# ARISTOTLE AND THE SCIENCE OF NATURE

*Unity without Uniformity*

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*In memory of*
*Mario Mignucci, my teacher, who cared*

*Lo duca e io per quel cammino ascoso*
*intrammo a ritornar nel chiaro mondo;*
*e sanza cura aver d'alcun riposo,*
*salimmo sù, el primo e io secondo,*
*tanto ch'i' vidi de le cose belle*
*che porta 'l ciel, per un pertugio tondo.*
*E quindi uscimmo a riveder le stelle.*

# *Contents*

# *Preface*

This book develops the investigation I began in *Corpi e movimenti: il* De caelo *di Aristotele e la sua fortuna nel mondo antico* (Naples, 2001). There I discussed Aristotle's reasons for the view that the celestial bodies are made of a special body which naturally performs circular motion and is different from, and not reducible to, earth, water, air, and fire. I have also shown that very few in antiquity, even within the school of Aristotle, were prepared to accept this doctrine, though many, if not most of them, shared Aristotle's view that the celestial world is a special and somehow distinct region of the natural world. This book incorporates material from the Italian one but presents it in the light of a new project. By studying the reception of the view that the heavens are made of a special body, I have come to appreciate not only how unusual Aristotle's conception of the natural world is; I have also come to understand how this conception may have affected the way Aristotle conceives of the science of nature. This book is an attempt to explore the significance of the study of the celestial bodies for Aristotle's project of investigation of the natural world.

While Aristotle argues, against his predecessors, that the celestial world is radically different from the sublunary world, he is not envisioning two disconnected, or only loosely connected, worlds. On the contrary, Aristotle conceives of the natural world as *one* department of reality with a sufficient unity to be the object of a single science. I show, however, that for Aristotle this world exhibits *unity* without *uniformity*. More specifically, there are features of the celestial world that outrun the explanatory resources developed by Aristotle for the study of the sublunary world. According to Aristotle, there is an important discontinuity between the celestial and the sublunary worlds, and this discontinuity leads him to a further conclusion: that the celestial bodies are made of a special body, unique to them.

But there is more to this book than an attempt to understand the reason that motivates Aristotle to endorse the view that the celestial bodies are made of a material principle unique to them. On the interpretation I am recommending, Aristotle is not only a systematic investigator of the natural world, he is also modest in recognizing human limitations on the extent of what can be known of this world. In the extant works, he is engaged in the study of the natural world in all its aspects on the crucial assumption that this world is a *cosmos*: that is, a structure that is intrinsically intelligible. But the study of this structure leads Aristotle to a certain view of the natural world and the place that we occupy in it. As a result of this view, Aristotle comes to think that what is intrinsically intelligible does not collapse into what can be known by us. Put differently, there is a lack of intelligibility *to us* in the natural world. I postpone discussion of this lack of intelligibility until the final chapter of the book.

Chapter 1 introduces the reader to a number of structural features of Aristotle's science of nature and the question of its unity and its boundaries. In the opening lines of the *Meteorology*, Aristotle outlines a program for the investigation of the natural world. I focus on this program and show that Aristotle's science of nature is structured in a certain way. I argue that this structure is crucially dependent upon a certain conception of the natural world. For Aristotle, the natural world is a causal system in which the direction of the explanation is from the celestial to the sublunary world only. A full appreciation of this conception of the natural world will help the reader to understand the precise sense in which Aristotle's science of nature is a distinctly organized science. In this context, I argue that the opening lines of the *Meteorology* reveal a firm grasp of the boundaries of the science of nature. Tellingly, the study of the soul is not mentioned as part of the program of inquiry into nature. Elsewhere Aristotle makes it abundantly clear that the study of the soul is preliminary to the study of life, but it is not a part of the science of nature. I discuss the problematic relation between the science of nature and the study of the soul and the unique status of the *De anima* within the Aristotelian corpus.

Once the conceptual structure and the scope of Aristotle's program for the investigation of nature are in place, in subsequent chapters the reader is introduced to Aristotle's view that the student of nature is concerned not only with natural bodies but also with the explanation of their motions.

Chapter 2 discusses the significance of Aristotle's emphasis on body in the opening lines of the *De caelo*. A close analysis of Aristotle's conception of natural body reveals that this conception is much richer and more complex than the concept of a three-dimensional object that occupies a certain region of the natural world. To begin with, natural bodies are divided into celestial and sublunary bodies. In the sublunary world, Aristotle admits a further distinction between composite and simple natural bodies. Finally, Aristotle develops a hierarchical conception of natural bodies: the natural bodies are themselves composed of natural bodies, and the simple bodies are the ultimate material principles of all natural bodies, and as such they are the natural bodies par excellence. For Aristotle, the natural world is the totality of the existing natural bodies.

Chapter 3 describes how and why Aristotle relates specific bodies to specific motions. Since the bodies in question are natural bodies, it is no surprise to discover that the explanation of their motions involves an appeal to their nature. More directly, Aristotle is committed to the view that motion is either natural or non-natural. I explore Aristotle's doctrine of natural motion and argue that he has left a coherent doctrine, even though at times he expresses himself in a way that is far from being crystal clear. I also study the way in which this doctrine is used to introduce the thesis of the existence of a simple celestial body which naturally performs circular motion. In this context, I suggest that celestial motion is not merely the circular motion performed by the celestial simple body, and that a full explanation of celestial motion requires an adequate psychological cause, namely a soul of a certain type. Finally, in the *De natura deorum*, Cicero credits Aristotle with the following tri-partition: (i) natural motion, (ii) forced motion, (iii) voluntary motion. The great intrinsic interest of this testimony, whose ultimate source presumably is Aristotle's lost dialogue *On Philosophy*, is the claim that celestial motion is a case of voluntary motion. I explore the reason for this claim which clashes with our basic intuitions about the voluntary.

Chapter 4 emphasizes Aristotle's epistemological pessimism regarding the possibility of knowledge of certain aspects of the celestial world. Aristotle's pessimism ultimately depends upon his conception of the natural world. Aristotle believes in the existence of celestial and sublunary natures, but he does not believe in the uniformity of nature. His considered view is that nature is not a uniform principle. I discuss the reasons that might have led Aristotle to take this view as well as the consequences following from this view for the study of the celestial world. In the extant works, Aristotle is reluctant to engage in an investigation of the celestial world when and where the lack of information at his disposal cannot be overcome by an appeal to similarities which the celestial natures share with the sublunary natures. He also makes a considerable effort to square the case of the celestial bodies with the conceptual resources developed and refined in the study of the sublunary world. But how successful is this effort? I focus on celestial matter as a case study.

The Epilogue studies the language traditionally used to refer to the celestial simple body introduced by Aristotle. Doxographers and commentators refer to Aristotle's celestial simple body as the fifth body, the fifth substance, the fifth element, the fifth nature, and even the fifth genus. No one of these expressions is used by Aristotle, who refers to the celestial simple body as the first element, the first body, or the first substance. Aristotle mentions *aithēr*, but only as the traditional name for the upper part of the natural world. I argue that this language is further evidence that Aristotle was fully aware of having arrived at a view of the natural world which was not only controversial but in some important sense also unique.

A final note on my language. I speak of natural world and natural bodies instead of physical world and physical bodies because our conception of the physical does not do justice to the richness and complexity of Aristotle's *ta physika*. This richness and complexity will become apparent in due course. For the time being, I am content to point out that we routinely contrast the physical with the mental. This contrast is emphatically not shared by Aristotle. What we recognize as the mental is part of Aristotle's natural world, even if he seems to be prepared to admit that what we recognize as the mind has the power to go beyond that which is merely natural.[1] For the very same reason, I prefer to speak of the science of nature instead of physics.

1 This claim requires elaboration. I refer the reader to my discussion on the boundaries of the science of nature in chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

# *Acknowledgments*

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The friendship of Carol Price has sustained me during the past few years. I thank her for this precious gift. She has successfully made me feel at home away from home.

The love of Cristina has nurtured me, especially in the years that we lived on different sides of the ocean.

This book is gratefully dedicated to Mario Mignucci. By his example I have learned that reading Aristotle not only requires philosophical acumen, together with a combination of philological and historical skills; it also requires the dedication and courage of a mind open to the enormous possibilities of a text which remains largely unparalleled.

# *Abbreviations and conventions*

Frequently cited ancient titles are abbreviated as follows:

Alexander of Aphrodisias

| | |
|---|---|
| *DA* | *De anima* |
| *In Metaph.* | *In Aristotelis Metaphysica commentarium* |

Aristotle

| | |
|---|---|
| *A post.* | *Analytica posteriora* |
| *Cat.* | *Categoriae* |
| *DA* | *De anima* |
| *DC* | *De caelo* |
| *EE* | *Ethica Eudemia* |
| *GA* | *De generatione animalium* |
| *GC* | *De generatione et corruptione* |
| *HA* | *Historia animalium* |
| *IA* | *De incessu animalium* |
| *Metaph.* | *Metaphysica* |
| *Meteor.* | *Meteorologica* |
| *NE* | *Ethica Nicomachea* |
| *PA* | *De partibus animalium* |
| *Phys.* | *Physica* |
| *PN* | *Parva naturalia* |
| *Rhet.* | *Rhetorica* |
| *SE* | *Sophistici elenchi* |
| *Top.* | *Topica* |

Cicero

| | |
|---|---|
| *Acad.* | *Academica* |
| *De fin.* | *De finibus bonorum et malorum* |
| *Nat. deor.* | *De natura deorum* |

*Tusc.* *Tusculanae disputationes*

[Galen]
*Hist. philos.* *Historia philosopha*

Hippocrates
*VT* *De vetere medicina*

Philoponus
*Contra Aristotelem* *De aeternitate mundi. Contra Aristotelem*
*In DA* *In Aristotelis De anima commentaria*
*In GC* *In Aristotelis De generatione et corruptione commentaria*

Plato
*Tim.* *Timaeus*

Proclus
*In Remp.* *In Platonis Rempublicam commentarii*
*In Tim.* *In Platonis Timaeum commentaria*

Sextus Empiricus
*M* *Adversus mathematicos*
*PH* *Pyrrhonei hypotyposes*

Simplicius
*In DC* *In Aristotelis De caelo commentaria*
*In Phys.* *In Aristotelis Physica commentaria*

[Simplicius]
*In DA* *In Aristotelis De anima commentaria*

Stobaeus
*Ecl.* *Eclogae*

Strabo
*Geo.* *Geographica*

Xenophon

| | |
|---|---|
| *Mem.* | *Memorabilia* |

Other frequently cited titles are abbreviated as follows:

| | |
|---|---|
| Aëtius | Aëtius, *Placita* (reconstruction in Diels, *Dox. gr.*) |
| Arius Didymus | Arius Didymus, *Epitome* (fragments in Diels, *Dox. gr.*). |
| *DK* | H. Diels and W. Kranz, *Die Fragmente der Vorsokratiker*, 3 vols. (Zürich, $1951^{6}$). |
| *Dox. gr.* | *Doxographi graeci*, ed. H. Diels (Berlin, 1879). |
| *LS* | A. A. Long and D. N. Sedley, *The Hellenistic Philosophers* (Cambridge, 1987). |
| *SVF* | J. von Arnim, *Stoicorum veterum fragmenta*, 3 vols. (Leipzig, 1903–5); vol. IV *Indexes*, ed. M. Adler (Leipzig, 1904). |

In accordance with general editorial practice, words in < > indicate addition to amplify translation. Where the author's name appears in square brackets it means that the work is generally regarded as not genuine.

CHAPTER 1

# *The unity, structure, and boundaries of Aristotle's science of nature*

## INTRODUCTION

> Asked to what end one should choose to live, Anaxagoras replied *"to study the heaven and the order of the whole cosmos"* (Aristotle, *EE* 1216 a 12–14 = *DK* 59 A 30).

Aristotle is not merely concerned with solving a list of problems or discussing a certain number of topics. He is engaged in an ambitious project of investigation. This project consists in an attempt to establish the right sort of connections – explanatory connections – between the things of the world. If this investigation is successful, it not only provides us with knowledge, but it gives us understanding of the world. The investigation of the natural world is no exception to this rule. Aristotle has left a certain number of *logoi*, each of which is a relatively independent and sufficiently self-contained argument devoted to a particular topic or problem.[1] But there is no doubt that these *logoi* are conceived as parts of a unitary project of investigation. There is also no doubt that Aristotle has a certain understanding of the relations between these parts. This understanding is strongly dependent upon a specific conception of the natural world and the substantial assumption that this particular department of reality is, at least to some extent, intelligible to us. More directly, Aristotle is persuaded that the natural condition for human beings is to know and understand the truth, and that we can know and understand a lot about the natural world if only our investigation is conducted in the appropriate way. But he is also aware that there are features of the natural world that we cannot adequately explain. I postpone discussion of this interesting tension.[2] For the time being, I would like to focus on the way Aristotle presents his inquiry into the natural world in the opening lines of the

1 For helpful comments on this point see Lang (1992: 2–13 and 1998: 3–33).
2 Chapter 4, "The limits of Aristotle's science of nature."

*Meteorology*. It is my intention to show that this presentation is not neutral with respect to a certain conception of the natural world. A better grasp of this conception will enable us to understand why Aristotle conceives of the study of the sublunary and the celestial world as forming a single science: the science of nature or natural science. A full appreciation of this conception will also help us to understand the precise sense in which Aristotle's science of nature is a distinctly organized investigation of the natural world. Aristotle does not think of the science of nature as a collection of loosely connected, if not disconnected, investigations. On the contrary, the investigations listed at the beginning of the *Meteorology* are distinct but related. Moreover, a close scrutiny of the opening lines of the *Meteorology* shows that these investigations are related in a certain way. I shall argue that the causal relation that holds together the different parts of the natural world provides us with the conceptual resources to understand the precise sense in which several distinct natural investigations are unified and integrated into a single science.

## ARISTOTLE'S INVESTIGATION OF NATURE

What follows is a partial translation of the prologue to the *Meteorology*:[3]

(1) Earlier we discussed the first causes of nature, and natural change in general; (2) also the stars ordered according to their motion, (3) and the bodily elements, <establishing> their number, nature, and mutual transformation, (4) and generation and perishing in general. (5) There remains to be considered a part of this investigation which all predecessors have called meteorology (*meteōrologia*). <This part is concerned with> that which happens naturally, but with an order that is less perfect than that of the first element of bodies, and which takes place in the region nearest to the motion of the stars. Such are the Milky Way, the comets, and the movements of meteors. <It studies> also the affections we may call common to air and water, and the kinds and parts of earth and the affections of its parts. These throw light on the causes of winds and earthquakes and all the consequences the motions of these kinds and parts involve. Of these things some

3 This passage not only contains a recommendation regarding the order of investigation of the natural world but also establishes the relevant relationships among the different natural writings. I limit myself programmatically to discussing this passage as containing a recommendation regarding the order of investigation of the natural world. For a recent study of the opening lines of the *Meteorology* as evidence for the relationships that hold among the different natural writings, I refer the reader to Burnyeat (2004: 7–24). Lately Myles Burnyeat has been advocating the view that Aristotle is a systematic philosopher in the sense that he holds strong views about the appropriate order of learning and study. The reader who is interested in this topic should read Burnyeat (2001) and Burnyeat (2002: 28–90).

puzzle us while others admit of explanation in some degree. Further, <this inquiry is concerned with> the falling of thunderbolts, whirlwinds and fire-winds, and further, the recurrent affections produced in these same bodies by concretion. (6) Once we will have dealt with these things, we will consider whether we are somehow able to give, in accordance with the method indicated, an account of animals and plants, both in general and separately. (7) Once this is discussed, perhaps the whole of what we established at the outset will be complete (*Meteor.* 338 a 20 – 339 a 9).[4]

Aristotle is about to engage in a new study – meteorology, *meteōrologia* – and finds it important to begin by placing this study within his larger project of inquiry into nature. Why? The phrase *ta meteōra* was commonly used to refer to the totality of the phenomena which take place in the sky, including the celestial ones.[5] This explains why Aristotle cannot take it for granted that people understand what *he* means by *meteōrologia*, but rather has to establish the place that this study occupies in his larger project of investigation of nature. By so doing, however, he offers some information about the project in which he is engaged and the way he conceives of it.[6]

4 For a vindication of the authenticity of this prologue see Cappelle (1912: 514–35).

5 Anaxagoras was commonly regarded as the champion of this sort of study. In the *Phaedrus* we are told that Pericles learnt from him "high speculations about <what is high in> nature" – *meteōrologia physeōs peri* (269 c – 272 b). More explicitly, Pericles learnt from Anaxagoras speculations about what is high in nature; that is speculations about *ta meteōra*. But the speculations about *ta meteōra* are also high-flown speculations of little use in life. Concern about *ta meteōra* is a prominent feature in Aristophanes' portrait of Socrates in the *Clouds*. See *Clouds* 225–35. In saluting Socrates, the Clouds say that they would not listen to any other of the *meteōrosophistai* of the time except Prodicus. See *Clouds* 358–60. The *meteōrosophistai* are the teachers of what is high in nature but also of superfluous accomplishments (both *ta meteōra* and *sophistai* have a double meaning in this case). Such hostility to the study of *ta meteōra* was not uncommon in the fifth and fourth centuries BCE. This study was regarded as useless and obscure; the thought was that it did not deliver results because *ta meteōra* are beyond the grasp of human cognitive capacities. The Hippocratic author of *On Ancient Medicine*, for example, contrasts his expertise with "the study of the things in the sky and below earth" (*VT* I 3.7). In this study, it is not clear either to the speaker himself or to his audience whether what is said is true or not, since there is no criterion to which one should refer to obtain clear knowledge (*VT* I 3.8–10). For an exhaustive discussion of the usage of the phrase *ta meteōra* in the fifth and fourth centuries BCE, see Cappelle (1935: 315–58).

6 In clause (5) Aristotle provides the agenda of meteorology. This consists of a list of phenomena that meteorology is expected to discuss. This is clearly part of an attempt to revise the received conception of the discipline. At any rate, Aristotle was not completely successful in his attempt to revise the view that *ta meteōra* are the totality of the phenomena that take place in the sky. Both in the Hellenistic and in the post-Hellenistic tradition the phrase *ta meteōra* continued to be used for all the phenomena that take place in the sky, including the celestial ones. It is significant, I think, that Theophrastus felt the need to change the name of Aristotle's discipline from meteorology to metarsiology – from *ta metarsia* – precisely in order to avoid the ambiguous reference to *ta meteōra*. On this terminology and what it implies, see Cappelle (1913: 321–58).

There is no doubt that Aristotle's investigation is carefully structured: it begins with an examination of the first causes of nature and natural change in general, continues with a study of the celestial region, and ends with an investigation of the sublunary world, including a study of plants and animals. The examination of the first causes of nature and natural change in general – clause (1) – is a compressed but precise description of the content of the *Physics*.[7] By dealing with nature and change, the *Physics* provides a foundation for the entire investigation of the natural world.[8] The language is specifically designed to insist on the generality of the *Physics*. By saying that the *Physics* is concerned with the *first* causes of nature and change *in general*, Aristotle makes it clear that the *Physics* provides the explanatory resources and the principles for a sensible investigation of the natural world. But does the *Physics* provide *all* the explanatory resources and *all* the principles for *all* natural investigations? The answer is emphatically no. *PA* 1 is a relatively self-contained and independent *logos* devoted to developing principles that are specific to the study of animal nature. If the *Physics* provided all the explanatory resources and all the principles that are necessary for a sensible study of animal nature, there would be no need of a specific introduction to the study of animals.[9] It is significant, I think, that the opening lines of the *Meteorology* leave it open whether the study of animals and plants can be exhaustively conducted in accordance with the method indicated – clause (6).

7 In late antiquity it was generally agreed that Aristotle's *Physics* consisted of two parts. According to Philoponus and Simplicius, Aristotle and his pupils referred to the first four *logoi* of the *Physics* as *ta peri archōn*, and to the last three *logoi* as *ta peri kinēseōs*. Simplicius informs us of the existence of another division: the first five *logoi* were thought to form *ta peri archōn*, and the last three *ta peri kinēseōs*. The prologue to the *Meteorology*, and in particular the description of its contents as an examination of (i) the first causes of nature, and (ii) natural change in general, may have encouraged the division of the *Physics* into two parts. But there is no reason to think that this division goes back to Aristotle. On this point see Brunschwig (1991: 11–39) and Barnes (1997: 1–69). See also Pellegrin (2003: 265–71).

8 Myles Burnyeat would say that the *Physics* provides a "conceptual foundation" for the study of nature. See Burnyeat (2004: 19–20).

9 On *PA* 1 as a *logos* devoted to establishing methodological standards for the study of animal nature, see Lennox (2001a: 133–43). A discussion of the way in which *PA* 1 does not only specify but also builds on the general account of nature offered in the *Physics* goes beyond the scope of the present study. I refer the reader to Code (1997: 127–43). This article contains a discussion of the way in which *PA* 1 completes the general account of causality offered in the *Physics*. In *Phys.* 2 Aristotle is not content to present his general account of causation and discuss how luck and chance fit it. The final section of *Phys.* 2 is devoted to explaining why nature (together with thought) is a final cause, and what place necessity has in the study of nature. However, the discussion offered in *Phys.* 2 is only partial, and Aristotle returns to this topic in *PA* 1. It is only in *PA* 1 that Aristotle argues for the methodological priority of the final over the moving cause.

The study of animals and plants comes at the end of the program of investigation. Once an account of animals and plants is offered, perhaps the investigation of nature will be complete – clause (7). At least two things are to be noted here. First of all, we only have a study of animals, and perhaps Aristotle has left only a study of animals. His references to works on plants are always impersonal and could be referring to the work of a Peripatetic colleague such as Theophrastus.[10] Secondly, and more importantly, Aristotle presents the study of animals as a part of the science of nature. This is confirmed by what Aristotle says in *PA* I, the official introduction to the study of animals. There Aristotle presents the study of animals as "an inquiry into nature" (639 a 12). He describes this study as "a theoretical <science> concerned with nature" (640 a 2, 641 b 11), and as "an investigation of nature" (644 b 16). He says that "the inquirer into nature" is concerned with both the soul and the matter, but more with the soul (641 a 29–30). Finally, he wonders whether the whole soul, or only a part of it, is the province of "the <science> of nature" (641 a 33–4). This language is mildly surprising, especially if one considers that in *PA* I Aristotle concerns himself, by his own admission, solely with animal nature (645 a 5–6). Why does Aristotle insist on nature if his focus is animal nature? Aristotle conceives of the study of animals as a specific investigation. For him, the relevant explanatory principles are to be biologically specific in order to provide an adequate explanation of animal life. In the end, the investigation of animal nature requires a reference to a soul of a specific type as form, and to a living body of a specific type as matter. At the same time, Aristotle wants to disabuse us of the view that the study of animal nature is an independent investigation. In other words, the specificity of the study of animal nature does not involve a denial of the explanatory unity of the science of nature.

Since Aristotle speaks of animals and plants, he obviously regards the study of animals as a discrete investigation. He is persuaded that we are able, at least in principle, to draw a line between animals and plants: animals have a share in cognition; plants do not. Here is how Aristotle makes this point in *GA*:

> The function of an animal is not only to generate, which is in fact common to all living beings; in addition, all animals partake in a form of cognition [*gnōsis*], some more, some less, some very little indeed. For they have perception [*aisthēsis*], which is a form of cognition . . . it is by perception that animals [*zōia*] differ from merely living beings [*zōntōn monon*] (*GA* 731 a 30–5 and 731 b 4–5).

10 I owe this point to Jim Lennox.

For Aristotle, plants are merely living beings, *zōnta*; but they are not *zōia*, because they have no share in perception, which is a form of cognition. Aristotle is clearly reacting to a certain tendency to connect the name *zōion* with the verb for living and being alive, *zēn*. From Plato's *Timaeus*, for example, we learn that everything that partakes of life, whatever it might be, can be rightly named *zōion*, "living being" (*Tim.* 77 B 1–2). The connection between the name *zōion* and the verb *zēn* explains why in the *Timaeus* plants are introduced as a second class of *zōia* alongside men (*Tim.* 77 A). Plants are recognized as *zōia* because they are living beings (*Tim.* 77 A). I shall return to the ambiguity of the name *zōia* in due course. For the time being, suffice it to say that the term *zōia* can be used to refer to all the living beings that there might be, including plants.[11] The fact that Aristotle normally uses the term *zōia* to refer to animals, to the exclusion of plants, is ultimately due to his conviction that animals are a distinct class of living beings, and animal life is a form of life different from plant life. Later on I shall argue that the *DA* provides the explanatory resources and the conceptual framework for an optimal study of animal life. For the time being, I am content to say that the first yet crucial step for an optimal study of animal life is an argument for the view that animals are a distinct class of living beings. It is precisely by relying on the results achieved in the *DA* that Aristotle can restrict himself to a study of animals and set aside a study of plants.[12]

But how does Aristotle conceive of the study of animals? Jim Lennox has recently drawn attention to the cross-references within *HA*, *PA*, *GA*, and *IA*. He has shown, to my mind successfully, that these works are all parts of a single, unified investigation. He has also shown that this single, unified investigation displays a definite structure of a certain type. Put differently, Aristotle credits the study of animals with unity, structure, specificity, and discreteness, but he does not recognize this study as an independent investigation.[13]

11 But it would be a mistake to think that the term *zōia* is ambiguous only between (1) *all living beings*, including *plants*, and (2) *animals*, to the exclusion of *plants*. In the *Timaeus* the name *zōion* is attributed to any living being that there might be, including any living being superior to man that there might be. Stars are recognized as *zōia*, on the crucial assumption that they are alive (*Tim.* 39 A; 39 E); moreover, the sensible world as a whole is a *zōion* (*Tim.* 30 B). I owe this clarification to Michael Frede.

12 Cf., for example, *PN* 467 b 4, 468 a 31, 442 b 25, and *GA* 716 a 1, 783 b 20.

13 J. G. Lennox, "The Place of Zoology in Aristotle's Natural Philosophy," presented at the Classical Philosophy Colloquium, Princeton, December 1–2, 2001. A revised version of this paper was given as the Keeling Lecture in the fall of 2003 and is now published in Lennox (2005: 55–71). Lennox rightly says that "this structure has nothing to do with the order in which the actual investigations were done nor with the order in which works were written" (57). The reader is expected to go

*PA* I confirms the idiosyncratic way in which Aristotle conceives of the study of animal nature. In this *logos* Aristotle insists not only on the unity of the science of nature but also on its structure, placing the study of animal nature *after* the study of the celestial substances:

> since we have already dealt with those substances [= the celestial substances], saying what appears to be the case to us, it remains to speak of animal nature, trying to omit as far as possible nothing, however noble or ignoble it may be (*PA* 645 a 4–7).

We may or may not believe that this passage is reminiscent of the beginning of the *Meteorology* (this is, in fact, open to debate), but there is no doubt, I think, that the study of animal nature is regarded as part of a larger inquiry, itself structured in a specific way.

## THE PLACE OF THE STUDY OF THE CELESTIAL WORLD IN ARISTOTLE'S INVESTIGATION OF NATURE

From the opening lines of the *Meteorology* we learn that the study of animals and plants comes at the end of a large and ambitious program of investigation. But why does it come *at the end* of this program? There is no doubt that certain conceptual resources are presupposed in the study of animals. For example, since animals and plants are perishable beings, we have to be clear about the nature of perishing. We have to know, in particular, that perishing is a case of going out of existence rather than a case of becoming something else. This helps us to understand why an investigation of generation and perishing is mentioned at the beginning of the *Meteorology* – clause (4) – and why this investigation comes before the study of animals and plants – clause (6). This investigation is conducted

through these writings in a certain order. A discussion of this order is not immediately relevant to the present discussion. I am content to claim that the reasons for this order are to be found in *PA* I, both in the distinction Aristotle here makes between gathering the data and providing causal explanations (639 b 8–10), and in his defense of the primacy of the final (formal) principle over the moving principle (639 b 15 – 640 b 5) and the material principle (640 b 5 – 641 a 17). For example, the study of the moving principle and the parts that are functional to reproduction (*GA*) comes *after* the study of the other bodily parts (*PA*). Aristotle provides a reason for this order at the very beginning of *GA*: the final (formal) principle comes *first*, and the material and the moving principle occupy *second* and *third* place respectively (715 a 4–6). There is no doubt that the reader of *GA* is expected to be already familiar with *PA* I and with the arguments that Aristotle offers there for the primacy of the final (formal) principle over the moving principle. On the relationship between the *PA* and the *GA,* see also Code (1997): "we need to know in a detailed way how and why the *ousia* is the way it is before we can account for the way in which the efficient cause operates. Knowledge of the efficient causes by means of which animals are generated is posterior to knowledge of their final causes" (143).

in the *GC*.[14] It is significant, I think, that some familiarity with this treatise seems to be presupposed on the part of the reader of the *DA* and the biological treatises.[15] This does not explain, however, why the study of the celestial region comes before the study of animals and plants. The *Meteorology* is nevertheless crystal clear on this point: the study of the stars ordered according to their motion occupies second place in the inquiry into nature and comes before the study of any aspect of the sublunary world – clause (2).[16] At first sight, this is a little surprising. There are two, if not three, good reasons to expect the study of the sublunary world to precede, rather than to follow, the study of the celestial world. To begin with, Aristotle admits that the study of the celestial world is more difficult, and that our grasp of the celestial bodies is slight, especially if confronted with what we can know about <plants and> animals (644 b 32 – 645 a 7). In addition, Aristotle insists on the existence of similarities between the celestial and the sublunary world, and claims that these similarities play a significant role in the study of the celestial world. Finally, at one point he even says that the study of <plants and> animals offers in exchange a certain grasp of the celestial bodies (645 a 3–4).[17] Why, then, should this study come after, rather than before, the study of the celestial world?

It is not difficult to find a first, tentative answer to this question. Aristotle is not the first thinker to engage in an investigation of the natural world in its entirety. At the time there was an already established tradition of inquiry into nature, which is registered and transmitted by Plato in the *Timaeus*. According to this tradition, the student of nature was expected to put all natural explanations into the context of an overall narration whose order of topics is *first* the heavens, *then* the elements, and *finally* the living beings.[18] There is no doubt that this is exactly the order

14 On the *GC* as a study of generation and perishing in general and its foundational character for the sublunary science of nature, see Burnyeat (2004: 7–24).

15 Aristotle seems to refer to the *GC* at *DA* 417 a 1–2, 423 b 29; *PA* 640 a 9–10, 646 a 15, 645 b 9–11.

16 *PA* I confirms that the study of animal nature comes after the study of the celestial bodies (645 a 4–5).

17 Here I follow Düring and his interpretation of the difficult *antikatalattetai* in 645 a 3. Cf. Düring (1943: 120).

18 Strictly speaking, the *Timaeus* does not provide an investigation of the natural world in all its aspects. Plato is remarkably shy about animals and plants. However, this is to be understood in the light of the fact that the *Timaeus* is programmatically an account of "the all" down to the generation of "man" (see, for instance, 90 E 1–3). Once an investigation of the human body (pathology and anatomy included) is offered, the program is completed. In spite of this programmatic restriction, there is no doubt that the *Timaeus* consists of a general, unified account of the natural (better: sensible) world in terms of which all the natural phenomena can be, at least in principle, explained.

that Aristotle follows in the opening lines of the *Meteorology*. However, if we want to understand why Aristotle insists on speaking of inquiry into nature, and indeed places the study of animals after the study of the celestial world, we cannot be content with a generic appeal to the pre-Platonic tradition of inquiry into nature. Aristotle routinely presents himself as continuing the tradition of the *physiologoi*. At the beginning of the *Physics*, for example, Aristotle puts himself in direct continuity with this tradition, and makes his own position grow out of the opinions and results achieved by his predecessors. But his position is not merely the culmination or perfection of this venerable tradition. It is a dramatically new position.

I would like to make a fresh start from a well-known Aristotelian "slogan": "it takes a man to generate a man."[19] Among other things, this slogan is designed to point to the fundamental fact that the generation of a man can be understood only in the light of the nature of the man. However, a slightly revised version of this slogan can be read in the *Physics*: "it takes a man *and the sun* to generate a man" (194 b 13). Interestingly enough, the revised slogan occurs also in *Lambda*. From *Lambda* we learn that the explanatory factors involved in the generation of a man are earth, water, air, and fire, a particular form of organization as the goal of the generation, the father, and finally the motion of the sun around the ecliptic (1071 a 11–17). In this compressed text, Aristotle is doing several things at once.[20] Among other things, he is trying to establish the explanatory role that both the father and the sun have in the generation of a man. Notoriously, Aristotle admits a plurality of explanatory principles: material, formal, final, and moving principles. According to him, both the father and the sun are moving principles, but they are related to the man in different ways. Father and son are the same in form; more precisely, the father is in actuality what the earth, water, air, and fire that will become the man are potentially.[21] The sun, unlike the father, is a moving principle of the man without being the same in form. It is a moving principle – or better, a remote moving principle – through its characteristic motion around the ecliptic; by so moving it indirectly secures the continuous generation of man from man, and hence the eternal permanence of the species.

19 From Bonitz (1870) we learn that this slogan occurs at *Phys.* 193 b 8, 198 a 26, 202 a 11; *GC* 333 b 7; *PA* 640 a 25, 646 a 33; *GA* 735 a 21; *Metaph.* 1032 a 25, 1033 b 32, 1049 b 25, 1070 a 8, b 34, 1092 a 16.

20 For a close discussion of this text in its context see Code (2000: 161–79).

21 A complication: from *Theta* 7 we are told that earth, water, air, and fire are not potentially the man (1048 b 37 – 1049 a 1).

I have insisted on the slogan that it takes a man and the sun to generate a man because I am convinced that this slogan sheds some light upon a substantial assumption that Aristotle makes about the character of the natural world. First of all, Aristotle is persuaded that the natural world is an arrangement or organization of a certain kind; that is, a certain kind of *cosmos*. Secondly, and more importantly, Aristotle thinks of this *cosmos* as a unified whole – in Greek *holon*. The parts of this unified whole are causally related to one another in a certain way. The celestial and the sublunary world are related to one another in such a way that the celestial world acts on the sublunary world. More specifically, the outer part of the sublunary world is immediately in contact with the lower part of the celestial world.[22] On Aristotle's account, what acts on something is normally affected by it. But this particular case represents an exception to the rule. The celestial world acts on the sublunary world but it is not affected by it. Why? For Aristotle, reciprocal action takes place only when the matter is the same (324 a 34–5).[23] The celestial and the sublunary world are not the same in matter. I postpone discussion of this crucial aspect of the theory to the following chapters. For the time being, I am content to say that Aristotle is famously committed to the view that the celestial world is made of a body which has the capacity to perform circular motion but does not have the capacity to be affected by anything: the so-called fifth body or fifth element.[24] By simply performing its characteristic circular motion, this particular body has an influence on the living and non-living beings populating the sublunary region.

22 Remember that Aristotle does not believe in action at a distance; under the appropriate circumstances A acts on B if, and only if, A is immediately in contact with B, or A is in contact with some suitable medium C which, in turn, is in contact with B.

