nothing absurd followed because ⟨the extensions of place⟩ are incorporeal. For what is three-dimensional (τὸ τριχῇ διαστατόν) is not immediately a body, nor will we allow this to be a definition of body. For body, being something else, is three-dimensional in this way. For body is a substance, and quantity belongs to substance as an attribute; the three-dimensional [i. e. tri-dimensionality], therefore, is an attribute of substance. But body is a substance; consequently, the three-dimensional is an attribute of body. For it is body insofar as it consists of matter and some particular form, but because quantity is an inseparable attribute (ἀχώριστον εἶναι συμβεβηκός) of body, it is three-dimensional because of this."

Although he operates with the same term, τὸ τριχῇ διαστατόν, Philoponus clearly distinguishes it as pure three-dimensional extension from the corporeal entity 'body'. The distinction is a logical one; ontologically tri-dimensionality is inseparable from body.

7.2.3 The three-dimensional: ὑποκείμενον and οὐσία

We may now turn to the treatise against Proclus. The novelty of the relevant chapters in the eleventh book lies in the fact that Philoponus couples his argument of the *Physics* commentary that the three-dimensional is the unchanged ὑποκείμενον of physical change with an explicit rejection of the concept of an "incorporeal and formless (i. e. prime) matter".[88] As a consequence of this rejection, the "three-dimensional"

[88] It is noteworthy that Philoponus does not reject the concept of a first substrate as such; as will be seen, he objects to the first substrate being understood as incorporeal and formless. – The description of prime matter in these terms is not Aristotelian, although it may have been influenced, e. g., by Aristotle's remark *Metaph.* VII 3, 1029 a 20 f. cited earlier. The Platonist Moderatus (1st century A. D.) apparently used this terminology for the first time; see Wolff (1971), 119 note 22 with reference to Simplicius *In phys.* 230,34 ff. The concept is clearly present in Plotinus (cf. *Enn.* II 4) and the Neoplatonists, see esp. Baeumker (1890), 402–409 and cf. Sorabji (1983), 162; 292.

acquires a different status. Philoponus no longer admits that it is a compound of prime matter and the form of pure tri-dimensionality, but claims that it is a *simple* entity. It functions not only as the ὑποκείμενον for all corporeal forms, but is, as such, the οὐσία of body. The argument, book XI, chapters 3–8 may be summarised as follows:

XI 3: *Thesis*: Philoponus proposes the thesis that the assumption of an incorporeal and formless matter (presupposed in Proclus' eleventh argument against the Christians) is unnecessary. Body *qua* body never changes; the first substrate of all change is the three-dimensional, i. e. pure, unqualified body, 412,15–28; 413,24–414,5; 414,16–20. The three-dimensional itself does not possess a substrate, 413,12–24; 414,20–415,10.

XI 4: *First objection*: The three-dimensional cannot be the first substrate because it does not remain unchanged in the case of quantitative change and the first substrate must remain unchanged, 415,16–417,17. Philoponus replies that even in the case of quantitative change the three-dimensional *qua* body remains unaffected, 412,19–28; 419,5–16; 421,4–15. 'The great' and 'the small', i. e. determinate quantity (in Philoponus), in terms of which things change when they change quantitatively, are not identical to the three-dimensional (four arguments), 419,16–421,4.

XI 5: *Second objection*: The three-dimensional is a quantity; therefore it belongs to some substance as its attribute. Hence, there must be some matter underlying it, 421,16–422,4.
Philoponus first distinguishes between accidental and essential qualities and argues that substances are not compounds of matter and accidental attributes, 422,4–423,13. He then replies to the objection that there exists an essential *quantity* too, which constitutes body essentially. This is nothing else but the three-dimensional, which is the οὐσία of body, 423,13–424,11.

XI 6: Philoponus elaborates his reply to the second objection. The indeterminate, three-dimensional bulk receives determinate quantity as its first differentia. He doubly describes it as 'the οὐσία of body as such' and 'the ὑποκείμενον of all physical forms', cf. 424,23 f.; 425,5 f. with 424,25–425,1; 425,9–14.

XI 7: *Third objection*: If the three-dimensional possesses a form, then it will follow that a form, rather than something formless, underlies all other forms, which is impossible, 425,25–426,4.

Philoponus replies that the conception of matter as formless is an unfounded postulate, 426,4–6. In the cases of nature and art the immediate substrate of change is always already formed, 426,10–427,5. In addition, nothing at all can exist without form, and if 'matter' is not just an empty word,[89] the same must be true of it, 427,5–428,5. Finally, the three-dimensional is not a compound but simple, 428,5–17.

XI 8: Philoponus gives an elaborate account of his claim that the first substrate of physical things can neither be incorporeal nor formless; see 444,24–28. It must be corporeal because nothing incorporeal ever comes to be anything corporeal. 440,19–443,13; cf. XI 3, 412,25–413,21. It is equally impossible to suppose that matter is only potentially incorporeal, 443,14–444,21. In addition, matter must already possess a form because nothing that exists is formless, 444,28.

The chapter further attempts to show that on the assumption of the three-dimensional as first substrate one is able to offer a better explanation of the quantitative change involved in elementary transformation, 429,2–436,7.[90]

In the following discussion we will attempt to bring out more clearly the continuity and discontinuity of Philoponus' treatments of the problem of matter in the *Physics* commentary and the *contra Proclum*.

The account in the treatise against Proclus agrees with the arguments of the *Physics* commentary discussed above in the following aspects:

1. In both works the three-dimensional is the ὑποκείμενον of all particular physical bodies. It admits of all corporeal forms and remains unaffected by any kind of physical change. In this respect, the *contra Proclum* merely endorses and reiterates the line of argument originally developed in the Σύμμικτα Θεωρήματα.[91] As in the *Physics* commentary, the three-dimensional is associated with the δεύτερον ὑποκείμενον,[92] although, as will be seen shortly, in the *contra Proclum* the relation between the two concepts is no longer one of identity.

[89] An ironical allusion to Plotinus *Enn.* II 4,11.13 and 12.22.

[90] This important aspect of Philoponus' theory does not concern us here; on the problem see Wolff (1971), 138–146.

[91] Cf. *In phys.* 156,10–17 with the argument in *contra Proclum* XI 3 and 4. Philoponus frequently and unambiguously refers to the three-dimensional as ὑποκείμενον, see, e. g., XI 3, 415,2; 6, 425,11 f.; 7, 427,7 f.

[92] See XI 7, 426,21–24.

2. Just as in the *Physics* commentary, the three-dimensional is a corporeal entity, i. e., nothing else but quantified matter or corporeal extension. This must be concluded from the argument in XI 3 and 8 that nothing incorporeal can become corporeal.[93] Moreover, in XI 8, 445,5–7 it is explicitly stated that prime matter can neither be formless nor incorporeal. If the three-dimensional were incorporeal, it would itself be subject to Philoponus' own devastating objections to the concept of incorporeal ὕλη.

The account in the *contra Proclum* differs from the one given in the *Physics* commentary in one important point. As has been shown, already in the *Physics* commentary the three-dimensional tacitly challenges the position of the traditional concept of 'prime matter' in virtue of the fact that it is regarded as the unchanged substrate of physical change. Nevertheless, in that commentary Philoponus still adhered to the view that the three-dimensional is a compound of prime matter and the most primitive form, i. e., that it is identical to the Peripatetic δεύτερον ὑποκείμενον. In the *contra Proclum*, Philoponus takes his position a step further. He now rejects the notion of an incorporeal and formless prime matter altogether. This not only entails that the three-dimensional acquires a different ontological status, but also creates a number of difficulties for the conception of the three-dimensional itself. In order to overcome the most severe problem, Philoponus develops the novel idea that the three-dimensional is not only the first ὑποκείμενον of the physical world, but also the οὐσία of body as such.

As the above summary of the argument shows, Philoponus presents himself with three objections to the thesis that an incorporeal and formless matter does not exist. The first and third objection do not cause him any difficulty. His replies are straightforward.[94] We may

[93] See XI 3, 412,25–27; 413,12–21; 8, 443,6–13 and 22 f. Cf. also the argument *In phys.* 558,27–30; 561,5–21 that three-dimensional space does not constitute body, and the dictum that no physical form can exist without matter, *In phys.* 578,25 f.; *contra Proclum* I 8, 20,29; VI 11, 158,15–17; IX 15, 372,1–4.

[94] See XI 4 (first objection) where Philoponus lays down that determinate quantitative change does not affect the three-dimensional as such. It never ceases to be the three-dimensional, i. e. a body. The line of argument had already been developed in the Σύμμικτα Θεωρήματα and the *Physics* commentary. –
In XI 7 (third objection) Philoponus rejects the traditional conception of an incorporeal and formless prime matter as an unfounded postulate (αἴτημα), and points out that in nature absolutely nothing exists without form, and that must be true of matter as well.

therefore pass on to the crucial second objection, which may be paraphrased as follows:[95]

> 'According to the doctrine of categories, quantity is different from substance; but the three-dimensional as such (αὐτὸ καθ' αὑτό) belongs to the category of quantity, whereas body is a substance. In consequence, the three-dimensional as such can hardly be a body. Body, on the other hand, is a substance, and it is three-dimensional, i. e. characterised (εἰδοποιεῖται) by tri-dimensionality. Therefore, there must be some substrate for the three-dimensional (or: 'tri-dimensionality'),[96] since body is constituted out of this substrate and the attribute of tri-dimensionality. The substrate must be incorporeal prime matter.'