23 Aristotle's notion of matter cannot be reduced to the notion of material out of which something is made. From *Zeta* we learn that matter is that which is capable of being and not being (1032 a 20–1). From *Lambda* we learn that matter is that which has the capacity for both <contraries> (1069 b 14–15). Finally, from the *GC* we learn that matter, *qua* matter, is capable of being acted upon (324 b 19). It is by resting on the last passage that Aristotle can claim that:

1. Of the things that can act on something else, those of which the form is not in matter cannot be acted upon (324 b 5–6).
2. Of the things that can act on something else, those of which the form is in matter can be acted upon <provided that the matter is the same> (324 b 6).

24 But Aristotle never makes use of the expressions "fifth element" or "fifth body." He also refrains from using the name *aithēr* to refer to the simple celestial body. In the *DC*, Aristotle is content to register that *aithēr* is the traditional name for the upper part of the world (270 b 20–1). It is unfortunate that Aristotle's reticence in using *aithēr* is not appreciated enough. The fact that Aristotle avoids this word is often overlooked, if not obscured and denied, by routinely referring to Aristotle's celestial simple body as *aithēr*. I shall return to Aristotle's language in the Epilogue.

Aristotle thinks of the living and non-living sublunary things as configurations that come into existence, endure for a while, and finally go out of existence. He never conceives of these ephemeral configurations in isolation. Both synchronically and diachronically they are conceived as part of a larger system, which ultimately coincides with the totality of the sublunary world they contribute to preserve. Diachronically they are parts of an everlasting process of generation and perishing that has no beginning and no end. Towards the end of the *GC*, Aristotle makes it clear that the continuity of this process can be secured only by the continuous celestial motion (336 a 14–18). At first, we might find it difficult to understand why the everlastingness of the process of coming into existence and going out of existence requires the existence of an individually everlasting motion. But we should bear in mind that going out of existence involves the liberation of a quantity of earth, water, air, and fire. These bodies are the material principles of everything in the sublunary world, and for Aristotle they are endowed with the capacity to move towards their own natural places. Under the appropriate circumstances they are naturally moving towards these places.[25] Something is therefore needed to prevent the liberated material principles from being completely relocated in their natural places. The dislocation of a certain amount of earth, water, air, and fire is in fact crucial for the persistence of the process of coming into existence and going out of existence. By keeping a minimal level of agitation in the sublunary world, the celestial motion crucially contributes to the maintenance of a quantity of dislocated earth, water, air, and fire; by so doing this motion crucially contributes to preserving the relevant level of *mixture* in the sublunary world (337 a 1–7).[26]

By now it should be clear that the program for the investigation of nature presented in the opening lines of the *Meteorology*, is strongly dependent upon a specific conception of the natural world. Aristotle seems to think of the natural world as *a causal system of a specific type*. I add the qualification "of a specific type" because the direction of the explanation within this causal system is from the celestial to the sublunary world only. This particular feature of the causal system helps us to understand why some grasp of the celestial world is for Aristotle not only necessary but also preliminary to the attainment of an understanding of important features of the sublunary. However, a few words of clarification

25 More on this point in chapter 2, "Bodies," and chapter 3, "Motions."
26 On this aspect of Aristotle's theory, see Bodnár (1997b: 81–117).

regarding the limits of my last remark are needed. To begin with, there are features of the sublunary world that can be adequately understood without taking into account the celestial world. Let us return to the generation of man from man. There is a sense in which the explanation of the generation of a particular man from a man can be given by pointing out four explanatory factors: the father, the *sperma*, the *katamenia*, and the goal of that particular generation; that is, a particular form of organization realized in a body of a specific type. The sun is required only to account for the continuity and eternity of the generation of a man from a man. Moreover, there are only some aspects of the celestial world which are of direct relevance to the study of the sublunary world. In the case of the generation of a man from a man, all we need to know is that the sun performs a specific circular motion; that is, a circulation with a specific orientation, a certain inclination on the ecliptic, a certain speed, and so on and so forth. Apparently, we are not required to know why the sun is engaged in such a motion, and why this motion takes place in the particular way it does.[27] Finally, so far I have focused only on the sun and insisted that the study of the sun comes before, rather than after, the study of any aspect of the sublunary world. However, it is fairly clear that the study of the celestial world in its entirety comes before, rather than after, the study of the sublunary world. In the opening lines of the *Meteorology*, Aristotle speaks of the stars ordered according to their motion – clause (2). Aristotle thinks that the job of the student of nature is to provide an explanation of the behavior of all celestial bodies. He makes it very clear that the celestial bodies are to be viewed as forming a single integrated system of a certain type. In the *DC*, for example, Aristotle engages in a discussion of two difficulties that presuppose the astronomical system of Eudoxus, and that make sense only if the aim is to provide an explanation of the behavior of a celestial body as part of a system of interconnected motions. These difficulties are the following: (i) why are the sun and the moon moved by fewer motions than some of the other planets? (291 b 29–31); and (ii) why are so many stars carried by one single motion – the motion of the heaven of the fixed stars – whereas many motions are

27 For Aristotle, any attempt to provide an adequate explanation of the motion of the sun should start from the assumption that the sun is a living being endowed with the capacity for cognition and desire. I postpone discussion of the idea that celestial motion is a special type of animal motion. See chapter 3, “Motions.” For the time being, I limit myself to saying that for Aristotle celestial bodies keep everything in constant motion by being continuously moved, on the crucial assumption that they are equipped with some form or other of celestial cognition and celestial desire.

needed to carry one, single planet? (292 a 10–14).[28] The requirement that all the motions of all the celestial bodes are to be considered together is at work also in *Lambda*. In chapter 8 of *Lambda*, Aristotle uses astronomy to determine the number of the divine intellects that are needed to account for celestial motion. In this context, Aristotle assumes that the motions of the heavens form a single interacting system and are to be treated as such by astronomers.[29]

As Burnyeat himself says, "it is tempting to take this thought a stage further" and wonder whether Aristotle conceives of the natural world as a teleological system. In other words, it is tempting to wonder whether Aristotle conceives of the natural world as a causal system that exists for the sake of a definite goal. But it is difficult to see what this goal could be. Burnyeat is content to gesture at the living creatures that inhabit the sublunary world as a possible goal for the entire causal system. On this interpretation, everything, including the celestial bodies, would exist for the sake of the formation, preservation, and reproduction of the living organisms that we encounter on earth.[30] I count myself among "the sober readers" of Aristotle. I find the temptation to think of the natural world as a teleological system that exists for the sake of the sublunary creatures resistible, even if the thought is that the entire causal system exists for the benefit of the living creatures that inhabit the sublunary world.[31]

28 I shall return to these difficulties in the discussion of voluntary motion in chapter 3, "Motions."

29 On the one-system requirement and its astronomical and philosophical significance, I refer the reader to Beere (2003: 1–20).

30 Burnyeat (2004: 23–4).

31 Aristotle can use the expression "for the sake of which" to refer not only to the goal but also to the beneficiary. In the *Politics*, for example, we are told that plants are for the sake of beasts, and beasts for the sake of man (1256 b 15–22). Here the view seems to be that plants and beasts are subservient to the end of procuring food and clothing for man. In other words, plants and animals have internal goals, but they exist and function also for the benefit of man. For a passionate attempt to articulate a specific version of the thought that the natural world, or perhaps its sublunary region, exists for the sake of human beings, see Sedley (1991: 179–97). According to Sedley, "[for Aristotle] the entire content of the natural world, including not only plants and animals but perhaps even seasons and weather, exist and function primarily for the benefit of man" (180). Matthen (2001: 171–99) has argued that the natural world of Aristotle is "a single teleologically structured entity" (182). But the teleology Matthen ascribes to Aristotle is significantly different from the one suggested by Sedley. On Matthen's reading, the natural world does not exist and function for the sake of a beneficiary, but it exists and functions for the sake of "an internal goal" (183). On this interpretation, the natural world is "so organized as to achieve an end proprietary to its own essence" (181). The present book is an indirect argument against an interpretation of Aristotle's cosmology of this type. I shall argue that the natural world, as it is understood by Aristotle, admits an important discontinuity between the celestial and the sublunary regions. If I am right, the discontinuity in question is compatible with the view that the natural world is a single thing, but not with the view that the natural world has an essence. More directly, I shall argue that the natural world is a certain arrangement or organization of celestial and sublunary bodies and as such displays a structure of a certain type, but the structure in question is not a form. *De caelo* I 9,

### CAUSAL UNITY

Interesting consequences as well as special problems follow from this particular approach. In particular, we are expected to be able to explain not only why the inquiry into nature displays a specific structure, but also why there is only a single inquiry. In other words, we are expected to be able to identify what gives unity to this inquiry; what makes it one inquiry rather than a mere collection of relatively independent and sufficiently self-contained investigations. This question can be approached in another way. Aristotle is committed to the view that there are sciences rather than science. Moreover, he endorses the view that each science is concerned with a specific *genos*. The *genos* is what a science is about – in Greek *to peri ho*.[32] The science of nature is no exception to this rule. From the *Metaphysics* we learn that all sciences are concerned with some *genos* (1025 b 7–8), and that the science of nature too happens to be concerned with some *genos*:

> the science of nature too happens to be about some *genos* of being, namely about that substance which has the principle of change and rest in itself (*Metaph.* 1025 b 18–21).[33]

But if we want to understand why celestial bodies, meteorological phenomena, animals, and plants are not an arbitrary division of reality but a *genos*, something more specific about this particular *genos* is to be said. More directly, an appropriate conception of this *genos* is required. The natural world does not display the unity that is distinctive of the highest *genos* (the so-called *summum genus*) in a specific divisional structure.[34] Simply put, celestial bodies, meteorological phenomena, animals,

as I read it, contains a reference to a structure of a certain type, not to a form. More generally, and more boldly, the natural world as it is understood by Aristotle is not an hylomorphic compound and is not subject to hylomorphic analysis.

32 On the *genos* as the subject-matter of a specific science, see McKirahan (1992: 1–3).

33 I take it that *Epsilon* 1 is an attempt to expand on the thoughts offered in *Gamma* 1–3. For the claim that nature is a single *genos* see, in particular, 1005 a 34.

34 For a discussion of the unity and structure that the highest *genos* in a specific divisional tree minimally displays, see Falcon (1996: 127–46). Aristotle has several ways of reminding us that the highest *genos* in a divisional tree displays unity together with a minimal amount of structure. At the beginning of the *Categories*, for example, footed, winged, aquatic, and two-footed are offered as differences in animals (*Cat.* 1 b 8–19). The example is notoriously difficult and elliptical. On the one hand, footed, winged, and aquatic are coordinate differences. In the Aristotelian jargon coordination is a relationship between differences that are simultaneous, mutually exclusive, and provide an exhaustive division of the *genos*. With the addition of two-footed, however, co-ordination is destroyed. This addition is to be understood, I think, as a reminder that a *genos* – in this case animal – is an ordered structure characteristically involving priority, posteriority, and simultaneity. Put differently, the addition of two-footedness to the list of differences provides the *genos* animal with the minimal amount of structure required.

and plants form one department of reality, but they do not fall under some higher *genos* like the different species of animals do. We have therefore to look for the relevant generic unity. One possibility is to argue that the science of nature is a methodologically unified science and claim that methodological unity is enough to secure the required generic unity. Let us return to the beginning of the *Meteorology*, and in particular to the question whether the study of plants and animals can be exhaustively conducted in accordance with the method indicated – clause (6). I have argued that the study of animals and plants requires additional principles specific to the particular objects of study. At the same time, there is no doubt that the study of plants and animals is conceptually related to the other natural investigations and is conducted in accordance with the principles indicated in the *Physics*. In the *Physics*, Aristotle makes it clear that the science of nature is the result of a search for the relevant explanatory principles: the principles of change. Aristotle is committed to the view that change is the distinctive feature of the natural world and famously argues for the existence of four principles of change: matter, form, the moving principle, and the goal. In the *Physics*, Aristotle claims that the job of the student of nature is to search for "all of them" (198 a 22–3). In this passage, Aristotle has in mind primarily the study of the sublunary world. But there is evidence that he does not intend to confine his claim to the study of this region of the natural world. He conceives the entire science of nature as the result of a search for these four explanatory principles. This point is explicitly made towards the end of the *GC*. Here Aristotle claims that the relevant explanatory principles are the same in number in the study of both the celestial and the sublunary world (335 a 28–9). Note, however, that Aristotle does not say that the student of nature is looking for the same explanatory principles, but for the *same type* of explanatory principles. The study of celestial bodies, meteorological phenomena, animals, and plants forms one and the same science because the search for a specific explanation is conducted on the assumption that four types of explanatory principles are relevant for an adequate explanation: matter, form, the moving principle, and the goal.

Aristotle defends the thesis that there is explanatory unity in the natural world; that is, that there are four types of principles in the natural world; at the same time, he insists on the specificity and appropriateness of these principles. Consider the case of matter. From the *Metaphysics* we learn that the student of nature is concerned with natural substances: the substances that have a nature as an internal principle of motion and rest (1025 b 18–21). For Aristotle, these substances are essentially realized in some matter or other. To put it in another way, the natural substances are essentially material substances. The job of the student of nature is to study these substances without omitting their material aspect or reducing them to their material aspect only. Yet these substances need not be realized in the same matter. Aristotle is firmly persuaded that there is no material unity in the natural world. He is able to speak of matter without committing himself to the thesis that there is one and the same material out of which everything in the natural world is made. I shall return to this crucial aspect of the Aristotelian doctrine of matter in due course.[35] For the time being, I am content to say that Aristotle believes in the existence of celestial matter as a significantly different type of matter from the one we encounter in the sublunary world.

At any rate, the unity of *genos* is not just the unity of method. The different parts of the program outlined at the beginning of the *Meteorology* are held together by explanatory unity. But this explanatory unity ultimately rests upon *causal unity*. The different parts of the natural world are related to one another in such a way that some of them have a determinate influence on the others. By simply performing circular motion, the celestial bodies secure the continuity of the generation of one thing from another in the sublunary world. For Aristotle, there would be no sublunary world without the action of the celestial world. Put differently, celestial bodies, meteorological phenomena, animals, and plants have sufficient unity to be one *genos* rather than an arbitrary division of reality because they are causally interconnected in a specific way, and the job of the student of nature is to uncover this specific causal interconnectedness.

## IS THE STUDY OF THE SOUL PART OF THE SCIENCE OF NATURE?

In the opening lines of the *Meteorology* Aristotle makes it very clear that the study of life belongs to the science of nature. The study of plants and animals seems to be understood as a central part, if not the culmination, of the science of nature. But does the study of the principle of life, the soul, belong to the science of nature? Interestingly enough, Aristotle makes no reference to a distinct investigation of the soul in the prologue to the *Meteorology*. He does say that once the meteorological phenomena have been addressed we should move to plants and animals and study

35 Chapter 4, "The limits of Aristotle's science of nature."

them according to the method indicated; however, he does not refer to a distinct investigation of the soul, either in clause (6) or (7). How is his silence to be understood? Tentatively, one might try to explain the absence of a reference to the *DA* from the beginning of the *Meteorology* by appealing to the programmatic nature of this passage. The *DA* would not be mentioned precisely because Aristotle is content to outline a program. Neither a work on the parts nor a work on the generation of animals is listed at the beginning of the *Meteorology*. Yet such works are not excluded from the science of nature as it is presented in this passage. Why should the case of the *DA* be different from that of *PA* or *GA*? Indeed the case of the *DA* is a different one, and I shall try to explain why.[36]

There is no doubt that the study of the soul is both relevant and preliminary to a study of life. Aristotle insists on this point in the opening lines of the *DA*. Note, however, that Aristotle does not say that the study of the soul is part of the study of nature. His language seems to be carefully designed not to say that the study of the soul is part of the science of nature:

> it also seems that knowledge of the soul contributes greatly to all the truth, but most especially to truth about nature; for the soul is a sort of principle of *zōia* (402 a 4–7).

In this particular case I have decided against translating the word *zōia*, which is tentative and ambiguous in various ways.[37] In its most general meaning, *zōia* refers to all the living beings that there might be, including any living being superior to human beings that there might be.[38] In the *DA zōia* is normally used to refer to animals. Aristotle is able to say that all living beings, *zōnta*, have life, but only animals, *zōia*, have

36 The view that the study of the soul is a branch of the science of nature is defended in Wedin (1988: 3–9). Cf. also Burnyeat (2001: 134n15): "psychology for Aristotle is part of physics: see *DA* 1.1 with the caveats of *PA* 1.1.641 a 32–b 10, *Metaph. Epsilon* 1.1026 a 5–6." Burnyeat (2002: 28–90, in particular 36): "his psychology is designed to be the crowning achievement of his physics." In the light of this conviction, it is not surprising to discover that Burnyeat can see a reference to the *DA* in the opening lines of the *Meteorology*: "this is a large scale map of Aristotle's natural philosophy, beginning with the *Physics*, going on to the *DC* and the *GC*, pausing here for the *Meteorologica*, looking forward to the *DA* and the biological works." Cf. Burnyeat (2004: 13). The debate on whether the study of the soul belongs to the science of nature goes back to antiquity. See [Simplicius], *In DA*, 1. 23–3. 28. This debate continued in the exegetical tradition in the format of a preliminary *quaestio* to the study of the soul. For a convenient, late scholastic summary of this debate, see the Coimbran authors, *In DA*, *quaestio unica*, *num intellectivae animae contemplatio ad physiologicae doctrinam pertineat, an non*.

37 I owe this point to Michael Frede.

38 See the passages from the *Timaeus* that I have quoted in footnote 11.

perception (413 b 1–4). But this cannot be the meaning that *zōia* has at the beginning of the treatise. Aristotle cannot say, at the outset of his investigation, that the study of the soul is relevant, and indeed preliminary, to a study of animals, let alone animal life (*pace* Hicks and Hamlyn). He has first to establish that animals are a distinct class of living beings, and that animal life is a form of life distinct from both human and plant life. To assume, right from the beginning, that animals are a distinct class of living beings, let alone a specific form of life, would amount to denying that the study of the soul is foundational with respect to the study of animal life which is conducted in the biological works. In a recent publication, Geoffrey Lloyd has drawn attention to the role of the *DA* in the context of Aristotle's zoology. He has considered the opening lines of the *DA* as evidence for the "zoological orientation" of the treatise and has read it in the light of the criticism that a few lines below Aristotle raises against his predecessors, who in considering the soul wrote as if human souls were the only type of soul (402 b 3–5).[39] The zoological orientation of the *DA* cannot be disputed. But the first, crucial step in this project is to show that the focus on animal life is not the result of an arbitrary decision, but it rather reflects the way the natural world is divided. In other words, the *DA* provides Aristotle not only with the conceptual resources but also with a theoretical justification for his decision to focus on animal life, to the exclusion of plant life.

Before embarking on the study of the soul Aristotle tells us that this study will result in knowledge of the soul, and that this knowledge will contribute to the study of nature because it is relevant to the study of all living beings, *zōia*. His view seems to be that in order to study life optimally, one has to engage in the study of the principle of life, the soul. However, this does not help us to understand why an investigation of the soul is not mentioned at the beginning of the *Meteorology*. On the contrary, Aristotle's silence invites a close scrutiny of the considerations that may have led him to exclude the study of the principle of life, the soul, from the program outlined at the beginning of the *Meteorology*. Here I would like to make two distinct but related points. Together they will help us to understand, or perhaps to begin to understand, why there is no reference to the *DA* in the opening lines of the *Meteorology*. To begin with, there is scant yet clear evidence that in the *DA* Aristotle does not concern himself with the soul without qualification. A couple of times Aristotle

39 Lloyd (1998b: 38–66).

explicitly confines his investigation to the soul of *perishable living beings* (413 a 31–2; 415 a 8–9). In the following chapters I shall argue that Aristotle is a modest investigator and explain why he does not engage in an investigation of the celestial souls, though he admits that the celestial bodies are equipped with cognition and desire. For the time being, I am content to notice that Aristotle's study of the soul is programmatically confined to the souls of perishable living beings.[40] Secondly, and more importantly, even this modest investigation, the investigation of the soul of perishable (= sublunary) living beings, goes beyond the boundaries of the science of nature. In *PA* I Aristotle wonders whether the entire soul, or only a part of it, is the province of the <inquiry into> nature (641 a 33–4). He concludes that the inquirer into nature is not concerned with the entire soul but only with a part of it:

> It is clear, then, that one should not speak of the soul in its entirety: for it is not the soul in its entirety that is a nature, but <only> some part of it (one part or more parts) (641 b 9–10).

How is this conclusion to be understood? In *PA* I Aristotle argues for the view that the science of nature does not study the soul in its entirety.[41] His argument crucially depends on the following piece of hypothetical reasoning:

1. If the science of nature studies the soul in its entirety, then it studies thought [*nous*].
2. But thought [*nous*] is *of* all the objects of thought [*ta noēta*]. Therefore
3. no philosophy [*philosophia*] is left besides the science of nature.

The problem with the conclusion (3) is that it conflicts with Aristotle's view that the science of nature does not exhaust the totality of what can be thought. For Aristotle, there are objects of thought that are not studied by the science of nature. For instance, mathematical objects are objects of

40 In the Aristotelian tradition the study of the soul is programmatically confined to the souls of perishable living beings. Here is how Alexander of Aphrodisias introduces his own *De anima*: "It is our intention to discuss the soul, *that of the body liable to generation and perishing*. We shall inquiry into its *ousia* and its capacities, what and how many these are, and how they differ among themselves" (*DA* 1. 1–3). The fact that the study of the soul is programmatically confined to the soul of perishable living beings should not be taken as evidence for the view that life manifests itself only in this way. Like Aristotle, Alexander believes that the celestial bodies are alive and engaged in the eternal and blissful life that is appropriate to their divine status. I shall return to the topic of celestial life in chapter 3, "Motions."

41 For a recent discussion of this argument, see Broadie (1996: 163–76, in particular 168–9); Caston (1996: 177–92, in particular 181–4). See also Lennox (1999: 1–17).

thought, and they do not fall under the science of nature. The mathematician rather than the student of nature concerns himself with these objects and their per se properties. This point can be extended to any body of knowledge that constitutes an Aristotelian science or expertise. Each Aristotelian science or expertise consists in a system of *noēta*. If accepted, the conclusion (3) would commit Aristotle to the claim that the science of nature studies the totality of that which can be grasped by thought; that is, the totality of that which is intelligible. For Aristotle, there is therefore a problem with either (1) or (2). But (2) is a piece of doctrine that Aristotle endorses. For Aristotle, each capacity, including the capacity for thought, has its correlative objects, and the study of each capacity results in a study of all the correlative objects. There remains (1) and the claim that the science of nature studies the soul in its entirety, including thought. This is the claim that Aristotle rejects. The science of nature does not study the soul in its entirety. For Aristotle, thought is a capacity that fully developed human beings naturally possess; at the same time, however, Aristotle regards thought as a natural capacity that enables them to progress beyond nature and the natural world.

The *boundaries* of the science of nature are clearly demarcated in *PA* 1: the job of the student of nature is to investigate the soul in so far as it is a principle of motion and rest – in so far as it animates a body of a specific type. His job is to study the soul in so far as this latter is responsible for the activities that are characteristic of this particular type of living body. Three types of activities are mentioned: growing, perceiving,[42] and moving around. Two specific parts of the soul are also listed: the part which is present *even* in plants, and the perceptive part, *to aisthētikon* (641 b 5–6).[43] There is no doubt that these parts are regarded as the relevant sources for the activities in question and therefore fall within the province of the science of nature. A third part of the soul is nevertheless mentioned in the *PA* 1: *to noētikon*. This part does not have a role in the explanation of the first two activities mentioned (growing and perceiving). It can but need not have such a role in the explanation of the moving around of an appropriate living body; that is, the living body of a human

42 Aristotle speaks of alteration – in Greek *alloiōsis*. In the *DA* Aristotle argues that perception is a sort (*tis*) of alteration (416 b 34). On how to understand this claim (and the qualification *tis*) I refer the reader to Burnyeat (2002: 28–90).

43 Remember that the focus of *PA* is animal life. By referring to the part which is present even (*kai*) in plants, Aristotle explicitly acknowledges that plants are alive. In the *DA* Aristotle has established that plants are alive and enjoy a specific type of life, distinct from animal life.

being. Aristotle makes this point in the *DA*: we often follow <our own> *phantasiai* against knowledge (433 a 10–11). What appears to be the good accompanied with the appropriate desire suffices for action. But if this is the case, for human beings as well as for the non-rational animals, *phantasia,* accompanied with the appropriate desire, is sufficient for moving from one place to another.

The position defended in *PA* I is briefly recalled in the *Metaphysics*. In his discussion of the partition of theoretical sciences into the science of nature, mathematics, and theology, Aristotle claims that the job of the student of nature is to study "some soul" (1026 a 5). He adds that this is to be identified with "the soul that cannot be without matter" (1026 a 6). In the *DA* Aristotle argues for the immateriality of thought on the basis of the fact that there is no restriction on the extent of that which can be thought (429 a 18). I do not need to enter into a discussion of this notoriously difficult aspect of Aristotle's psychology. I only note that the study of thought (*nous*) is a crucial part of psychology, and that for this reason psychology seems to enjoy a special status in the Aristotelian system. Let us return, finally, to the partition of the theoretical sciences into the science of nature, mathematics and theology. There is no doubt that this classification is meant to be exhaustive and that psychology is to fall under one of these three broad theoretical sciences *if* it is a science. However, the conditional is more than appropriate in this case: given that the study of the soul does fall under these three broad theoretical sciences but does not fall *completely* under any of them, one may wonder whether for Aristotle the study of the soul is a science at all.[44]

Perhaps I am now able to say why there is no reference to an investigation of the soul at the beginning of the *Meteorology* and, more generally, why Aristotle, in the *DA* or elsewhere, refrains from saying that the study of the soul is part of the science of nature. Since Alexander of Aphrodisias

44 Alan Code (in a private communication) tells me that there is a theoretical study of the soul corresponding to each of the theoretical sciences. This is required by the argument that Aristotle offers in *PA* I and the idea that thought and its objects are correlatives. But I have already insisted that a(n Aristotelian) science is always about a specific domain and that this domain has to satisfy certain constraints. Minimally, it must possess a specific kind of unity – generic unity. It is just unclear whether this kind of unity is possible in the account of the soul. An objection: for Aristotle, the soul is sufficiently united to be the object of a single study (*pragmateia*). My answer is that the *DA* is devoted to the soul of the perishable living beings, not to the soul without qualification. In due course I shall return to this topic. I shall argue that Aristotle has a plan for the study of the soul. I shall show that this plan crucially depends on a firm grasp of the boundaries of the investigation of the soul. See chapter 4, "The limits of Aristotle's science of nature."

it has been routinely suggested that the *Meteorology* must contain an implicit reference to the *DA* and that this implicit reference is to be read in clause (6).[45] On the contrary, there is no reference, either implicit or explicit, to the *DA* at the beginning of the *Meteorology* because the investigation of the soul, or rather the section of the *DA* concerned with thinking and thought, goes beyond the boundaries of the science of nature. As Aristotle himself puts it at the beginning of the *DA*, the study of the soul is relevant for getting to *all* truth (as opposed to truth about nature and the natural word only, 402 a 4–7).[46]

45 Here is how Alexander elaborates on the reference to "the account of animals and plants" in clause (6):

> one will include in the study of animals <the works> (1) on the soul, (2) on perception and the objects of perception, (3) on memory and sleep and divination through sleep, (4) on youth and old age, (5) on length and brevity of life, and (6) whatever else has been written by Aristotle and refers to animals (*In Meteora* 3.29 – 4.1).

Note that the investigation of the soul (the *DA*) is mentioned at the beginning of this passage, and the short treatises to which we usually refer with the collective title *Parva naturalia* (*PN*) occupy second place. They are considered a sequel to the *DA*. For the epistemological status of the *PN* see next footnote.

46 On the interpretation I am recommending, Aristotle's science of nature and his study of the soul overlap in various ways, but they are distinct disciplines. Aristotle seems to have a firm grasp of their boundaries. Consider how the short investigations collected under the title *PN* are introduced:

> (1) Since we have already dealt with the soul by itself and with each of its capacities, (2) we have next to consider animals [*zōia*] and all the beings that have life, <investigating> what are their common and what are their proper activities [*praxeis*]. (3) Now let it be assumed what has been said about the soul; let us consider the remaining questions, <dealing with> those which come first (*De sensu* 436 a 1–6).

From clause (3) we learn that in the *PN* Aristotle is working within the theoretical background established in the *DA*. Aristotle presupposes the general account of the soul offered in the *DA*; he intends to build on it, providing important clarifications concerning, among other things, his account of perception and memory. Clause (2) makes it clear that the short treatises collected under the label *PN* are immediately relevant to the study of animals. But Aristotle promptly adds that these treatises are relevant to the study of all the beings that have life, including plants. Note, however, that Aristotle is about to engage in a new enterprise. The object of the investigation is no longer the soul but the living beings. The short treatises collected in the *PN* fully belong to the science of nature and are immediately relevant to the study of life as encountered on earth. Today it is not unusual to refer to the complex of problems and issues originating from the *DA* and the *PN* as psychology. Psychology so understood is a complex business whose epistemological status is dubious. Though the study of the soul offered in the *DA* is preliminary, and even necessary, to the science of nature, the account of thought and thinking that Aristotle offers in the *DA* goes beyond the boundaries of the science of nature. By contrast, the specific studies that are collected in the *PN* are meant to discuss some aspects of specific types of life and are clearly subordinated to the further study of animal life.

## MORE ON THE BOUNDARIES OF ARISTOTLE'S SCIENCE OF NATURE

Each Aristotelian science is a structured body of knowledge. Aristotle's science of nature is no exception to the rule. From the opening lines of the *Meteorology* we learn that the student of nature is engaged in a complex and at the same time ambitious investigation of a specific department of reality: the natural world. In order to understand what gives structure to this investigation and makes it a single inquiry rather than a collection of loosely connected, if not disconnected, investigations, we have to bear in mind that Aristotle's science of nature is a causal investigation of the natural world whose ultimate aim is to provide causal knowledge of this specific department of reality. But causal knowledge of specific features of the sublunary world can be gained only on the basis of some previous knowledge of the celestial world. More directly, there are features of the celestial region which play a causal role in the explanation of the natural phenomena which take place in the sublunary region. I have argued that this view is ultimately dependent upon a certain conception of the natural world. Aristotle thinks of the natural world as a causal system consisting of a celestial and a sublunary part causally interconnected in a specific way. However, the structure of the science of nature presented in the opening lines of the *Meteorology* reflects not only a certain conception of the natural world but also a certain view of the way natural investigation is to be conducted. The discrete investigations listed at the beginning of the *Meteorology* are preceded by an account of "the first causes of nature, and natural change in general" – clause (1). The language chosen for this brief yet accurate description of the content of the *Physics* suggests that the student of nature is expected to engage in a sensible investigation of nature. This investigation is sensible in the sense that it is conducted on the basis of a specific conceptual apparatus. The opening lines of the *Meteorology* make it clear that this conceptual apparatus grows out of a general account of nature and change. It is precisely in this sense, and only in this sense, that in the *Physics* Aristotle concerns himself with the foundation of the study of nature. By looking at *Physics* 1 and the way the inquiry into nature is introduced, I now would like to show that this foundation presupposes a strong grasp of the *boundaries* of the science of nature.

Aristotle announces the topic of *Physics* 1 at the outset:

> The science of nature, <like the other sciences>, must begin by trying to settle the question of the principles (184 a 14–16).

Evidence that this *logos* is a somewhat independent and self-contained study comes from the very end of the book. At this point, Aristotle is manifestly confident that the question raised at the beginning is settled:

That there are principles, and what and how many they are, let it be established for us in this way. Let us now make a fresh start (192 b 2–4).

The principles Aristotle is interested in are the principles of nature, which in the end turn out to be principles of change. Interestingly enough, Aristotle does not pause to tell us what nature is. Nor does he make an attempt to connect nature and change or to say what a principle is. He takes a certain familiarity with these concepts for granted and immediately engages in a study of the principles of nature.[47] One way to explain this strategy is to assume that Aristotle is provisionally relying on the way nature, change, and principle were understood by his contemporaries and predecessors, whom he refers to with the collective title of *physikoi*. Suffice it to say that in this tradition to have a certain nature is not merely to be something or other, but rather to become something or other (under certain circumstances). In this tradition the study of the entire natural world was conducted on the assumptions that a thing becomes what it is (again, under certain circumstances), and that "nothing comes to be from what is not" (187 a 28–9).[48] Also, in the light of these assumptions, it is not difficult to understand why the study of nature was typically a study of the nature of things from the beginning, in Greek *ex archēs*: namely, a study of how natural things have become what they are, which in turn boils down to a study of the material principles out of which these things are ultimately constituted.[49]

47 See also Bostock (1982: 179): "Aristotle opens *Physics* I by stating that an inquiry into nature like other inquiries, should begin with an account of the relevant principles. He does not tell us what he means by 'nature' – for that we have to wait until book 2 – and he does not tell us what he means by a 'principle' in this context."

48 See chapter 4, "The limits of Aristotle's science of nature."

49 The Hippocratic author of *Ancient Medicine* provides us with a vivid description of the study of man in the tradition of natural investigation:

(1) certain *sophistai* and certain doctors assert that nobody can know medicine who is ignorant of what a man is; he who would treat men properly must, they say, learn this [= what man is]. (2) But this *logos* takes them into philosophy [*philosophiē*]; it is the province of those who, like Empedocles, have written on nature; what man is from the beginning [*ex archēs*], namely how man came into existence at first, and from what elements he was originally constructed (*VT* XX 1.1–7).

This frequently cited passage contains an attempt to separate medicine from an enterprise that has obvious overlaps with medicine and that at the beginning of clause (2) is called *philosophiē*. What follows in clause (2) is intended to provide some content to the name together with a description of the way man is studied by "those who, like Empedocles, have written on nature."

In *Physics* 1, Aristotle accepts the language of becoming and the conceptual framework developed by his predecessors only to revise it in the course of his investigation. For Aristotle, his predecessors and contemporaries were never entirely clear on the crucial distinction between principles and *first* principles. As a result of this lack of clarity, they all failed to offer an adequate starting point for their investigations. They all agreed in making the contraries principles, but the way they selected their contraries was not supported by a strong grasp of the distinction between contraries and first contraries.[50] More directly, they all failed to find out a rational way to reduce the plurality and complexity of contrariety to two primary contraries. In other words, in the natural world we are confronted with fundamentally different contraries. These contraries are fundamentally different in the sense that they cannot be explained away or eliminated, though they can be understood in the light of a conceptual schema whose generality enables the student of nature to grasp what they all have in common. According to Aristotle, his predecessors and contemporaries failed to work out the conceptual apparatus needed for an adequate analysis of the fundamentally different contraries. Put differently, they all adopted the *language* of contrariety, but failed to develop a *theory* of contrariety.[51] As for Aristotle, the first contrariety is secured through an analysis of becoming conducted on the most general level. By his own admission, in *Physics* 1, Aristotle concerns himself with all becoming; that is, becoming in general (189 b 30):

> for the natural procedure is first to say what is common to all cases, and only then to consider what is peculiar to each <case> (189 b 31–2).

In this passage, Aristotle is not only announcing an analysis of becoming *in general*; he is also making it clear that this *general analysis* of

50 Consider the following passage:

> (1) It is then clear that everybody makes, in one way or another, the contraries principles. (2) And this is plausible: the principles must come neither from one another nor from something else, and everything else must come from them. (3) The primary contraries have these characteristics; because they are primary they do not come from anything else; because they are contraries they do not come from one another (*Phys.* 188 a 26–30).

Aristotle starts out with the claim that all his predecessors and contemporaries adopted the language of contrariety – clause (1). Clause (2) contains the reason for the universal recourse to the language of contrariety. In clause (3), Aristotle makes it clear that the primary contraries (*prōta enantia*) alone fulfill the general requirement that motivated his predecessors and contemporaries in adopting the language of contrariety.

51 More on the language versus the theory of contrariety in chapter 4, "The limits of Aristotle's science of nature."

becoming is only preliminary to a more substantive investigation of the different cases of becoming. In other words, this general analysis does not explain away the complexity and variety of the natural world; it only provides an explanatory schema to deal successfully with it.[52] It is precisely for this reason that the principles Aristotle arrives at have little in common with the principles discovered by his predecessors and contemporaries. Whereas they ended up offering a set of things as the principles of everything, Aristotle insists that his principles (matter, form, and deprivation) are not things; they are types of things.[53]

In *Physics* 1, Aristotle's investigation is conducted on the assumption that there is change, and that change takes different forms and manifests itself in different ways. However, in the intellectual background in which Aristotle grew up, the existence of change could not be taken for granted. As Aristotle himself points out, Parmenides and Melissus denied the existence of change and argued that what is is one. This explains why Aristotle does not begin with a review of the positions held by the *physikoi,* but with a refutation of Parmenides and Melissus. Interestingly enough, the reader is told not to take this refutation as a piece of science of nature:

> the question whether what is is one and is not subject to change does not belong to <the science of> nature (184 b 25 – 185 a 1).

In this passage Aristotle is not saying that a refutation of Parmenides and Melissus is not possible. Nor is he saying that this refutation is not relevant to the study of nature. Parmenides and Melissus happened to raise *aporiai* that are relevant to the science of nature – in Greek *physikai aporiai* (185 a 18–19). Dealing "to some extent"[54] with these *aporiai* is perfectly appropriate, and perhaps even required, at the beginning of an investigation of nature. But dealing with these *aporiai* is *external* to the science of nature. Aristotle makes it abundantly clear that he considers the Eleatic challenge a criticism moved by outsiders who happen to write about nature. In *Physics* 1, Parmenides and Melissus are equated with people who advance an eristic argument, a *logos eristikos* (185 a 8). They are like people who have not mastered the standards of the discipline that they happen to write about, and out of their incompetence argue from

52 In *Phys.* 1, Aristotle insists that "becoming is said in many ways" (190 a 31). More directly, becoming something or other (e.g. becoming white or hot) is different from becoming *simpliciter*; that is, coming into being, or coming into existence.

53 More on matter, form, and deprivation in chapter 4, "The limits of Aristotle's science of nature."

54 Aristotle adds the qualification *epi mikron* (185 a 19).

false premises and violate the rules of the syllogism (185 a 9–10).[55] In this context, the student of nature is equated to the expert who has to protect himself and his expertise from a criticism moved by someone who claims to be an expert but in fact does away with the expertise and its principles and by so doing reveals his incompetence. Antiphon the Sophist and his supposed quadrature of the circle are mentioned (185 a 17). For Aristotle, Antiphon made no positive contribution to geometry, and no one who has mastered geometry should be impressed by it. A refutation of Antiphon is not even a business of the geometer, who instead is expected to discuss the mistakes that are made by mathematicians (for instance the supposed quadrature of the circle by means of segments or lunes).[56]

Building on the model of geometry, Aristotle seems to suggest that refutation of Parmenides and Melissus is to be attempted either by

55 Aristotle's language is not neutral with respect to the definitions offered at the beginning of the *Topics* and the *SE*. From the *SE* we learn that "eristic arguments, for example, are those which deduce or appear to deduce a conclusion from premises that appear to be plausible but are not so" (165 a 38 – b 8).

56 The quadrature of the circle was already a major concern in the second half of the fifth century. We find a reference to it beyond geometry in Aristophanes' *Birds* (1001–5). Also in the light of this fact, we should not be surprised to discover that the quadrature of the circle drew the attention of outsiders such as Antiphon. In the secondary literature Antiphon is often presented as a dilettante or an amateur who happened to be interested in this mathematical problem. But this is not Aristotle's view. Aristotle considers Antiphon an intruder with no genuine interest or competence in mathematics. For an informative introduction to the problem of the quadrature of the circle and its discussion in the Aristotelian corpus, I refer the reader to Müller (1982: 146–64). The supposed quadrature of the circle by means of segments of lunes is traditionally attributed to Hippocrates of Chios, who is in all probability to be exonerated from this fallacy. See Lloyd (1988: 103–27). In *Phys.* 1, Aristotle restricts his discussion to the case of geometry. However, the problem is a more general one, and ultimately goes back to the debate on the arts or *technai* that took place in the second half of the fifth century. At the time, it was not uncommon for an expert to have to protect himself and his arts against denigrators. The Hippocratic treatise *The Art* is a defense of the art of medicine against "those who make an art [*technē*] out of vilifying the arts [*technai*]" (*De arte*, I 1.1). What is remarkable about *The Art* is that the author is "fully aware of the fact that not only the existence of medicine as an art was at stake in this debate, but equally the existence of every other art and science. The general form given to the argument at the outset of the author's refutation is proof of this, for it undertakes to mount a defense on behalf of all the arts, not just of medicine" (Jouanna 1999: 246). It would be interesting to know who these adversaries were, who at the time attacked the arts in general and medicine in particular. The author of *The Art* is not helpful on this particular point. He refers to them by some plural circumlocution such as "those who thus invade the art of medicine," "those who attribute recovery to change and deny the existence of the art." Jacques Jouanna tentatively suggests the name of Protagoras, who wrote a work entitled *On Wrestling and the Other Arts*: "Since the work is known to have examined each art in particular it must have included objections against the art of medicine. It is not impossible that *The Art* was in fact a reply to attacks that ultimately derived from this work of Protagoras. Objections to the existence of the art of medicine may therefore have come from the Sophistic circle" (Jouanna 1999: 244). If we bear in mind this more general debate over the arts that took place in the second half of the fifth century, it becomes easier for us to understand why Aristotle equates Parmenides and Melissus to Sophists who advanced an eristic argument (185 a 8).

another departmental science, if there is one, to which the science of nature is subordinated, or by an <*epistēmē*> that is common to all <sciences> (alternatively: common to all <men>) (185 a 2–3). Aristotle is remarkably reticent and does not discuss the alternative he is offering in this passage. He is content with the result secured by the alternative, namely that the refutation of the Eleatic position is not a piece of the science of nature.[57] In translating 185 a 2–3, I have made it explicit that the relation between the science of nature and this other departmental science envisioned by Aristotle must be a relation of subordination. Subordination is a well-known Aristotelian technique of coordination among autonomous sciences. Aristotle thinks of the mathematical sciences as forming a hierarchy, going from general mathematics to geometry and arithmetic, and to optics, astronomy, and mechanics (subordinated to geometry) and harmonics (subordinated to arithmetic).[58] However, the possibility that the science of nature is subordinated to some other science is to be excluded by the fact that in the *Metaphysics* Aristotle presents the science of nature together with first philosophy and then mathematics as the three *philosophies*, in Greek *philosophiai* (1026 a 18–19). There is no evidence that Aristotle has ever thought of the science of nature as a subordinated science, either in the *Metaphysics* or elsewhere. We are therefore left with the possibility that there is another *epistēmē* that deals with the Eleatic challenge precisely because this *epistēmē* is common to all sciences (alternatively: common to all men). Dialectic is in all probability the *epistēmē* in question. This is not the place to enter into the much debated question of what exactly dialectic is and what function and role Aristotle reserves to it. Suffice it to say that an examination of the arguments of Parmenides and Melissus, though relevant to the science of nature, goes beyond the *boundaries* of the science of nature. Aristotle does not deny that this examination can be conducted by the student of nature. His view is that, in this examination, the student of nature cannot invoke any of the principles appropriate to the science of nature, which are likely to have no impact on Parmenides and Melissus. In discussing their arguments, the student of nature should make use of the general ability of examining a thesis only on the basis of the principles that are common to him and to Parmenides and Melissus.[59] These are in

57 Aristotle does not change his mind on this point. See *Phys.* 193 a 4–9. For a discussion of this second passage, I refer the reader to Waterlow (1982: 30–1).

58 For an introduction to Aristotle's conception of subordination see McKirahan (1978: 197–220).

59 Cf. *Rhet.* 1354 a 1–6.

fact the only things that are likely to be accepted by Parmenides and Melissus.[60]

## LOOKING AHEAD

So far I have insisted on the unity of the natural world and argued that Aristotle conceives of this world as a causally unified system. In the following chapters I shall argue that Aristotle believes in the existence of *celestial* and *sublunary natures* but does not believe in the *uniformity of nature*. In the natural writings as well as elsewhere, there is evidence that Aristotle is committed to the view that there is an important discontinuity between the celestial and the sublunary worlds. Here is a passage that I have discussed only in part and that I now quote in its entirety:

> (1) Since these causes are four, it is the job of the student of nature to know about them all, and he will give an answer to the "why?" [*dia ti*] in the way appropriate to the science of nature [*physikōs*], bringing it back to them all: matter, form, that which originated the change, and that for the sake of which. (2) The last three often come down to one: for what the thing is and that for the sake of which it is are one, while that from which the change first originated is the same in form as these: for *it takes a man to generate a man* – and in general things that change by being themselves changed. (3) Things that are not so fall beyond the province of the science of nature: for they change without having change or a principle of change, but by being not subject to change. (4) For this reason [*dio*] there are three studies [*pragmateiai*]: one that is concerned with the things that are not subject to change, one with the things that are changed but imperishable, and one with the things that are perishable (*Phys.* 198 a 22–31).

From this passage it is clear not only that the student of nature is engaged in a causal investigation, but also that this causal investigation is a search for all the relevant or appropriate causes. Aristotle makes the latter point by saying that the student of nature is expected to answer the question "why?" in the way that is appropriate to the science of nature – in Greek *physikōs*, clause (1).[61] Clause (2) starts out as a specification on the doctrines of the four causes: the form and the goal are numerically one, and they are the same in form as the moving principle. This is one of the many passages where Aristotle reports his favorite slogan that it takes a man to generate a man. This time, however, Aristotle does not add "and

60 Even this brief and somewhat inadequate treatment of dialectic is sufficient to understand why Aristotle insists on the *genos*-neutrality of dialectic. From the *A post.* we learn that dialectic is not *genos*-oriented but is common to all the sciences (77 a 25–35).

61 For the interpretation of *physikōs* I follow Simplicius, *In Phys.* 363. 6–7.

the sun."[62] This small yet significant fact reveals that Aristotle is not primarily interested in the unity of the natural world. This is confirmed by what immediately follows in the passage. At the very end of clause (2) Aristotle argues that the science of nature is about things that change by being changed. From clause (3) we learn that not everything that changes is itself changed; in fact, there are things that change without being changed. These things are not changed because they do not have a principle of change: more specifically, they are not subject to change at all; they are *akinēta*. Also on the basis of this remark, Aristotle concludes that there are three studies or *pragmateiai*: (i) the study of that which is not subject to change, (ii) the study of that which is subject to change but not perishing, and finally (iii) the study of perishable things – clause (4). This conclusion is mildly surprising. On the one hand, Aristotle claims that the domain of the science of nature is the realm of change; on the other, he breaks this science into two *pragmateiai* and, at least in this passage, shows no concern for their coordination. This is not the only passage in the Aristotelian *corpus* where the discontinuity of the natural world is stressed over its unity. *Lambda* 1 is another remarkable case. I shall return to *Lambda* in due course.[63] For the time being, I am content to say that even when the unity of nature becomes an overriding concern, Aristotle never fails to remind the reader that there is an important discontinuity between the celestial and the sublunary region. For instance, the investigation conducted in the *Meteorology* crucially depends upon the assumption that the totality of the sublunary bodies is continuous with the celestial body. In this context, Aristotle is expected to insist on the continuity between the celestial and sublunary region of the natural world. But even in the *Meteorology* Aristotle does not fail to add a small yet significant qualification. According to some of the MSS, the totality of the sublunary bodies is *somehow* – the Greek is *pōs* – continuous with the celestial body (339 a 21–2). In the rest of the book I shall make an attempt to shed some light on the force of the *pōs* as well as on the consequences descending from it. I shall argue that according to Aristotle there is a lack of uniformity in nature, which ultimately puts severe limits on what can be known about the celestial natures. Aristotle seems to be reluctant to engage in an investigation of the celestial natures when and where the lack of information at our disposal cannot be overcome by an appeal to the similarities that the celestial natures share with the sublunary natures.

62 But he does at 194 a 13.
63 Chapter 4, "The limits of Aristotle's science of nature."

# CHAPTER 2

# *Bodies*

## BODIES AND MAGNITUDES

> The science of nature is clearly concerned for the most part with bodies and magnitudes, the affections and motions of these, and the principles of this kind of substance (Aristotle, *DC* 268 a 1–6).

By this point I hope to have established that Aristotle sees his science of nature as a systematic whole. It should also be clear that this science is seen as a systematic whole because it presents an account of a world that is similarly systematic. More directly, and more boldly, the science of nature mirrors the system of nature. Aristotle's conception of the natural world follows from the research program conducted in the science of nature. In other words, it is the study of the celestial and sublunary bodies that leads him to believe that the natural world is a causal arrangement of a certain type, and to the view that the study of the celestial world should precede, rather than follow, the study of the sublunary world. In the first two books of the *DC* are collected the results that Aristotle reached in the study of the celestial world. In the following chapters, I shall focus on specific parts of the *DC* and show how unusual Aristotle's conception of the celestial word is, especially if it is considered in its historical context in relation to his predecessors and successors. In this chapter, I would like to focus on the very beginning of the *DC*, which I have quoted in the epigraph, and discuss the idea that *bodies* and *magnitudes* are the object of the science of nature.

For Aristotle, bodies are magnitudes; they are magnitudes of a certain kind. In the lines that immediately follow the quoted passage, Aristotle provides three distinct but related definitions of body by recourse to the notions of *continuity* and *divisibility*. Continuity is reduced to divisibility: something is continuous if, and only if, it can be divided in ever-divisible parts (268 a 6–7). If a magnitude can be divided in one dimension it is a line; if it can be divided in two dimensions it is a surface; and finally if it can be divided in three dimensions it is a body. A body is therefore a magnitude divisible in three dimensions – *Def.* 1. Since for Aristotle there cannot be more than three dimensions, to say that a body is divisible in three dimensions is the same as saying that it is divisible in all dimensions. Hence a body is a magnitude divisible in all dimensions – *Def.* 2 (268 a 7–10). Admittedly, "dimension" does not occur in the text. Aristotle spells out *Defs.* 1 and 2 by saying that body is *to epi tria* <*diaireton*>.[1] But a few lines below Aristotle says that a body has all dimensions, *diastaseis* (268 b 6–7). The Greek even has a word for each of the three dimensions: length, breadth, and depth are *mēkos*, *platos*, and *bathos* respectively.[2] Finally, it is not difficult to find a definition of body that makes an appeal to the dimension distinctive of body: depth. In the *Timaeus* Plato defines body by saying that it also has depth (53 c 5–6). Interestingly enough, there is no mention of divisibility in the *Timaeus*. In due course I shall argue that in the *DC* Aristotle intends to offer a definition of body that is alternative to the one presented in the *Timaeus*. On Aristotle's interpretation, Plato is committed to atomism. For the time being, however, I limit myself to saying that ancient atomism is a family of different theoretical positions, all sharing the view that the ultimate magnitudes from which the world is constructed are indivisible magnitudes. By stating that a body is a continuous magnitude divisible in three or all dimensions, Aristotle is reacting against the supposed atomism of the *Timaeus* (and its Academic varieties).

The equivalence between *Def.* 1 and *Def.* 2 ultimately rests on the conviction that there are three, and only three, dimensions. Aristotle cannot take it for granted that there are only three dimensions but has to provide some evidence in support of this claim. Since antiquity commentators have routinely complained that the evidence Aristotle offers is surprisingly weak. He is content to make an appeal to (i) the

1 Both *diaireton* and *diastaton* are grammatically possible. By understanding *diaireton* one does not deny that bodies are three-dimensional but stresses that bodies are divisible in three dimensions. More directly, bodies are divisible in three dimensions because they are three-dimensional. If one understands *diastaton*, it becomes difficult to see why Aristotle introduces the notion of continuity – divisibility – in lines 268 a 6–7 rather than in line 268 a 24.

2 Aristotle can refer to the three dimensions as *diastēmata* (rather than *diastaseis*). Cf. *Phys.* 209 a 4–5: "<Place> has three dimensions [*diastēmata*], length, breath, and depth, by which every body [*sōma*] is delimited." In *Phys.* 4 Aristotle takes it for granted that each body occupies a certain place by virtue of the fact that each body is surrounded by other bodies. There is no need to enter into a discussion of the Aristotelian notion of place. Suffice it to say that it is distinctive of *Phys.* 4 to conceive of the body as a magnitude extended in three dimensions, themselves conceived as intervals between two extremities. The Greek *diastēmata* points to the fact that a dimension is always an *interval* between two extremities.

authority of the Pythagoreans, who claimed that the number three is distinctive of the all and the totality of the things that are; that is, the things that exist (268 a 10–13); (ii) the use of the number three in ritual practices (268 a 13–15); and finally (iii) the linguistic usage, according to which the Greek *panta* is used when there are at least three things (268 a 15–19). This reflection on the language enables Aristotle to add that *pān*, *panta*, *teleion* are formally synonymous and to claim that body alone is *teleion* among magnitudes – *Def.* 3. From *Metaph.* Δ 16 we learn that what is called *teleion* is (i) that outside of which it is not possible to find even a single one of its parts, or (ii) that which in respect of excellence and goodness cannot be surpassed in its genus, or finally (iii) that which has reached its end or its fulfillment. Moreover, this tri-partition is reduced to a bi-partition. What is called *teleion* is (i) that which lacks nothing in respect of goodness and cannot be surpassed and has nothing to be found outside it (1021 b 31–3) or (ii) that which in general is not surpassed in its genus and has nothing outside it (1021 b 32 – 1022 a 1). The strategy Aristotle follows in the *Metaphysics* is intricate; but even without tracing the intricacies of this chapter it is possible to highlight what is relevant for the present discussion. The notions of completeness and perfection conflate in the honorific epithet of *teleion*. When Aristotle claims that something deserves this epithet, he may want to say that something is (i) perfect, or (ii) complete, or finally (iii) perfect and complete. There is no doubt that when we read that body alone is *teleion* among magnitudes, we are to understand that body alone is complete among magnitudes. On the assumption that Aristotle has sufficiently proved that there are only three dimensions, we can safely infer that body alone is *complete* among magnitudes since body alone extends in all dimensions. But however difficult it may be for us to accept it, we cannot a priori exclude that, when we read that body alone is *teleion* among magnitudes, Aristotle means to say that body alone is *complete* and *perfect* among magnitudes.[3]

Only a closer look at the strategy adopted by Aristotle may help us to decide which notion of *teleion* is required. In particular, it would be a

3 The claim that bodies are perfect magnitudes may even look absurd to some of us. Cf. Wildberg (1988: 22) and Leggatt (1995: 170). Aristotle shares with us the assumption that the aim of science is to provide an objective description of the natural world. But the natural world as it is conceived by Aristotle is not a value-free world. Quite the contrary. Aristotle is committed to the view that there are values in the natural world, or that values are part of the furniture of the natural world. Our job as students of nature is to attain understanding of the perfection and goodness of the natural world, on the crucial assumption that we can objectively make value judgments about the natural world.

mistake to think that the opening lines of the *DC* are merely devoted to the introduction of a certain conception of the body. This chapter is designed to lead to a specific conception of the all or the totality of the things that exist – in Greek *to pān*. *Defs.* 1–3 prepare this particular conception of the all. From *Def.* 1 to *Def.* 3 Aristotle is inviting the reader to think of a body as a three-dimensional magnitude. But this is not the only way in which a body can be conceived. A body can also be conceived as a part of a whole. Put differently, a body can be conceived as a part of the all or the totality of the bodies that exist. By inviting the reader to think of a body as a part of the all, Aristotle introduces a certain conception of the all. This is not a mere collection or sum of separate parts but consists of parts that are appropriately related to one another. At the beginning of the *DC*, Aristotle does not engage in a discussion of the structure of the all. He does, however, suggest that each body is in contact with the immediately surrounding bodies, and that by being in contact with one another they all together form a unified whole (268 b 5–8). The information supplied is not sufficient to form an adequate conception of the all. But *if* this book is addressed to an intelligent, educated reader who has already studied the *Physics*, there is no doubt that this reader is being encouraged to conceive of the totality of the bodies as a plenum. In the *Physics*, Aristotle argues against the existence of void, and for the claim that each body, by being in contact with the immediately surrounding bodies, occupies a certain place in the plenum. In the *DC*, Aristotle adds that this plenum is finite in extension, ungenerated and imperishable. But the reference to contact immediately suggests that this plenum displays a certain kind of unity. Minimally, it displays causal unity.[4] From the *Physics* the reader learns that change always presupposes an agent and a patient. For Aristotle, contact is necessary for the agent to act on the patient, and for the patient to be affected by the agent. The reference to contact is therefore enough to alert the reader to the fact that the different parts of the plenum are causally related to one another in a certain way. In the course of the *DC*, Aristotle will argue that the heavens are made of a simple body, which naturally performs circular motion, and which cannot be reduced to earth, water, air, and fire. According to Aristotle, this particular body, by simply being in contact with the sublunary bodies, has an influence on them. Note, however, that Aristotle is committed to the view that this body cannot be acted upon by the sublunary bodies.

4 On causal unity see chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

From the *Meteorology* and the *GC* the reader will learn *how* the celestial body and the sublunary bodies are causally related to one another. More specifically, the reader will learn that the different parts of the plenum are related to one another in such a way that some of them have an influence on the others, and the latter would not be what they actually are without this influence. I have sufficiently insisted on this point in chapter 1. The only thing that I would like to add now is that this particular conception of the all forces Aristotle to revise and qualify his third definition of body: a body is a perfect magnitude in so far as it is a three-dimensional magnitude. There is no doubt that only the all – the totality of the existing bodies – deserves the honorific epithet of *teleion* without qualification (268 b 8–10).

If I am right, in the opening chapter of the *DC* Aristotle goes through three definitions of body with the ulterior purpose of introducing a certain definition of the all or the totality of the existing bodies. The word *teleion* plays a crucial role in this strategy. It is used in two distinct ways throughout the chapter. First, it is used to focus on *three-dimensionality*, which for Aristotle is equivalent to *three-divisibility* (*pace* the atomists). It is then used to focus on the unique case of the all. This is understood as a unified whole constituted by the totality of the parts – the totality of the bodies – that exist. The very same notion of *teleion* must apply in both cases. In both cases this notion involves a reference to completeness and perfection. This is required to do justice to the particular conception of the all that Aristotle introduces toward the end of the chapter. The idea that a body does not exist in isolation but is part of a causal system of interconnected bodies plays an important role in the opening lines of the *DC*. This idea helps us to understand why a discussion about bodies leads to a certain conception of the all or the totality of the existing bodies. It does not explain, however, why the all or the totality of the existing bodies should be conceived as a unified whole. The disappointment for what appears to be a rather dogmatic approach is somehow mitigated if we bear in mind that the *DC* is addressed to an intelligent, educated reader. I have already argued that this reader is supposed to study the *DC* after the *Physics*. I now add that familiarity with the *Timaeus* and with the conception of the sensible world that is offered in that dialogue is expected on the part of the reader. In the *Timaeus* the sensible world is presented as a unified whole. But Plato thinks of it as a living creature endowed with soul and understanding (30 B 6–7). This living creature is the creation of a divine craftsman. There is a sense in which the job of the divine craftsman is not different from that of any other craftsman. He has to act on a material. This material is to be receptive of the model in order to be made like the model. In 30 C 2 – D 4, Timaeus asks himself what this model is. Timaeus has just established that the sensible world is a living creature. He now adds that an intelligible living creature is its model. But it is significant that this intelligible living creature must satisfy at least one further constraint. According to Timaeus, it cannot be any of the intelligible living creatures that are mere parts of a whole (30 C 4). For what is merely a part of a whole fails to account for the goodness and beauty of the sensible world. What is a part of a whole is in fact *ateles* (30 C 5). At least two things are to be noted here. First of all, the occurrence of *kalon* at 30 A 5 dissipates, I think, any reasonable doubt about the normative reading of *ateles*. Secondly, and more importantly, this passage of the *Timaeus* is very close in language to the end of the prologue to the *DC*.[5] In as compressed a text as the beginning of the *DC*, this is very unlikely to be a mere coincidence. My suggestion is that this is a conscious echo of the *Timaeus*.

In antiquity Plato and Aristotle were not the only thinkers to claim that the world is to be conceived as a unified whole of a certain kind. The Stoics, too, conceived of the world as a whole. But they distinguished between the all and the whole.[6] It is not difficult to find an explanation for this distinction. Though the Stoics were committed to the view that there is no void within the world, they had reasons to think that there is void outside it. Whereas the Stoic all consisted of the whole together with the surrounding void,[7] the Stoic whole was thought of as a unified body and as having a soul as the internal principle of unity (*M* IX 78). Simply put, the Stoics admitted a hierarchy of principles of unity and argued that the whole is held together by the best of these principles of unity: a soul (*M* IX 81–4).[8] Interestingly enough, the Stoics were not content to claim

5 Compare *tōn men oun en merous eidei pephykotōn* (*Tim.* 30 C 4) with *tōn men oun en moriou eidei sōmatōn* (*DC* 268 b 5).

6 Sextus Emp., *M* IX 332 (= *SVF* II 254 = *LS* 44 A).

7 Apollodorus departed from the general Stoic theory and argued that by "all" is meant either (i) the *cosmos*, or (ii) the system of the *cosmos* and the void outside it (Diog. Laert., VII 143 = *SVF* III *Apollodorus* 9).

8 Sextus documents that the Stoics distinguished the unified bodies from both (i) the bodies that are composed of separate parts (e.g. an army), and (ii) the bodies that are composed of contiguous parts (e.g. a ship or a house). They further subdivided the unified bodies by appeal to the fact that the principles that hold these bodies together are different. Some of these bodies are held together by a mere *hexis* (stones), and others by a *physis* (plants); finally some of them are controlled by a soul or *psychē* (animals). Reinhardt insistently argued that this tri-partition of principles of unity (*hexis, physis*, and *psychē*) goes ultimately back to Posidonius. See Reinhardt (1921: 347; 1926: 45–54; and 1935: 650–2). Pohlenz always spoke against this thesis. See Pohlenz (1965: 172–98, and 199–232). According to Pohlenz, this classification of principles of

that the world is held together by a soul. They explicitly took the view that the world is an intelligent living being. By so doing, they put themselves in continuity with the Platonic tradition of the *Timaeus*. There is no doubt that a living being, either intelligent or not, is a unified whole in a much stronger sense than the one suggested at the beginning of the *DC*. Here Aristotle is content to say that the all is a unified whole because its parts are in contact with one another; that is, because the totality of the bodies are causally related to one another in a specific way. He never suggests that there is an internal principle which is ultimately responsible for the fact that these parts are one thing rather that a mere plurality of bodies. He is obviously reticent about taking this view. This reticence is better understood, I think, as an implicit claim that the natural world as a whole is *not* a living thing. This book is intended to cast some light upon the reasons that might have led Aristotle to deny life, and therefore understanding, to the natural world as a whole. On the one hand, Aristotle seems to think that the celestial and sublunary bodies form a causal system of a specific type; on the other, he seems to think that this causal system does not possess enough unity to be a living thing. Why? I shall argue that the celestial and the sublunary world form a causal system that admits an important discontinuity within itself.[9]

## NATURAL BODIES

Divisibility and three-dimensionality are the two ingredients that Aristotle uses in the formation of the notion of body in the prologue to

unity is not an original contribution of Posidonius. On the contrary, Posidonius could rely on a well-established tradition, which ultimately goes back to Chrysippus. The dispute between Reinhardt and Pohlenz concentrated on the way Plutarch, *De defectu oraculum* 28 (= *SVF* II 366) is to be read and understood. But the reader should see also [Philo], *De aeternitate mundi* 79–80 (= *SVF* III *Boëthus Sidonius* 7). Here the Stoic Boethus is credited with an argument for the eternity of the world that crucially depends on the classification of bodies into (i) bodies that are composed of separate parts (ii) bodies that are composed of contiguous parts, and (iii) unified bodies. This strongly suggests that the classification of bodies that makes appeal to different principles of unity was part of the conceptual apparatus available to a Stoic philosopher well before Posidonius.

9 Matthen (2001: 171–99) has recently argued for the view that Aristotle does not fit the Greek cosmological tradition that thinks of the universe as an animal. According to Matthen, "[Aristotle's] *cosmos* falls short of the strong conditions of unity that characterize an animal" (198). I am convinced that the lack of the relevant type of unity is the primary reason for the denial of a soul, and therefore of life, to the natural world. In other words, Aristotle credits the natural world with *unity* but not with *uniformity*, and the ultimate reason for the denial of uniformity is Aristotle's belief in the existence of an important discontinuity within the natural world. I shall return to this topic in chapter 4, "The limits of Aristotle's science of nature." There I shall also explore the consequences that immediately depend on the discontinuity in question.

the *DC*. This notion is nevertheless open to criticism. One may wonder how useful this notion is in distinguishing a body from the corresponding geometrical solid, for instance the Great Pyramid built by the Pharaoh Cheops some 4,600 years ago from the corresponding geometrical figure. That a body is to be kept distinct from the corresponding geometrical figure is also suggested by the language. Whereas the name *sōma* is ambiguous and may be used to refer to the Great Pyramid of Cheops as well as the corresponding geometrical solid, the term *stereon* is exclusively used with reference to the latter. But it is easy to see that three-dimensionality alone, or in combination with divisibility, is of no help if we should want to distinguish a *sōma* from the corresponding *stereon*. A geometrical solid also extends in three dimensions: it too may be defined as that which has length, breadth, and depth.[10] Moreover, in this context divisibility brings nothing to the notion of body that may enable one to distinguish bodies from geometrical solids. By stating that a body is divisible into ever-divisible parts, Aristotle simply presents himself as a partisan of the continuum theory, like Anaxagoras[11] (and later on the Stoics[12]).

In the light of the strategy followed in the opening chapter of the *DC*, this criticism represents an uncharitable misinterpretation of Aristotle's intentions. In this context, Aristotle does not intend to provide the best possible definition of body: that is, a definition that among other things may enable him to distinguish a body from a geometrical solid. Rather, he introduces a definition of body with the ulterior purpose of arriving at a particular conception of the all or the totality of the existing bodies. It is significant, I think, that in the rest of the *DC* Aristotle no longer speaks of bodies as three-dimensional (or three-divisible) magnitudes but focuses on *natural bodies* – in Greek *physika sōmata*. Natural bodies are constituted by a nature. By saying that a body is constituted by a nature, Aristotle suggests that the body exhibits a characteristic behavior, and that the nature of the body manifests itself in that particular behavior.

In the *DA*, Aristotle distinguishes the natural bodies that have life from the natural bodies that do not (412 a 13). Natural bodies that have life are *living bodies*. Life, as it is understood in the *DA*, minimally involves self-nutrition, growth, and diminution (412 a 14–15). Self-nutrition, growth,

10 Euclid, *Elementa* XI, Def. 1: "body [*stereon*] is that which has length, breadth, and depth."
11 Cf. Simpl., *In Phys.* 155. 21–30 (= *DK* 59 B 1); 164. 17–20 (= *DK* 59 B 3); 164. 26 – 165. 1 (= *DK* 59 B 6).
12 Cf. Stob., *Ecl.* I 142. 2–7 (= Aëtius I 16. 4 = *SVF* II 482 = *LS* 50 A), Diog. Laert., VII 150 (= *SVF* II 482 = *LS* 50 B).

and diminution are constitutive of perishable life. In other words, whatever is alive and perishable is minimally subject to growth and diminution; in addition, both growth and diminution require the use of nourishment, which is not possible without engaging in self-nutrition.[13] Each of these activities is itself normally constituted by activities. For a peach tree, for example, to be engaged in reproduction implies having leaves and pink flowers growing on its stems at a certain time of the year, and to bear soft round fruits with pinkish yellow skin and juicy flesh ripening at a different time. All the characteristic activities of the peach tree are to be explained by appealing to the appropriate nature: a soul of a certain kind. The soul is an internal principle of regulation and unity: it governs the characteristic activities of the peach tree and shapes them into a unified behavior – the distinctive behavior of the peach tree. In the *DA*, Aristotle famously argues that the soul is the first actuality of a body which is not only natural but also organic (412 b 5–6). In all probability, Aristotle is inviting us to think of the body as an organ or a tool of the soul.[14] He obviously does not intend to deny that the body in question has organs. Quite the contrary: an organ may be composed of organs.[15] However, the organs in question need not be eyes, limbs, and the like. Most living bodies display a much simpler organization. Several times Aristotle says that the roots are to plants what the mouth is to animals.[16] He often adds that the entry of the nourishment is the upper part of the living body. In other words, branches, leaves, flowers, and fruits appear to us to be the upper part of the peach tree, but they are in fact the lower part of the plant.[17] His insistence on this apparently curious, if not bizarre, doctrine is not gratuitous. By so doing, Aristotle points at a fundamental

13 It should be noted that the power of self-nutrition is also the power of self-replication or generation of a like self. Aristotle is committed to the view that the use of nourishment and reproduction are aspects of the same power. In the *DA*, Aristotle is pushing the overall view of the nutritive soul as that which has the capacity *to save* (the Greek verb is *sōzein*, 416 b 18) a certain form of organization. Put differently, the living body is the beneficiary of the operations of the nutritive soul, but the goal of these operations is the soul itself. By saving that which has the soul, namely the ensouled body, the nutritive soul saves itself.

14 There has been a great amount of discussion on the meaning of the Greek *organikon* in this context. On the very idea that the body is a tool or instrument of the soul, see Menn (2003: 83–139, in particular 108–12). I refer the reader to this paper for a convenient summary of the ongoing discussion on the meaning of *organikon* in *DA* 412 b 5–6.

15 I owe this point to Alan Code.

16 *DA* 412 b 3; *IA* 705 b 7–8; *PN* 468 a 9–11.