Before Philoponus replies directly, he adduces an argument which draws attention to the distinction between accidental and essential attributes, 422,4–423,13.[97] Accidental attributes (τὰ συμβεβηκότα) are attributes which belong to a substance, but are not a part or element of a substance. Consequently, the substance will remain if one abstracts the accidental attributes from it.[98] Essential attributes, on the other hand, are primarily understood as qualities (τὰ οὐσιώδη ποιά, 423,15); they differ from accidental attributes in virtue of the fact that they themselves contribute to the constitution of a substance. For instance, the heat of fire, the heaviness of earth, the whiteness of snow, or the sphericity of the heavens are constitutive differentiae (συστατικὴ διαφορά, 423,22 f.) of their respective substances. It is not possible, Philoponus argues, to *conceive of* these substances without their essential attributes, 423,28–424,4.

In order to understand Philoponus' following argument a further point not made explicit in the text has to be borne in mind. According

[95] Cf. *contra Proclum* XI 5, 421,16–422,4.

[96] Here, and in 422,4 τὸ τριχῇ διαστατόν is used in the sense of tri-dimensionality; however, Philoponus is not putting forward his own conception of it, but an objection. The objection depends on τὸ τριχῇ διαστατόν being understood purely as a ποσόν. That 'the three-dimensional' can be used ambiguously has become clear from a passage in the *Physics* commentary; see above and *In phys.* 561,3–12. The striking affinity of the second objection to that passage in the *Physics* commentary does not need pointing out.

[97] The distinction dates back to Lucius (2nd century A. D.; see Capelle (1927)), but the theory of accidental and essential attributes belongs to Porphyry, see *apud* Simplicium *In cat.* 48,11–33. On the origin and history of the problem see esp. Wolff (1971), 110–116.

[98] Philoponus' account of accidental attributes agrees with Aristotle's conception of an attribute as that which is in a subject, but not as a part of it, and which cannot exist in separation from that in which it is; cf. *Cat.* 5, 3 a 31 f. with *contra Proclum* XI 5, 422,27–324,9.

to Porphyry's theory all attributes are *accidental* attributes of *prime matter*, but some of these attributes are *essential* attributes of *second substrates*, i. e., in Porphyry some individual ποιόν, e. g., copper or Socrates.[99] This is the reason why Philoponus takes the second objection (i. e. XI 5, 421,16–422,4) to claim that tri-dimensionality is an *accidental* attribute of prime matter. Therefore he sets out to show first that while accidental attributes play no part in the constitution of physical bodies, essential attributes do. Philoponus then adduces an analogy (ὥσπερ ... οὕτω, 423,14; 424,4 and 6): just as there are essential qualities constituting substance, Philoponus suggests (δήπου) that in the same way there is an essential *quantity*, and this is nothing else but the three-dimensional, 424,4–7. This passage seems to suggest that Philoponus intends to endorse the view that the three-dimensional is an essential attribute of bodies.[100] But then, significantly, he drops this suggestion and states that the three-dimensional is in fact the οὐσία of body as such, XI 5, 424,7–11:

> "For this (i. e. the three-dimensional) is the only thing conceived of theoretically in bodies which exists independently (αὐθυπόστατον) and is the οὐσία of body as such (οὐσία ἁπλῶς τοῦ σώματος); it is some three-dimensional bulk (ὄγκος τις τριχῇ διαστατός), indeterminate as regards magnitude and smallness."

Why does he make this subtle move? There are at least two reasons: First, if he claimed that the three-dimensional is an essential attribute of prime matter, nothing is won. For an orthodox objector could reply that the assumption of an incorporeal and formless matter is still required. Porphyry may have been wrong in supposing that all attributes are accidental attributes of prime matter, but Philoponus' theory would not challenge the position of prime matter itself.

Secondly, as has been shown, in the *Physics* commentary Philoponus uses the term 'the three-dimensional' in the majority of cases not to denote mere quantity but rather quantified matter, i. e. some basic extended corporeality. Given that he adheres to this terminology in the *contra Proclum*, it would be strange for him to claim that extended corporeality is an attribute of body. For these reasons, I take it, Philoponus introduces the notion that the three-dimensional is not an attribute, but the οὐσία of body. He sets out to explain his ideas in

[99] See *apud* Simplicium *In cat.* 48,11–33 and cf. Wolff (1971), 115 f.

[100] Wolff's interpretation, I take it, relies on this short passage.

greater detail in the following chapter XI 6. Here he reiterates that τὸ τριχῇ διαστατόν is the οὐσία of body, 424,23 ff.; 425,5 f. But what does he mean by this? Presumably, if someone asked the question what it is to be a physical body, the answer would be: three-dimensional and material. Extended corporeality is the οὐσία of body because it is just that.[101] Being a body means, essentially, to be a three-dimensional material bulk. The idea of an incorporeal matter underlying body does not, according to Philoponus, contribute anything to an understanding of what body is. If the three-dimensional is the οὐσία of body as such, it follows that the traditional notion of prime matter can be abandoned, 425,6–10:

> "So if the three-dimensional is both the οὐσία of body as such and that which alone remains unchanged in the change of bodies (i. e. both οὐσία and ὑποκείμενον[102]), as has been shown, then there is no argument which shows that incorporeal matter necessarily underlies it."

Why does this follow? Because οὐσίαι are by definition self-substantial (αὐθυπόστατος) and possess no ὑποκείμενον.[103] Hence, the three-dimensional must be the most basic entity, XI 7, 428,5–7, as such constituting body *and* serving as a substrate for all physical forms, XI 6, 425,10–24.

In conclusion, Philoponus' conception of the three-dimensional must not be misunderstood as incorporeal tri-dimensionality, nor be described as an attribute of physical bodies. τὸ τριχῇ διαστατόν is basic corporeal extension, or better still, extended corporeality. Though not much less mysterious than the 'traditional' idea of an incorporeal and formless matter, it comes indeed close to the Cartesian *res extensa*.[104]

Tracing the development of Philoponus' ideas on the subject in his writings, notably the *Physics* commentary and the *contra Proclum*, it has become clear that Philoponus does not commit a violent *volte face*, but rather modifies his earlier conception of quantified matter in two

[101] It seems to be inadequate to translate οὐσία by 'substance'; 'essence' is perhaps more appropriate and could be justified by passages such as *contra Proclum* I 6, 16,28 f.; XI 7, 427,17 f.24–26. Since a translation would have to be justified in the context of Philoponus' general ousiology, which cannot be the subject-matter of this inquiry, the term will remain untranslated.

[102] See also 425,11 f.

[103] Cf. *contra Proclum* VIII 3, 307,19–27.

[104] On the problem see Sorabji (1987 b), 21 f., who points out that unlike Philoponus, Descartes refuses to draw a distinction between corporeal and spatial extension.

important respects, a) by rejecting prime matter explicitly, and b) by promoting the three-dimensional to the status of οὐσία of body as such.

In a final section on this topic, I shall attempt to confirm the present interpretation by looking at the fragmentary evidence of the *contra Aristotelem*.

7.2.4 The three-dimensional in the *contra Aristotelem*

Simplicius did not read Philoponus' treatise against Proclus,[105] and in consequence misconceived the philosophical weight behind Philoponus' assertions on matter in the *contra Aristotelem*. Nevertheless, he makes two short but interesting remarks in his discussion of the fourth and the fifth book respectively. At *In de caelo* 134,9–12 (see. fr. IV/71) he says:

> "It seems that this man regards that body as matter which the Peripatetics called second substrate, for he spends many arguments seriously showing that the heavens possess a body – and therefore also matter."

From the evidence in the *contra Aristotelem*, Simplicius received the impression that Philoponus' 'matter' resembles the Peripatetic δεύτερον ὑποκείμενον. Given that Simplicius uses the term in the same sense as Philoponus,[106] he is, at least to a certain extent, right. In the *Physics* commentary, for instance, Philoponus himself identified 'the three-dimensional' with 'second substrate'. Simplicius' account is inadequate, however, because what is called the 'second substrate' is a compound, whereas Philoponus' extended corporeality (according to the *contra Proclum*) is primitive; moreover, it is the οὐσία of body as such. Simplicius misses this second aspect completely. This can be shown from his remarks on an argument occurring in the fifth book of the *contra Aristotelem*, which evidently confuses him. The issue is whether or not a substance can be contrary to another substance. Part of Philoponus' strategy in frr. V/82–86 is to turn Aristotle against himself, for he argues in the *Categories* that nothing is contrary to substance but speaks in the *De caelo* of 'contrary bodies'.[107] Philoponus seems to agree with Aristotle that there is no contrary to substance, but he does not

[105] See *In de caelo* 135,30 f.

[106] Which he in fact does elsewhere too; see above note 86.

[107] On the problem see above 4.1.2 and cf. below 7.3.1.

agree that things like fire and earth are not contraries, for they do possess contrary essential qualities.[108] Simplicius does not understand this, for how can one distinguish between fire and earth being contraries in respect of their qualities, but not being contraries in respect of their substance?[109] According to him, every natural substance is already characterised by contrary qualities of some kind or other, and he asks what kind of οὐσία there is then, besides the one already characterised by contrary qualities, of which it is true to say that it possesses no contrary, *In de caelo* 165,26–166,11 (fr. V/86):

> "Then, if ⟨the Grammarian⟩ does not suppose these and similar bodies (i.e. fire and earth, etc.) to be contraries in respect of substance,[110] – since every composite substance, which above all he considers not to possess a contrary, is a compound of matter and the essential qualities (οὐσιώδεις ποιότηται) – what other natural, composite substance remains of which he thinks it is true to say that there is no contrary to substance? ... What kind of natural body is composed of matter and form but is not characterised by opposite qualities? For even if one assumed it to be the three-dimensional – this, according to the Grammarian, is identical to matter – it still comes to be a natural body and composite substance once it is characterised by opposite qualities, and the ⟨matter⟩ characterised by opposite qualities is not anything besides this. ... What kind of substance composed of matter and form is there, then, besides the one which is characterised by opposite qualities of hot and cold and light and heavy, of which he thinks the proposition that nothing is contrary to substance is true?"

The answer to Simplicius' question is simply: the three-dimensional. Philoponus seems to have used the second aspect of his concept of the three-dimensional, viz., it being the οὐσία of body, arguing that indeed nothing at all is contrary to extended corporeality. Simplicius evidently does not understand the ontological framework behind Philoponus'

[108] See fr. V/86: *In de caelo* 165,18–21: "These are the consequences if they call things moving with contrary movements bodies contrary in substance. But suppose they are not contrary in substance – because absolutely nothing is contrary to substance – but that things moving in contrary directions partake at all events of contrary qualities, as is the case with fire and earth. For the one element is in fact hot, the other cold, and the former is light, but the latter is heavy."

[109] See fr. V/86: *ibid.* 165,21–25: "You notice that ⟨the Grammarian⟩ has contrasted contraries in respect of quality with contraries in respect of substance, thinking that the former are clearly different from the latter – and that they are not opposites in terms of accidental qualities but in terms of essential qualities, as in the case of fire, he claims, and of earth."

[110] But nevertheless as contraries with respect to their qualities.

argument, but his remarks seem to indicate clearly that in the *contra Aristotelem* Philoponus presupposes and reiterates his idea that the three-dimensional is both ὑποκείμενον and οὐσία.

7.3 The Structure and Argument of Book V

We may now turn to the fifth and last book of the *contra Aristotelem* dealing with Aristotle's theory of aether. The issue under discussion is still Aristotle's problematic argument for the eternity and incorruptibility of the celestial region. As an introduction to the fragments of this book it may help to outline the structure of Aristotle's line of reasoning as perceived by Philoponus. Aristotle argued in *Cael.* I 3, 270 a 12–22 that the celestial body is entirely removed from the realm of generation and destruction.[111] His argument relied mainly on two premises:

(i) Everything generated is generated out of a contrary, 270 a 14–17;
(ii) Nothing is contrary to the celestial body, 270 a 18 f.

As has been shown, Philoponus rejected the first premise in the preceding book IV, frr. 64*–72. In the present book he sets out to repudiate the second premise.[112] Premise (ii) is in turn established by two further assumptions:[113]

(P_{ii}) If the bodies are contrary, then the local movements are contrary.[114]
(Q_{ii}) No movement is contrary to circular movement.[115]

In order to topple premise (ii) of Aristotle's argument, Philoponus attempts to demonstrate the falsehood of these two assumptions. Assumption P_{ii} is rejected in frr. V/82–86, and assumption Q_{ii}, which is supported by a number of arguments in *De caelo* I 4, in frr. V/87–107.

[111] On the argument see above 4.1.2.
[112] See fr. V/81: *In de caelo* 156,28–157,3.
[113] See fr. V/81: *ibid.* 157,22–25.
[114] "The local movements of contrary bodies are contrary as well," *Cael.* I 3, 270 a 17 f. For convenience the assumption is rephrased as a conditional. – On the problem of ἐναντία being understood as 'contrary bodies', see above 4.1.2.
[115] See *Cael.* I 3, 270 a 19 f.

7.3.1 Fragments V/82–86

As a first point, Philoponus confines himself to raising doubts concerning the intelligibility of assumption P_{ii}, fr. V/82: *In de caelo* 157,26–158,1. What does Aristotle mean by the word ἐναντία? If he speaks of contrary substances, he contradicts himself because he laid down in the *Categories* that there is no contrary to substance.[116] On the other hand, if he speaks of bodies or substances being contrary by virtue of contrary qualities and attributes they may possess, then he may be confronted with even greater difficulties, *In de caelo* 158,1–11. For why should it be the case that bodies possessing contrary movements in space be contrary bodies at all? Bodies possess all kinds of contrary qualities in virtue of which they undergo all kinds of alteration and change between the contraries. Thus, bodies undergoing contrary changes in respect of their qualities should much rather be regarded as contrary bodies, given that local motion is merely an accidental property. Philoponus supports this last claim by an interesting suggestion, which, unfortunately, he does not pursue any further. He says that air moves in fact in two directions, upwards and downwards, and suggests that perhaps this behaviour ought to be ascribed to the force of the vacuum.[117] He says fr. V/82: *In de caelo* 158,13–20:

> "For the air possesses not only a principle of upward but also a principle of downward motion. For if some part of the earth which underlies air, or some part of the water, is taken away from underneath, the air will immediately fill the space, just as it is carried upwards if some part of that which lies on top of it is taken away. But if one takes the force of the vacuum and not a natural principle to account for the movement downwards, what prevents us from saying that the air's local movement upwards has the same cause? For it is carried upwards if there happens to be empty space, but otherwise it is not."

Conversely, Philoponus argues, if one does not want to concede that bodies moving with contrary qualitative movements are contrary bodies, one should also deny that contrariety in local motion presupposes contrariety on the level of body and its attributes, fr. V/82: *In de caelo* 158,20–25.

[116] Cf. *Cat.* 5, 3 b 24–32.

[117] That is to say, no similar argument suggesting that natural movements are in fact movements due to the force of the vacuum is found in the *Meteorology* commentary and the *De opificio mundi*. – On the explanation of the natural movements of the elements by imparted forces see below chapter 8.

In fr. V/83*: *ibid.* 162,20–33 Philoponus is censured by Simplicius for taking a certain equivalence of propositions for granted. Aristotle argued in P_{ii} that 'if the bodies are contrary, then the local movements are contrary'. Philoponus' argument above, however, seems to attack the converse proposition that 'if the movements are contrary, then the bodies are contrary' (P_{ii}). Yet one may convert a proposition only if the terms (or, as in our case, the protasis and the apodosis) are equivalent. This equivalence has not been demonstrated by Philoponus beforehand, and his argument is therefore objectionable.

Simplicius' position is that the terms are indeed equivalent, but only in so far as local movements are concerned. Bodies moving locally by nature in contrary directions may justly be regarded as contrary bodies, and *vice versa*, but this is not true in the case of quantitative and qualitative motions, *In de caelo* 161,18–26. Simplicius bases this view on a distinction between active and passive motions. Whereas quantitative and qualitative motions may be either active or passive, *natural* local movements are active motions only, for physical bodies possess an active principle of motion in themselves, *In de caelo* 159,26–34. Philoponus' objection therefore is futile because he does not take into account that Aristotle's argument crucially depends on the fact that it deals with natural local motion, and not with any other kind of motion or change, fr. V/83: *In de caelo* 162,33–163,3.

In fr. V/84 (*ibid.* 163,11–30) Philoponus launches an attack on a different level. Aristotle's assumption P_{ii} is in fact false because it contradicts the phenomena. Curiously, Philoponus does not attack the literal version of P_{ii}, although he could have done so. E. g., if it is true that the elements earth and water are, in some sense, contrary bodies because they partake of a set of contrary qualities, then they ought to move with contrary movements in space, which is not the case.[118] Instead, Philoponus argues differently, fr. V/84: *In de caelo* 163,14–30. In fact, there seem to be two arguments. Again, his point of departure is the converse of Aristotle's assumption P_{ii}, i. e.,

[118] A critique of this kind is perhaps unjustified because in his theory of aether Aristotle carefully chooses 'fire' and 'earth' as examples of contrary bodies, whereas 'water' and 'air' are viewed as their 'congeners' (τὰ συγγενῆ τούτοις), *Cael.* I 2, 268 b 29. On the problem see above 3.1.4.

(P_{ii}*) If the local movements are contrary, then the bodies are contrary.[119]

Philoponus then argues that if P_{ii}* is true, its contrapositive must be true as well. Hence, from P_{ii}* follows:

(R) If the bodies are not contrary, then the local movements are not contrary either.[120]

But, Philoponus continues, it is not valid to infer

(S) If the local movements are not contrary, then the bodies are not contrary either,[121]

for this means committing the fallacy of denying the antecedent. Simplicius, of course, would deny that this is a fallacy because the protasis and apodosis are equivalent. Why does Philoponus adduce this argument? If proposition S is false, then it does not follow, as Aristotle supposed it did, that the celestial body possesses no contrary simply because circular motion has no contrary. I. e., even if it is granted that no movement is contrary to circular motion, the whole Aristotelian argument remains false because proposition S, which is in fact assumption P_{ii} transposed, is false.