17 *Phys.* 199 a 27–9; *IA* 705 a 27 – b 2; *PN* 467 b 2; 467 a 33–4; 468 a 4–12. Aristotle does not know of photosynthesis. For him, plants take in nourishment through the roots. Leaves are for the sake of the fruit (they are regarded as a shelter for it).

truth: life implies organization; if something is a living body, it is *minimally* structured with a lower and an upper part. However, Aristotle is also committed to the view that there are different degrees of organization which correspond to distinct forms of life, themselves fixed with the help of a certain number of activities which are necessarily realized in a living body of a certain type. If the living bodies of the sublunary world are all engaged in self-nutrition, growth, and diminution, some of them are capable of bodily displacement in the form of progressive motion – in Greek *poreia*. The capacity for *poreia* takes different forms: some animals move around by walking, others by flying, and others by swimming or creeping. But if an animal is capable of *poreia*, it possesses the maximum degree of organization available in the natural world. According to Aristotle, its nature must be a soul minimally equipped with the capacity for perception, and *phantasia*. This latter is the capacity to form representations of a certain kind on the basis of perception. It is intuitively clear why *poreia*, perception, and *phantasia* go together: to move around, a living body must be sensitive to the environment, and perception and *phantasia* are the minimal cognitive equipment required to navigate from one place to another. A living body capable of *poreia* is therefore equipped with an appropriate locomotory apparatus as well a sensory apparatus of the right kind. From the *IA* we learn that the sensory apparatus is always implanted in the front of the living body (705 b 8–13), and that the actual mechanism of locomotion always involves the existence of another important symmetry: the existence of a right and a left side of the living body (705 b 30 – 706 a 26). In short, an upper and a lower part, a front and a back, and finally a right and a left side must be present to those living bodies that are equipped with the capacity for *poreia* and are not in some way mutilated. Since these living bodies possess the maximum degree of complexity available in the natural world, in the *DC* Aristotle calls them "perfect bodies" (284 b 21–4).

So far I have argued that Aristotle's science of nature is concerned with natural bodies. A clarification, nevertheless, is needed. In the *DC* Aristotle is concerned with natural bodies in so far as they are endowed with the capacity to undergo motion from one place to another. This capacity is not to be confused with the capacity for *poreia*. Aristotle credits only a limited group of sublunary living bodies with *poreia*. By contrast, all natural bodies are credited with the capacity to be moved from one place to another. This capacity can be explained by recourse to the material principles of natural bodies. Aristotle has a hierarchical conception of body such that natural bodies are themselves composed of natural bodies.[18] For example, a man is composed of flesh, bones, and sinews, which in turn are composed of earth, water, air, and fire in a certain ratio. Earth, water, air, and fire are at the bottom of the hierarchy and deserve the honorific title of <sublunary> *simple bodies*. Aristotle conceives of them as homogeneous bodies endowed with the capacity to perform a simple motion – either the downward or the upward motion. In other words,

> 1. If *x* is a sublunary SB, than *x* has the capacity to perform either UpM or DnM.

The simple motion of a sublunary simple body is routinely described as a motion towards a certain place – either towards the center or the extremity of the natural world.[19] Simple motion is a case of change from one place to the other, and a change is normally named after the new state of affairs which emerges from it. Each simple body, under the appropriate circumstances, invariably terminates its motion when it has reached its own natural place. In the *DC* fire is explicitly said "to rise over all <the bodies> that move upwards" (311 a 17–18), and earth "to settle below all <the bodies> that move downwards" (269 b 24–5). Since the four sublunary simple bodies come to rest in four different places, they perform four different natural motions. I shall return to the notion of natural motion in chapter 3. For the time being, I am content to note that Aristotle consistently says that fire moves towards the extremity of the natural world but never claims that fire comes to rest at the extremity of the natural word. For Aristotle, the extremity of the natural world is occupied by the simple body which is naturally moved in a circle – the <celestial> simple body. This body is emphatically not a boundary preventing the sublunary simple bodies from getting dispersed. There is no room in the natural world as it is understood by Aristotle for unbounded motions: that which is in motion is always capable of being at rest, and that which is at rest is always capable of being in motion.

18 I borrow the phrase "hierarchical conception of body" from an unpublished paper that Alan Code presented at the USC/Rutgers Annual Conference in Ancient Philosophy in December 2000. As Code points out, this conception of body extends outside the realm of nature. Natural bodies are in fact the material principles of artificial bodies – artifacts are made of natural bodies. The consequence is that earth, water, air, and fire, by being the material principles of a natural body, are the material principles of an artificial body as well.

19 Aristotle speaks as if there were something that is the extremity and the center of the natural world. In other words, he speaks as if the center and the extremity of the natural world had reality prior to, and independent of, the simple body that moves towards them. But since the center and the extremity are places, and a place is always the limit of a body, they cannot exist independently of the body they contain. On this point, see Waterlow (1982: 115).

Aristotle is famously committed to the view that nature is always an internal principle of motion *and* rest. In other words, motion and rest are facets of the same nature – the nature *of* something.[20]

## THE SCIENCE OF NATURE IS CONCERNED FOR THE MOST PART WITH BODIES AND MAGNITUDES

Let us return now to the opening sentence of the *DC*:

> The science of nature is clearly concerned for the most part with bodies and magnitudes, the affections and motions of these, and the principles of this kind of substance (*DC* 268 a 1–6).

This characterization of the science of nature is to be understood in the light of Aristotle's conception of science. Each Aristotelian science is about a certain department of reality, namely about a certain *genos*.[21] From the *Analytics* we know that each Aristotelian science provides a demonstration from proper principles of the per se attributes of the *ousia*. Right at the beginning of the *DC* Aristotle is offering a characterization of the science of nature that makes use of this conceptual apparatus: the science of nature is concerned with a specific department of reality – bodies and magnitudes – and the job of the student of nature is to provide an explanation of the per se attributes of bodies and magnitudes – affections and motions – on the basis of appropriate principles. What are the bodies and magnitudes Aristotle is thinking of at the beginning of the *DC*? Compare this passage with the beginning of *Zeta* 2, where Aristotle offers bodies as the most obvious example of *ousia*:

> (1) *ousia* is thought to belong most obviously to bodies; (2) and so we say that both animals and plants and their parts are substances, (3) and so are natural bodies such as fire and water and earth and everything of that sort, (4) and all things that are parts of these or composed of these (either of parts or of the whole bodies), for example the heaven and its parts, stars and the moon and the sun (*Zeta* 1028 b 8–13).

In this passage we are encouraged to think of the heaven in its entirety as well as the stars, the sun, and the moon as bodies – clause (4). For

20 Cf. Bodnár (1997b: 81–117). In this excellent article, Bodnár rightly insists on the fact that the simple bodies possess a fully fledged nature, namely a nature that is a principle of both motion and rest. I agree with his arguments against recent interpretations suggesting that the nature of a simple body is somehow incomplete. See Gill (1989: 236–40) and Cohen (1994: 150–9).

21 On this point see chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

Aristotle, they are made of a special simple body. This body is distinct from, and not reducible to, earth, water, air, and fire. The sun, the moon, and the rest of the stars form a distinct class of bodies: the class of the celestial bodies. Plants and animals open the list of the sublunary bodies. They are a second class of bodies – clause (2). Aristotle thinks of them as a certain arrangement of bodily parts that are themselves composed of other bodies. Aristotle calls earth, water, air, and fire natural bodies – clause (3), but he does not want to suggest that they are the only natural bodies. Quite the contrary. The natural world as it is conceived by Aristotle is composed of natural bodies. These natural bodies can be divided into celestial and sublunary bodies. In the sublunary world, Aristotle admits a further distinction into simple and composite natural bodies. Finally, within the natural bodies he distinguishes the natural bodies that have life, animals and plants, from the natural bodies that do not. By calling earth, water, air, and fire natural bodies, Aristotle in all probability wants to suggest that they are *the* natural bodies. Moreover, they are *the* natural bodies because they are the ultimate material principles of all the natural bodies populating the sublunary world.

By saying that the science of nature is concerned with bodies and magnitudes, Aristotle offers a compressed but precise description of the object of this science. Compare the list of natural bodies I have just offered with the program of inquiry into the natural world presented at the beginning of the *Meteorology*. Note that at the beginning of the *DC* Aristotle adds a significant qualification: the science of nature is concerned *for the most part* with bodies and magnitudes. In all probability, the addition is designed to remind the reader that the student of nature has to deal with things such as place and time.[22] If place is for Aristotle the limit of a body, time is the measurement of the motion of a body. To put it in another way, we learn nothing about place and time independently of the fact that there is a body and this body is liable to motion and is immediately surrounded by other bodies. The following sentence may also be intended to cast some light on Aristotle's reasons for the addition of "for the most part":

> For of the things constituted by nature some are bodies and magnitudes, others have body and magnitude, others are principles of those that have <body and magnitude> (*DC* 268 a 4–6).

22 Cf. Simpl., *In DC* 7. 20–8.

The text is difficult, but plants and animals presumably are the things that have body and magnitude.[23] If this is correct, Aristotle is not only committed to the view that animals and plants are living bodies but also to the view that they have (a) body. This further view is to be understood in the light of Aristotle's distinctive conception of the soul. In the *DA*, Aristotle explicitly takes the view that animals and plants are natural bodies that have life (412 a 13–15). There he is also committed to the view that the provider of life, the soul, is not a body (412 a 17). It is notoriously difficult to provide an adequate description of the position of Aristotle and do justice to his distinctive attempt to avoid both dualism and reductionism. On the one hand, Aristotle seems to be persuaded that animals and plants are living bodies, and the provider of life, the soul, is nothing over and above those living bodies; on the other, he consistently argues against the corporeality of the soul. For him, animals and plants are not just bodies but ensouled bodies. As this line of argument would take me beyond our current scope, it has to be sufficient here to say that, if the *incipit* of the *DC* is to be taken as a compressed but adequate description of the subject-matter of the science of nature, it cannot be a surprise to discover that Aristotle makes an effort to do justice to this crucial aspect of his doctrine of the soul.[24]

An Aristotelian science characteristically assumes the reality of its subject-matter. The prologue to the *DC* confirms that the science of nature is no exception to the rule. The student of nature is concerned with bodies on the crucial assumption that bodies exist. Significantly enough, the *DC* does not begin with an attempt to argue for the existence of bodies but with a certain characterization of body – *Defs.* 1–3. Since we are at the beginning of the study of nature, this characterization is very unlikely to provide us with an adequate conception of what a body is. We have to go through the *DC* and the rest of the natural writings, including

23 Cf. Simpl., *In DC* 6. 34–7. 3.

24 Sharples (1998: 42) suggests an alternative translation of the passage, which has the advantage of restoring the parallel with the previous sentence. According to the previous sentence, the science of nature is concerned with (i) bodies and magnitudes, (ii) their affections, (iii) their principles. Now Aristotle would continue as follows: of the things constituted by a nature (i) some are bodies and magnitudes, (ii) others are things that bodies and magnitudes have, and (iii) others are principles of these. Perhaps the Greek *ta d'echei sōma kai megethos* can be interpreted either as "others have body and magnitude" or "others are ones that body and magnitude have." But the parallel passage we find at the beginning of the third book of the *DC* confirms that the traditional interpretation is the right one:

> the study of nature is concerned for the most part with bodies: for all natural substances are either bodies or *with* bodies and magnitudes (298 b 2–4).

the biological writings, to form this conception and to realize that a body is *minimally* a three-dimensional magnitude. At the same time the initial definition cannot be solely a nominal definition. It must grasp some salient feature shared by all bodies. In the *DC*, Aristotle emphatically claims that even a small deviation from the truth at the beginning of the inquiry may make a great, if not an immense, difference at the end of the inquiry (271b 1–17). Evidently, he is persuaded that a small mistake made at the beginning of the inquiry may ruin the entire enterprise. It is significant, I think, that Aristotle makes this comment with reference to the belief in the existence of indivisible magnitudes. This comment sheds some light on the reasons that may have motivated Aristotle to begin the *DC* with a characterization of bodies in terms of continuity and divisibility. The fact that Aristotle always thinks of each body as part of a larger system of bodies explains why he concludes the prologue to the *DC* with the visionary sketch of the natural world as a unified whole of bodies that are interacting in a certain way.[25]

A final clarification is needed. Aristotle states that the science of nature is concerned for the most part with bodies and magnitudes. But why magnitudes? Doesn't the student of nature study bodies only? Note, first of all, that the expression "body and magnitude" is often used in contexts in which the ambiguity of body between *sōma* and *stereon* is crucial for the argument.[26] Secondly, and more importantly, in antiquity this ambiguity was usually exploited to provide a geometrical account of bodies. We have already seen that in the *Timaeus* Plato provides a definition of the body in terms of three-dimensionality: a body also has depth (53 C 5–6). This definition allows Plato to switch from *sōma* to *stereon* and vice versa.[27] This definition is functional to a certain geometrical reconstruction of reality, and in the *Timaeus* a geometrical structure is in fact assigned to earth, water, air, and fire. This structure consists of regular polyhedra, which are constructed out of two elementary triangles (the half-equilateral and the half-square isosceles). The general result is that each body is correlated with a regular polyhedron. More precisely, any part of earth consists of cubes, which are constructed out of half-square isosceles triangles. Any part of fire consists of pyramids, which are constructed

25 I refer the reader to chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature," for the significance of the qualification "in a certain way."

26 See, for example, the discussion of the Democritean arguments against the possibility that *body and magnitude* are divisible at any point (*GC* 316 a 14–16 = *DK* 68 A 48 b).

27 In the *Timaeus* the word *sōma* is used to refer to both earth, water, air, and fire (e.g. 53 C 4–5, 57 C 7–8) and the regular solids (e.g. 54 B 4–5, 55 A 7, 56 D 7, 56 E 2).

out of half-equilateral triangles. Finally, any part of air and water consists of octahedra and icosahedra respectively, which are both constructed out of half-equilateral triangles. Plato makes it also clear that the geometrical structure is meant to account for the natural phenomenon of intertransformation of these bodies. Fire, air, and water can be transformed into one another because pyramid, octahedron, and icosahedron, that is to say the solids they are associated with, are all constructed out of the same triangle, the half-equilateral triangle. On the contrary, earth cannot be transformed into water, air, or fire (and vice versa), because the cube, the solid that is associated with earth, is constructed out of a different kind of triangle, the half-square isosceles triangle. Plato is the champion of the weak version of the theory of intertransformation. According to this version, earth can be dissolved and dispersed in water, air, and eventually fire, but it can never be transformed into any one of them.[28] On the contrary, Aristotle is the champion of the strong version of this theory. For Aristotle (and later on, for the Stoics),[29] earth is included in the circle of intertransformation and all simple bodies can be transformed into one another. For Aristotle, the material principles of natural bodies are themselves natural bodies, and more generally the material principles of bodies are themselves bodies. The *Timaeus* is representative of a diametrically opposed view. According to Plato, the material principles of bodies are not bodies. Aristotle makes this assumption explicit in his critique of the Platonic doctrine of intertransformation. He reads the *Timaeus* as claiming that the material principles of bodies are triangular surfaces (306 a 23–6). For him, the phenomenon of intertransformation as it is described in the *Timaeus* would involve a process of resolution into triangles. This interpretation entails notable difficulties for Plato. First of all, if the peculiar feature of a body is three-dimensionality, how is it possible that a body (more so if it is a natural body) can be generated from surfaces that do not possess this feature? Secondly, if bodies can be reduced to mathematical entities, why must one stop precisely at these particular surfaces, the triangular surfaces? Why cannot these surfaces be reduced to lines, and finally lines to points?

The use Plato makes of geometry in the *Timaeus* is open to different interpretations, and Aristotle's is only one among the several that are possible. It is significant, I think, that a different reading of the *Timaeus*

28 For a helpful presentation of this geometrical reconstruction see Vlastos (1975: 66–115).

29 For the Stoic theory of elemental change and its cosmogonic significance see Stob., *Ecl.* I.10 (= Arius Didymus fr. 21 *Dox. gr.* = *SVF* II 413 = *LS* 47 A).

was advanced by Proclus in a work that he wrote in defense of Plato. Though this work is now lost, a few citations are preserved by Simplicius in his commentary on the *DC*.[30] Proclus defended Plato by replying to each of the objections moved by Aristotle. In particular, he defended Plato against Aristotle's criticism that the account of intertransformation ends up with the claim that bodies are generated out of triangular surfaces. Proclus conceived of the elementary triangles as solids, and read the *Timaeus* as claiming that these triangles possess also depth; that is, they possess a *minimal thickness*.[31] If one follows the reading suggested by Proclus, one must take three-dimensionality as a primitive feature. Interestingly enough, there is little yet significant evidence that this interpretation was not a late invention. We find it already in Epicurus, who criticized the Platonic doctrine of body in his *On Nature*. Few fragments survive of the original thirty-seven volumes that composed this monumental work. *Herculaneum Papyrus* 1148 preserves fragments from book XIV, which contained, among other things, a critique of the doctrine of body advanced in the *Timaeus*. An edition of this book has recently been published by Leone (1984). Column XXXVIII of her edition suggests that Epicurus took the Platonic triangles as indivisible three-dimensional magnitudes.[32] This interpretation has an obvious advantage: if the elementary triangles possess a minimal thickness, they satisfy the definition of body offered at 53 C 5–6. In other words, these triangles also have depth.[33]

30 Simpl., *In DC* 648. 19–28. Simplicius quotes extensively from this book, though he never cites the title of it. But in his commentary on the *Timaeus* Proclus himself tells us that he wrote a work entitled *Inquiry into Aristotle's Objections against the Timaeus* (*In Tim.* III 279. 2–3). There is no reason to think that the excerpts preserved by Simplicius come from a different work. On Proclus and his defense of the doctrine of the *Timaeus*, see Siorvanes (1996).

31 The hypothesis of a minimal thickness of the elementary triangles was influential in antiquity. We find a reference to this hypothesis both in Simplicius and in Philoponus. Cf. Simpl., *In DC* 563. 26 – 564. 3, 573. 3–11, 577. 17–19; Philoponus, *In GC* 210. 12–16.

32 This is not the place to enter into a discussion of Epicurus' criticism of the *Timaeus*. But the fact that the elementary triangles of the *Timaeus* are thought of as possessing a minimal thickness is enough evidence to discourage any attempt to establish a connection between Epicurus' objections and Aristotle's critique of Plato in the *DC*.

33 Even these few observations are enough to emphasize that it is not sufficient to attribute the label of atomism to the *Timaeus*. Ancient atomism is not a monolithic doctrine but a constellation of different positions. If it is true that the atomists share the hypothesis that there are entities that cannot be further analyzed, it is also true that these entities can be conceived in different ways. I only add that in the *DC* Aristotle is witness to a further version of atomism in which the atomic entities are thought of as solids (305 b 28 – 306 a 1). We know nothing about this particular version of ancient atomism. Even if it is possible to conjecture that it is an Academic variation of the doctrine put forward in the *Timaeus* and aimed at rendering this doctrine more acceptable, we cannot exclude that it is only a theoretical possibility taken into account by Aristotle for reasons of completeness. In any event, it is significant how in this case the atomic entities are not triangles but regular polyhedra.

Aristotle may, or may not, be right in reading the *Timaeus* literally, but he is surely right when he says that the doctrine of body of the *Timaeus* commits Plato to atomism. Aristotle explicitly mentions Democritus (307 a 16–17), and makes it clear that the Platonic account is somehow a refinement and elaboration of the theory of Democritus (306 a 26 – b 2).

Let us return to the opening line of the *DC*. The fact that the *Timaeus* is a polemical target of the *DC* explains why Aristotle begins this treatise with a minimal notion of body: a notion that, among other things, does not distinguish bodies from geometrical solids. Provisionally, Aristotle accepts the ambiguity of body between *sōma* and *stereon*. What matters to him, at least for the moment, is clarity about the fact that bodies are magnitudes, and magnitudes are always divisible into ever-divisible parts.

## BODIES AND ELEMENTS

Earth, water, air, and fire are the ultimate material principles of the sublunary natural bodies, and precisely for this reason Aristotle refers to them as the natural bodies par excellence. But at times Aristotle refers to earth, water, air, and fire using the term *element* – in Greek *stoicheion*. In other words, earth, water, air, and fire are not only the natural bodies par excellence; they are also the elements of the sublunary world. In order to understand what the term *stoicheion* is intended to evoke it is necessary to go back to the use of this term in the Platonic dialogues. According to Simplicius (who, as he himself confesses, depends on Eudemus of Rhodes for this information[34]) Plato was the first to introduce this term into the technical vocabulary of Greek cosmology.[35] Interestingly enough, in the Platonic dialogues this term is normally used in reference to the letters of the alphabet. *Philebus* 17 A – 18 D is certainly among the more significant passages regarding this subject. Here Socrates attributes to the god – or demigod – Theut first the discovery of the vowels and then the discovery of the other sounds that are not vowels but that can still be pronounced (probably sounds such as /s/ and /m/). After the discovery of the vowels and these other sounds, Theut would have demarcated a third group of

34 Simpl., *In Phys.* 7. 10–15 (Wehrli, *Eudemos* fr. 31).
35 Empedocles called his four principles roots, *rhizōmata*.

mute sounds different from both (probably the consonants). Finally, Theut would have given a name to each sound and would have called the sounds thus distinguished letters – in Greek *stoicheia*. Evidence that the use of *stoicheion* in a cosmological context is derived from a reflection on language is implicitly offered in a much celebrated passage from the *Timaeus*. Here Plato exploits the letters of the alphabet in order to illustrate one of the most characteristic theses of the entire dialogue. According to Plato, the case of earth, water, air, and fire is not analogous to that of the letters of the alphabet. Strictly speaking, their case is not even remotely similar to that of the simplest composites that can be formed into combinations taken from the letters of the alphabet: the syllables (48 B 7 – C 1). I have already shown how, in the Platonic geometrical reconstruction, these four bodies are associated with four regular polyhedra – earth to a cube, water to an icosahedron, air to an octahedron, and finally fire to a pyramid – and how, in their turn, these four polyhedra are constructed out of two elementary triangles. According to Plato, anyone who says that earth, water, air, and fire are the principles of everything is committing an error. The true principles are the two elementary triangles, which are really the letters of which the words, the propositions, and, ultimately, the entire book of nature are composed. In this passage from the *Timaeus*, we find, probably for the first time, the indispensable conceptual elements for the elaboration of the well-known and far-reaching metaphor of nature as a book. After Plato, the association between the study of language and the study of nature is put forward again on several more occasions. From this point of view, I find the following testimony to be exemplary with regard to the Pythagorean school of the Hellenistic age. The genuine philosopher, Sextus says, resembles the scholar of language: just as the latter is concerned primarily with the letters of the alphabet from which all verbal expressions can be constructed, going from the most complex down to syllables, so too the true student of nature, who concerns himself with everything, must above all examine the elements (*stoicheia*) from which nature is constructed.[36] This testimony is placed at the beginning of a passage that concludes with the thesis that the principles or first elements of reality are the monad and

36 Sextus Emp., *M* x 249–50: "They [= the Pythagoreans] say that those who are engaged in philosophy are like those who are concerned with language. The latter first examine the words (the language is formed from words), and since the words are formed from syllables, they first investigate the syllables; and as the syllables are resolved into the elements of the written speech, they investigate these first. So likewise the true student of nature, as the Pythagoreans say, when investigating the all, ought in the first place to establish the elements the all can be resolved into."

the dyad.[37] In an efficacious way it shows how, from a certain point onward, the association between language and reality has become a commonplace in antiquity. It also documents how this association is crucial for the derived use of *stoicheion* in the context of natural science. It is a derived use that, after Plato and thanks mainly to Aristotle and to the Stoic tradition, has entered, fully fledged, into the history of ideas.[38]

Therefore when Aristotle uses the term element in referring to earth, water, air, and fire, he must be aware of the association between language and nature suggested in the *Timaeus* and evoked, although in a less explicit manner, in the *Philebus*. Aristotle must also accept the implicit intuition involved in the association. Even for Aristotle, the physical reality must be reducible to a finite number of original components, which represent the base of departure for the construction – following combinatory processes that imply also the alteration of the properties of the initial components – of more complex entities. More specifically, earth, water, air, and fire are the original components of each sublunary natural body, and as such they are present in some ratio in each of these bodies. Interestingly enough, Aristotle does not confine his use of the term *stoicheion* to the sublunary world. He is able to refer to the celestial simple body as the first of the elements, *to prōton tōn stoicheiōn*, or the first element, *to prōton stoicheion*.[39] It is important to realize that this particular use of the term *stoicheion* is derived from the use of *stoicheion* with reference to earth, water, air, and fire. The use of *stoicheion* in the context of the physics of the sublunary world has not yet lost his intended force: the elements are the ingredients that can be combined to form a more

37 This passage has often been considered an indirect testimony on Plato's unwritten doctrines. See *Testimonia Platonica* 32 in Gaiser (1962) and *Testimonia Platonica* III 12 in Krämer (1989).

38 A history of the notion of *stoicheion* was attempted by Diels (1899). This work initiated a debate that continued for half a century. See Voll-Graff (1949: 89–115), Koller (1955: 161–74), and above all Burkert (1959: 167–97). This last article represents the most mature fruit from this debate. It is not necessary here to go into the details of Burkert's proposal, which in many ways rectifies or corrects the thesis advanced by Diels. It is enough to remember that the word *stoicheion* was coined in the second half of the fifth century BCE, and it is indisputably tied to the linguistic observation. Its use in a cosmological context is therefore derived. Moreover, there is no reason to doubt Eudemus' testimony that attributes the paternity of this use to Plato. Burkert nevertheless makes note of how Eudemus' testimony attributes to Plato the usage of *stoicheion* in a physical context, but not necessarily in reference to earth, water, air, and fire (cf. Simpl., *In Phys.* 7. 12–15). In light of *Tim.* 48 B 7 – C 1, Eudemus' caution is more than understandable. For the use of *stoicheion* in reference to earth, water, air, and fire we must search elsewhere. First Aristotle and then the Stoics codified and made traditional this particular usage. For the Stoic tradition, the most significant testimony is collected by Arius Didymus and preserved in Stobaeus. Cf. Stob., *Ecl.* I 129. 1 – 130. 20 (= Arius Didymus, fr. 21 *Dox. gr.* = *SVF* II 413 = *LS* 47 A).

39 See *DC* 298 b 6; *Meteor.* 338 b 2, 339 b 16–17, 340 b 11.

complex yet intelligible reality. Since the celestial world is part of the natural world, the celestial simple body can surely be regarded as an element or a *stoicheion* of this department of reality, even though, strictly speaking, it does not enter into any of the combinations that are formed from earth, water, air, and fire.[40]

## THE HELLENISTIC CONCEPTION OF BODY

In these pages I have made an effort to reconstruct a few notions of body that play an important role in the science of nature as it is conceived by Aristotle. Among other things, I have tried to distinguish the notion of natural body from that of mere body. I now wish to take a wider perspective and bring to light the different strategies that in antiquity were adopted to distinguish natural bodies from mathematical entities. The testimonies that Sextus Empiricus collects in *M* I and in *PH* III are an ideal point of departure for an investigation of this type. Among the definitions of body reported in *M* I 21 there is one that Sextus attributes explicitly to Epicurus. To the usual three-dimensionality, this definition adds an ingredient that we have not encountered in Aristotle: *antitupia*.[41]

40 This does not explain, however, why the celestial simple body is called the *first* element (or the *first* of the elements). I shall return to Aristotle's language and its significance in the Epilogue.

41 Sextus Emp., *M* I 21: "(1) body is either a conjunction by aggregation of magnitude, shape and *antitupia*, as Epicurus says; (2) or that which is extended in three dimensions, namely length, breadth, and depth, as the mathematicians say, (3) or that which is extended in three dimensions and has *antitupia*, again as Epicurus says, so that in this way he can distinguish <body> from void, (4) or *antitupos* mass, as others say." In this passage Sextus reports four definitions of body, two of which are explicitly attributed to Epicurus. The first Epicurean definition involves: (i) magnitude, (ii) shape and (iii) *antitupia* – clause (1). In the second, only two items are recorded: (i) three-dimensionality and (ii) *antitupia* – clause (3). Here I confine myself to this second definition of body. Its usage is amply attested to by Sextus. See Sextus Emp., *PH* III 38; 126; 152 and *M* IX 226. Elsewhere we are given a third Epicurean definition that makes reference to the following three ingredients: (i) size, (ii) shape, and (iii) weight. See [Plutarch], *Placita* 887 E 3–4 (= Aëtius I 3. 18 *partim*). This definition and the previous one seem to be fused in *M* X 240. In this last case, body is that which is endowed with (i) magnitude, (ii) *antitupia*, and (iii) weight. In our passage, Sextus gathers two other definitions of body, the first of which makes reference only to three-dimensionality – clause (2). It is significant, I think, that Sextus attributes this definition to the mathematicians. The fourth and last definition makes reference to (i) mass and (ii) *antitupia* – clause (4). This confirms, at least indirectly, the importance of the reference to *antitupia* in the Hellenistic definitions of body. In his recent translation of *M* I, David Blank suggests that this last definition be considered an interpolation. Cf. Blank (1998: 96n39). In his view, this definition is out of place, and its presence can be explained only by hypothesizing the intervention of someone with a good knowledge of the doxographical tradition. The same definition is found, again, in [Plutarch], *Placita* 882 F 4, and Stob., *Ecl.* I 140. 15. In reality, if mass and *antitupia* are considered as two distinct ingredients (as I have implicitly proposed), then it is not very difficult to assimilate this definition into the previous ones. It too is construed as a conjunction of a certain number of ingredients (in this case two).

The property to which Epicurus refers is the one that bodies exhibit when they are touched and that may be described as *resistance to contact*. The way in which Sextus reports this same definition in *PH* III 39 nevertheless suggests that its function is decidedly more general than the one that he recognizes in *M* I 21. In *PH* III 39 the definition of body appears at the end of a conventional series of definitions of mathematical entities: point, line, and surface. According to some, Sextus says, in order to move from the notion of surface to that of body, it is not sufficient to add depth, *bathos*; one must refer also to *antitupia*.[42] The impression one obtains is that the latter ingredient is indispensable because the bodies being referred to are not bodies in general but are instead natural bodies. They can be distinguished from the mathematical entities that we generally call solids only if we attach to depth an ingredient that is not shared by these latter ones. Although Sextus tells us nothing about the identity of those advocating this position, in light of *M* I 21, it would seem natural to assume that they are Epicureans. The definition of body that calls upon three-dimensionality and *antitupia* is contrasted by Sextus to the Stoic definition that we know to have been formulated by Zeno of Citium. According to this definition, body is that which is capable of acting or being acted upon.[43] However, the situation is decidedly more complicated. If it is true that these two definitions are juxtaposed also in the testimony collected in the *Philosophical History* traditionally attributed to Galen,[44] it is almost certain that this comparison reflects the more general comparison between Epicureanism and Stoicism. Even if the definition of body in terms of three-dimensionality and *antitupia* is never attributed to Zeno of Citium and his successor Cleanthes, it is not difficult to find testimonies that assign this same definition to the Stoics in general. As a matter of fact, it is impossible to confine the use of this definition solely to the Epicureans. Presumably, this definition was an intellectual heritage in the Hellenistic age, and in the specific case of the Stoics, at least from a certain point onward, it was placed alongside the traditional definition of body in terms of acting and being acted upon.[45]

Once it is ascertained that the definition of body in terms of three-dimensionality and *antitupia* enjoyed great popularity in the Hellenistic

42 Sextus Emp., *PH* III 39: "(1) Others say that body is that which is extended in three dimensions and has *antitupia*. (2) For they say that point is that which has no parts, line length without breadth, plane length with breadth; (3) when this latter gains both depth and *antitupia* there is a body – which is our present subject – composed of length, breadth, depth, and *antitupia*."

43 This definition of body is explicitly ascribed to Zeno in Cicero, *Acad.* I 39 (= *SVF* I 90 = *LS* 45 A).

44 [Galen], *Hist. philos.* 23 (= *Dox. gr.* 612.19 – 613.2).

45 For this claim see Mansfeld (1978: 134–78).

time, there remains the task of clarifying exactly what its specific function was. The context of Sextus' two testimonies is illuminating in this regard. In *M* I 21, the definition of body in terms of three-dimensionality and *antitupia* appears immediately after a definition that makes use of the notion of three-dimensionality only (and which Sextus attributes significantly to the mathematicians). In *PH* III 37, the same definition is preceded by the purely mathematical ones of point, line, and surface. Something similar occurs also in the testimony gathered in the *Philosophical History.* Even here the definition of body in terms of three-dimensionality and *antitupia* is found next to that of point, line, and, above all, body as three-dimensional entity. The context in which the notion of *antitupia* is usually mentioned seems to suggest that its primary function is to introduce an element capable of unraveling the ambiguity of the Greek term *sōma*, differentiating natural bodies from the corresponding three-dimensional mathematical entities. What other reason would [Galen] have for mentioning the definition of body as an entity extended in length, breadth, and depth, after having already made reference to two definitions of body, one in terms of acting and being acted upon and the other in terms of three-dimensionality and *antitupia*? The only (convincing) reason, at least to my mind, is that he wishes to differentiate the latter two definitions of body, which belong to the province of the science of nature, from the first definition of body, which is purely mathematical.[46] If I am right, the Epicureans as well as the Stoics have recourse to both a general and a specific notion of body. The general notion can be formulated in the following way: *body is that which extends in three dimensions – length, breadth, and depth.* It is easy to see how this characterization is equivalent to the *Defs.* 1 and 2 introduced in the prologue to the *DC*. By this point I hope to have shown that a definition of this type does not permit a distinction between solids and natural bodies. It is precisely for this reason that the Stoics as well as the Epicureans (and Aristotle too) adhere to a more specific definition of body. This second definition enables them to differentiate the case of the Pyramid of Cheops from that of the corresponding geometric figure. In

46 The idea that, for the Stoics, three-dimensionality was not by itself sufficient to characterize a physical body seems also to be indirectly confirmed by a testimony of Diogenes Laertius about the Stoic Apollodorus of Seleucia. In this case, the entity that extends itself in three dimensions is not called *sōma* but *stereon sōma* (where *stereon* qualifies *sōma* and specifies the type of body that is defined in this way). Therefore, for the Stoics as well, three-dimensionality by itself can, at most, characterize a mathematical body, a *stereon sōma.* See Diog. Laert., VII 135 (= *SVF* III *Apollodorus Seleucensis* 6 = *LS* 45 E).

the case of the Stoics and the Epicureans this latter definition can be reformulated to say that *body is that which is three-dimensional and resistant to contact.*[47] We can speculate on the motives that may have induced first Aristotle and then the Stoics and the Epicureans to develop different strategies with the common objective of separating the notion of the natural body from the mere body. In my view the dominant motive behind these different strategies is the intention of obstructing the path to the geometric reconstruction of the natural world attempted by Plato. Without a suitable definition of body that allows a pathway from mathematical entities to non-mathematical ones (and vice versa), the reconstruction proposed by Plato is impossible. It is the ambiguity of the Greek term *sōma* that renders the entire Platonic operation plausible. Moreover, this is an ambiguity that Plato exploits knowledgeably, using *sōma* to refer to the four bodies of the Empedoclean tradition as well as to the four regular polyhedra with which these simple bodies are associated.