In a second move Philoponus tries to establish the falsehood of proposition S in another way. Suppose both propositions R and S are logically equivalent to P_{ii} because the lerms 'local movements being contrary' and 'bodies being contrary' are equivalent (ἐξισάζειν), fr. V/84: *In de caelo* 163,22–30. Although inference from P_{ii} to R to S may be regarded as valid, proposition S is nevertheless refuted by the facts (τὰ πράγματα): the totalities of the elements which clearly possess contrary qualities, e. g., air and fire, move in a circle, but their movement does not possess, according to Aristotle himself, a contrary movement.[122]

7.3.2 Fragments V/87–91

Philoponus now proceeds to refute assumption Q_{ii} that no movement is contrary to circular movement, fr. V/87: *In de caelo* 170,14–22:

[119] See *In de caelo* 163,14–16. Simplicius agrees that in this case conversion is valid.
[120] See fr. V/84: *In de caelo* 163,17–20.
[121] See fr. V/84: *In de caelo* 163,20–22.

> "Even if we agree that it is true that body is contrary to body, and furthermore that the local movements of contrary bodies are contrary as well, and, in inverse consequence, that if there is no movement contrary to the movement of a body, then there is no body contrary to it, it must of course be shown that no movement is contrary to circular motion. Now if we cite each argument by which Aristotle attempted to prove this and refute it, then it is evident that if it has not been shown that no movement is contrary to circular movement, it will not have been shown that there is no body contrary to a body that moves with a circular motion."

In the following discussion, Philoponus divides Aristotle's chapter *De caelo* I 4, in which it is argued that circular motion possesses no contrary, into six different arguments.

First argument: In *Cael.* I 4, 270 b 33–271 a 5 Aristotle decided that circular motion is not opposed to rectilinear motions because the two natural rectilinear movements, upwards and downwards, are already opposed to one another.[123]

Philoponus replies fr. V/88 (*In de caelo* 171,17–32) against both Aristotle and the interpretation of Alexander[124] that a movement in a straight line may indeed be regarded as contrary to both the other movement in a straight line and the movement along a circle. These movements would not be contrary to each other in the same respect, but "each in virtue of something else" (κατ' ἄλλο δὲ καὶ ἄλλο), just as 'excess' is contrary to both 'deficiency' and 'proportion', or just as fire is contrary to both air and earth, only in virtue of a different quality. He continues, fr. V/88: *In de caelo* 171,24–32:

> "In the same way, upward movement conflicts (μάχεται) with downward movement in virtue of the contrariety of places, but circular movement conflicts with each of the rectilinear movements – not in virtue of the contrariety of places but in virtue of the form of the movement itself. For in the one case the movement takes place from one point to the other and is unbent in every part, but in the other case the movement takes place from the same point to the same point, no part whatever remaining unbent. Further, the former cannot occur twice along the same line without having

[122] Cf. also fr. V/85: *In de caelo* 164,21–27. Fr. V/86: *ibid.* 165,10–25 recapitulates the former argument on the impossibility of contrariety of substances. The second half of that fragment has already been discussed above, see 7.2.4.
[123] On Aristotle's argument see above 4.3.1 and cf. fr. V/87: *In de caelo* 170,29–34.
[124] See fr. V/87: *In de caelo* 170,22 ff.

come to a halt whereas circular movement revolves infinite[125] times in the same manner without pause. In consequence, if they are characterised by contraries, they clearly ought to be contrary movements."

Next, Philoponus picks up Aristotle's unexplained suggestion that concave and convex are believed to oppose one another, *Cael.* I 4, 271 a 35. Philoponus elaborates on this point fr. V/90 (*In de caelo* 173,25–174,13), arguing that concave and convex actually oppose one another as *contraries*, and not as relative terms, nor as state and privation, nor as affirmation and negation. This leads him to conclude, fr. V/90: *ibid.* 174,1–4:

"It remains, therefore, that 'concave' and 'convex' are opposed as contraries. If they are some kind of qualities or properties of the celestial body, then the celestial body is recipient of contraries, and consequently of destruction and generation as well."

A further point is to be noted. Aristotle's discussion of contrariety in circular motion gave rise to the impression that he treated the problem almost as a geometrical one.[126] 'Concave' and 'convex' are taken to refer to the shape of lines along which movements occur. Philoponus refuses to accept this methodology: a line cannot exist without body,[127] fr. V/90: *In de caelo* 174,5–11:

"While Aristotle assumed 'concave' and 'convex' in the case of a line along which circular movement takes place (for every movement takes place along a line), ⟨the Grammarian⟩ understood 'concave' and 'convex' as belonging to a solid, saying that a line cannot exist by itself without body; rather, all natural lines have existence in body. In fact, the 'concave' and 'convex' exist in different boundaries of the spherical body."

But if the lines Aristotle is talking about are indeed natural lines which exist in body, then that body partakes of a contrary shape, provided 'convex' and 'concave' are indeed contraries. Concluding the argument Philoponus attempts to turn the Peripatetics against themselves, fr. V/91: *In de caelo* 175,13–22:

"If they hold that participating in whatever kind of contraries, either in both or in one of them, is universally a proof of the fact that the thing

[125] For the sake of the argument Philoponus accepts the Aristotelian position that circular motion is eternal.

[126] Cf. above 4.3.1. ff.

[127] This point ties in well with Philoponus' general refusal to apply mathematics to the solution of problems of a physical inquiry, cf., e. g., fr. V/93: *In de caelo* 178,13–16. Philoponus may have been under the influence of Xenarchus, see *apud* Simplicium *In de caelo* 25,11–13; 42,6–8; cf. Moraux (1973), 198 ff.; *id.* (1967), 1423–1426.

which partakes of these contraries is generated and destructible, then, seeing that the celestial body is a recipient of contrariety in terms of 'concave' and 'convex', and that the 'concave' of the lunary sphere is one of the contrary places, they ought to say that the heavens are generated and destructible as well. But if not every kind of contrariety is the cause of generation and destruction of bodies, just as moving in space in contrary directions upwards and downwards is in fact neither generation nor destruction, then the things that are deprived of contrary movements in space are not deprived of generation and destruction simply because of this."

7.3.3 Fragments V/92–93

Second argument: In *Cael.* I 4, 271 a 5–10 Aristotle argued that the movement along the circumference from point A to point B is not contrary to the movement from B to A because an infinite number of different circumferences may be drawn between the two points. According to Simplicius, the rationale behind this and some of the following arguments is the following:[128] Contrary movements are defined as movements between contrary places. Contrary places, on the other hand, are places which are furthest away from one another. The distance between two places is one and determinate – it is determined by the straight line between them. The distance between points A and B *qua* points on the circumference is indeterminate because a curve does not determine the distance between them. Therefore, their distance cannot be the greatest, for this is a determinate distance, nor are points A and B contrary places, nor the movements between them contrary movements.[129]

Themistius and Alexander interpreted the argument in slightly different ways. Philoponus, in order to refute Aristotle, pursues the interpretations of these two important commentators. Themistius said that the movements are not contrary because each movement from A to B would then be contrary to an infinite number of movements from B to A, and *vice versa*, because the number of circumferences through A and B is infinite.[130] Themistius thought that this was absurd, but Philoponus replies that it is not: along each of the infinite number of

[128] Cf. also above 4.3.2.

[129] See Simplicius *In de caelo* 176,15–26 (fr. V/92).

[130] See fr. V/92: *In de caelo* 177,1–4 and cf. Themistius *In de caelo* 19,6–23.

circumferences there are two movements contrary to one another.[131] His most cunning reply, however, is the following, fr. V/92: *In de caelo* 177,12–16:

> "I wonder how ⟨Themistius or Aristotle⟩ did not realise that the same follows in the case of rectilinear movements. For while the centre of the universe towards which all heavy bodies move is one, the light bodies moving away from the centre towards the periphery do not terminate at *one* point, but at an infinite number of points."

Again, an infinite number of things is opposed to one. Alexander's interpretation is comparable to Simplicius'. He argued that the movements in question cannot be contrary because the distance between A and B *qua* points on the circumference is indeterminate, for an infinite number of circumferences may be drawn between them.[132] To this Philoponus replies fr. V/93: *In de caelo* 178,11–21:

> "⟨The Grammarian⟩, again, finds fault with the attempt to demonstrate things of nature from geometrical principles. For the possibility, he says, of drawing circumferences *ad infinitum* through the same points until no larger circumference can be assumed is spoken of correctly in the case of mathematical entities arrived at by abstraction, but in the case of natural entities which are assumed to have quality and matter, this is impossible. It is therefore possible, he says, to take the largest natural circumference of the universe. Certainly then, the things moving along the largest circumference of the universe in opposite directions away from the limits of the diameter of the universe are moving with contrary movements because the points from which they have been moving are furthest away from each other on the circumference. For the existence of a circumference larger than the one of the extremity of the universe is impossible."

This argument does not deny outright that mathematics may be applied to the realm of physics. Philoponus only claims that the physical world imposes certain limits in virtue of which it is not possible to treat physical problems entirely on the basis of mathematical principles. This, of course, is *a fortiori* true in cases where the notion of the infinite is involved. As a consequence, in this particular case the number of circumferences to be drawn through physical 'points' is always finite, and it is necessary to assume one largest circumference, i. e. the circumference of the universe. Movements along the circumference of the

[131] Fr. V/92: *In de caelo* 177,4–6.
[132] *Apud* Simplicium *In de caelo* 178,7–11.

universe must be regarded, even according to Aristotelian principles, as contrary movements, and the bodies in motion as contrary bodies accordingly.[133]

7.3.4 Fragments V/94–100

Third argument: Aristotle assumes in *Cael.* I 4, 271 a 10–13 that the movement takes place along one definite circumference of a circle, a semicircle with distance C D as its diameter and base. Movements from C to D are not contrary to the movements from D to C because the distance between C and D *along the circumference* is indeterminate. For all distances are determined and measured by the straight line.[134]

The discussion of this argument in Philoponus and Simplicius is very long and often tedious. It may suffice to summarise the most important points.

Philoponus rejects Aristotle's assumption that all distances are measured and determined by the straight line, fr. V/94. For, he argues, the circumference itself, or any curve, is not measured by the straight line, nor can they be measured in this way. In the case of a circle, the knowledge of the length of the diameter provides the knowledge of the length of the circumference too, but this is true the other way round as well. Hence, in some cases it is possible to 'measure' or calculate the length of a straight line by means of a circle, or its arc.

But even if it were true that all distances are measured by the straight line, it does not follow that points C and D are not contrary places.[135] Take the circumference of the universe. The zodiac signs Aries and Libra[136] are furthest away from each other because whichever way one goes round, they are six zodiac signs (i. e. 180°) away from one another.

There follows a discussion of Alexander's interpretation of Aristotle's arguments, fr. V/96–100, which gives the reader an impression of the extent to which such an important issue as Aristotle's theory of aether could become entrenched in entirely fruitless scholasticism.

[133] See fr. V/93: *In de caelo* 178,21–26.
[134] See above 4.3.2.
[135] Fr. V/95: *In de caelo* 181,20–33.
[136] In accordance with the usage in ancient and mediaeval astronomy, Philoponus does not refer to the constellations of these names but to the respective sections of 30° on the ecliptic.

7.3.5 Fragments V/101–107

Fourth argument: in fr. V/101 (*In de caelo* 187,28–188,25) Philoponus expresses his agreement with Aristotle's argument of *Cael.* I 4, 271 a 13–19 that the movement along two semicircles which are joined together such that they form a full circle are not contrary movements, for they constitute one uniform movement in a circle. Philoponus, although he censures Themistius for misrepresenting the argument,[137] thought this to be the only case of which it is true to say that the movements in a circle are not contrary movements.[138]

Fifth argument: The crucial argument of *Cael.* I 4, 271 a 19–35 tries to establish that, in modern terms, 'clockwise' and 'counterclockwise' motions along the same circle are not contrary movements. Aristotle gives two reasons. The first reason Philoponus takes to be the fifth argument and rejects it in frr. V/102–104. Aristotle relies on his definition of contrary movements as movements between contrary places, and he argues that this kind of circular motion occurs between the same places; therefore, the movements are not contrary to one another.[139] Philoponus replies that it is not universally true that contrary movements are movements between contrary places, fr. V/102: *In de caelo* 189,28–190,15. Specifically different motions involve different types of contrariety. Hence, contrariety in circular motion differs from contrariety in rectilinear motions.

In an aside Philoponus seems to have conceded for the sake of the argument that contrariety in circular motion does involve contrary places as well, for he argues that the points on the diameter of a circle are, in fact, contrary places.[140]

In the first part of fr. V/104 Simplicius tries to show that Philoponus' arguments are self-contradictory because he assumes on the one hand that circular motion is in some way contrary to the rectilinear movements, but says on the other hand that the contrarieties in both types of motions are specifically different.[141] Philoponus exemplifies contrariety in celestial motion with the movement of the planets as

[137] See fr. V/101: *In de caelo* 188,6–12.
[138] See fr. V/101: *In de caelo* 188,23–25.
[139] Cf. fr. V/102: *In de caelo* 189,22–28.
[140] See fr. V/102: *In de caelo* 190,16–24.
[141] Fr. V/104: *In de caelo* 192,19–193,7.

opposed to the movement of the outer, fixed sphere,[142] which leads him to his criticism of Aristotle's sixth argument.

Sixth argument: Aristotle provides a second reason why the movements in different directions along one circle are not contrary movements, *Cael.* I 4, 271 a 22 f. + 31–34. One of the movements, Aristotle says, would be useless because it would be cancelled by the prevailing movement in the other direction. But God and nature produce nothing useless.[143] Philoponus, who takes this as a sixth argument, replies that Aristotle should have considered the case in which two movements occur along two different circles in opposite directions.[144] Aristotle's theoretical supposition of movements along the same circle has no counterpart in the physical world. The celestial bodies move along different spheres, and the present inquiry is, after all, an inquiry into the nature of the celestial movements and bodies. Simplicius replies that if the absence of contrariety can be shown in the case of movements along one single circle, the conclusion is even more true if one assumes two different circles, fr. V/106: *In de caelo* 195,9–14.

Admittedly, Philoponus' methodological objection remains unconvincing; a rather better point is raised in fr. V/107: *In de caelo* 197,7–15, where again Aristotle is effectively turned against himself:

> "But since Aristotle says 'if one circular movement were contrary to another circular movement, the second one would be purposeless' because bodies coming from contrary places and being in conflicting dispositions have the effect that the prevailing body cancels the movement of the subordinate one, ⟨the Grammarian⟩ objects to this passage, asking why does the same absurdity not follow in the case of bodies moving in opposite directions along the straight line as well, i. e. that the one movement is purposeless because the other one prevails? Or if they are equal in force they would halt each other and both would be purposeless, given that we take 'purposeless' (μάτην) to mean 'not actualising its own active force'. But this is absurd because neither God nor nature act without purpose."

7.4 Conclusion

In the two final books on Aristotle's theory of aether Philoponus criticises the arguments for the eternity of the celestial body. He focuses

[142] Fr. V/104: *In de caelo* 193,8–19.
[143] On the problem of this argument see above 4.3.2.
[144] See fr. V/105: *In de caelo* 194,21–23; fr. V/106: *In de caelo* 195,14–17.

his critique on Aristotle's central proof at *Cael.* I 3, 270 a 12–22 that the heavens are not subject to generation and destruction because they are physically removed from the realm of contrariety. However, Philoponus does not express disagreement with Aristotle over the denial of qualitative and quantitative change in the celestial region. Philoponus apparently concedes that the spheres are unaffected by these mutations, for their immutability is prerequisite for the preservation of the universal order itself. Nevertheless, Philoponus strongly rejects Aristotle's claim that the heavens are incorruptible *per se*.

Philoponus' refutation of Aristotle's argument possesses the form of a dilemma. Characteristically, Philoponus attempts to turn Aristotle against himself:

(i) when Aristotle supposes that all things, including physical bodies, are generated out of a contrary, he not only contradicts himself – for he stated in the *Categories* that substances do not possess a contrary – but also makes a false assumption. For many things, Philoponus argues, do not come to be out of a contrary.

(ii) On the other hand, if in view of these arguments one is inclined to accept the position that all processes of generation involve matter, form, and privation – as laid down in Aristotle's *Physics* – the heavens too may surely be regarded as being subject to generation and destruction, for these terms no doubt apply to them as well.

In the context of his refutation Philoponus introduces a novel conception of matter. He claims that the sole material substrate of the entire universe, including the celestial region, is indeterminately extended corporeality, the 'three-dimensional'. Apparently, first steps towards this idea were first expounded in an early treatise entitled Σύμμικτα Θεωρήματα; it is expressed in its most mature form in the treatise against Proclus. There Philoponus rejects the Neoplatonic conception of prime matter as incorporeal and formless and establishes the tenet that corporal exteusion is at the same time the primitive substrate of all physical change (including quantitative changes) and the οὐσία of body as such.[145]

[145] If the interpretation offered in this chapter is correct, it would be worth-while to explore the extent to which Philoponus' ideas on matter may have anticipated the mediaeval conceptions of *quantitas materiae*. Cf. section 7.2. with, e. g., Jammer (1961), 37–48; see also Sorabji (1987 b), 21 f.

Philoponus not only argues that the heavens are subject to generation and destruction, but also claims, in accordance with Christian dogma, that the whole world has been created out of nothing. He relies, again, on arguments adduced in the *contra Proclum* where he attempted to put the belief in generation out of nothing on a secure philosophical footing. The most salient point in his defence of the dogma is the extreme claim that once properly analysed, everything, even the things generated by nature and art, will be seen to assume generation out of nothing.

The fourth book terminates with a rejection of Aristotle's dialectical arguments for the eternity of the world in *De caelo* I 3. The fifth book contains a meticulous and often tedious analysis of Aristotle's argument in *De caelo* I 4 that no movement is contrary to circular motion. Philoponus challenges not only every single point adduced by Aristotle, but also the reinforcing comments made by Alexander and Themistius. Philoponus' general strategy is to reveal the implausibility of these arguments by placing them into a physical context. He refuses to allow speculation on the nature of the heavens to proceed on a purely theoretical level of quasi-geometry.