47 I have already emphasized how the Stoics possess another definition of body. This second definition may be reformulated to say that *body is that which is capable of acting or being acted upon.* This definition of body was introduced by the founder of the Stoa, Zeno of Citium, in an open polemic with the Academic and Peripatetic tradition. From Zeno's point of view, if $x$ is a body, then $x$ is capable of acting and of being acted upon; and if $x$ is capable of acting and of being acted upon, then $x$ is a body. In the Stoic causal chain, there is no room for incorporeal entities. Moreover, in the Stoic world there are entities capable of acting *and* of being acted upon, and entities capable of acting *or* of being acted upon (where "or" is understood in a rigorously exclusive sense). Remember that in Stoic philosophy there is room for two principles: an active principle capable only of acting (god), and a passive principle capable only of being acted upon (matter). In light of the definition of body introduced by Zeno, both of these principles cannot be anything other than bodies. Note that the two Stoic definitions of body are not extentionally equivalent. When the Stoics maintain that the active principle (god) is a body, they certainly do not mean to say that this body is a three-dimensional entity that offers resistance to contact. The first manifestation of the active principle, *pneuma*, is emphatically not a body of this type. It acts on matter, and by virtue of the second definition of body, it is something corporeal. In light of this last observation, it should emerge more clearly why the Stoics were not able to renounce the definition of body introduced by Zeno, and why they could not be content with the definition of body shared with the Epicureans. The Stoic philosophy is anything but a naive materialism. Only the definition of body introduced by Zeno allows the Stoics to consider corporeal entities both matter and the active principle that gives a form and a resolution to it.

# CHAPTER 3

# *Motions*

> Both Leucippus and Democritus speak of the primary bodies as always moving in the infinite void; they ought to say with what motion and what is their natural motion (Aristotle, *DC* 300 b 8–10).

## NATURAL AND NON-NATURAL MOTIONS

The student of nature assumes the reality of the natural world and conceives it as a certain arrangement of natural bodies. Within the broad compass of natural bodies is found a remarkable array of bodies. They range from *the living celestial bodies* performing a circular motion around the earth, to *the living sublunary bodies* endowed with the capacity for *poreia* and displaying the maximum degree of bodily complexity (perfect bodies), to the stationary living sublunary bodies (inferior animals and plants), and finally to *the inanimate sublunary bodies.* The student of nature is concerned with all these bodies on the assumption that they are either *simple* or *composite bodies.* Composite natural bodies are themselves composed of natural bodies. Earth, water, air, and fire are the *sublunary simple bodies.* They are the ultimate material principles of all the bodies that we encounter in the sublunary world, including the artificial bodies.

All these bodies are liable to undergo motion from one place to another. Consider the case of a stone: if dropped from a hand, a stone falls downwards. But why? Aristotle's view is that a stone is composed of earth, water, air, and fire in a certain ratio, and earth so predominates as to impart its own natural downward motion to the stone. In other words, downward motion is the natural motion of the stone because it is the natural motion of the predominating material principle of the stone, earth. However, by saying that a stone naturally moves downwards, Aristotle does not deny that a stone can be moved in a circle by a stick, or that it can be thrown up by a hand. His view is rather that a stone non-naturally performs the motions in question, and so does the earth in the stone. Even these few remarks suffice to illustrate that the student of nature is not only concerned with natural bodies; he is also concerned with their motion, or better with the *explanation* of their motion. Moreover since the bodies in question are constituted by a nature, it cannot be a surprise to discover that the explanation of their motions involves an appeal, direct or indirect, to their *nature*.

It is significant, I think, that Aristotle begins his investigation of the sublunary simple bodies with the claim that the ultimate material principles of the sublunary world naturally perform a specific motion, and with a criticism of the cosmological doctrines that overlook this fundamental truth. What Aristotle has to say against Leucippus and Democritus is particularly interesting.[1] The model of atoms perpetually colliding in the void fails to give a truly explanatory account of the motion of atoms. For Aristotle, the motion of an atom, as it is conceived by Leucippus and Democritus, can only be a case of non-natural motion. But *non-natural motion* presupposes, temporally as well as conceptually, a *natural motion* of a certain kind. More particularly, if an atom performs a certain motion as a result of a certain number of collisions, that atom must have performed an original motion prior to all the collisions undergone by the atom in its history. The nature of the atom must have manifested itself in that original motion. In short, that motion was the natural motion of the atom. But Leucippus and Democritus say nothing about that motion. They seem to be content to state that the atom has always been in motion. In this way they do not simply fail to provide an account for the natural motion of the atom. They thus fail to provide an adequate account of the motion of the atom.

The Aristotelian doctrine of natural and non-natural motion can be reconstructed as follows. Let us suppose that the natural body $x$ performs a certain motion F. This motion is either a case of natural motion, NM, or a case of non-natural motion, NNM. In other words:

1. If $x$ performs F, then either F is the NM of $x$ or F is the NNM of $x$.

Since the non-natural motion of $x$ conceptually presupposes the natural motion of $x$, one can say that:

2. F is the NNM of $x$ if, and only if, F is not the NM of $x$.

1 I have quoted the text in the epigraph. Aristotle's criticism of the atomistic account of motion is collected both in the *DC* and in the *Metaphysics* (*Lambda* 1071 b 31–4).

But (2) does not adequately grasp the Aristotelian conception of non-natural motion. If F turns out to be a case of non-natural motion, the body that performs F also performs some other motion, and this latter motion is the natural motion of the body. In other words:

3. If F is the NNM of $x$, there is a motion G $\neq$ F, and G is the NM of $x$.

In the *DC* Aristotle not only claims that, if a body non-naturally performs F, it naturally performs another motion. Surprisingly enough, Aristotle adds that F must be the natural motion of some other body. He argues that circular motion, since it is non-natural to all the sublunary bodies, must be natural to some other body (269 a 32 – b 2). In other words, Aristotle is committed to the following (stronger) thesis:

4. If F is the NNM of $x$, then there is a $y \neq x$, and F is the NM of $y$.

## ARISTOTLE'S ARGUMENTS FOR THE EXISTENCE OF A SIMPLE BODY PERFORMING CIRCULAR MOTION

In the *DC*, Aristotle introduces his most controversial reform of the previous cosmological theories: the thesis of the existence of an ungenerated and imperishable celestial simple body that naturally performs circular motion. His arguments, among other things, shed further light upon the Aristotelian conception of natural and non-natural motion. In reconstructing these arguments I shall make use of the following, additional abbreviations: SM = Simple Motion, SB = Simple Body, CM = Circular Motion, UpM = Upward Motion, DnM = Downward Motion, E = Earth, A = Air, W = Water, F = Fire.

The *first argument* is presented at 269 a 2–9. Aristotle has already established that circular motion is a simple motion. He now argues for the existence of some simple body that performs this kind of motion. The argument goes like this:

> assuming, then, that there is simple motion, and motion in a circle is simple, and the motion of a simple body is simple and simple motion is <the motion> of a simple body (for if <simple motion> is <the motion> of a composite body, it will be in virtue of the prevailing <simple body>), there must necessarily be some simple body that naturally moves with motion in a circle according to its own nature. By force it is in fact possible that the motion of a body is also the motion of another; but this is not possible according to nature, since the motion according to nature of each simple body is one (*DC* 269 a 2–9).

The argument of Aristotle can be rephrased as follows:

6. There is SM

7. CM is an SM
8. Every SM is the motion of an SB
9. There is an SB performing CM.

The crucial premise in the argument is (8). At first sight, it appears to be questionable. From the fact that we are observing a simple motion, we cannot conclude that a simple body is moving. Without additional information we can conclude only that a body is moving. In other words, from the fact that we are seeing a downward motion, we cannot decide what sort of body is performing it. A downward motion can be performed either by a composite body – for example, a stone – or by a simple body – the earth that is present in the stone. The words reported in brackets serve exactly to block this possible objection. The simple motion of a composite body is ultimately to be explained by recourse to one of the simple bodies. This is the simple body that predominates so as to impart its own characteristic motion to the compound.

The argument concludes that there must be a simple body that moves in a circle. Yet it does not prove very much. It simply proves that there must be at least one simple body that performs circular motion. People who held that stars and planets are of a fiery nature would have accepted this conclusion. As it stands, the argument allows them to identify the simple body performing circular motion with fire. But this is exactly what Aristotle does not want. The argument must therefore be revised in order to prevent the identification of the body that performs circular motion with fire. This explains why Aristotle introduces the notion of natural motion, and argues that any simple body has its own natural motion, and that there is just one natural motion for each simple body. Two premises are therefore to be added:

10. Every SM is the NM of an SB
11. There is only one NM of an SB.

Thanks to these two additional premises, Aristotle is now able to conclude that there must be a fifth simple body that is none of the four sublunary simple bodies, and that circular motion is its natural motion. The revised argument goes as follows:

6. There is SM
7. CM is an SM
8. Every SM is the motion of an SB
10. Every SM is the NM of an SB
11. There is only one NM of an SB

12. There is an SB $\neq$ E, W, A, F performing CM, and CM is its NM.

The crucial premise in the revised argument is (11). It is not difficult to see why there cannot be more than one natural motion for each simple body. Simple bodies have such a nature that under the appropriate circumstances they always move in the same direction. The nature of earth, for example, explains why some unimpeded part of earth invariably moves downwards. Earth can be thrown up, but this upward motion is non-natural with respect to the nature of earth. Furthermore, since the nature of a simple body is one, its natural motion too must be one. And if the downward motion is the natural motion of earth, any other simple motion cannot be natural with respect to earth. A general principle can be extrapolated from this example. I shall refer to it as the *principle of the uniqueness of natural motion*:

13. If F is the NM of $x$, then any G $\neq$ F cannot be the NM of $x$.

If the first argument is meant to prove that there must be a simple body that naturally performs circular motion, the *second argument* serves to block a possible reply by those who hold that celestial bodies are made of a fiery stuff. This reply runs as follows. Fire cannot *naturally* perform circular motion because each simple body performs only one natural motion, and fire naturally moves upwards. But fire can *non-naturally* perform circular motion. In the light of this fact, there is no need to introduce a celestial simple body to account for the motion in a circle: fire can non-naturally move in a circle. Aristotle's argument consists in a *reductio ad absurdum*:

Again, if the motion against nature is contrary to the motion according to nature, and for one thing there is one contrary, then motion in a circle, being a simple motion, must necessarily be against nature, if it is not according to nature, for the moving body. If then fire or some other such body is that which is moving in a circle, its motion according to nature must be contrary to the motion in a circle. But for one thing there is one contrary, and upward and downward motion are <already> contrary to one another. If some other body is moving in a circle against nature, there will be some other motion that is according to its nature. But this is impossible: if this is upward motion, it would be fire; if this is downward motion, it would be water or earth (*DC* 269 a 9–18).

If fire is non-naturally moving in a circle, then:

14. CM is the NNM of F.

Since fire naturally moves upwards, and upward and downward motion are contrary to one another, fire non-naturally performs downward motion. In other words:

15. UpM is the NM of F
16. *Contr*(UpM, DnM)
17. DnM is the NNM of F.

By aggregation of (17) and (14), we obtain that fire non-naturally performs circular and downward motion:

18. CM is the NNM of F and DnM is the NNM of F.

But (18) clashes with the Aristotelian principle that "for one thing there is one contrary <at most>" – in Greek *hen heni enantion*. Consequently, fire can neither naturally nor non-naturally perform circular motion.[2]

The principle that for one thing there is only one contrary at most turns out to be crucial for the argument. At first sight this principle is baffling. Aristotle himself appears to provide examples against it.

1. In his ethical theory Aristotle claims that virtue is a mean. But if virtue is a mean, there are clearly two ways to go wrong: that is, there are two vices for each virtue, one in the direction of excess and one in the direction of deficiency.
2. Aristotle seems to violate this principle in the *Meteorology*. On his account, phenomena such as the shooting stars or the comets take place in the outer sphere of the sublunary world. This sphere is a highly inflammable combination of fire and air that under the appropriate circumstances can be lit by the agency of the immediately surrounding celestial region. For the present purpose it is not necessary to enter into the details of Aristotle's account of these phenomena. It is enough to recall that the celestial simple body is naturally moved in a circle, and by so doing it carries around the outer sphere of the sublunary world. The circular motion of this sphere appears to be a case of non-natural motion: it is in fact caused by the agency of an external principle.
3. Even a *third argument* for the existence of a celestial simple body seems to be an overt violation of the principle that only one thing is contrary to another thing. The argument goes like this:

2 I shall return to the language of contrariety in chapter 4. For ancient discussions on this particular theme in the Aristotelian tradition, I refer the reader to Sharples (1985a: 109–16).

<this is manifest> even on the assumption that every motion is either according to nature or against nature, and that the motion that is against nature for a body is according to nature for another, as it happens in the case of upward and downward motion: for motion against nature for fire is according to nature for earth and vice versa; it is necessary, therefore, that motion in a circle, too, being against nature for these bodies, is according to nature for some other body (*DC* 269 a 32 – b 2).

A possible reconstruction of the argument goes as follows:

19. CM is SM
20. Every SM is the NM of an SB
21. CM is the NNM of E
22. CM is the NNM of W
23. CM is the NNM of A
24. CM is the NNM of F
25. CM is the NM of an SB $\neq$ E, W, A, and F.

Aristotle assumes that all sublunary simple bodies can non-naturally perform motion in a circle. But if they can non-naturally perform circular motion, the principle that only one thing is contrary to another thing is to be abandoned. In short, either Aristotle gives up the principle that only one thing is contrary to another thing, or he holds this principle but gives up the third argument.

Does the third argument really force Aristotle to abandon the principle that only one thing is contrary to another thing? More to the point, does Aristotle really advance two arguments that are mutually inconsistent? The answer is emphatically no. Aristotle is playing with two distinct conceptions of non-natural motion. In the third argument circular motion is non-natural to fire because it is not the natural motion of fire. In other words, every simple motion is either natural or non-natural. If circular motion is not the natural motion of fire, then it must be non-natural to it. Every motion not in accordance with the nature of a body is therefore non-natural:

26. The NM of $x \neq$ the NNM of $x$.

This conception of non-natural motion does not make any reference to contrariety – and a fortiori to the principle that one thing cannot have two contraries. In other words, any motion that is *different* from the natural motion of the body is a case of non-natural motion. By contrast, the conception of non-natural motion applied in the second argument crucially depends on contrariety. In this case only one motion of the body can be its non-natural motion, and this is the motion that is *contrary* to its natural motion. In other words,

27. NNM of $x =$ *Contr*(NM) of $x$.

Apparently, Aristotle in the *DC* makes use of these two conceptions of non-natural motion without any further comment. He never says that they are clearly distinct conceptions and that they should not be confused. But once these two conceptions of non-natural motion are highlighted and accepted, they can be applied outside the *DC*. Let us return, briefly, to the *Meteorology*, and to the circular motion that is assigned to the outer sphere of the sublunary world. Though this motion is a case of non-natural motion, it does not involve a violation of the principle that for one thing there is only one contrary at most. As a matter of fact, Aristotle does not need to make reference to the notion of contrariety to describe this motion. This motion is non-natural because it is different from the motion that the air and the fire of which the sphere is composed naturally perform. Put differently, the motion of the outer sphere of the sublunary world is a case of *forced motion*: it is the motion of the celestial simple body immediately surrounding the sphere that forces the air and the fire of which this sphere is composed to move in a circle.[3]

## AFTER ARISTOTLE

The thesis of the existence of a celestial simple body was very controversial in antiquity and did not gain the acceptance one might expect in the light of the reputation that the same thesis enjoyed in the late Middle Ages and up until around 1650.[4] Proclus, for example, informs us that some Platonists even reeled back in horror from this thesis because they felt

3 Olympiodorus, Simplicius, and even Philoponus (both in his commentary on the *Physics* and in his *Contra Proclum*), consider this motion a case of motion *above nature* (or *supernatural motion*). Simplicius, for example, compares it to the motion of the planets, which are carried around by the agency of the sphere of the fixed stars:

> let us say, even now, that circular motion is not proper to fire, since <fire> is carried around by the fixed sphere, as the motion from the east is not proper to the planets. Nevertheless, it is not the case that <this motion> is against nature so that it is harmful, but so that it is above nature, in so far as <fire> is overcome by something superior and stronger (Simpl., *In DC* 34. 14–19).

In his commentary to the *Meteorology*, Philoponus ascribes this solution to the problem to Damascius (*In Meteora* 97. 20–2). Wildberg (1988: 129) suggests that Damascius may be the originator of this solution.

4 For a useful introduction to the fortune of this thesis in antiquity, see Moraux (1964: 1171–263). For a study of its fortune in the Middle Ages and the Renaissance, see Grant (1994).

there was something barbaric in it (*In Tim.* II 42. 9–12). This is clearly an exaggeration. But, as with all exaggerations, it contains a grain of truth. The truth is that the overwhelming influence of the *Timaeus* played a decisive role against the diffusion of this thesis. Very few people in antiquity were prepared to share with Aristotle the view that celestial bodies are made of a celestial simple body. Even within the school of Aristotle, and from the very beginning, the thesis of the existence of a celestial simple body was resisted. The very unsatisfactory state of the information at our disposal does not allow us to establish whether Theophrastus endorsed this thesis.[5] But we know that Strato of Lampsacus, the head of the Lyceum after Theophrastus, rejected it and turned to the Platonic view that celestial bodies are made for the most part of fire.[6] Xenarchus of Seleucia even wrote a book of objections against the thesis. Tellingly, this book was entitled *Against the Fifth Substance*.[7] Citations from this book have come down to us from Simplicius in his commentary on the *DC*.[8] Simplicius has at least two good reasons for reporting and debating these objections. First of all, they were a fully developed part of the exegetic tradition of the *DC*. Alexander of Aphrodisias had already reported and debated them in his commentary on the *DC*. From this point of view, Simplicius is doing nothing more than following his reference model, Alexander's commentary. Moreover, when Simplicius wrote his commentary, the debate on the Aristotelian doctrine of the fifth substance was anything but closed. This doctrine had recently been attacked by Philoponus in his *Contra Aristotelem*. In debating Philoponus' arguments, Simplicius suggests, venomously, an association between the

5 A convenient review of the information at our disposal is offered in Sharples (1998: 88–94). See also Sharples (1985b: 577–93).

6 Stob., *Ecl.* I 200. 21–2 (= Aëtius II 11. 4 = Wehrli, *Straton* 84), Stob., *Ecl.* 206. 7–8 (= Aëtius II 17. 2 = Wehrli *Straton* 85).

7 As for the title of the book, see Simplicius, *In DC* 13. 22; 20. 12; and 21. 33. Note that Xenarchus refers to the celestial simple body as the fifth substance. This fact suggests that by this time it was already customary to refer to the *first* substance (*first* element, *first* body) as the *fifth* substance (*fifth* element, *fifth* body). Regarding the life of Xenarchus, the information in our possession is scarce and originates almost entirely from the geographer Strabo. Cf. Strabo, *Geo.* XIV 5. 4. (670). Xenarchus was originally from Seleucia, Cilicia, but spent most of his life teaching philosophy, first in Alexandria, then in Athens, and finally in Rome. Xenarchus reached the zenith of his career as a philosopher and teacher in Rome, where he was introduced at court and even enjoyed a friendship with Augustus. Arius of Alexandria (Arius Didymus?) must have had an important role in Xenarchus' career. Strabo tells us that Arius and Xenarchus were friends. Presumably, Arius introduced Xenarchus to Augustus. On the basis of this scant information, it is possible to date Xenarchus' activity to the second half of the first century BCE.

8 For a convenient presentation of the work of Xenarchus, see Moraux (1967: 1420–35 and 1984: 197–214). See also Sambursky (1962: 125–32) and more recently Hankinson (2002–3: 19–42).

work of Philoponus and that of Xenarchus.[9] In doing so, Simplicius emphasizes, polemically, how Philoponus' arguments are not original, but rather are the result of a reelaboration, if not an outright plagiarism, of Xenarchus. Here I am content to stress that Philoponus is only the last link of a longer and more complicated chain. His dependence upon Xenarchus documents how persistent and well known the critique of Xenarchus was throughout antiquity. Apparently, this critique became an essential source for the debate on the existence of a celestial simple body. However, there is yet little clear evidence that Xenarchus did not limit himself to raising objections against the doctrine of the fifth substance. He also provided a positive doctrine of natural motion. I am persuaded that this doctrine was designed to fit the conception of the sensible world offered in the *Timaeus*. This doctrine had considerable influence among the Platonists of late antiquity. Both Proclus and Simplicius credit Plotinus with this doctrine and, in all probability, it was Plotinus and his decision to make this doctrine an essential part of his interpretation of the *Timaeus* that is ultimately responsible for the fortune of Xenarchus in late antiquity. I shall return to this point in due course.

It is a substantial claim of Aristotle's that every simple body performs a simple motion. Alongside the claim that the four simple bodies of the sublunary world naturally move either upwards or downwards, Aristotle argues for the existence of a celestial simple body that naturally performs circular motion. Since upward and downward motion are types of rectilinear motion, the claim that every simple body naturally moves with a simple motion can be rephrased as follows:

28. If $x$ is an SB, then $x$ naturally performs either CM or RM.

"Either . . . or" is here to be taken with an exclusive sense in virtue of *the principle of uniqueness of the natural motion*. From Simplicius we learn that Xenarchus attacked (28) by distinguishing the element or the simple body from something that is becoming the element or the simple body:

Rectilinear motion is not the motion according to nature for anything that is already one of the four elements, but only for something that is becoming <one of the four elements>. What is becoming is not without qualification: it is something between being and not being, like what is moving: for this is between the place to be occupied and the place previously occupied, and becoming is of the same genus as motion, being itself some kind of change. For this reason we

9 Simpl., *In DC* 26. 31–3 (= Philop., *Contra Aristotelem*, fr. 1) and 42. 19–20 (= Philop., *Contra Aristotelem*, fr. 18).

do not say that the so-called fire that is moved upwards is, properly speaking, fire, but that it is becoming <fire>. Once it has reached its own place, and has risen over all the other bodies, it has become, properly speaking, fire: for it has realized its form, in so far as it is light, and in virtue of that position. And earth is, properly speaking, earth only when it has settled below all other bodies, and occupies the middle place. Water and air: air when it has risen over earth and settled below air, and air when it has risen over water and settled below fire. It is therefore false that the motion according to nature of a simple body is simple, for it has been shown that motion is not an attribute of something that is, but of something that is becoming, <one of the four elements>. But if some motion, and a simple one, is to be assigned to what is already <one of the four elements>, circular motion is to be assigned, since these motions are only two, motion in a circle and rectilinear motion, and rectilinear motion is the motion of something that is becoming, but it is not one of the four elements: it is thus not absurd to assign circular motion to fire and rest to the other three <elements> (Simpl. *In DC* 21. 35 – 22. 17).[10]

10 A note of caution. Since Simplicius is the only source for the objections leveled by Xenarchus, we have to accept that we are not able to reconstruct a text that is independent of his testimony. For the same reason, it is impossible for us to evaluate just how liberal Simplicius is being in his reporting of these objections. The fact that Simplicius introduces some of these objections with a *phēsi* – making reference to direct discourse – does not prove that we are reading first-hand citations, if not actually word for word, from Xenarchus' book. The casualness with which the ancients reported the citations of others is a well-known fact. Citations from memory, or even second-hand citations (or, if one prefers, citations of citations), are the rule in the ancient world. In particular, one should not forget that many of the citations from Xenarchus (but certainly not all) have been copied from Alexander's commentary together with the defense of Aristotle proposed by the latter. This method of proceeding would have had the advantage of being extremely practical. Instead of first copying the objections from Xenarchus' book, and then consulting Alexander's commentary for his defense of Aristotle, Simplicius could have consulted only Alexander's commentary for both Xenarchus' objections and Alexander's defense. In the worst-case scenario, we would be dealing with citations largely copied from Alexander. In the most favorable scenario, we would instead be dealing with first-hand citations which nevertheless would not exclude the possibility of some reformulations of the text. Moreover, these reformulations can take very different forms: from the simple alteration of the order of appearance of words, to the substitution of several elements with others originally absent in the text, without obviously excluding the presence of abbreviations or additions. Nevertheless, the study of cases more renowned than that of Xenarchus suggests a cautious optimism. Simplicius' citations from the *Contra Aristotelem* by Philoponus are particularly encouraging. A study conducted on these citations has revealed Simplicius' habit of abbreviating and selecting the material for citation. Simplicius quotes word for word in only about ten cases, and in these cases the citations are usually introduced by *paragraphein* or *paratithesthai*. See Wildberg (1993: 187–98). In the others, the citations from the *Contra Aristotelem* are in reality paraphrases of the text. In these cases, we can justifiably say that we are dealing with testimonies rather than fragments. But this does not mean that they are inadequate or unfaithful testimonies. Simplicius seems to have been an accurate witness and even when he offers a paraphrase, he does it while trying to leave the spirit of the text unaltered. In the absence of indications to the contrary, there is no reason to doubt that Simplicius proceeded with the same scrupulousness and the same liberty in the case of Xenarchus as well. The citations from Xenarchus are probably neither true and proper fragments nor unfaithful paraphrases. Yet, even in this case, the word "citation" must be given a significantly broad sense in order to take into account the possibility of reformulations.

Apparently, Xenarchus relied on a notion of simple body that can be characterized as follows: *x* is a simple body if, and only if, *x* satisfies all the conditions that Aristotle posits for being a simple body, and in addition to that, *x* is in its own natural place. In order to understand what Xenarchus was trying to do, it is important to bear in mind that Aristotle describes the natural motion of a simple body as a motion towards its actuality (*Phys.* 255 a 29–30 and *DC* 310 a 3), or towards its form (*DC* 310 a 33–4). Simply put, the natural motion of a simple body, as it is conceived by Aristotle, is never an unbounded process. On the contrary,

1. this process always has a starting and an ending point; and
2. the ending point of the process is to be identified with the culmination or perfection of the process.

Xenarchus attacked Aristotle where his doctrine of natural motion is weaker. That earth, water, air, and fire come to rest once they have reached their natural places is a fact that we do not see or experience. Xenarchus attacked this aspect of the doctrine by exploiting Aristotle's idea that the end of a process is also its culmination or perfection. More directly, by introducing the distinction between a simple body and what is becoming a simple body, he suggested that the statements about the nature of a simple body should be made with reference to the simple body in its natural place. In fact, only in its natural place is the nature of the simple body fully realized. But once the simple body has reached its natural place, at least for Xenarchus, this simple body either is at rest or is moved with circular motion. But since the circular motion in question is performed by *the perfected simple body*, this motion is the natural motion of the simple body. In other words:

29. If *x* is an SB, then either *x* is at rest or *x* naturally performs CM.

However, Xenarchus was not content to state (29). He added that rectilinear motion is performed by a simple body when this body is away from its natural place and, properly speaking, is not yet a simple body. Since rectilinear motion is articulated in upward and downward motion, this final claim can be rephrased as follows:

30. If *x* is becoming an SB, then *x* performs either UpM or DnM.

Both the original doctrine of Aristotle and the revised version of this doctrine proposed by Xenarchus are supported by ordinary observations only to some extent. Both of them go well beyond what we see and experience in the sublunary world. First of all, when Aristotle and

Xenarchus claim that fire regularly moves upwards, they do not mean to say that the flame of the candle or the fire burning in the fireplace move, under the appropriate circumstances, upwards. They mean to say that the simple body that is liberated from that flame or the fire burning in the fireplace does it. But we never see a simple body performing a simple motion. We always see a certain behavior of a certain body that we conceptualize as the simple motion of a simple body. Secondly, it is even more difficult to establish what the simple body does once it has reached its natural place. For Aristotle, a simple body comes to rest once it has reached its natural place; for Xenarchus it occupies that place either by staying at rest or by being moved in a circle. Both claims are equally difficult to verify. Claim (29), together with (30), enable Xenarchus

1. to dispose of the thesis of the existence of a celestial simple body distinct from earth, water, air, and fire, and
2. to incorporate the concepts of natural place and natural motion into a Platonic conception of the sensible world.

Since Strato of Lampsacus had abandoned the doctrine of the celestial simple body, it has been suggested that Xenarchus was under his influence, or alternatively that he was influenced by the Stoics.[11] Though there may be points of contact between the Hellenistic theories of motion and the positive doctrine of Xenarchus, this doctrine is not reducible to any of the previous theories. Claims (29) and (30) represent a creative interpretation of the doctrine of natural motion presented in the *DC*. It is significant, I think, that Simplicius, who is notoriously well documented, never says that Xenarchus depends for his positive doctrine upon the exegetical activity of someone else. On the contrary, Simplicius presents Xenarchus as the originator of a doctrine that had a certain success in antiquity:

> it is to be known that Ptolemy in the book *On the Elements* and in the *Optics*, the great Plotinus, and Xenarchus in the objections *Against the Fifth Substance*, say that rectilinear motion is <the motion> of the elements that are still becoming, that are in a place against nature, that have not yet reached the place according to nature (Simpl. *In DC* 20. 10–15).

From this passage we learn that Ptolemy and Plotinus endorsed the claim that rectilinear motion is performed by simple bodies when they are away from their own natural place. We also learn that they took the view that

11 Gottschalk (1981: 1120).

away from the respective natural places these bodies are not yet, properly speaking, simple bodies. A few lines below, Simplicius adds that Plotinus and Ptolemy were also committed to the view that simple bodies, once they have reached their natural place, either stay at rest or move in a circle, and in particular that fire and thin air occupy their natural place by moving in a circle (*In DC* 20. 23–5).

Simplicius is not the only ancient source in our possession to credit Plotinus with the claim that fire is moved in a straight line when it is away from its natural place, but that it naturally performs circular motion when it has reached that place. Proclus provides us with the same information in his commentary on the *Timaeus*. In defending the *Timaeus* against Aristotle and his thesis of the existence of a special simple body distinct from earth, water, air, and fire, Proclus makes an appeal to a doctrine of natural motion that he explicitly ascribes to Plotinus. This doctrine goes like this. When a simple body is in its natural place it is either at rest or is moved in a circle because it is only by being at rest or by being moved in a circle that this body can occupy its natural place. By contrast, when a simple body performs rectilinear motion, this body is not yet in that place or it has just left it (*In Tim.* II 11. 24–31). Elsewhere Proclus ascribes the same doctrine to both Ptolemy and Plotinus (*In Tim.* IV 113. 30–1). By so doing Proclus provides further confirmation of what we read in the commentary of Simplicius on the *DC*. I add only that Simplicius does not depend on Proclus, and that his testimony is not an abbreviation of the testimony offered by Proclus in his commentary on the *Timaeus*. Unlike Proclus, Simplicius names Xenarchus, and preserves evidence for the conjecture that Xenarchus was the ultimate source for both Plotinus and Ptolemy.

There is only one text which Proclus and Simplicius can refer to in ascribing also to Plotinus the doctrine of motion that ultimately goes back to Xenarchus. This is the difficult treatise that is transmitted by Porphyry with the title *On Circular Motion* [14]. Plotinus is here committed to the view that celestial bodies are living bodies, and that their motion is to be explained by recourse to both their body and their soul. By relying on the *Timaeus*, Plotinus assumes that the celestial living bodies for the most part are composed of fire. He takes into account, first of all, the possibility that fire naturally performs rectilinear motion. In this case, however, the circular motion peculiar to the celestial living bodies could be only the result of the action of a soul which redirects the rectilinear motion of fire and forces this body to move in a circle (II 2. 1. 14–19). But this is highly unsatisfactory, especially in light of the fact that the celestial living bodies are thought to be divine beings enjoying an eternal life appropriate to their divine status. There is, nevertheless, always the possibility that celestial fire already moves in a circle. The advantage of thinking of celestial motion as a result of the action of a soul on a body that already performs circular motion is suggested by Plotinus himself when he points out that in this way the celestial souls do not get tired of carrying their bodies around (II 2. 1. 37–9). But how can fire perform circular motion? Doesn't every body, including fire, move in a straight line? Plotinus answers these questions by recourse to the doctrine of natural motion that both Proclus and Simplicius ascribe to him. Fire performs rectilinear motion until it has come to the place destined to it (II 2. 1. 19–23). Once fire has reached that place, it does not stay at rest but moves in a circle. Plotinus also provides a reason for this particular behavior: the nature of fire is such that fire is always in motion (II 2. 1. 23–4). Plotinus is very tentative at this point: fire can no longer perform rectilinear motion when it has reached the extremity of the world, either because fire would get dispersed if it always moved in a straight line (II 2. 1. 24–5), or alternatively because there is nothing beyond the extremity of the sensible world and therefore fire cannot keep on moving in a straight line (II 2. 1. 27–9). There is therefore only one possibility left, namely that fire keeps on moving, but in a circle rather than in a straight line.

## LOOKING AHEAD

Xenarchus was a remarkably independent thinker. His critique of Aristotle took the form of a point-by-point refutation of the arguments in favor of the existence of what Xenarchus (in all probability following an already established tradition)[12] calls the fifth substance. His knowledge of Aristotle was vast and solid and was not confined to the *DC*. He did philosophy with Aristotle and through a word-by-word exegesis of the texts of Aristotle. Though this way of doing philosophy may look familiar to some of us, we should bear in mind that it was relatively new at that time. Xenarchus, together with Andronicus of Rhodes and Boethus of Sidon, belonged to the first generation of interpreters of Aristotle. However, the case of Xenarchus may be significantly different from that of Andronicus and Boethus. They seem to have been two independent and intelligent men who put in order the work left by Aristotle. Their job seems to have been that of organizing, clarifying, and defending the

12 I refer the reader to the Epilogue for a discussion of this claim.

philosophical work of the master. To the best of my knowledge, none of this is applicable to Xenarchus. It is significant, I think, that our sources never make reference to Xenarchus having any direct link with Andronicus or with Boethus.[13] At any rate, the exegesis of Aristotle did not mean for Xenarchus the cessation of genuine philosophical thought. The authority of Aristotle provided Xenarchus with the starting point for philosophy, not its cessation. He revised Aristotle's doctrine of motion and made it acceptable to late antiquity. Apparently, he agreed with Aristotle that the celestial world is a special, and somehow distinct, region of the natural world. He shared with Aristotle the view that the celestial bodies are not subject to generation and perishing. Like Aristotle, he held the view that these bodies are moved around the earth with an eternal motion. But he did not see the need to introduce a material principle that is different from, and not reducible to, earth, water, air, and fire to account for these features of the celestial bodies. He was persuaded that the motion of the celestial bodies could be explained without recourse to the postulation of an additional simple body. The study of the reception of the doctrine of the so-called fifth body shows that many people in antiquity found themselves in the position of Xenarchus. They simply could not see the need to introduce a special body to account for the characteristic incorruptibility and stability of the celestial world. They all thought that pure fire, or fully realized fire, adequately accounts for these features of the celestial bodies. Against this background Aristotle emerges as an extraordinary exception. This explains why the doctrine of the so-called fifth body is recalled over and over again in the doxographical tradition.[14] The truth of the matter is that Aristotle consciously departed

13 In Falcon (2001: 158–74) I argue that the title "Peripatetic philosopher" which the tradition attributes to Xenarchus is to be taken as an indication of his interest and mastery of the work of Aristotle. In my opinion, Xenarchus was not a disciple struggling with problems left unresolved by his master. He was a creative thinker who concerned himself with several of the same themes with which Aristotle had already concerned himself and who uses the work of Aristotle as a point of departure for his own philosophy. The truth of the matter is that the return to Aristotle that took place in the first century BCE did not involve the acceptance of the views stated by Aristotle. Aristotle was regarded as an authority, not in the sense that he was over and above criticism, but only in the sense that he deserved to be studied carefully. Xenarchus is too often described as an "unorthodox peripatetic philosopher." See, for instance, Hankinson (2002–3: 19–42). I find this description misleading: it obscures the fact that there was no orthodoxy in the Aristotelian tradition at this early stage. The return to Aristotle in the first century BCE took different forms and involved a variety of distinct positions.