8. Conclusion

The preceding chapters have attempted to elucidate two relatively neglected episodes in the history of ancient cosmological theory, Aristotle's highly influential theory of aether, and John Philoponus' criticism of it during the final efflorescence of Greek philosophy in late antiquity. In addition to the provision of continuous commentary on the relevant texts and fragments, the discussion touched upon such diverse issues as the relation of mathematics to physics in Aristotle, the principles of Aristotle's philosophy of nature, Philoponus' views on the substance and qualities of the celestial bodies and his conception of matter. The present and final chapter serves three purposes. First, it will draw together the conclusions emerging from the commentary, so as to allow, secondly, a summary comparison of Aristotle's and Philoponus' cosmologies. Lastly, since this study has attempted to trace Philoponus' development of particular cosmological tenets from the *Physics* commentary to the *contra Aristotelem* and the *Meteorology* commentary, it seems appropriate to consider relevant passages from his last major work, the *De opificio mundi*. As will be seen, Philoponus' beliefs have once more undergone substantial changes.

8.1 Retrospect

The cosmological controversy initiated by John Philoponus in late antiquity can hardly be understood adequately without prior consideration of the origin of the debated ideas. The study commenced with an analysis of Aristotle's theory of aether as developed in the first chapters of his treatise *On the Heavens*. From the interpretation of the introductory chapter *De caelo* I 1 the conclusion was drawn that Aristotle is indirectly justifying the methodological procedure he subsequently follows. The method employed may be described as the application of geometrical concepts in a broad sense to the realm of physics.[1] A reader favourably disposed to Aristotle would perhaps conclude that

[1] See sections 2.2–2.3.

his postulation of a primary celestial element emerges plausibly from his conception of natural elemental motion in the sublunary world. However, even on the assumption of the principles of Aristotelian physics, the central arguments in *De caelo* I 2 fail to provide conclusive proof of his thesis. The two main inferences rely on dubitable assumptions and involve a premise which has been arrived at by invalid induction.[2]

Aristotle's theory of aether is designed to underpin his conception of the world as a self-identical, spatially finite, and temporally eternal universe. Yet his philosophical and dialectical evidence for the eternity of the celestial element is ambiguity-ridden, elliptical, and misguided. The denial of any physical attribute to aether save local motion results in the postulation of an elementary body whose domain is entirely removed from the ordinary natural world.[3] Aristotle has erected an unnatural and apparently insurmountable ontological barrier between the sublunary and the superlunary regions.

For obvious reasons, Aristotle's theory of aether did not remain unchallenged in antiquity, the most formidable critics being Xenarchus, Plotinus, and Philoponus. The second and major part of this study attempted to reconstruct Philoponus' criticism of Aristotle's theory of aether from the fragments of the lost treatise *De aeternitate mundi contra Aristotelem*. This polemical work was probably written between 530 and 534, not long after the treatise against the Neoplatonist Proclus had been completed and probably shortly before the composition of Philoponus' final commentary on Aristotle, the *Meteorology* commentary.[4] In the polemic Philoponus attacks Aristotle on the issue of the eternity of the world. In its original form, the work consisted of at least eight books, but not all of these dealt with problems of Aristotle's philosophy of nature.[5] The present study provided commentary on the fragments of the first five books. Here, Philoponus not only examines fastidiously Aristotle's cosmological theory, conceived almost 900 years earlier, as well as the apologetic comments of Alexander and Themistius, but also attempts to modify and improve cosmological ideas current in late antiquity. Among these are, most prominently, the theory of the

[2] See section 3.2.
[3] See chapter 4.
[4] See Wildberg (1987 a), 200–207.
[5] See Wildberg (1987 b), 24–28 and section 5.1.

movement of the firesphere,[6] the theory of the substance and qualities of the celestial body[7] including the explanation of the generation of heat by the sun,[8] and the theory that celestial motion is generated by the dual principle of nature and soul.[9] In addition, Philoponus reiterates ideas originally devised in earlier treatises, in particular the *contra Proclum*: for instance, his attempted philosophical justification of the Christian doctrine of *creatio ex nihilo*[10] and, more importantly, the theory of indeterminate, corporeal extension, the 'three-dimensional'.[11]

In order to give a concluding impression of Philoponus' theory at the time of the *contra Aristotelem*, a comparative summary of the opponents' cosmological tenets may now be presented.

8.2 Aristotle and Philoponus: A Summary Comparison

In what respects does Philoponus' cosmological framework differ from Aristotle's? We may begin with the most obvious metaphysical tenets. Aristotle's universe is temporally eternal; for the Christian Philoponus the world is temporally finite. Whereas Aristotle's analysis of the cosmos culminates in the postulation of a prime, unmoved mover, Philoponus believes that the world has been created at some time out of nothing by a Creator-God. Symmetrically, his world, whose existence depends ultimately on the will of God, necessarily has to come to an end at some time in the future.

In Aristotle's cosmos there exists a strict dichotomy between the celestial and the sublunary regions. To emphasise the division, Aristotle goes so far as to postulate different elements, even different kinds of matter for each region.[12] Philoponus, on the other hand, insists that the world is materially uniform. The ultimate substrate of both the celestial and the sublunary bodies is a basic corporeal entity, 'the three-dimensional'.

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[6] See section 5.4.
[7] See sections 6.1–6.2.
[8] See section 6.2.2.
[9] See section 6.1.4.
[10] See section 7.1.3.
[11] See section 7.2.
[12] For the latter claim see, e.g., *Metaph.* VIII 1, 1042 b 5 f.; 4, 1044 b 4–6; XII 2, 1069 b 24–26. On the problem of Aristotle's distinction between ὕλη γενητή and ὕλη τοπικὴ κινητή see Happ (1971), 473–503.

Neverthelss, such fundamental disagreements do not preclude certain theoretical continuities. Both thinkers conceive of the world as spatially finite, limited by the outer sphere of the fixed stars. In common is the belief that outside the universe there is absolutely nothing at all; at its centre the earth rests in a state of equilibrium, surrounded by consecutive layers of the totalities of water, air, and fire. These elementary bodies are in motion by nature, and Philoponus retains Aristotle's doctrine of sublunary elemental motion. Earth and water possess the natural tendency to travel downwards to the centre of the universe, while fire and air tend upwards to the periphery of the sublunary region bounded by the sphere of the moon.

Yet, as regards the sublunary elements, Philoponus disagrees with Aristotle on two important issues. First, the question of weight and lightness. He claims with the Platonists that these properties accrue to the elementary bodies only when they are removed to a counternatural place. The elemental totalities, located as they are naturally, lack heaviness and lightness. Daringly, Philoponus denies weight even to the whole mass of earth. Secondly, by the assumption of this theory Philoponus diverges yet further from Aristotle. Since on his view the elements within their proper places are neither heavy nor light, Philoponus sees no reason to confine their natural movements to the rectilinear when so placed. The nature of a body no longer determines a unique natural kinetic state; the movements both *towards* and *in* the proper places belong to the elemental bodies naturally. Philoponus claims – again in agreement with Platonism – that while earth and water in their proper places enjoy rest, fire and the upper air move in a circle *by nature*. Philoponus holds that the ultimate sphere of the sublunary region, the 'firesphere', revolves about the centre of the universe. Accordingly, in the same way as Aristotle, Philoponus inclines to interpret the meteorological appearances in the sky as sublunary phenomena.[13] But importantly, in decisive opposition to both Aristotle – who is not clear on this subject – and the school-philosophy of his time, Philoponus argues in the *contra Aristotelem* that the movement of the firesphere is an entirely natural motion.[14] Hence, fire and air possess *two* natural movements, rectilinear and circular.

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[13] With the exception of the Milky Way; see Philoponus' commentary on *Meteorology* I 8.
[14] See 5.4.3. In earlier treatises, however, Philoponus adhered to the doctrine perhaps devised by Damascius that the movement of the firesphere is a supernatural motion, 5.4.2.

In proposing this theory Philoponus defies the fundamental idea behind Aristotle's theory of aether, the axiological priority of the circle over the straight line. According to Philoponus, who opposes the application of mathematical concepts to the realm of physics, nothing distinguishes circular and rectilinear motions in terms of merit. Natural and simple circular locomotion belongs to the sublunary world as much as it does to the celestial spheres. With this thesis Philoponus largely erodes the ontological barrier between heaven and earth erected by Aristotle. In Aristotle's theory, the circularity of the celestial motion is taken to warrant the conclusion that the celestial body possesses a nature entirely different in kind from the sublunary elements. In consequence, Aristotle postulates the existence of a primary elementary body which is, above all, incorruptible and divine. Having disowned the assumed distinction between circular and rectilinear motion, Philoponus of course also rejects the postulation of aether. The celestial spheres consist of material which is not unique to that region. Again drawing on Platonic tradition, Philoponus asserts that fire is the predominant but not exclusive element of the things in heaven. Although the four elements as they occur in the heavens are of a purer kind, they are essentially of the same nature as their sublunary congeners. Only in this way is Philoponus able to claim plausibility for his ultimate thesis that the celestial body is corruptible. Diverging from Platonism as well, Philoponus argues that the things in heaven possess precisely the same properties as the things in this world. The sun itself, for instance, is nothing but a huge fireball transmitting both light and heat to the sublunary region.[15] The ontological assimilation of the two regions make the entire cosmos open to destruction. Only by virtue of their spherical arrangement do the celestial spheres enjoy superior stability, and their present state will remain unaltered so long as the will of God preserves the global existence of the universe.

In the *contra Aristotelem* Philoponus arrives at the important anti-Aristotelian theses that the cosmos is materially uniform and that fire moves in a circle by nature. Since the celestial body consists for the most part of fire, it follows that its motion occurs naturally. Some arguments suggest that Philoponus pursues the project of deriving all cosmological movements from a single principle, nature. But Philoponus falls short of such a project of both a material *and* dynamical

[15] See 6.2.2.

unification in so far as he retains the assumption of a world-soul. In the *contra Aristotelem*, nature and soul in conjunction are taken to be the cause of the celestial revolutions. While the fire in the sublunary region may naturally possess and actualise two different movements, the uniform movement of the celestial fire is actualised by two complementary principles, nature and soul. In proposing this theory – which may be called his theory of double causation – Philoponus revises his earlier views and jettisons the doctrine accepted by contemporary Neoplatonists. They hold, just as Philoponus in the *Physics* commentary and the *contra Proclum*, that circular motion is in fact a supernatural motion; in the case of the heavens it is brought about by the effortless agency of the world-soul, in the case of the firesphere by the agency of the heavenly spheres.

Philoponus' theory of double causation may well be regarded as an unsatisfactory compromise. It has the appearance of an *ad hoc* solution to the problem of circular motion on the assumption of a unified cosmos. Why does Philoponus even provisionally endorse so awkward a thesis? Perhaps he was swayed by the idea's double advantage, since it at once attacks Aristotelian cosmology and makes a conciliatory gesture to Platonism. More importantly, one of the theory's tenets asserts the naturalness of circular motion, and this idea proved to be fruitful, if not decisive for Philoponus' later thoughts on cosmological theory, a topic I shall pursue tentatively in the final section.

8.3 The Application of Impetus Theory to the Celestial Spheres

One can show that in the *Meteorology* commentary, which is probably later than the treatise against Aristotle,[16] Philoponus explicitly rejects the view that circular motion belongs to fire supernaturally or is caused by any kind of external force.[17] Circular motion is, as in the *contra Aristotelem*, one of the two natural movements of fire. But what about the second arm of the thesis of double causation? Do the heavens move by the agency of both soul and nature? It appears to be a remarkable coincidence that in that commentary the doctrine of the world-soul is never explicitly endorsed. More than that, one passage

[16] As argued in Wildberg (1987 a); but cf. Evrard (1953).
[17] See *ibid.*, 206 f. with reference to *In meteor.* 37,18–23; 91,18–20; 97,12–16.

even suggests that Philoponus is eager to avoid the issue. Commenting on Aristotle's statement in *Meteor.* I 2, 339 a 24–27 that the celestial body revolves in a circle eternally, Philoponus says *In meteor.* 12,24–27:

> "But why does it move in a circle? Plotinus answers: Because it imitates the νοῦς. For just as the divine and demiurgical νοῦς in returning upon itself thinks all things and himself in them, in the same way, I say, the things in the celestial region generate (ποιεῖται) circular motion, imitating the νοῦς to the best of their ability."

Philoponus' answer to the question raised remains obscure. How do the things in heaven 'generate' circular motion, and in which sense are they said to be imitating νοῦς? Surely, at this point the reader may reasonably expect to find some statement on the doctrine of the world-soul. The avoidance of the issue becomes conspicuous if the passage just cited is compared to an argument in the earlier *contra Proclum*, a treatise in which Philoponus still adheres to the doctrines of supernatural motion and the existence of the world-soul, *contra Proclum* XIII 2, 486,16–23:

> "For if ⟨Plato⟩ says that circular motion belongs, above all, to the νοῦς, and, as Plotinus says, ⟨the celestial body⟩ moves in a circle because it imitates the νοῦς, then it is clear that he wants circular motion to originate for it from the soul moving its own body to imitate the noetic activity. For one would not reasonably suppose that the body-without-soul imitates the νοῦς without the soul, merely on account of its irrational and natural tendency."

The contrast with the evasive passage in the *Meteorology* commentary is manifest. In the *contra Proclum* Philoponus has no doubts about the traditional association of circular motion with the activity of the νοῦς. In the later commentary the situation appears to be a different one, and the impression that Philoponus gradually departs from the doctrine of the world-soul is confirmed by the fact that the idea is repudiated in his last major treatise, the *De opificio mundi*, written 20–30 years after the *contra Aristotelem* and the *Meteorology* commentary.[18] What are the reasons Philoponus puts forward in order to justify his step of abandoning a doctrine he had subscribed to for the better part

[18] The problem is discussed in section 2 of book VI of the *De opificio mundi* VI 2, 231,2–234,6. Already the summary statement of the argument's thesis makes Philoponus' new position plain, 231,3–6: "2. That there is no argument which can show that the things in heaven possess a soul, nor is there evidence ⟨for this⟩ in the Holy Scripture; from this it is concluded that the angels did not come into existence together with the heavens."

of his life? The passage suggests that his reasons are twofold. First, there is no argument which can show that one ought to accept the postulate of a world-soul. Bodies with and without soul are distinguishable by virtue of their activity (ἐνέργεια), but the celestial bodies, revolving in a circle, show no sign of any psychical activity like προαίρεσις, 231,24–232,10. At VI 2, 232, 8–12 he says:

> "In the case of the things in heaven there is no indication whatsoever that their circular motion takes place by virtue of some psychical choice (κατὰ προαίρεσιν ψυχικήν).[19] For the firesphere and the adjacent air too move in a circle, and they move not by virtue of some force, as we have shown elsewhere."

The last subclause may be taken as a clear reference to the treatise against Aristotle, book I. Since some sublunary elements, which clearly lack soul, are capable of natural, continuous circular motion, it would be wrong to explain celestial motion by reference to a world-soul. Nor does astrology provide an argument: the way the celestial bodies affect the sublunary world is purely qualitative-physical (κατὰ ποιότητα), not psychical (οὐ ψυχικός), 232,19 f. But there is a second reason, which does not appear to carry less weight than the first: the Mosaic *Genesis* does in fact not speak of the heavens being created as bodies-with-soul. Philoponus concludes at 233,10–17:

> "If therefore none of the arguments mentioned show that the things in heaven possess a soul, it is much less the case that they partake of a rational or intellectual soul; the hypothesis is entirely undemonstrated; however, the regular movement of the stars has been given to them by God (ἡ δὲ εὔτακτος αὐτῶν κίνησις θεόθεν αὐτοῖς), not by a soul; above all, the great Moses did not intimate anything of this kind about these things. So it is reckless to take something for granted which is neither made clear by argument nor borne out by the Holy Scripture."

Apart from the explicit rejection of a world-soul, a further important point may be noted. Philoponus hints briefly at how he himself seeks to explain the regular movements of the heavens. In another, famous passage he is slightly more explicit, though his remarks there too seem to be no more than a tentative hypothesis, *De opificio mundi* I 12, 28,20–29,9:

> "The advocates of the opinion of Theodorus ought to tell us from what sort of divinely inspired scripture they have learnt that angels move the moon and the sun and each of the stars, either pulling ⟨them⟩ in front

[19] I.e. the imitation of the νοῦς.

like asses, or pushing at the back like dockers rolling cargo, or both, or carrying them on their shoulders. Now, what would be more ridiculous than this? Though it is not impossible that God, who created all these things, imparted a motive force (κινητικὴν ἐνθεῖναι δύναμιν) to the moon, the sun, and the other stars – just as the inclination to heavy and light bodies, and the movements due to the internal soul to all living beings – in order that the angels do not move them by force. For that which is moved not naturally (μὴ φύσει) possesses a forced and counternatural movement, and a cause of destruction. So how could the angels suffice for pulling bodies of such a number and size for so long by force?"

The passage is important becauses it represents the earliest attempt to apply impetus theory to the celestial spheres and in doing so anticipates ideas of mediaeval impetus theorists.[20] Circular movement is no longer attributed to continual motive agents, call them world-soul or angels, but to internal forces impressed by God at the time of the creation. The sentences quoted are part of a polemic, presumably against Cosmas Indicopleustes, a figurehead of a faction of Nestorians in Alexandria.[21] Taking this into account, M. Wolff points out cautiously that the thesis of cosmological impetus may be nothing more than a

[20] Notably Jean Buridan and Nicole Oresme. On the problem see Wolff (1978), 27–30; 67–83; 212–246; and Sorabji (1987 b), 11 f.
– The most fundamental difference between impetus theory and the tenets of Aristotelian dynamics is the following. Aristotle supposes that everything moving is necessarily moved by something (*Phys.* VII 1, 241 b 34), and that mover and moved must be together (ἅμα), i. e. in contact (see, e. g., *Phys.* VII 2, 243 a 32–34). Whenever a body is moved there has to be a concomitant mover. This of course is true also of animals, i. e., of bodies whose movements are generated by soul. (Aristotle concedes that the exact analysis of mover and moved in these cases is a separate problem; see *Phys.* VIII 4, 254 b 24–33). In all cases, according to Aristotle, *motions* are imparted from the mover to the moved object, whereby mover and moved are somehow in contact. Thus, Simplicius, who adheres to this theory of imparted motions, speaks of the celestial motion as a vital motion imparted by a superior being: τοῦ κρείττονος ζωτικὴν ἐνδιδόντος τὴν κίνησιν, *In de caelo* 51,22–26.
According to impetus theory, on the other hand, a *force* is imparted to the moved object from without; in virtue of this *vis impressa* objects continue to move even when they are no longer in contact with the mover. Impetus theory thus greatly improved the understanding of the forced movements of projectiles, for instance, which were now thought to occur by virtue of these imparted forces rather than by virtue of the continual pressure of displaced portions of air (ἀντιπερίστασις). In addition, impetus theory supposes that the internal motive force exhausts itself as a result of its activity; see Wolff (1987), 84 ff.