14 Cf. (i) Stob., *Ecl.* I 196. 5–16 (= Arius Didymus fr. 9 *Dox. gr.*); (ii) [Plutarch], *Placita* 878 B 8–9 and Stob., *Ecl.* I 128. 4–9 (= Aëtius I 3. 22); (iii) [Plutarch], *Placita* 881 E 10 – F 7 and Stob., *Ecl.* I 37. 16–18 (= Aëtius I 7. 32); (iv) [Plutarch], *Placita* 887 D 7 – 11 and Stob., *Ecl.* I 195. 20 – 196. 2 (= Aëtius II 7. 5); (v) [Plutarch], *Placita* 888 B 10–11 and Stob., *Ecl.* I 200. 25 (= Aëtius II 11. 3);

from the tradition of the *Timaeus* in order to develop an alternative conception of the celestial world. Evidently, he was persuaded that the celestial world is not just a special and somehow distinct region of the natural world. The postulation of the existence of a celestial body that is distinct from, and not reducible to, earth, water, air, and fire, makes sense only on the assumption that the celestial world is in some important respect different from, and not completely reducible to, the sublunary world. The thesis of the existence of a celestial simple body distinct from earth, water, air and fire suggests that Aristotle took the view that there is an important discontinuity within the natural world. I shall engage in a study of this discontinuity in chapter 4. For the time being, suffice it to say that the doctrine of the celestial simple body points to the existence of an important discontinuity between the celestial and sublunary world, but it does not provide a reason for the existence of this discontinuity. In other words, for Aristotle the celestial world is made of a special material because there is some important discontinuity between the celestial and the sublunary world, rather than there being some important discontinuity between the celestial and the sublunary world because the celestial world is made of a special material.

## VOLUNTARY MOTION

So far I have argued that Aristotle is committed to the view that motion is either natural or non-natural. I have also argued that Aristotle admits at least two different concepts of non-natural motion. He explicitly identifies the non-natural motion of a body with the motion contrary to the natural motion of the body:

31. NNM of $x$ = *Contr*(NM) of $x$.

But at times Aristotle simply equates non-natural motion with forced motion. In other words, any motion that a body may perform against its nature is a case of non-natural motion. This concept of non-natural motion may be characterized by saying that any motion which is *not* in

(vi) Athenagoras, *Legatio pro christianis* 6. 4. 25–30; (vii) [Iustinus], *Cohortatio ad graecos* 5. 2. 15–20; (viii) Hippolytus, *Refutatio omnium haeresium* I 20. 4, VII 19. 3–4; (ix) Sextus Emp., *PH* III 31 and *M* IX 316; Diog. Laert., V 32; (xi) [Galen], *Historia philosopha* 18 (= *Dox. gr.* 610–611); (xii) Achilles, *Isagoge* 2. 1 (= 30. 25–7 Maas); (xiii) Basil, *Hexaemeron* I 11 (= 18. 17–18 de Mendieta and Rudberg); (xiv) Ambrogius, *Exameron* I 6. 23 (= 21 D–E Schenkel); (xv) Theodoretus, *Graecarum affectionum curatio* IV 12, IV 18, IV 21; (xvi) Nemesius, *De natura hominis* 5. 165 (52. 18–23 Morani).

accordance with the nature of the body is a case of non-natural motion. In other words:

32. NNM of $x \neq$ (NM) of $x$.

I would like to enrich the conceptual apparatus so far developed by taking into account a testimony preserved by Cicero, whose ultimate source is presumably Aristotle's dialogue *On Philosophy*:

(1) But neither is Aristotle undeserving of praise, in that he thought everything that is moved is moved either by nature or by force or by will [*voluntate*]; (2) the sun, the moon, and all the stars are moved, (3) but the things that are moved by nature are moved either downwards by being heavy or upwards by being light; (4) neither of which is proper to heavenly bodies, because their motions are circular. (5) But neither could it be said that it is by some greater force that the celestial bodies are moved against nature. (6) For what can be greater? (7) It remains, then, that the motion of the celestial bodies is voluntary (Cicero, *Nat. deor.* II 44 = *On phil.* fr. 21b Ross = fr. 836 Gigon).[15]

The great intrinsic interest of this testimony is the claim that celestial motion is voluntary – clause (7). This claim is the conclusion of an argument whose first premise is the tri-partition: (i) *natural motion*, (ii) *forced motion*, and (iii) *voluntary motion* – clause (1). The desired conclusion is reached by excluding that the characteristic motion of celestial bodies is either a case of forced or natural motion. Since forced motion is any motion that is imposed from the outside, it is relatively easy to see why celestial motion cannot be a case of forced motion – clause (5). This would imply the existence of some force greater than the celestial bodies

15 Cicero goes on as follows: "(8) Anyone who sees this truth will show not only ignorance but also wickedness if he will deny the existence of gods." Following Rose (1886) and Walzer (1934), Ross (1955b) prints this clause in 21b. I prefer to follow Gigon (1987), who does not print (8). This clause does not seem to be part of the argument which ultimately goes back to Aristotle and describes celestial motion as a case of voluntary motion. The reference to the existence of gods makes it clear that Cicero is going back to the *divinitas* of the celestial bodies, which was his original issue. For a vindication of this interpretation, see Effe (1970: 131). Even if we opt for this more prudent hypothesis, at least two scenarios are still possible: (1) Cicero read Aristotle's *On Philosophy* and decided to corroborate the Stoic arguments in which he is primarily interested with the citation from Aristotle (this possibility is advanced in Furley (1989)); (2) Cicero did not read Aristotle's *On Philosophy* but found, in his Stoic source (Poseidonius?), the arguments already corroborated with Aristotle's citation. I share the prudence and the skepticism of Moraux (1964: 1222–3), but cf. also Van den Bruwaene (1978: 65n47). With careful examination, the alleged fragments of an ancient author frequently reveal their nature as testimonies (often only second-hand). I do not think that the argument reported by Cicero is an exception to this general rule. In the best case, it is nothing more than a Latin paraphrase of a lost dialogue of Aristotle. In the worst case, it is a Latin testimony of a Greek testimony of a lost dialogue of Aristotle.

and imposing circular motion upon them – clause (6).[16] It is much more difficult to see why celestial motion cannot be a case of natural motion. Yet the testimony is crystal clear on this point: if something is a natural body, then it naturally performs either upward or downward motion only – clause (3). A more careful reading of this clause, however, shows that the natural motion in question is the motion that a natural body performs in so far as it is heavy or light. Heavy bodies fall because that motion is in their own nature; in other words, falling is natural to them. This does not exclude that the motion a natural body performs in so far as it is a living body can be a case of natural motion. Suppose that the heavy body in question is a man. A man is naturally equipped with a locomotory and sensory apparatus for moving around by walking. For Aristotle, a man moves around by walking because it is in his own nature to do so; in other words, walking is natural to him. Of course it is always possible to think of a situation in which a man is constrained to walk (for example, somebody threatens him with a gun). Though I think that Aristotle would count constrained walking as a case of natural motion (because the ultimate source of the motion is still an internal principle of motion), I confine myself to the much simpler case of a man who is moving around by walking and is not constrained to do so. It is hard to imagine that Aristotle, in his *On Philosophy*, could deny that this walking is a genuine case of natural motion. This walking is natural to the man simply because there is no external force compelling the man to move from one place to the other. Admittedly, external factors may play a role in the production of this particular motion, but its basic shape and course are ultimately regulated by a nature of a specific type: a human soul. More generally, it is hard for me to imagine that Aristotle could deny that animal motion is a genuine case of natural motion, if the animal engaged in the motion is not externally forced or compelled to perform the particular motion it does. Animal motion is a case of natural motion because it is caused by the appropriate type of nature, an animal soul. In other words, what is distinctive of animal motion is that it has a *psychological cause*.

Let us return, in the light of these remarks, to celestial motion and the way this motion is presented in the *DC*. From the *DC* we learn that the

16 Notice that this force would have to be infinite. On Aristotle's principles, only an infinite force could keep the constraint upon the celestial bodies forever. But there is no such force in the natural world. Alternatively, we could posit the existence of an infinite number of finite forces successively keeping celestial bodies moving in the relevant way. But this would be regarded, I think, as a highly questionable assumption.

celestial bodies are not deprived of life and that their distinctive circular motion around the earth is the motion of living bodies. More specifically, we are required to think of celestial bodies as intelligent living bodies engaged in motion (292 a 18–22).[17] Admittedly, Aristotle never offers a direct argument in support of this claim, in the *DC* or elsewhere. He presumably thinks that the explanatory benefits that depend upon this assumption are also an indirect argument in support of the assumption itself. Whatever the case may be, it is clear that for Aristotle the study of the celestial bodies is to be conducted in the same way as the study of all perishable living bodies is conducted; that is, moving from the activities that are constitutive of the behavior of these living bodies, and looking for an internal source governing these activities and shaping them into a unitary behavior – the behavior distinctive of the living bodies in question. I speak of activities (rather than activity) because from earth the celestial bodies do not appear to be engaged in simple circular motion, but they appear to revolve around the earth with a relatively complex behavior. However, complexity does not involve flexibility: the celestial bodies do move around the earth with a relatively complex behavior, but they are unable to stop moving or to move in any other way than they actually do. Put differently, *lack of flexibility* appears to be a distinctive feature of the motion of the celestial bodies.[18] I postpone discussion of this lack of flexibility and its relevance; for the time being, I focus only on the complexity of celestial motion. Aristotle presumably thinks that the complex behavior of the celestial bodies can be adequately explained only by appeal to a psychological principle of unity and intelligibility, a soul of

17 Aristotle makes this claim in discussing the following two difficulties: why are the sun and the moon moved by fewer motions than some of the other planets? (291 b 29–31); and (ii) why are so many stars carried by one single motion – the motion of the heaven of the fixed stars – whereas many motions are needed to carry one single planet? (292 a 10–14). We are used to thinking of celestial bodies as mere bodies and units which do have order but do not have a soul (292 a 18–20). On the contrary, we should conceive of them as partaking of life and action: in this way what occurs will not seem to be anything contrary to reason (292 a 20–2). Thinking of something as a unit means making abstraction of some of its natural properties and conceiving of it as a point. In other words, the difficulties stated above can be successfully treated only if we abandon the geometrical models offered by Eudoxus of Cnidus and his followers and conceive of celestial bodies as living beings. Notice that celestial motion is here presented as a case of action (292 a 20–2). From Aristotle's discussion of the two difficulties, it is clear that the relevant notion of action – the notion of action on which Aristotle is here relying – makes a crucial reference to the good. Apparently, to be alive is to be sensitive to the good, and action is the way in which a living being is sensitive to the good. Action so understood is attributed to plants, animals, human beings, and celestial bodies. For this particular notion of action, see also *DA* 415 b 1–3.

18 We usually focus on the *regularity* of celestial motion rather than on its *lack of flexibility*. But it is easy to see that regularity involves lack of flexibility (and vice versa).

a certain type.[19] In his view, celestial motion is for the celestial bodies as natural as walking is for men. In the latter case the ultimate source of walking is a psychological principle of a specific type: a human soul. Accordingly, the ultimate source of celestial motion is a psychological principle of a specific type: a celestial soul. The similarities existing between the two cases should not obscure the fact that Aristotle admits important differences too. First of all, walking is a case of progressive motion or *poreia* and implies, minimally, the actual exercise of perception and *phantasia*. By contrast, celestial motion is not a case of navigation from one place to the other, and it does not require the actual exercise of perception or *phantasia*. I shall return to this doctrine in chapter 4. Secondly, it is in the nature of man to walk (in the sense, for example, that it is up to him to cover some distance by walking). But though walking is natural to him, it is not natural to his bodily parts. To begin with, we get tired of carrying our body around and need to stop walking and rest (and eventually eat and drink). Moreover, we can damage our joints, and finally get injured, by covering excessive distances without appropriate rest. By contrast, the celestial natures do not make any effort to move in a circle. Nor do they get tired of carrying around their body. They are composed of a simple body that already performs circular motion. It is not difficult to find a reason for a doctrine that at first appears to be bizarre, if not redundant. From the *DC* we learn that any account of the celestial bodies should accommodate the belief that the celestial bodies are divine beings engaged in an eternal blissful life. By being realized in a body that is naturally moved in a circle, they can enjoy the eternal and blissful life that is appropriate to their divine status.

By simply accepting that Aristotle conceives of celestial bodies as intelligent living beings engaged in action, and thinking of this action

19 In connection with this claim I find it useful to think of the way in which the apparently erratic motion of the planets was routinely explained by the help of geometrical models, which all went back, in one way or the other, to the one developed by the great mathematician Eudoxus of Cnidus. According to the tradition, Eudoxus produced his geometrical models in response to Plato's challenge to "save the phenomena." Roughly, by combining a certain number of homocentric (or concentric) spheres into a single system, and by giving each sphere a specific rotation and angle of inclination, Eudoxus and his followers were able to approximate the motion described by a celestial body in the heavens. Though Aristotle thinks that these geometrical models can by no means provide an adequate explanation of celestial motion, he is ready to accept the idea that the complex behavior of a planet can be analyzed into a certain number of simple circular motions. But if this is the case, an appropriate nature as principle of unity (and intelligibility) is required to transform these simple activities into a single, complex behavior; that is, the behavior of the planet. For Aristotle, this nature can be only a specific type of soul, a celestial soul. On the soul as principle of unity (and intelligibility), I refer the reader to chapter 2, "Bodies."

as a rational activity involving the exercise of the capacity for thought and desire, we have explained how it is possible for Aristotle to think of celestial motion as a psychological activity; however, we have not yet explained how it is possible for him to speak of this activity as a case of voluntary motion, let alone as a case of voluntary action. From our point of view, something performing circular motion forever, without being able to stop moving, or to perform a different type of motion, or to perform the same motion but in a different direction, is by no means engaged in a voluntary motion. Our difficulty ultimately depends, I think, on a certain conception of the voluntary. We are inclined to make the voluntary conceptually dependent on that which can be chosen. For the sake of illustration, let us return to animal motion as experienced on earth. We may think that walking is voluntary because it is performed as the consequence of a choice and conforms to that choice. Though a walking man can continue to walk, it is in his power to stop walking. It is in his power to continue to walk because the other option is available to him. In other words, he can decide to act otherwise. Clearly, this is not the conception of the voluntary on which Aristotle could rely in his *On Philosophy* to claim that celestial motion is voluntary. Though it is not possible to say exactly to which conception of the voluntary Aristotle may have had recourse in this lost dialogue, we can always turn to his ethical works for enlightenment on this matter. There Aristotle is not only content to make use of the conception of the voluntary; in addition, he spells out theoretically what the voluntary is. For him, the voluntary is simply that which is not forced or compelled by the outside, but takes place in accordance with an internal principle of motion. This is particularly clear from the way the non-voluntary is introduced in the *NE*: an action is non-voluntary if it takes place by force or through ignorance (1109 b 35 – 1110 a 1). Moreover, an action takes place by force as it comes from a source external to the agent and nothing is contributed by the agent itself (1110 a 1–4). Apparently, Aristotle recognizes the voluntary as a particular case of the natural (and, accordingly, the non-voluntary as a particular case of the non-natural). This is not the place to enter into a discussion of the eventual merits and limits of this treatment of the voluntary.[20] What matters is that this particular approach provides us with the conceptual resources to make sense of the testimony preserved by Cicero. From Cicero we know that this activity cannot be imposed upon

20 For a convenient discussion of Aristotle's reduction of the voluntary to the natural, see Broadie (1991: 132–42).

the celestial bodies from outside. There is nothing in the natural world that can force the celestial agents to act in the way they do – clauses (5) and (6). Celestial motion is therefore to be explained exclusively with reference to an internal source of motion. But since this activity is conceived as a case of rational activity, involving the exercise of the capacity for thought and rational desire, it can be nothing but a case of voluntary action.[21]

## THE FIFTH BODY IN THE *EPINOMIS*

Up until now, I have spoken of the simple celestial body as if it were a unique creation of Aristotle. And yet the claim of the existence of a fifth body along with earth, water, air, and fire is present from the very beginning in the Platonic tradition.[22] From this point of view, the *Epinomis* is a model document. The notion that this dialogue is not Plato's but the work of one of his immediate disciples (Philip of Opus?) dates back to the sources of Diogenes Laertius.[23] Interest in this dialogue resides primarily in the fact that it documents, in an extraordinarily efficacious way, how, from a certain point on, Plato's thought, especially as it is presented in the *Timaeus* and the *Laws*, became Platonic doctrine. Part of this doctrine, though not necessarily part of Plato's thought, is the thesis of the existence of a fifth body. What is most important for the present discussion is to ascertain whether there is some relationship between the fifth body of the *Epinomis* and the simple celestial body of Aristotle. Once light has been shed on the fact that the author of the *Epinomis* makes use of a different conceptual apparatus to introduce his own fifth body, it will be easier to understand why, since antiquity, Aristotle has been presented as the

21 In passing, I point out that Alexander of Aphrodisias recognizes celestial motion as a case of free motion. See Alexander, *De fato* 181. 16–20. A final note on Aristotle's *On Philosophy* is needed. From the scanty information concerning its content, we cannot be certain that in this dialogue Aristotle was committed to the existence of a celestial simple body that is different from, and not reducible to, earth, water, air, and fire (*pace* Jaeger, 1948). Certainty in this matter remains beyond our reach. However, I am inclined to think that Aristotle always thought that the celestial bodies are made of a special body, unique to them. In other words, this view is not specific to the *DC*, and from the little we know about the content of *On Philosophy* we should not conclude that in this dialogue Aristotle offers an explanation of celestial motion that is at variance with that of the *DC* (*pace* Guthrie, 1986[6]). On this point see also Moraux (1964: 1210–13).

22 For a survey of the testimonies in our possession, see Moraux (1964: 1184–6).

23 Diog. Laert., III 37. The ancient debate on the authorship of the *Epinomis* is partially preserved in the *Anonymous Prolegomena*, X 25. 1–10. From this Neoplatonic introduction to the philosophy of Plato we learn that Proclus was skeptical about the authenticity of the dialogue. For a convenient introduction to the *Epinomis*, and the ancient and modern debate over its authorship, see Tarán (1975: 3–47). For a recent introduction to the *Epinomis*, see Dillon (2003: 178–97).

discoverer of the simple celestial body. This will also explain how, in the Platonic tradition, a doctrine that contemplates the existence of five bodies can coexist with a criticism of the Aristotelian view that the celestial bodies are made of a celestial simple body which is different from, and not reducible to, earth, water, air, and fire.

The way in which the fifth body is introduced and justified in the *Epinomis* has nothing to do with the way in which the simple celestial body is proved in the *DC*. While Aristotle establishes a correlation between *bodies* and *motions*, the author of the *Epinomis* links *bodies* to *regular polyhedra*. More specifically, the speculations of the author of the *Epinomis* on the nature and number of bodies are the result of a creative interpretation, if not a deliberate misunderstanding, of the *Timaeus*. In the *Timaeus*, earth, water, air, and fire are associated with four regular polyhedra.[24] These four solids are constructed from two elementary triangles: the scalene rectangular triangle and the isosceles rectangular triangle. The icosahedron, the octahedron, and the pyramid are constructed from the scalene rectangular triangle, the cube from the isosceles rectangular triangle. However, geometry at the time of Plato recognized also a fifth regular polyhedron that consists of twelve pentagonal faces and that can be constructed from either of the elementary triangles, the dodecahedron. Plato assigns to the dodecahedron a rather mysterious task: god availed himself of this fifth figure in order to decorate the universe (*Tim.* 55 C 4–6). Even these few mentions are sufficient to appreciate the importance of the *Timaeus* as a historical document on the state of geometry during Plato's time. From independent sources we know that several of the results achieved in the field of the geometry of solids are attributable to Theaetetus, the gifted mathematician to whom Plato dedicated one of his most important dialogues.[25] Among the reasons that motivated Plato to make extensive use of Theaetetus' discoveries, and of those of his contemporaries and predecessors, was surely the conviction that geometry could offer a method of studying and analyzing the natural world. The fate reserved for the dodecahedron is nevertheless instructive. It helps us to understand how, at least for Plato, geometry could offer a method for analyzing nature but it could not provide a criterion for establishing what exists in nature. In particular, the fact that there are

24 I have briefly presented and discussed this doctrine in chapter 2: "Bodies."

25 *Suda Lexicon*, s.v. *Theaetetus*: "Theaetetus of Athens, astronomer, philosopher, disciple of Socrates, taught at Heraclea. He was the first to construct the so-called five solids. He lived after the Peloponnesian war." Apparently, Theaetetus was the first to study the octahedron and the icosahedron, and it is believed that Book XIII of Euclid's *Elements* is based on his work.

five regular polyhedra is not, at least for Plato, a sufficient reason for introducing a fifth body alongside earth, water, air, and fire. In all probability, the author of the *Epinomis* was also convinced that geometry could not offer the ultimate criterion for deciding what there is in nature. And yet, using the *Timaeus* and the results reached by Theaetetus as a point of departure, he concluded that if the regular polyhedra are five in number (981 B 3–4), then the bodies must also be five in number: fire, *aithēr*, air, water, and finally earth (981 C 5–8). Why?[26]

The operation attempted by the author of the *Epinomis* will become clearer if we concentrate on the order in which the bodies in question are offered. Fire and earth are the two outermost bodies. They are present in every composite body. But they cannot be mixed without the help of *aithēr*, water, and air. The job of these three intermediate bodies is that of glue or cement: they serve to hold earth and fire together. These five bodies are present, in different proportions, in every composite body. Moreover, a predominant element is easily detectable in each composite body. In our body, for example, earth predominates. Yet, besides the earth, a certain amount of water, air, *aithēr*, and finally fire is also present (981 C 8 – D 5). The celestial bodies are no exception to the rule. The sun, the moon, and the remaining planets are composite bodies. More specifically, these bodies are composed, for the most part, of fire.[27] But next to fire it is possible to detect not only the presence of earth and air, but also traces of *aithēr* and water. Even from these few remarks, it is evident that the author of the *Epinomis* accepts some version of the principle that can be extracted from *Tim.* 31 B – 32 C:

**P**: if $x$ is a body, then $x$ is composed of E, W, A, and F.[28]

26 Note that the author of the *Epinomis* calls his fifth body *aithēr*. Aristotle refrains from using this name. I refer the reader to the Epilogue for a discussion of Aristotle's silence. For the time being, I only note that the name *aithēr* is used in the *Timaeus* to refer to a specific kind of air, not fire. In all probability, Anaxagoras was the first to use the term *aithēr* to refer to fire. The (ab)use of the name *aithēr* to refer to different things did not prevent the author of the *Epinomis* from using it.

27 Here the author of the *Epinomis* follows the *Timaeus*. This text was usually read in the light of *Tim.* 58 C 5–7, where Plato claims that there are different forms of fire.

28 More specifically, the author of the *Epinomis* accepts the following version of this principle:

**P***: if $x$ is a body, then $x$ is composed of E, W, A, *Aithēr*, and F.

Is Plato really advancing principle **P** in *Tim.* 31 B – 32 C? At least at first sight, one is tempted to answer no. In this passage, Plato is not offering an account of the composition of every single body. He is rather offering an account of the body of the universe as a composition of earth, water, air, and fire. However, one has also to acknowledge that this particular body is not merely a body among others but the body par excellence. And this may explain why the whole passage could easily be understood as offering an account of the composition of every single body. Moreover, a comparison of the first two lines of our passage with *Tim.* 28 B 7 – C 2 suggests that

It is less easy to understand up to what point he is aware of distancing himself from the doctrine reported in *Tim.* 31 B – 32 C. The doctrine of the *Epinomis* is in fact incompatible with the mathematical speculations contained in *Tim.* 31 B – 32 C on the number of intermediate elements needed to mix with the outermost ones. The introduction of a fifth body allows one to leap over the mathematical conjectures in support of the existence of two intermediate bodies (water and air) and two outermost bodies (fire and earth). The intermediate bodies that carry out the function of glue are in fact three: besides water and air he also considers *aithēr*. But is it possible to preserve the doctrine of bodies offered in the *Timaeus* by renouncing the mathematical speculations that sustain it? For the author of the *Epinomis* evidently yes.

I do not think it is a mistake to present the *Epinomis* as the attempt to construct a doctrine of bodies that also reserves a space for that fifth regular polyhedron: the dodecahedron. Nevertheless the author of the *Epinomis* does not limit himself to introducing a fifth body. He uses this body to construct a demonology that develops, in a systematic way, the frequent references in the Platonic dialogues to the existence of intermediate entities whose primary task is that of functioning as mediator between humanity and the divine. Once again, the way in which the author of the *Epinomis* proves the existence of demons is the result of a creative

Plato is ready to extend his speculations about the composition of the universe to every single body. I would like to focus on a consequence descending from this reading of *Tim.* 31 B – 32 C. What we usually call earth, water, air and fire are not the same as the elements which are usually referred to with the name "earth," "water," "air," and "fire." If principle **P** holds, any quantity whatsoever of the body we usually call earth is a composition of earth, water, air, and fire, and therefore the name "earth" is merely an indication of the dominant element, earth. In fact, from

1. **P**: if $x$ is a body, then $x$ is composed of E, W, A, and F.

By replacing $x$ with E, W, A, and F, one obtains:

2. if E is a body, then E is composed of E, W, A, and F
3. if W is a body, then W is composed of E, W, A, and F
4. if A is a body, then A is composed of E, W, A, and F
5. if F is a body, then F is composed of E, W, A, and F.

This interpretation of *Tim.* 31 B – 32 C is discussed – rejecting **P** – by Alexander of Aphrodisias in *Mantissa* 123.4 – 126.23. I owe this point to Bob Sharples. In all probability, Alexander's polemical target is a certain interpretation of *Tim.* 31 B – 32 C which was endorsed, among the others, by Numenius. Cf. Proclus, *In Tim.* III 9. 4–5 (= Numenius fr. 51 Des Places). For the reception of **P** in the Platonic tradition, see Falcon (2001: 123–44). I argue that *Tim.* 31 B – 32 C played an important role in the critique of Aristotle's simple celestial body. Plotinus and Proclus provide us with good examples of the way **P** could be used against Aristotle (Plotinus, II 1.6.1–21, and Proclus *In Tim.* II 43. 20 – 44. 18). From *GC* 334 b 30–1, we learn that Aristotle was ready to accept that a version of **P** holds for the sublunary world. In other words,

6. **P****: if $x$ is *a sublunary body*, then $x$ is composed of E, W, A, F.

interpretation, if not a deliberate misunderstanding, of the *Timaeus*. More specifically, he associates each element with a particular type of creature. Earth is associated with a rather broad genus that comprises all terrestrial creatures (981 C 8 – D 5). Fire is instead associated with the divine genus of celestial creatures – the celestial bodies. Between the terrestrial and celestial genus, there must exist creatures of an intermediate nature associated with the intermediate bodies. *Aithēr* is the origin of a first type of beings, which are specifically called demons (984 E 1). Apparently, demons are invisible to our eyes because the predominant element in their body is transparent (984 B 6 – C 2; 984 D 8 – E 5). The intermediate nature of *aithēr* places these beings between the earth and the sky, thus allowing them to carry out that mediating function between gods and humans that is characteristic of them (984 B 4 – E 5). After the demons, the author of the *Epinomis* considers two other intermediate types of creatures: the aerial and aqueous creatures, in which air and water respectively carry out the role of the dominant element. Thanks to the intermediate nature of their dominant element, even the aerial creatures (like the demons) seem to share a function that is peculiar to the demons: they can in fact pass with ease from earth to the celestial region and vice versa (985 B 1–4). Although information on the aqueous creatures is scarce, we understand that their intermediate nature makes them semi-divine creatures (985 B 4–C 1). However, the author of the *Epinomis* does not seem to grant to these creatures any intermediary function between the heavens and earth.

Even this brief presentation of the demonology of the *Epinomis* should suffice to demonstrate how the doctrine of the celestial simple body defended by Aristotle has nothing to do with the doctrine of the fifth body advanced in the *Epinomis*. To begin with, the *use* of the doctrine introduced in the *Epinomis* is significantly different. For the author of the *Epinomis* the introduction of the fifth body is not a consequence of convictions about the nature of the celestial bodies. In the vein of the Platonic tradition of the *Timaeus*, he is committed to the material unity of the natural world. The introduction of the fifth body is functional to a task foreign to Aristotle's concerns, but perfectly comprehensible within the Academic tradition. Though few, the testimonies in our possession are sufficient for maintaining that demonology was a serious business within Plato's Academy.[29] With the introduction of the fifth body, the author of

29 Xenocrates was particularly active in this field. The best introduction to Xenocrates and his demonological theory is still Heinze (1892: 78–125). On Xenocrates' demonology see Plutarch, *De*

the *Epinomis* is able to elaborate a cosmology that gives space to the demonic beings of intermediate nature between gods and humans which are frequently referred to in the Platonic dialogues. Secondly, and more importantly, the *theory* that underpins the introduction of the fifth body in the *Epinomis* is incompatible with the conceptual apparatus to which Aristotle makes reference in arguing for the existence of a celestial simple body. The author of the *Epinomis* endorses the theory advanced in the *Timaeus*, and in particular the idea that a geometric structure is to be assigned to each body. But the geometrical account offered in the *Timaeus* clashes with the principle of the ever-divisibility of body. Moreover, from the *DC* we learn that for Aristotle ever-divisibility (along with three-dimensionality) is a distinctive feature of a body. Lack of clarity on this point, admonishes Aristotle, jeopardizes the final result of our investigation.[30] In the *DC* Aristotle also proves that the idea of assigning a geometric figure to each body functions only on the condition that one assumes that the bodies in question are not divisible into ever-divisible parts (306 a 30 – b 7).

I would like to end this brief discussion of the doctrine of the fifth body in the *Epinomis* with the map of ancient dogmatic philosophy that Sextus draws with respect to the attitude it shows towards the much debated question of the divisibility of body:

> (1) There is an undecidable dispute amongst all the philosophers: some of them say that body is indivisible, others that it is divisible; (2) and of those who say that body is divisible some claim that body is infinitely divisible, others that the division stops at what is minimal and atomic (*M* I 27).

According to Sextus, there are philosophers who believe in the divisibility of body and philosophers who do not – clause (1). Moreover, those who claim that body is divisible can be further divided. Whereas some philosophers believe in the infinite divisibility of body, others think that there are items which cannot be further divided and that the division of

*defectu oraculorum* 12. 416 B–D (= Heinze fr. 23); Proclus, *In Remp.* II 48. 4–27 (= Heinze fr. 23); Plutarch, *De Iside et Osiride* 25. 360 D–F (= Heinze fr. 24). Interestingly enough, from Simplicius we learn that Xenocrates in his *Life of Plato* ascribed to Plato the view that the *zōia* can be divided to arrive at five *stoicheia*, which are called *schēmata* and *sōmata*: *aithēr*, fire, water, earth, and air. Cf. Simpl., *In DC* 12. 22–6 and *In Phys.* 1165. 35–9 (= Heinze fr. 53). The Greek *zōia* is ambiguous in various ways. Cf. chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature." In this case it refers to all animals there are, including any living beings which there might be superior to men. If this is the case, this testimony is part of an attempt to develop a demonology from the doctrine of the *Timaeus*.

30 I have discussed the importance of this principle in chapter 2, "Bodies."

body stops when these items are reached – clause (2).[31] Sextus' aim is clear: he wants to provide two claims and two counterclaims on the issue of the divisibility of body – body is divisible/body is not divisible; body is ever-divisible/body is not ever-divisible – in order to end up in a suspension of judgment because it is not possible to come down on one side or the other in the dispute. Of course we do not have to buy into Sextus' conclusion – the suspension of judgment. We have only to realize that the *DC* and the *Timaeus* (and therefore the *Epinomis*) are on different sides in the dispute over the divisibility of body.

## TAKING STOCK

Before proceeding we would do well to pause and take stock of the results achieved so far. The student of nature is concerned not only with natural bodies but also with the explanation of their motions. For Aristotle, the celestial bodies are intelligent, living bodies that perform a regular but complex motion around the earth. He is persuaded that the explanation of the behavior of the celestial bodies requires an appeal to a psychological cause, a soul equipped with the capacity for thought and desire. In the following chapter I shall return to celestial thought and celestial desire. For the time being, I am content to insist on the following crucial, though too often neglected, truth: *the celestial motion* that is naturally performed by the celestial bodies is not *the circular motion* that is naturally performed by the celestial simple body. Celestial motion is the motion of a living body engaged in a specific animal motion, and as such it involves the reference to a psychological cause: a soul of a certain type. This motion is complex and involves the exercise of celestial cognition and celestial desire. By contrast, the circular motion that is naturally performed by the celestial simple body is a simple motion and does not necessarily involve the reference to a psychological cause. Interestingly enough, this motion is never described, in the *DC* or elsewhere, as the motion of a living being. A gap seems to exist between the circular motion of the celestial simple body and the celestial motion performed by the celestial bodies. In order to bridge this gap, we can opt for one of the following two solutions.

31 I have argued that ancient atomism is a constellation of positions, and that these atomic items may be conceived in a number of ways, in chapter 2: "Bodies."

1. We may insist that the circular motion of the simple body is not only a necessary but also a sufficient condition for the explanation of celestial motion. We may argue that the arguments offered at the beginning of the *DC* do not merely prove that there is a simple body that naturally performs circular motion but provide also an adequate account of celestial motion. In this case, we have to identify the nature of the simple body with a soul of a specific type. Apparently, Alexander of Aphrodisias took this view. He argued that celestial motion is the motion that the celestial simple body performs in accordance with its own nature. He identified this nature with a soul of a certain type, a celestial soul.[32]
2. We may contend that these arguments do not provide an account of celestial motion but supply only the material condition for celestial motion; that is, a simple body that is naturally moved in a circle. In this case we have to specify the contribution of the soul to the explanation of the distinctive motion of the celestial bodies. In antiquity, much time and effort was devoted to detecting this possible contribution. The ancient interpreters of the *DC* concentrated on the case of the heaven of the fixed stars. Julianus of Tralles argued that the soul of the first heaven is not responsible for the production of circular motion, but only for its being oriented in a certain direction.[33] Herminus agreed that the soul of the heaven of the fixed stars is not responsible for the production of circular motion. But he argued that this soul causes the circular motion of the celestial simple body to be continuous and everlasting.[34]

It is significant, I think, that the ancient interpreters of the *DC* who engaged in this exegetical exercise did not have doubts about the involvement of the soul in the explanation of celestial motion. They all assumed that celestial motion involves a reference to a psychological cause of a certain type. Disagreement among them was confined to the precise nature of the involvement.[35]

32 Simpl., *In DC* 380. 29–381. 2. See also Simpl., *In Phys.* 1219. 3–7. For a presentation of the position of Alexander, see Sharples (1983: 62–6) and Bodnár (1997a: 190–205).

33 Simpl., *In DC* 380. 1–3. We know virtually nothing about Julianus. For a modern vindication of the position of Julianus, see Judson (1994: 155–71).

34 Simpl., *In DC* 380. 3–5. For a presentation of the life and work of Herminus, see Moraux (1984: 361–99).

35 I devoted an entire chapter to the discussion of this exegetical problem in Falcon (2001: 187–241).

CHAPTER 4

# *The limits of Aristotle's science of nature*

> It is worthwhile seeking to attain more understanding regarding these things, though the resources at our disposal are few and we are at such a great distance from what happens in the heavens (Aristotle, *DC* 292 a 14–17).

## REMOTENESS

From the opening lines of the *Meteorology* the science of nature emerges as a systematic investigation of the natural world. This investigation is systematic in the sense that it consists of an inquiry into the different parts of the natural world in the attempt to discover the explanatory connections existing between its parts. If this investigation is successful, it does not provide mere knowledge of the natural world; it provides understanding of it. But this investigation is systematic also in the sense that it consists in a study of the natural world in its entirety. While Aristotle does not insist on this point in the opening lines of the *Meteorology*, he is more explicit towards the end of *PA* 1. This *logos* ends with an exhortation to the study of the entire natural world: the celestial together with the sublunary world, and this latter in all its parts, plants and animals included (645 a 4–7).[1] Aristotle takes it for granted that the natural world is constituted by a celestial and a sublunary part, and argues that the study of each of these two parts has its own appeal. In this *logos*, however, the emphasis is on the study of plants and animals. This gives us opportunities for knowledge that are not available to us in the study of the celestial world:

(1) Among the substances constituted by a nature, some neither come into being nor perish for all time, and others share in coming into being and perishing. (2) It has turned out that we have fewer ways of studying the first type of

1 I have discussed this passage in chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

substances, honorable and divine though they are: (3) for both the starting points of the inquiry and the things we would like to know about present very few things to perception. (4) We are better supplied with opportunities for knowledge about perishable plants and animals because we live among them: (5) for much can be learned about each kind if one is willing to undertake the appropriate labor (*PA* 644 b 23–32).

In this passage Aristotle is not content to say that the study of the celestial world is more difficult. He also shows a remarkable amount of pessimism regarding the possibility of knowledge about the heavens. He acknowledges the existence of an *informational gap* affecting the study of the celestial world – clause (2) – and provides *remoteness* as the reason for this gap – clause (3). Admittedly, Aristotle says very little about remoteness in clause (3). He is content to claim that the celestial bodies are perceptually remote. What he says in the *DC*, however, suggests that the remoteness that puts the celestial world beyond our grasp cannot be reduced to mere physical distance:

(1) since no circular motion is contrary to circular motion, (2) we have to inquire why there are several motions; (3) we have to try, though we are far removed, to make an inquiry; (4) we are far removed not only in place but much more because of the fact that we have perception of very few of their features (286 a 4–7).

I postpone discussion of the significance of clause (1) and focus, for the time being, on the rest of the passage.[2] In clause (2) we are told that we have to explain why celestial motion does not consist in simple circular motion but is articulated in a plurality of circular motions. But in clause (3) we are warned that we may encounter some obstacles in our attempt to provide the relevant explanation for this fact. Once again, perceptual remoteness is identified as the main source of the problem. But this time Aristotle is more informative. He makes it clear that what he has primarily in mind is not physical distance. Remoteness is mainly due to the fact that we have only a limited access to the celestial region – clause (4). In other words, no matter how extensive and careful our observations may be, they will provide only a little information about few features of the celestial bodies.[3] However elusive and cryptic this further passage may be, it

2 I shall return to the claim that there is no (circular) motion contrary to circular motion in the discussion of celestial matter. See below, pp. 106–7.

3 In the passage I have quoted in the epigraph, Aristotle insists that it is worthwhile seeking to attain more understanding concerning these bodies, though the resources at our disposal are few *and* we are at such a great distance from what happens in the heavens (292 a 14–17).

confirms that physical distance alone does not supply a full account of the difficulties encountered in the study of the celestial world. The celestial bodies are at a great distance from earth and too far away to be accessible to us by perception. But this is not the whole story. If, therefore, we want to understand why Aristotle is so pessimistic about the extent to which we can know the celestial world, I suggest that we turn to his conception of this world. It is in fact the very way in which Aristotle conceives of the celestial bodies that makes them remote from the natural bodies we experience on earth, and this quite independently of any considerations about the physical distance that may exist between them and us. Put differently, the celestial bodies are conceptually, and not simply geographically, remote. Moreover, the *conceptual remoteness* in question ultimately depends on the fact that the explanatory resources at our disposal, according to Aristotle, are not adequate to provide a positive characterization of certain important features of the celestial world. More directly, the celestial bodies are conceptually remote because they possess a nature different from, and not completely reducible to, the natures we find in the sublunary world.

## DISCONTINUITY

In antiquity it was commonly held that the celestial world is a somehow special region of the sensible world. Stability and incorruptibility were often offered as the differentiating features of the celestial world. But the position of Aristotle is more specific and in fact stronger than a generic commitment to the existence of some difference between the celestial and the sublunary world. So far I have argued that the natural world is understood by him as a causal system of a specific type. I now would like to add that this causal system admits an important *discontinuity* between the celestial and the sublunary world, and that as a result of this discontinuity there is unity *without* uniformity in the natural world. An example may help to illustrate his position. Aristotle is committed to the view that the characteristic behavior of the celestial bodies – their complex but regular motion around the earth – requires the existence of a specific type of material principle. He is persuaded that the distinctive motion of the celestial bodies can be explained only on the assumption that they are made of a simple body that naturally performs circular motion. For him, this celestial simple body is distinct from the ultimate material principles out of which everything in the sublunary world is constituted. Very few in antiquity were prepared to postulate the existence of a material principle different from, and not reducible to, earth, water, air, and fire. This was ultimately due to the fact that very few in antiquity were prepared to share with Aristotle the belief in the existence of an important discontinuity between the celestial and the sublunary world. The belief in the existence of unity together with an important discontinuity explains not only why Aristotle takes the view that the celestial bodies are made of a special simple body; it also explains why he does not admit the existence of a nature over and above the celestial and the sublunary natures. Aristotle at times speaks of nature, and says that nature does nothing in vain, or that it always does the best possible thing.[4] Both slogans may be understood as claims about a cosmic nature, but in general they are better understood, I think, as claims about a collection of particular natures. It is notoriously difficult to explain why this interpretation is to be preferred.[5] My suggestion is that Aristotle does believe in the existence of celestial as well as sublunary natures, but does not think that nature is a uniform principle of motion and rest. On the contrary, he is persuaded that the celestial natures are in some important respect different from, and not completely reducible to, the natures we experience in the sublunary world.

The beginning of *Lambda* is dogmatic but instructive on this point. *Lambda* is an investigation into substance on the crucial assumption that there are different kinds of substances. According to *Lambda*, there are sensible and immovable substances. First of all, a relation is established between the fact that the sensible substances are subject to motion and rest and the fact that they are sensible. The idea is that these substances need to be realized in some matter or other in order to be subject to motion and rest. By being realized in some matter or other, they are sensible. By contrast, the immovable substances are immaterial and non-sensible, as they are not subject to motion and rest. Secondly, sensible or material substances are themselves divided into two parts: eternal sensible substances (celestial bodies) and perishable sensible substances (animals and plants). In other words:

(1) there are three kinds of substances: (2) one that is sensible – which all admit, and of which one subdivision is perishable, namely plants and animals, and

4 In the physical writings the assumption that "nature does nothing in vain" occurs in *DC* 271 a 33, 291 b 13–14; *DA* 432 b 21, 434 a 31; *PN* 476 a 13; *PA* 658 a 8, 661 b 24, 691 b 4–5, 694 a 15, 695 b 19–20; *IA* 704 b 15, 708 a 9, 711 a 19; *GA* 739 b 19, 741 b 4, 744 a 37–8, whereas the assumption that "nature always does the best possible thing" is found in *Phys.* 260 a 22–3; *DC* 288 a 2–3; *GC* 336 b 27–8; *PN* 469 a 27–8; *PA* 658 a 23, 687 a 16–17; *IA* 704 b 15, 708 a 9–10.

5 On this point see, for example, Balme (1987: 275–85); Furley (2003: 71–84, in particular 73); Preus (1975: 221–48).

another eternal – of this we must grasp the elements, whether one or many; (3) and another that is immovable (1069 a 30–3).[6]

This passage confirms that Aristotle conceives of the natural world as one region divided into two parts: animals and plants form one subdivision of the sensible substances, and they are contrasted with the celestial bodies. The division into sensible and immovable substances casts some light upon another fundamental, though often neglected, truth: for Aristotle, the natural world is only one department of reality, not the totality. Both in the *Metaphysics* and in the *Physics*, Aristotle puts himself in direct continuity with the activity of the *physiologoi*. He presents the activity of his predecessors as a search for the explanatory principles of the natural world. There is no doubt that Aristotle is in essence right. From the very beginning, and independently of Aristotle, the investigation of the natural world consisted in the search for the relevant explanatory principles of a variety of natural phenomena on the basis of the fundamental assumption that the natural world is to some extent intelligible to us. There is, nevertheless, at least one important difference between the activity of the *physiologoi* and the investigation of the natural world as it is understood by Aristotle. The pre-Platonic inquiry into nature was rooted in the conviction that the natural world is the totality of reality. By contrast, Aristotle is committed to the view that the natural world is not a causally closed system and can be adequately explained only by an appeal to a certain number of extra-natural principles. In Book 8 of the *Physics,* Aristotle provides an argument for the existence of a type of principle which is a principle of change but itself stands outside any actual and possible change. This argument is required for a fully adequate account of change, and as such it is an essential piece of Aristotle's science of nature; however, it also takes Aristotle outside of the natural world.

## THE BOUNDARIES AND THE SCOPE OF ARISTOTLE'S STUDY OF THE SOUL

Aristotle's conviction that there is an important discontinuity within the natural world between the celestial and the sublunary world leads him to the further view that the celestial and the sublunary natures cannot be explained in the very same terms. I would like to provide evidence for this

6 The transmitted text may be corrupted. I follow Michael Frede and transpose *hē pantes homologousin* before *hēs hē men phthartē* and keep the second occurrence of *aidios*. For a discussion of the text, see Frede (2000: 78–80).

further view by looking at the way Aristotle's account of the soul is generated in the *DA*. From the *DC* we have learned that celestial bodies are not mere bodies but intelligent living bodies engaged in motion (292 a 18–22). I have argued that Aristotle credits celestial bodies not with mere life but with intelligent life because they are engaged in a special type of motion which can be adequately explained only if these bodies are credited with thought and desire.[7] But how much of what Aristotle says in the *DA* about the soul is relevant to the study of celestial life?

In the *DA* Aristotle is concerned with the soul on the crucial assumption that the soul is the provider of life. Though life is a phenomenon that cannot be reasonably denied, what counts as life is far from being clear. Part of Aristotle's enterprise consists in seeking clarity about the soul and, accordingly, life. One of the most important results delivered by the *DA* is the view that living and being alive (*zēn*) is said in many ways (413 a 22). But this view cannot be presupposed or anticipated at the outset of the investigation. In the opening lines of the *DA* we are told that the study of the soul will result in knowledge of the soul, and that this knowledge is relevant to all the truth, but in particular to truth about nature, for this knowledge is relevant to the study of *zōia*.[8] On the interpretation I have recommended, the most generous reading of *zōia* is to be preferred. In this context, *zōia* means *all the living beings that there might be*, including any living beings that there might be superior to human beings.[9] The most general and inclusive reading of *zōia* does justice to the fact that the *DA* is a systematic investigation of life, and as such it is not restricted to animal life. Aristotle is persuaded, rightly, that any such restricted investigation would prevent the investigator from arriving at a full

7 I have also argued that Aristotle never offers an argument in support of the claim that the celestial bodies are engaged in intelligent life. Apparently, Aristotle thinks that the explanatory benefits depending upon the assumption that the celestial bodies are living bodies are also an indirect argument in support of the assumption itself. In chapter 3 I have made an attempt to provide (some of) the reasons that may help us to understand why Aristotle credits celestial bodies with life.

8 I have reported and discussed this passage in chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

9 I have already pointed out that in the *Timaeus* the stars are *zōia*, on the assumption that they are alive. More directly, they are immortal living beings (92 c), and as such they are also divine living being (40 b). Moreover, the sensible world as a whole is a *zōion* (29 b; 30 d; 33 b, etc.). The sensible world contains all the immortal and mortal living beings that there might be (92 c), and for this reason it is also called the perfect living being (32 d). I have also pointed out that Xenocrates in his *Life of Plato* ascribed to Plato the view that there are five types of *zōia*, one for each of the five elements. See Simpl., *In DC* 12.22–6 and *In Phys.* 1165.35–9 (= Heinze, fr. 23). In this case *zōia* is used in its most general and inclusive sense to refer to all the living beings that there might be, including demons and gods.

understanding of life. Consider, however, the next occurrence of *zōion* in the *DA*:

For those who now speak and inquire into the soul seem to study the human soul only. But we have to be careful not to overlook whether the definition of the soul is one, just as in the case of *zōion*, or different for each soul, as in the case of horse, dog, man, god; *zōion,* the universal, being either nothing or posterior (similarly with regard to any other common predicate) (402 b 3–9).

At this preliminary stage of the investigation we only know that Aristotle is about to embark on an investigation that is not restricted to any particular class of souls. But the unity of the soul is a real problem for an investigation with the aspiration to be unrestricted. In this passage, Aristotle recommends considering whether there is one definition for the soul as there is one definition for *zōion* because the possibility that horse, dog, man and *god* do not form a genus cannot be ruled out. By now the insertion of god along with horse, dog, and man should be no surprise. This insertion is not only intended to make the case for equivocity more vivid; it is also dictated by the logic of the Greek language. Needless to say, this insertion raises a genuine concern about the scope and the boundaries of the investigation conducted in the *DA*.

One thing that this passage makes very clear is that the problem of the unity of the soul (and, accordingly, life) requires a firm grasp of the scope and the boundaries of the investigation conducted in the *DA*. Interestingly enough, in the *DA* Aristotle does not concern himself with all the living beings that there might be. By his own admission, he restricts his investigation to *perishable living beings* (413 a 31–2; 415 a 8–9). The fact that the study of the soul is programmatically confined to the soul of perishable living beings must not be understood as evidence for the view that life manifests itself only in the form of perishable life. Aristotle's natural science is hospitable to both perishable and imperishable life. Like Plato, Aristotle is prepared to speak of celestial life. Unlike Plato,[10] Aristotle never refers to the celestial bodies as *zōia*. But there is no doubt that he is prepared to ascribe a certain form of life to the celestial bodies. This is immediately relevant to the scope and the boundaries of the investigation conducted in the *DA*. As a dedicated student of life, Aristotle

10 In the *Timaeus*, Plato recognizes the celestial bodies as *zōia* (39 A; 39 B). Elsewhere he is more tentative. In the *Laws*, the explanation of celestial motion requires a soul of a certain kind (897 B–C). But this time Plato leaves it open whether this kind of soul is directing the body from inside, or pushing the body from outside, or conducting the body in some other way (899 A). Accordingly, he is no longer sure that the celestial bodies are *zōia* (899 A–B).

is interested in life in all its manifestations; unlike his predecessors, he does not arbitrarily restrict his investigation to any class of living beings. At the same time, however, Aristotle does restrict his investigation to a study of perishable life, to the exclusion of imperishable life. Why does Aristotle restrict the scope of his investigation to perishable life? How can he restrict his investigation to this type of life? Why is this restriction not an arbitrary one (like, for example, the restriction of the investigation to the case of animal or human life)?

One way to answer these questions is to reflect on the analogy between souls and rectilinear figures which Aristotle offers just before engaging in a study of the nutritive soul. The centrality of this analogy for the correct reading of the *DA* cannot be disputed.[11] Among other things, this analogy reveals that Aristotle is a systematic investigator of the soul in the sense that he has a plan for the study of the soul and this plan dictates not only the order but also the boundaries of the investigation. Aristotle argues that just as the rectilinear figures are ordered in a series beginning with the triangle, so are the souls beginning with the nutritive soul (414 b 20–1). The analogy with the rectilinear figures provides Aristotle with a method of studying the different types of souls (and, accordingly, the different forms of life). Just as the triangle exists potentially in the rectangle, so the capacity for nutrition, growth, and decline exists potentially in the capacity for perception. But this crucially depends on the fact that self-nutrition, growth, and decline are constitutive of perishable life. Note that in this context Aristotle is not merely speaking of capacities of the soul; he is speaking of types of souls (414 b 22 and 24–5). The specific accounts of the nutritive, sensitive and intellective souls are secured on the crucial assumption that the souls are *ordered in series*.

I do not deny that what Aristotle says in the *DA* may be relevant to a study of celestial life, celestial thought, and celestial desire. But I contend that the celestial souls go beyond the scope of the investigation offered in the *DA*.[12] The celestial souls and the celestial bodies are intractable by the

11 Ward (1996: 113–28) rightly insists on the "logical interpretation" of the analogy. Aristotle is not only denying that there is a generic soul over and above the different types of souls; he is also denying that the different types of soul constitute a genus and that they can be studied in the way a genus is studied.

12 The ancient debate on the scope of the *De anima* is reflected in the *Prologue* to the commentary on the *DA* which is traditionally attributed to Simplicius. See [Simplicius], *In DA* 3.21 – 4.11. In the Aristotelian tradition, psychology is programmatically restricted to the study of the soul of perishable living beings. Like Aristotle, Alexander does not deny that there are celestial souls, but he is persuaded that the celestial and sublunary souls are merely homonymous. See Alexander of Aphrodisias, *DA* 28. 25–8. For Alexander, no unitary account of the soul would be possible, if the

conceptual resources developed and refined in the study of the sublunary world. More directly, Aristotle cannot embark on a study of the celestial souls because *no serial relationship* exists between the perishable and the celestial souls. Moreover, there is no serial relationship because the celestial creatures are not engaged in any of the activities that are minimally constitutive of sublunary life.[13] The celestial creatures do not take in nourishment, and as a result of this they are not subject to growth and decline.

By this point I hope to have shown that Aristotle has to restrict his investigation of life to the case of *perishable* (= *sublunary*) *life*. Since Aristotle is convinced that life as encountered on earth and celestial life are not continuous, this restriction is not arbitrary. But can the results achieved in the *DA* be extended to the celestial world? By looking at the activities that are constitutive of celestial life, and what is distinctive of each of them, we may come to appreciate how difficult it might be for Aristotle to extend the results he has achieved in the *DA* to the case of the celestial souls. I shall focus on celestial motion, celestial thinking, and celestial desire, on the assumption that distinctions between natures become evident in different kinds of life. More specifically, if the celestial bodies do not partake in the activities that are constitutive of life as it is encountered in the sublunary world, or they do partake in some of the same activities but their activities cannot be reduced to the corresponding sublunary activities, then this will be sufficient proof that the celestial natures which are responsible for governing these activities, and shaping them into one and the same behavior, cannot be reduced to the sublunary natures.

On Aristotle's account of celestial motion, the celestial bodies are living bodies which perform motion from one place to another, but which are not engaged in any of the forms of animal motion we encounter in the sublunary world. From the *DA* we learn that the animal motion we are familiar with in the sublunary world is progressive motion, in Greek *poreutikē kinēsis* (432 b 14) or *poreia* (432 b 25). This is the capacity of a living body to move around by walking, swimming, and the like. Moreover, *poreia* (or *poreutikē kinēsis*) is a case of motion for the sake of a

investigation of the soul was extended to the celestial soul. Alexander is here speaking in his own voice. Aristotle never says, in the *DA* or elsewhere, that the celestial and sublunary souls are homonymous. But I shall show that Alexander is in essence right: Aristotle does credit celestial bodies with life, but this life has little in common with the life Aristotle studies in the *DA*.

13 I say "minimally" because from the *DA* we learn that perishable life takes different forms and there are different types and, ultimately, different gradation of perishable life.

specific goal (432 b 15–16). Finally, it consists in the displacement of a living body equipped with an appropriate desiderative and cognitive apparatus. The capacity for this type of displacement involves the possession of desire and *phantasia* (432 b 16). Since *phantasia* is the ability to form representations on the basis of perception, and is causally dependent on perception, we can say that perception together with *phantasia* form the minimal cognitive equipment required for progressive motion.[14] It is not difficult to see why Aristotle thinks that both perception and *phantasia* are required for progressive motion. Progressive motion is a case of navigation from one place to the other; and at times this motion even requires highly sophisticated navigational abilities: for instance, the ability to return home from an unfamiliar territory, or the ability to migrate from one place to the other. While perception provides the animal with sensitivity to the environment, *phantasia* presents it with the goal of motion, which also happens to be the object of desire (433 a 15) – e.g. home or food. From the *De memoria* we learn that *phantasia* also plays a crucial role in the formation of memory. And there is no doubt that perception, together with *phantasia* and memory, provide all the conceptual resources we need to explain even the most sophisticated navigational achievements.[15] In the *Timaeus* Plato credits the celestial bodies with *poreia* (*Tim.* 39 B 4, and D 8). To my best knowledge, Aristotle never credits the celestial bodies with progressive motion or *poreia.* I suspect that the lack of flexibility of celestial motion is the ultimate reason for his silence. As a matter of fact, the celestial bodies do move, but they are unable to stop moving or to move in any other direction or way than they actually move. I also suspect that this lack of flexibility explains why Aristotle never credits the celestial creatures with perception or *phantasia.* Aristotle regards perception and *phantasia* as the minimal cognitive equipment required for navigating from one place to another. But the motion that the celestial bodies perform regularly in the sky does not seem to require any sensory apparatus for navigating from one place to the other. Evidently, Aristotle does not regard celestial motion as a case of navigation from one place to the other. But if celestial motion is not a case of navigation, the celestial bodies need not be sensitive to the surrounding environment. And if they need not be sensitive to the surrounding

14 On *phantasia*, and the relation between *phantasia* and perception, I refer the reader to Wedin (1988: 23–63). Here I am content to recall that for Aristotle *phantasia* is a change resulting from the activity of perception (*DA* 428 b 30 – 429 a 2).

15 For a discussion of *phantasia* in connection with progressive motion see Wedin (1988: 39–45). See also Labarrière (1984: 17–49).

environment, they need not be capable of *phantasia*. In fact, *phantasia* is causally dependent on perception. To put it in another way, celestial motion does not require the existence of celestial perception, or celestial *phantasia*.[16] Nor does it require a specific locomotory apparatus. The celestial bodies are composed of a body that naturally performs circular motion and that crucially contributes to the explanation of the eternal, blissful life that, according to Aristotle, these celestial creatures enjoy.

If we turn to celestial thinking, another constitutive activity of celestial life, we find a similar situation. Any attempt to reduce celestial thinking to human thinking as it is discussed in the *DA* runs into severe difficulties. On the one hand, Aristotle is explicitly committed to the existence of celestial thought; on the other, he does not postulate the existence of celestial perception or celestial *phantasia*. The exercise of celestial thought, celestial thinking, does not depend on the possession of perception and the exercise of *phantasia*. On the contrary, from the *DA* we learn that human thought crucially presupposes *phantasia*, perception, and ultimately, a living body of a certain kind. More directly, thinking as it is encountered on earth is only human thinking, which is crucially dependent on a bodily organization of a very specific type, a human body. In the *DA* Aristotle insists several times on the necessity of *phantasia* for the exercise of human thought. Right at the beginning of the *DA*, for example, he claims that (human) thinking is not without *phantasia* (403 a 8–10). Later on in the *DA*, he insists that human beings never think without *phantasmata* (431 a 16–17, 431 b 2, 432 a 8–10, 432 b 12–14). Of course, this would not be possible if we were not capable of *phantasia*. But *phantasia* depends on the possession and the actual exercise of perception (429 a 1–2) and, ultimately, the use of one or more of the sense organs.[17] There is also evidence that human thinking might be crucially dependent on perception in a different, though related, way. In his discussion of thinking, Aristotle appears to be willing to consider the idea that there are not two distinct discriminatory capacities – perception and thought – but rather one capacity which can be in two different states (429 b 13 and b 20–1). It is also significant that at the end of the *DA*, turning to animal motion, Aristotle speaks of one, and only one discriminatory capacity

16 Celestial motion does not require the existence of celestial memory either. Quite independently of any considerations about the nature of celestial motion, there cannot be room for celestial memory because for Aristotle memory is generated by perception and crucially depends on the possession of *phantasia*.

17 On the relation between thinking and *phantasia*, see Wedin (1988: 100–59). On thinking in general, see Modrak (1987: 209–36) and Wedin (1992: 243–71).

(432 a 15–16). At this stage of the discussion, having already gone through perception and thought, this can hardly be just a loose way of speaking of two distinct discriminatory capacities. It is not necessary to enter into a discussion of the sort of relationship between thought and perception that Aristotle might be trying to establish here. For the present discussion it is enough to realize that, for Aristotle, it is not the case that human beings are equipped with two wholly independent and disconnected cognitive capacities, namely perception and thought. On the contrary, the actual exercise of thought, and perhaps its existence, rests on the exercise of perception. Also, in the light of these remarks, it should be clear why the activity of thinking and the capacity for thought are a genuine problem for Aristotle.[18]

We come to a similar conclusion when we finally turn to celestial desire. I have already said that Aristotle does not only credit celestial bodies with thought but also with desire. The ultimate reason for this idea is to be found in the assumption that both cognition and desire are required for an adequate explanation of celestial motion. More specifically, from the *DA* we learn that Aristotle is committed to the view that there are three kinds of desire: appetitive desire, spirited desire, and rational desire (414 b 1–6).[19] Celestial desire is obviously a case of rational desire: since celestial bodies are not equipped with celestial perception, they cannot be equipped with non-rational desires (either appetitive or spirited desires). In the light of what I have argued so far, however, it is clear that the celestial bodies cannot be related to their appropriate object of desire, a specific object of thought, by virtue of *phantasia*. There is in

18 The situation seems to be the following. On the one hand, Aristotle seems to be confident that a unified account of thinking, that is an account that includes human, celestial and divine thinking, is possible. On the other hand, he never engages in an attempt to provide this unified account. By "divine thinking" I mean the thinking of divine intellects. This latter is to be distinguished from the thinking of any of the intelligent living creatures that we encounter in the natural world, including the celestial region of the natural world. For Aristotle, divine intellects are disembodied intellects whose life consists in thinking. Simply put, they are not engaged in thinking, but they *are* thinking. There is evidence that for Aristotle divine thinking, or the thinking of the disembodied intellects, is not a form of thinking among others. The word "thought" is used without qualification only with respect to divine thought. In the *DA* human *nous* is often qualified. At least a couple of times, Aristotle refers to it as "the so-called *nous*," *ho kaloumenos nous* (429 a 22; 432 b 26). Evidently, *nous* refers primarily to a divine being and the reference to human thinking is derived from this primary meaning. Needless to say, this fact is relevant for the project of finding a unitary account of thinking; that is, an account that unifies divine, celestial, and human thinking. I shall not engage in this further project.

19 This tri-partition of desire is part of a more general thesis. For Aristotle, if something is capable of desire (minimally appetitive desire), then it is capable of cognition (minimally perception in the form of sense of touch), and vice versa. In other words, for any *x*, if *x* is able to desire, then *x* is able to cognize; and if *x* is able to cognize, then *x* is able to desire.

fact no *phantasia* in the celestial world. Once again, this conclusion does not square with the account of progressive motion offered in *DA*:

(1) In general, then, as it has been said, it is in so far as the animal has the capacity for desire that it has the capacity for its own motion; (2) but the capacity for desire is not without *phantasia*: (3) all *phantasia* is either connected with reason or with perception; (4) also the other animals partake in the latter (433 b 27–30).

Clause (2) commits Aristotle to the claim that desire requires *phantasia*. Apparently, Aristotle is committed to the view that animals are presented with their own object of desire by virtue of *phantasia*. Clauses (3) and (4) help us to understand that this is a claim about rational as well as non-rational animals: *phantasia* is connected with reason or with perception, and the latter is shared by all animals. However, clause (1) helps us to qualify this claim. Apparently, this is to be taken as a claim about desire and *phantasia* in the context of progressive motion. More directly, the animals that have a capacity to engage in progressive motion are normally presented with their object of desire – rational or non-rational desires – by virtue of *phantasia*.[20]

## THE LIMITS OF THE SCIENCE OF NATURE IN THE *DE CAELO*

Both in the *DC* and in the *PA* Aristotle acknowledges the existence of limits affecting the extent to which we can know the celestial world. The study of the soul offered in the *DA* confirms the existence of such limits. If I am right, these limits ultimately depend on the fact that the investigation into nature is conducted on the assumption that there is lack of uniformity in the natural world, that is, some important discontinuity. I would now like to look at the way in which Aristotle proceeds in cases where, as he himself admits, such limits are particularly acute. In *DC* II 5 Aristotle turns to the daily rotation of the heaven of the fixed stars, the first heaven, and focuses upon its distinctive orientation. Aristotle has already established that this rotation takes place from the right (285 b 19–20). He now engages himself in an attempt to provide an explanation

20 I add "normally" because from the *DA* 428 a 8–11 we learn that *phantasia* belongs to many but not all non-stationary animals. Apparently, grubs (and perhaps ants and bees) are not capable of *phantasia*. According to Aristotle, the non-stationary animals that partake in touch only and do not have the ability for *phantasia* move indeterminately – in Greek *aoristōs* (433 a 4–5). I take it that this claim is equivalent to saying that indeterminate motion is not a case of navigation. For a discussion of this passage and the relation between desire, *phantasia*, and progressive motion I have profited greatly from reading Lorenz (2001).

for this particular orientation. Since nothing that concerns the eternal can be a matter of chance or spontaneity, and the heaven of the fixed stars is eternal, there must be a reason why this heaven moves in the direction it does, rather than in the opposite direction (287 b 24–7). He goes on as follows:

(1) Perhaps, then, the attempt to make some statement on certain things, indeed on everything, passing nothing by, might well seem to be a mark of great simple-mindedness or of much zeal. (2) Yet it is by no means right to censure all people alike, but one ought to consider their reason in speaking, and the sort of conviction involved in their account. (3) If someone hits upon more exact necessities, then we should be grateful to the discoverers; (4) but as it is, we must state what appears to be the case (*DC* 287 b 28 – 288 a 2).

This passage is symptomatic of a position in which Aristotle at times finds himself in the study of the celestial world. This position may be described, tentatively, as one in which Aristotle makes a judgment as to what is the case, assumes that there has to be an explanation for what is the case, and finally makes an attempt to provide this explanation, though it is clear that he is not in a privileged position to provide an explanation. Interestingly enough, Aristotle does not think that we have to give up any attempt to say something about that which we cannot explain. All attempts to say something are not to be censured alike. In particular, the reasons motivating a person to claim what he does, and the epistemic attitude involved in his claim, are also to be taken into account – clause (2). These remarks should be understood, I think, in the light of what immediately follows, and as a sort of justification for it. What immediately follows is not the explanation of the particular orientation exhibited by the heaven of the fixed stars in its daily rotation. What follows is, as Aristotle himself puts it, *what appears to be the case*, in Greek *to phainomenon* – clause (4). Clearly what follows in the text is not a genuine explanation, though it is the result of a genuine effort to answer the question "why?" What appears to be the explanation is not too far, I think, from capturing what Aristotle has in mind. However difficult it might be to understand what Aristotle has in mind, it seems to me that two possible interpretations should be rejected. First of all, what appears to be the explanation is not a provisional account that will be, sooner or later, replaced by a genuine explanation. Given the human limitations on knowledge about the celestial world, nobody can be in the privileged position to provide a genuine explanation; though somebody in the same situation as Aristotle's may perhaps give a better account. Aristotle is envisaging this possibility in clause (3). Secondly, and more importantly, what appears to be the case is not what looks plausible to Aristotle as opposed to what may look plausible to other people. If that were the case, there would be some stress on the fact that what appears to be the case is apparent because it may be controversial. From the mere fact that Aristotle explicitly claims that he is going to provide what appears to be the case, we are not entitled to come to the conclusion that he is going to provide what appears to be the case to him. On the contrary, Aristotle is making a genuine effort to supply an account which is as objective as possible. In other words, Aristotle is making an effort to arrive at an account which can satisfy us as intelligent, rational beings who are approaching the study of the celestial world in the right way.

What Aristotle says at the very beginning of the *DC* II 12 is in line with the interpretation so far offered.

(1) Since there are two difficulties about which one might reasonably be troubled, we ought to make an attempt to say what appears to be the case, (2) considering the eagerness to do so a mark of modesty rather than of excessive ambition, if, out of thirst for philosophy, one is content with small solutions in things in which we have the greatest difficulties (*DC* 291 b 24–8).

Aristotle provides these remarks as a general introduction to a discussion of two difficulties, the first of which concerns the number of the motions of the moon and the sun, and the reason why both celestial objects are moved by fewer motions than some others above them (291 b 29–31), and the second the relation between these motions and the daily rotation of the heaven of the fixed stars, and the reason why many stars are carried on by one single motion (292 a 10–14). Admittedly, to say that where the difficulties are the greatest, eagerness is a mark of modesty rather than of excessive ambition, provided that one is satisfied with small solutions, is ambiguous – clause (2). We might be tempted to think that where the difficulties are the greatest, to be satisfied with the small difficulties one is able to handle, and correspondingly with the small solutions one is able to provide, is a mark of modesty rather than of excessive ambition. In the light of what I have so far argued this is hardly plausible. If I am right, for Aristotle there is nothing wrong in attempting to say something about any difficulty, provided that one has the right epistemic attitude towards what one is going to say. I propose, therefore, to read what Aristotle is saying as follows: where the difficulties are the greatest, eagerness is a mark of modesty rather than excessive ambition, provided that one is satisfied with the solutions one is able to offer, even though one is aware that these solutions are only small solutions. Admittedly, to say that something is a small solution of a great difficulty is to say very little about the nature of the solution and the reason for its being only a small solution. To shed some light upon what Aristotle has in mind, we have to turn to the very beginning of the passage. Here Aristotle is not saying that there are two difficulties and we must make an attempt to solve them; rather, he is saying that there are two difficulties and we must make an attempt to say *what appears to be the case*, in Greek *to phainomenon* – clause (1). What appears to be the case in this context is what appears to be the solution to a difficulty. Aristotle makes it clear that he is not in a privileged position to provide the solution to these difficulties. There can be only one reason for this. The difficulties in question are to be counted among the greatest difficulties to which we are able to provide only small solutions. In the light of this, we can appreciate, perhaps, what Aristotle has in mind when he talks of small solutions. Something is a small solution neither because it is a solution of a small difficulty nor because it is a partial solution of a great difficulty. Rather, something is a small solution because the only reason for Aristotle to accept it is that this is the best solution available to him, given that he is persuaded that at times the limits on the extent to which we can learn about, and understand, something are so acute that our capacity to provide a solution to a certain difficulty concerning this very thing is seriously affected.