[21] The details of this polemic do not concern us in the present context. See, e. g., Wolff (1978), 70–75 with further references, and Chadwick (1987), 51. Cosmas' work entitled Χριστιανικὴ Τοπογραφία has been edited by Winstedt (1909) and more recently by Wolska–Conus (1968/1970/1973), with a French translation. See also Wolska (1962).

hypothetical, provisional, even quite arbitrary reply to Cosmas, a tenet not necessarily accepted by Philoponus himself.[22] Looked at in isolation, Philoponus' application of impetus theory to the celestial spheres may indeed be regarded as a far-fetched and baseless idea. But it would be surprising, to say the least, if one accepted this conclusion without qualification in view of the evidence assembled in this study for Philoponus' lasting interest in problems of cosmology and physics, his readiness to repudiate doctrines he regards as untenable, and, above all, his ability to establish alternative theories and explanations. Of course it would be futile to attempt to show that in the course of his intellectual development Philoponus was inevitably led to the idea of applying impetus theory to the movements of the heavens; one may legitimately ask the question, however, whether the striking views expressed in the *De opificio mundi*, as tentative as they may seem to be, possess a sound foundation in the sense that they emerged plausibly from issues discussed and settled in earlier treatises.

If one compares Philoponus' theories of celestial motion in the *contra Aristotelem* and the *De opificio mundi*, his views have clearly shifted in two respects. In the *contra Aristotelem*, circular motion is regarded as both natural and psychical, whereas in the *De opificio mundi* it is described as being due to an imparted force, and as non-psychical. The obvious question to ask is whether the shift from 'psychical' to 'non-psychical' is closely connected with the shift from 'natural' to 'imparted'. This does not seem to be the case. In the passage just quoted Philoponus draws a curious analogy between the forces imparted to the sun and the moon, the inclinations of heavy and light sublunary bodies, and, more importantly, the psychical movements of animals: all these things are due to the creative power of the demiurge. World-soul and celestial impetus as such do not seem to be mutually exclusive explanations of the same phenomenon; God could have implanted both soul and motive force, and indeed, Philoponus nowhere argues that the ideas of a world-soul and Nestorian angels ought to be given up *because* reason demands the explanation of celestial motion through imparted forces. The reasons Philoponus himself gives are quite different. First, as has been shown, no argument positively establishes and supports the postulation of a world-soul; secondly, the Holy Scripture has nothing to say on the subject either. The arguments for the first reason have largely been laid

[22] See Wolff (1978), 74 f.

down in the *contra Aristotelem*;[23] it was left for the *De opificio mundi* to draw the conclusions. But this, in turn, appears to have been triggered by the second reason: Philoponus is now taking into serious account the text of the Book of *Genesis*, a fact which should not be underestimated.

The second shift from circular movement being due to nature to it being explained by imparted forces is, in the general opinion of historians of science, the decisive step forward in the direction towards classical mechanics. It may be doubted, however, that Philoponus perceived this step as another dramatic innovation on his part, comparable, say, to his earlier reasoned explanation of circular motion by the natural tendency of fire, or the denial of a world-soul. Indeed, the shift from 'natural' to 'imparted' can be understood quite easily. Two points suggest themselves. First, the thesis of cosmological impetus was formulated in the context of a popular treatise on biblical cosmogony. If one, like Philoponus, accepts the doctrine that the present cosmos was brought into existence by God, it is only reasonable to honour the creator with the ultimate responsibility for the celestial movement's perpetual regularity.[24] Impetus theory, fruitfully worked out in an entirely different context, provided the conceptual framework within which such an intrinsically theological idea could be spelt out philosophically. That Philoponus was careful not to commit himself wholeheartedly to the new theory suggests not so much that he himself perhaps remained unconvinced by it,[25] but rather reflects the fact that — just as the idea of the world-soul — impetus theory happens not to be one of the doctrines one readily finds in the Scriptures.

The second point to be made is that movements due to forces imparted by the *creator* do not cease to be natural movements.[26] Although Philoponus indicates that the celestial bodies may be moved by a motive force (κινητικὴ δύναμις) which has been imparted to them

[23] The heavens, consisting for the most part of fire, move in a circle by nature, for circular motion is one of the natural movements of fire, be it celestial or sublunary. In the *De opificio mundi*, Philoponus reiterates that he still considers the arguments laid down there as valid; see VI 2, 232,8–12.

[24] In this respect I do not think one has to look much further than Krafft (1982), 60 f. who rightly underlines the fact that Philoponus' innovative ideas were at least in some respects motivated by Christianity.

[25] As suggested by Wolff (1978), 75.

[26] Here I disagree with Wolff (1978), 74 f. who regards the movement due to imparted forces as an 'artificial' motion since it is caused by the demiurge.

(ἐνθεῖναι) at the moment of creation, he compares this motion to the evidently natural tendencies of heavy and light bodies and the movements of animals. In addition, he contrasts the movements due to imparted forces with non-natural movements and says of the latter that they are the cause of destruction.[27] For Philoponus, as for most other thinkers in late antiquity, it would have been unthinkable to suppose that the untrammelled movements of the spheres are non-natural, irrespective of the way they may have been brought about. In retrospect, steps no less decisive than the one from 'natural circular motion' to 'imparted circular motion' were taken, to my mind, by his efforts in the *contra Aristotelem* and in the *Meteorology* commentary to overcome the Neoplatonic doctrine of the supernatural origin of circular motion, and to declare it a natural motion in the first place, thus liberating the phenomenon of the celestial rotation from its traditional asssociation with the activity of the νοῦς.

If this is true, Philoponus' application of impetus theory to the movement of the celestial spheres may be understood as the natural upshot of at least three different conditions. First, the idea presupposes that the cosmos has been brought into being by a Creator-God, and that the Bible gives a valid (thought perhaps cryptic) account of the act of this creation (Christianity); secondly, the idea requires a clear conception of the theory of impetus in a way worked out by Philoponus in his *Physics* commentary (impetus theory); thirdly, it is necessary to realise that the movement of the spheres can be regarded as a natural motion in the same sense as the movements of sublunary bodies are said to be natural. The foundation for this third condition is to be sought, as Philoponus himself indicates,[28] in central arguments of the *contra Aristotelem*. Although there, somehow still impeded by the burden of Platonic cosmology, he proposes the provisional theory of double causation, the *contra Aristotelem* may nevertheless be regarded as paving the way for an explanation of celestial motion by impetus theory alone, for it was there that he took the necessary step towards the demystification of curvilinear motion.

Such a reconstruction of the evolution of an important cosmological thesis must, however, remain conjectural. Since the full discovery and analysis of Philoponus' thought after the composition of the *contra*

[27] *De opificio mundi* I 12, 29,5–7.

[28] See *De opificio mundi* VI 2, 232,8–12.

Aristotelem and the *Meteorology* commentary exceed the limits of this study, I choose to conclude my researches with the tentative suggestion that the application of impetus theory to the celestial spheres is in fact a plausible consequence of Philoponus' life-long concern with both cosmological theory and Christian theology.

9. List of Fragments

The surviving fragments of Philoponus' treatise *De aeternitate mundi contra Aristotelem* have been assembled and translated into English by the author; see C. Wildberg. 1987 b. *Philoponus. Against Aristotle on the Eternity of the World.* London.

Book I

Fr. 1*:	Simplicius, *In de caelo*	26,31–27,4
Fr. 2*:	Symeon Seth, *Conspectus* (36)	Delatte (1939), 41,1–14
Fr. 3:	Farabi, *Against Philoponus* (9–15)	Mahdi (1967), 257–259
Fr. 4:	Simplicius, *In de caelo*	28,1–11
Fr. 5:		30,26–34
Fr. 6:		31,6–16
Fr. 7:		32,1–11
Fr. 8:		33,17–20
Fr. 9:		34,5–11
Fr. 10*:		34,21–24 + 30–32
Fr. 11*:		34,33–35,8
Fr. 12*:		35,12–20
Fr. 13*:		35,28–33
Fr. 14:		36,9–18
Fr. 15:		36,21–25
Fr. 16:		37,3–12
Fr. 17*:		37,12–29
Fr. 18:		42,17–22
Fr. 19:		42,27–31
Fr. 20:		43,8–12
Fr. 21:		43,22–25
Fr. 22:		44,15–18
Fr. 23:		45,2–7
Fr. 24:		45,27–29
Fr. 25:		46,4–11
Fr. 26:		46,17–25
Fr. 27*:		46,29–47,3
Fr. 28:		47,10–13
Fr. 29*:		47,27–30
Fr. 30*:		48,5–11
Fr. 31:		48,14–22
Fr. 32:		48,35–49,12
Fr. 33:		56,26–57,8