A note of caution: we should not confuse the relevant use of *to phainomenon* on which I have focused in these pages with the more common use of *ta phainomena*. In the *DC ta phainomena* are the celestial phenomena, that which can be observed in the sky from the earth (289 b 5, 297 a 4).[21] It is significant, I think, that the relevant usage of *to phainomenon* can be found outside the *DC*. In *PA* 1 Aristotle insists on the structure and unity of the study of the natural world: having already dealt with the celestial world, saying *what appears to be the case to us human beings* – in Greek *to phainomenon hēmin* – we have to move to the study of animal nature, trying as far as possible to omit nothing, however noble and ignoble it may be (645 a 4–7).[22] The use of the expression is to

21 This is in line with the traditional usage of *ta phainomena* in Greek astronomy. See, for instance, Geminus, *Elementa astronomiae* 1. 19–22; Theon, *Expositio* 177. 9ff; Proclus, *Hypotyposis* 4. 7; Simpl., *In DC* 488. 3–24. The slogans "saving the phenomena" and "saving the appearances" come from this usage. On these slogans, see Lloyd (1991: 248–77) and Goldstein (1997: 2–12). The celestial phenomena can, but need not, be observational data. See Owen (1986: 239–51).

22 I have discussed this passage in chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature".

be understood in the light of the informational gap that affects our study of the celestial world and the difficulties of understanding the celestial region on which Aristotle insists in *PA* I. Even here Aristotle finds a way to remind us that in the study of the celestial world we should neither go beyond what we can say nor stop making an effort to provide an account, but state what appears to be the case to us, human beings with a limited access to the celestial world.[23]

## CELESTIAL MATTER

Aristotle is remarkably selective in his study of the celestial world. He limits himself to a discussion of some topics, while he consistently evades others. For example, he takes the view that celestial bodies are endowed with the capacity for thought and desire, but he never engages, in the *DC* or elsewhere, in an attempt to say how celestial souls think and desire. This silence is open to different interpretations, but it is better understood, I think, in the light of Aristotle's belief in the existence of an important discontinuity within the natural world. From the *DA* we learn that Aristotle is reluctant to extend the results achieved in the study of plants and animals to the imperishable creatures populating the celestial world. Evidently, he is persuaded that the celestial souls work in a way that is different from, and indeed not reducible to, the one described in the *DA*, and consequently that the lack of information at his disposal cannot be overcome by an appeal to what we know about the perishable creatures.[24] But when Aristotle finally engages in a discussion of particular

23 *PA* 644 b 23–32, *DC* 287 b 28 – 288 a 2, and *DC* 291 b 24–8 are discussed, together with other texts, in Lloyd (1998a: 160–83). Lloyd takes these passages as evidence that Aristotle was not a totally engaged researcher but conceived of himself as an amateur astronomer. I do not want to deny this, but I think that Aristotle would have made these disclaimers even if he had had a better command of astronomy. If I am right, these disclaimers depend upon a certain conception of man and the place that he occupies in the natural world, rather than on the state of art of a certain discipline or the competence that someone may have in it. I find it useful to compare the situation in which Aristotle at times finds himself in the study of the celestial world with the one that Plato puts into the mouth of Timaeus:

> Don't therefore be surprised, Socrates, if on many matters concerning the gods and the whole world of change we are unable in every respect and on every occasion to render consistent and accurate account. You must be satisfied if your account is as likely as any, remembering that both I and you who are sitting in judgment on it are merely human, and should not look for anything more than a likely story in such matters (*Tim.* 29 C 4 – D 3).

24 Since antiquity, commentators have often engaged in the exegetical exercise of filling the gaps left by Aristotle. I have argued that for Aristotle there is no need to postulate the existence of celestial perception and celestial *phantasia*. However, Aristotle's silence has encouraged a debate about the

features of the celestial world, he makes use of the explanatory resources developed and refined in the study of the sublunary world. In those cases, and only in those cases, he evidently feels that the results achieved in the study of the sublunary world can be safely extended to the celestial world. It is significant, however, that even in those cases he makes a considerable effort to square the case of the celestial bodies with those explanatory resources, and this effort is not without consequences for the explanatory resources themselves. Matter is a particularly interesting case. The notion of matter is first introduced in the study of change as it is encountered in the sublunary world, and then extended to the celestial world to account for celestial motion. But how successful is this extension? I shall try to answer this question by looking at the way matter is introduced and discussed in *Lambda* 2.[25]

Though *Lambda* 1 announces the existence of an important discontinuity within the sensible world,[26] *Lambda* 2 begins by pointing to the feature that eternal and perishable sensible substances have in common: these substances, in so far as they are sensible, are all subject to change (1069 b 3). Aristotle's intention is transparent and consists in identifying the principles of the sensible substances with the principles of change. In this context, the reader is reminded that change takes place between contraries (1069 b 4–5), and that it involves the existence of something that admits one of two contraries and, under the appropriate circumstances, can become the other (1069 b 6–7). This third principle is identified with matter (1069 b 8–9). It is not difficult to see why the notion of contrariety is placed at the center of Aristotle's investigation of change. Change is the emergence of a new state to the exclusion of a previous one. Moreover, this new state is never extrinsic to the change in question. Recovering from an illness is a standard example. Relying on ancient medicine, Aristotle thinks of health as an equilibrium of certain bodily factors (hot/cold, wet/dry), and illness occurs when this

existence of celestial perception and celestial *phantasia*. There are traces of this debate in Philoponus, *In DA* 595.37 – 598.24, and [Simplicius], *In DA* 320.17 – 321.2. Plutarch of Athens – who reestablished the Academy at Athens in the late fourth century CE and was the teacher of Syrianus, who in turn was the teacher of Proclus – argued for the existence of some form of celestial perception and celestial *phantasia*. It is not clear whether Plutarch was committed to the existence of non-rational celestial desire too. On the other hand, Alexander of Aphrodisias and his followers defended the orthodox view that celestial natures do not need the capacity for perception and the ability to form impressions or *phantasia*.

25 For a detailed study of *Lambda* 2, see Charles (2000: 81–110). I have been influenced more strongly than the footnotes can indicate by this excellent study.

26 See my discussion of *Lambda* 1 in this chapter pp. 88–9.

equilibrium is disrupted.[27] Recovering from an illness may or may not be a natural process, but it always takes place between illness and health. In particular, someone cannot recover indefinitely from a certain illness, but it is in the very nature of the process to terminate at some point; that is, when the original equilibrium of the bodily factors is restored. Contrariety provides Aristotle with the conceptual resources to express this fundamental truth as well as to insist on the fact that health and illness exclude each other and do so in such a way as to point at one another.[28]

The use of the language of contrariety was not exclusive to Aristotle. Quite the contrary. Consider, for example, the first argument for the immortality of the soul that is advanced in the *Phaedo*. This is what Socrates says to Cebes:

> <Socrates> Do not confine yourself to human beings, if you want to understand this more readily, but take all animals and all plants into account, and, in short, for all things that come to be, let us see whether they come to be in this way, that is, from their contraries if they have such, as the beautiful is contrary to the ugly and the just to the unjust, and a thousand other things of the kind. Let us see whether those that have a contrary must necessarily come to be from their contrary and from nowhere else, such as, for example, when something comes to be larger it must necessarily become larger from having been smaller before. <Cebes > Yes. <Socrates> Then, if something smaller comes to be, it will come from something larger before, which became smaller? <Cebes> That is so. <Socrates> And the weaker comes to be from the stronger, and the swifter from the slower? <Cebes> Certainly. <Socrates> Further, if something worse comes to be, does it not come from the better, and the juster from the more unjust? <Cebes> Of course. <Socrates> So we have sufficiently established that all things come to be in this way, contraries from contraries? <Cebes> Certainly (*Phaedo* 70 D 7 – 71 A 10, translation Grube with alterations).

In this passage Socrates is making a general point about what comes to be (according to an alternative translation, closer to the text, about what is becoming). It is significant that he does not distinguish the case of something which comes to be something or other – which acquires a property – from the case of something which comes to be *tout court* –

27 The view that health consists in the right balance of the relevant bodily factors was common ground in ancient medicine. See, for instance, the author of *Ancient Medicine*, XIV, 4.16, and the author of *The Nature of Man*, IV, 172.15 – 174.4. Outside of the Hippocratic corpus, see the imaginative language used by Alcmeon of Croton: health is the *isonomia* or equilibrium of the dry and the wet, the hot and the cold, and the like; whereas illness is the *monarchia* or domination of one of these bodily factors alone (*DK* 24 B 4). See also the *Timaeus*, 82 A–B, for the same idea.

28 For language of contrariety in ancient medicine, see also the author of *Breaths* and his claim that "contraries are cures for contraries" (I, 4.10–11). For the importance of the language of contrariety in the Hippocratic tradition, see Jouanna (1988: 31–4).

which comes into existence. His point is about coming to be (alternatively, about becoming). It was not unusual in the pre-Platonic investigation of nature to blur this distinction and talk of becoming in such a way as to make it equivalent to coming into existence.[29] Socrates, or rather Plato, is simply content to register this widespread tradition. Aristotle acknowledges his dependence on this tradition. At the beginning of the *Physics*, Aristotle presents himself as continuing, and indeed completing, the work of his predecessors. But his doctrine of change is a substantial revision, rather than a mere refinement, of the previous reflection on change. First of all, Aristotle makes it clear that, strictly speaking, there is no such thing as coming to be as such. Coming to be is said in many ways. More precisely, coming to be something – coming to acquire a certain quantity, size or place – and coming into existence are distinct processes. Secondly, and more importantly, Aristotle, unlike his predecessors, does not limit himself to making use of the *language* of contrariety. He attempts a comprehensive analysis of this notion and works out a *theory* of contrariety.[30] To put it in another way, when Aristotle says that "everything that comes to be comes to be from, and everything that passes away passes away into, its contraries or something in between" (*Phys.* 188 a 22–4), he is making a substantive claim about all forms of change, and this claim is ultimately supported by a general theory of contrariety. A recovery of this theory goes beyond the scope of the present discussion. I am content to say that this theory must supply Aristotle, minimally, with:

1. a definition of contrariety;[31]
2. a classification of the different types of contrariety (e.g. contraries that admit intermediates and contraries that do not);[32]
3. a rational way to move from the plurality of and variety of contraries to a *primary* contrariety.[33]

29 On this point see also chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature".

30 For an attempt to recover Aristotle's theory of contrariety see Anton (1957) and more recently Bogen (1992: 1–21).

31 For Aristotle, contrariety or *enantiosis* is "the greatest difference" (*Metaph.* 1055 a 4–5), and contraries or *enantia* are "the things that differ most in the same genus" (*Cat.* 6 a 17–18, *Metaph.* 1018 a 27–8 and 1055 a 27–8).

32 Many *topoi* involving contraries are collected in the *Topics*. These *topoi* document the existence of a classification of contraries. On contraries that admit contraries and contraries that do not, see in particular *Top.* 123 b 1–37.

33 In the *Physics*, Aristotle insists on the reduction of the contraries to the primary contrariety. However, he does not provide the details of this reduction. Nor does he provide them elsewhere. Was this reduction offered in one of his lost books on the contraries? Perhaps so. In the

This theory enables Aristotle to reconsider, critically, the views of his predecessors and detect their common failure. For example, from the first book of the *Physics* we learn that they all failed to find a rational way to reduce – in Greek *anagein* (189 b 27) – the plurality and variety of contraries to the two primary contraries. This criticism is to be understood in the light of point (3) above. In the natural world we are confronted with fundamentally different contraries. These contraries are fundamentally different in the sense that they cannot be explained away or eliminated, though they can be understood in the light of some conceptual apparatus whose generality enables us to grasp what they all have in common.[34] Aristotle's predecessors failed to work out the conceptual apparatus that is needed for an adequate analysis of the fundamentally different contraries. More explicitly, they did not possess a theory of contrariety to deal successfully with the complexity of the natural world. According to Aristotle, the way they selected the primary contrariety was random: some of them identified the primary contraries with hot and cold or wet and dry, the Pythagoreans with odd and even, and Empedocles with love and strife. Against all of them, Aristotle argues that form and deprivation constitute the primary contrariety.

Let us return, also in the light of these remarks, to *Lambda* 2. Here Aristotle makes use of the language of contrariety in the attempt to provide a general description of change which applies to all natural processes. It is easy to see that the language of contrariety is not neutral with respect to his specific theory of contrariety. Matter is defined as "that which has the capacity for both <contraries>" (1069 b 14–15). Form and deprivation are identified as the contraries in question (1069 b 33–4). But Aristotle is not content to appeal to the language and theory of contrariety. Interestingly enough, he makes an effort to extend the language, and indeed the theory, of contrariety to the celestial world. Since the celestial bodies are moved in a circle, they must possess an appropriate type of matter: that is, a matter endowed with the capacity for this particular type

*Metaphysics*, Aristotle mentions a *Selection of Contraries* (1004 a 2) and a *Division of Contraries* (1054 a 30). In his commentary on the *Categories*, Simplicius several times refers to a book *On the Opposites*. Following Rose (1886), Ross collected all the extant testimonies under the title *On the Contraries* (Ross, 1955b). He himself decided on this title presumably on the basis of the catalogue of Aristotle's books preserved by Diogenes Laertius. This catalogue lists the title *On the Contraries* (Diog. Laert., v 21 (30)). But the situation may be decidedly more complicated. On this point, I refer the reader to Guariglia (1978).

34 In other words, Aristotle's reduction is not a case of elimination of the complexity of the natural world but rather an attempt to enrich our understanding of this complexity. For a convenient introduction to Aristotle's notion of reduction, see Byrne (1997: 23–5).

of motion. In *Theta* Aristotle refers to this matter as "topical matter," in Greek *topikē hylē* (1042 b 5–6). But in *Lambda* 2 he is more specific and refers to this matter as *pothen poi* matter; that is, "matter for motion from one place to another" (1069 b 26). By referring to celestial matter as *pothen poi* matter, Aristotle is not only claiming that a certain orientation is intrinsic to celestial motion, and that celestial matter is that which has the capacity for that particular motion rather than for the motion that takes place in the other direction; he is also making an effort to square celestial matter with the language and theory of contrariety. Admittedly, he does not say that celestial matter is that which has the capacity for both contraries. Rather, he says that celestial matter is that which has the capacity to move from one place to the other. But Aristotle cannot go any further than this. He cannot characterize celestial motion as a motion between contraries. In the *DC*, Aristotle provides arguments for the thesis that there is no motion contrary to circular motion. He does so by showing that circular motion cannot be integrated into a system of contrary motions. More directly, contrary motion occurs between contrary places. But there is no motion contrary to circular motion. The language of contrariety simply does not apply to circular motion. This motion does not take place between contraries but, as Aristotle himself says, from the same place to the same place:

that motion [= circular motion] is from the same to the same, whereas contrary motion was defined as motion from one contrary to the other contrary (*DC* 271 a 20–2).[35]

35 We must not underestimate the importance of this thesis. That there is no motion contrary to circular motion is crucial for Aristotle's view that the celestial body which naturally performs circular motion is not subject to generation, perishing, growth, and alteration. Consider the following passage from the *DC*:

Similarly it is also reasonable to assume of it [= the celestial body which naturally performs circular motion] that it is not subject to generation, perishing, growth, and alteration; on the ground that everything that comes to be comes to be from a contrary and from some substrate, and is destroyed by a contrary and into a contrary, given that there is some substrate (270 a 12–15).

In the *DC*, chapter 4, Aristotle offers a battery of arguments for the view that circular motion has no contrary. If there is a motion contrary to circular motion, this is either a rectilinear or a circular motion. Let us suppose that a rectilinear motion is contrary to circular motion (CM). Since rectilinear motion is either upward (UpM) or downward motion (DnM), then either *Contr* (UpM, CM) or *Contr*(DnM, CM). But UpM and DnM are contraries to one another; that is, *Contr*(UpM, DnM). Therefore UpM and DnM would be contraries to one another *and* to CM. But Aristotle is committed to the principle that for one thing there can be one contrary at most – in Greek *hen heni enantion* (for this principle I refer the reader to chapter 3, "Motions," pp. 60–2). Moreover, no circular motion can be contrary to circular motion. In the *DC*, Aristotle argues that the motions which take place in opposite directions along the same circle are not contraries to one

To put it in another way, *Lambda* 2 contains an attempt to provide a unified account of change that crucially depends on the applicability of the language and theory of contrariety to the case of celestial motion. But this language and this theory, originally designed to account for sublunary change, cannot be easily extended to the case of celestial motion. Doubts about the applicability of the language and theory of contrariety to the celestial world were already being raised in antiquity. Alexander of Aphrodisias was one of the few people who accepted, and indeed defended, the thesis of the existence of a celestial simple body that naturally performs circular motion.[36] But even Alexander was reluctant to admit the existence of celestial matter. Here is the evidence in our possession:

1. In his commentary on the *Metaphysics* Alexander insistently repeats that the substratum of the heavens is *body*, not *matter* (e.g. *In Metaph.* 22. 2–3; 169. 18–19; 375. 37 – 376. 1)
2. At times Alexander contrasts the divine body with *the material things* of the sublunary world.[37] This contrast is to be understood, I think, in the light of the difficulties that arise once the concept of matter is applied to the celestial world.
3. *Quaestio* I 10 documents the existence of a debate internal to the school of Alexander on the applicability of the concept of matter to the celestial world. It sheds some light on the reasons that might have led Alexander and his school to contrast the case of the divine body to the sublunary material things. Some difficulties are here connected to the fact that matter is that which is receptive of both contraries in turn (20. 31–2). This is a reference to *Lambda* 2. There is also no doubt that the author of this *quaestio* is not fully persuaded by Aristotle's attempt to transfer the concept of matter as it is developed and refined in the study of the sublunary change to the case of celestial motion. He even proposes that this concept of matter be replaced by recourse to the

another. In antiquity Aristotle's arguments for this view were subjected to close scrutiny and criticism by Philoponus. See Simplicius, *In DC* 156.25 – 201.10 (= Philoponus, *Contra Aristotelem*, frr. 81–107). A study of this aspect of the ancient debate on the *DC* is not needed for the present discussion. Quite independently of the soundness of the arguments that Aristotle offers in support of the thesis that there is no motion contrary to circular motion, the tensions and problems that this very thesis causes for the doctrine of celestial matter should have made Aristotle reconsider, and eventually soften, the original thesis. But there is no evidence that he ever reconsidered, or even rejected, this thesis.

36 From Simplicius' commentary on the *DC* we learn that Alexander, in his (lost) commentary on the *DC*, devoted much time and effort to defending this thesis against the objections moved by Xenarchus.

37 See also Bodnár (1997a: 190–205, in particular footnote 3). In this context, Bodnár stresses the importance of *De mixtione* 229. 6–9.

characterization of matter as the ultimate shapeless substrate. This alternative characterization of matter is not found in the *Metaphysics* or elsewhere, but it is a creative interpretation of what Aristotle himself says in *Phys.* 192 a 21 and 193 a 11.

A final clarification is needed. By extending the language and theory of contrariety to the celestial world Aristotle makes a significant effort to provide a unified account of matter which applies to the variety and complexity of the natural processes. But this effort does not commit Aristotle to the existence of one unified matter which is the substrate of all the natural processes.[38] On the contrary, in *Lambda* Aristotle explicitly says that

> everything that is subject to change has matter, but <it has> different <matter>: of the eternal substances those that are not subject to generation but to motion in place <have> not genetic [*genētēn*] but rather *pothen poi* <matter> (1069 b 24–6).

In this compressed text Aristotle is doing several things at once:

1. He credits the eternal sensible substances, that is to say the celestial bodies, with *pothen poi* matter, whereas he denies them a share in genetic matter, since they are not subject to generation (and perishing).
2. He acknowledges that genetic matter is the primary matter of perishable sensible substances. In other words, if plants and animals possess matter for motion in place, they must possess genetic matter too.
3. He proves that *pothen poi* matter is a special case of matter and cannot be reduced to matter for motion in place as it is encountered in the sublunary world (from (1) and (2)).

One might accept that Aristotle in this passage introduces *pothen poi* matter as a distinct case of matter alongside genetic matter. Yet one might insist that this does not prevent Aristotle from postulating the existence of some other matter shared by both eternal and perishable substances. This other matter would be located at a more basic level, and it would be prior to the distinction between genetic matter (which applies to perishable sensible substances) and *pothen poi* matter (which applies to eternal sensible substances). Richard Sorabji has recently argued that, when Aristotle says that celestial bodies have different matter, he need not mean that their primary matter is different, but only that their elemental matter is

38 On this point see Charles (2000: 81–110). As Charles remarks, the demand that there be one unified type of thing is not to be confused with the demand that there be one unified thing (97).

different. The difference would ultimately be due to the fact that celestial bodies are made of an element which has the capacity for motion in place only, whereas the other four elements can undergo other kinds of change, including generation and perishing.[39] Admittedly, Aristotle does not exclude, *expressis verbis*, the existence of some primary matter shared by both eternal and perishable substances. But his silence is to be understood as denying that there is such a further level of analysis. The logic of the argument offered in *Lambda* 2 strongly suggests that *pothen poi* and genetic matter represent the very last level of analysis, and that there is no further level of analysis on which the unity of matter is secured. This is a consequence of the identification of matter with that which has a capacity for change. Since the only change that Aristotle admits in the celestial world is circular motion, it is difficult to see how the analysis of matter could be carried out in order to reach some more basic matter than celestial and genetic matter.[40]

## LACK OF INTELLIGIBILITY TO US

By this point I hope to have established that for Aristotle there is a region in the province of the science of nature where we are confronted with difficulties exceeding our capacity to provide a solution to them. It should also be clear that the idiosyncratic conception of the natural world held by Aristotle is the ultimate reason for this lack of intelligibility *to us* of important features of the celestial world.[41] However, one may still argue that the difficulties in question, given that they affect only a limited region

39 Sorabji (1988: 15).

40 Sorabji is led to this conclusion on the basis of a certain reading of *Zeta* 3. Though it is not my intention to engage in a discussion of this notoriously difficult chapter, I would like to point out that no link is here established between matter and change. Matter is presented as that which remains when all the other things are stripped away. Apparently, the stripping procedure takes place in two stages. Stage 1: affections and doings and capacities are removed (1029 a 12–16). Stage 2: length, breadth, and depth are subtracted (1029 a 16–19). Aristotle concludes by saying that matter alone necessarily seems to be substance "to those considering <the issue> in this way" (1029 a 18–19). These words might be taken as an indication that Aristotle does not find this *reductio* argument particularly attractive. It has also been suggested that this argument is based on assumptions that Aristotle does not hold. On this point see Charlton (1970: 136–8); Schofield (1972: 97–101); Frede and Patzig (1988, vol. II: 44–5); Gill (1989: 26–31). But even if Aristotle endorses this argument, it is far from clear that the matter left over once the stripping procedure has taken place provides us with a solution to the problem of the unity of matter. The objects of the stripping procedure are presumably ordinary objects such as a statue. What is left over once all the other things have been subtracted is not some primary matter but rather the matter of the statue. Primary matter is simply not at issue in *Zeta* 3.

41 I add "to us" because I want to provide Aristotle with the resources to claim that the natural, though it is not completely intelligible to us, is intrinsically intelligible.

in the province of natural science, should not force us to modify the official image of Aristotle's science of nature as it emerges from other passages. There is more than a grain of truth in this argument. Yet one has to realize the importance of the study of the celestial bodies to Aristotle. In the exhortation concluding *PA* 1, Aristotle claims that the celestial bodies are the most honorable and divine among the substances we experience in the natural world. This statement is not to be underestimated. Aristotle thinks of the study of the celestial world as the culmination of natural investigation. This is also the reason why at times he offers this very study as an illustration of what a theoretical life, dedicated to theoretical activities, and pursued for its own sake, should be like. One should also bear in mind that Aristotle admits causal, and therefore explanatory, unity in the natural world. Aristotle does not think of the natural world as a mere collection of separate, or only loosely connected, parts, but as a unified whole articulated into causally interrelated parts.[42] But if Aristotle takes the view that the different parts of the natural world are causally related to one another, how is it possible for him to confine the lack of intelligibility to the celestial world? This lack of intelligibility is transmitted to the sublunary world by virtue of the fact that certain features of the celestial world play a role in the explanation of features of the sublunary world. Some distinction needs to be introduced here. If my reconstruction of Aristotle's conception of the natural world is correct, there is no doubt that explanatory factors of important features of the sublunary world are not completely accessible to us, and consequently an explanation of these features is, strictly speaking, not available to us. Nevertheless, the temptation to conflate the lack of intelligibility experienced in the study of the celestial world and the consequences that derive from this lack of intelligibility in the study of sublunary world into one and the same case should be resisted. Let us return to the slogan that it takes a man to generate a man.[43] On the one hand, Aristotle is able to provide the explanation for the generation of a particular man. He is able to point out the factors involved in the explanation of that generation: the father, the *sperma*, the *katamenia*, the goal of that particular generation – that is, a particular form of organization realized in a body of a certain type. On the other hand, Aristotle is not able to explain why the generation of that particular man is part of a continuous process of coming into existence and going out of existence. In order to be able to provide an

42 See chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."
43 See ibid., pp. 9–13.

explanation for the continuity of this process Aristotle would have to be in a position to say why the celestial revolutions take place in the precise way they do. But because of the very way in which Aristotle conceives of celestial motion he is not in possession of the relevant information to explain why celestial revolutions take place in the precise way they do. I am finally in a position to specify the claim that some grasp of the celestial world is not only necessary but also preliminary to the attainment of an understanding of important features of the sublunary world. I insist on the qualification "some grasp" because:

1. only some features of the celestial world are relevant for the study of the sublunary world; and
2. access to these very features is limited to us by the physical distance which separates us from the celestial world *together with* the fact that these bodies cannot be adequately explained on the basis of the conceptual resources developed and refined in the study of the sublunary world.

Aristotle's view that there is a lack of intelligibility to us of important features of the celestial world is to be understood and appreciated in its historical context by relation to his predecessors. Concern, if not fascination, with *ta meteōra* was a conspicuous feature of Anaxagoras' thought.[44] In antiquity, Anaxagoras was often remembered for his audacious views in this field. For him, the sun and the rest of the celestial bodies were stony and heavy bodies ignited by the resistance and tearing of the surrounding *aithēr*.[45] Though Anaxagoras could not be entirely responsible for the widespread hostility to meteorological speculations in the fifth and fourth century BCE, the audacity of his views surely contributed to a debate on the extent of what could be investigated and what could be known about *ta meteōra*. Consider, for example, the way Xenophon's Socrates reacts to Anaxagoras' view that the sun is a fiery stone (*Mem.* IV 7. 6–7). The problem with Anaxagoras is not simply that he fails to recognize that there are human limitations to the extent of what can be known about *ta meteōra*. These limitations are set by god (or gods), and Anaxagoras' attempt to go beyond human limitations results in madness.[46] In other words, Anaxagoras is not only seriously mistaken;

44 For the use of the phrase *ta meteōra* to refer to the study of the heavens see ibid., footnote 5.
45 Plutarch, *Lysander* 12 (= *DK* 59 A 12). This testimony is confirmed by Diog. Laert., II 12 (= *DK* 59 A 1.12). Cf. Stob., *Ecl.* I 23. 10–15 (= Aëtius II 13.3 = *DK* 59 A 71).
46 For the language of madness in connection with natural philosophy, see Xenophon, *Mem.* I 1.1 13–14.

he has gone mad. His madness is the divine punishment for his failure to recognize and accept the limitations set by god (or gods) to our capacity to gain knowledge of the world. This is not the place to discuss how seriously to take this testimony as evidence about Socrates' attitude to the study of nature. Much of this may well be idiosyncratic to Xenophon's Socrates. But it is revealing of a typical skepticism about the extent of what we can know of the celestial phenomena, which is well documented in the fifth and fourth century BCE. This skepticism seems to be rooted in the conviction that there are limits to our ability to acquire knowledge of the world, and the study of *ta meteōra* often results in an attempt to go beyond these limits.

Both Aristotle and Anaxagoras are engaged in vast and ambitious projects of investigation of the natural world, on the crucial assumption that this world is intelligible. They share the same desire to understand every single aspect of the natural world. They also share the same concern, if not fascination, with the celestial world. Unlike Anaxagoras, however, Aristotle recognizes the existence of a gap between *what is intrinsically intelligible* and *what can be known by us*. To the best of my knowledge, there is no evidence that Anaxagoras is willing to accept this distinction. Note also that Anaxagoras' meteorological speculations were often equated with atheism in the fifth and fourth century BCE. His study of the celestial phenomena resulted in a rejection of the common supposition that the celestial bodies are alive and enjoy the blissful life of gods. By contending that the sun and the rest of the celestial bodies are heavy and stony objects Anaxagoras denied not only life but also divinity to the celestial bodies.[47] By contrast, Aristotle can accommodate the popular supposition that the celestial bodies are alive. His considered views about the celestial world do result in an extensive revision of popular piety, but they do not result in a rejection of the pre-philosophical (or pre-theoretical) intuitions about the gods. More specifically, Aristotle's investigation of the celestial world ends up in a radical revision of the received views about the heavens; but this revision also fits certain pre-theoretical conceptions of the heavens as the seat of the gods.[48]

47 Anaxagoras was put on trial on a charge of impiety. See Diog. Laert., II. 12 (= *DK* 59 A 1.12).

48 The rationalization of the religious tradition and its consequent appropriation is not a distinctive feature of Aristotle's philosophy. The Stoics shared Aristotle's view that the best considered view of the philosophers should meet certain pre-theoretical intuitions about the gods. The Stoic rationalization of Greek and Roman religious tradition is to be understood in the light of this idea.

# *Epilogue*

There would be no problems for Aristotle,
if one accepted his assumptions regarding the fifth body (Plotinus, II 1. 2. 12–13).

## ARISTOTLE'S LANGUAGE

In antiquity it was common to refer to the celestial simple body as the fifth body,[1] the fifth substance,[2] the fifth element,[3] the fifth nature,[4] or even the fifth genus.[5] This language strongly suggests that there was a

1 Together with the passage in the epigraph, see Stob., *Ecl.* I 37. 16–19, and [Plutarch], *Placita* 881 E 10 - F 7 (= Aëtius I 7. 32): "an aetherial body called by Aristotle fifth body." Stob., *Ecl.* I 128. 4–9, and [Plutarch], *Placita* 878 B 8–9 (= Aëtius I 3. 22): "some fifth aetherial body, not liable to change"; [Galen], *Hist. philos.* 54 (= *Dox. gr.* 623. 21–2). Sextus Emp., *M* X 316: "along with the four elements they [= Aristotle and Ocellus Lucanus] adopted the fifth body which revolves in a circle." The presence of Ocellus along with Aristotle calls for an explanation. In the Pythagorean tradition it was customary to assign the Platonic speculations about the fifth regular polyhedra to Pythagoras (and the Pythagoreans, including Philolaus). In all probability, Sextus (or his source) conflated the Platonic/Pythagorean and the Aristotelian fifth body into one and the same thing. I have argued that the Platonic/Pythagorean fifth body is the result of an attempt to give a place to the fifth regular polyhedron, the dodecahedron, and as such it has nothing to do with the never stationary celestial simple body which is forever revolving in a circle. See chapter 3, "Motions," in particular pp. 77–83. The expression "fifth body" is frequently used by the commentators. See, for example, Olympiodorus, *In Meteora* 2. 19; Philoponus, *In Meteora* 3. 37; 14. 32, 37.

2 From Simplicius we learn that Xenarchus' book was entitled *Against the Fifth Substance*. Cf. Simpl., *In DC* 13.22; 20.12; 21.33. Stob. *Ecl.* I 212. 25–7 (= Arius Didymus fr. 10 *partim* = *Dox. gr.* 451. 7–8): "the heaven and the things that populate it are constituted of a fifth substance, different from fire." See also Hippolytus, *Refutatio omnium haeresium* VII 19. 3–4 : "there is a certain fifth substance, according to Aristotle, as it were a certain super-mundane substance. And this has become a necessity in his system, in order to account for the division of the world."

3 Diog. Laert., V 32: "<According to Aristotle,> besides the four elements, there is also a fifth <element>, of which the aetherial bodies are constituted." See also Arnobius, *Adversus nationes* II 9; and [Clement] *Recognitiones* VIII 15. Like "fifth body," the expression "fifth element" is routinely used by the commentators. See, for example, Olympiodorus, *In Meteora* 2. 14–16; 2. 29–30; Philoponus, *In Meteora* 5. 9–10; 5. 13; 9. 31; 9. 33; 31. 29, 58. 8–9.

4 Cicero often refers to the celestial simple body as *quinta natura*. See *Tusc.* I 10, 22; *Tusc.* I 17; *Tusc.* I 41; *De fin.* IV 5, 12.

5 Cicero, *Acad.* I 7, 26.

tendency to think of the celestial simple body as an *additional* body. In all probability, from very early on, the view that earth, water, air, and fire were the simple bodies out of which the other bodies are made was largely accepted and relatively uncontroversial. Disagreement was confined to the existence of a celestial simple body. This body was perceived as an innovation whose need was not transparent to everyone and called for an explanation. In other words, from very early on, the scope of the debate was narrowed down to, and focused on, the need for *another* body alongside earth, water, air, and fire. At the beginning of the *DC*, however, it is an entirely open question how many simple bodies or elements there are. It is only in the course of the argument that Aristotle comes to the conclusion that there is a celestial simple body which is naturally moving in a circle along with four sublunary simple bodies which naturally perform rectilinear motion. In the *DC*, Aristotle first argues for the existence of a celestial simple body that naturally performs circular motion, and then establishes the existence of four sublunary simple bodies or elements. But the existence of four sublunary simple bodies or elements is not taken for granted. Aristotle's arguments for the existence of four sublunary simple bodies are only postponed until the existence of a celestial simple body is secured and the discussion of the celestial world is concluded. Obviously it is not the existence of earth, water, air, and fire that requires an argument, but rather the existence of earth, water, air, and fire as *elements* (or *simple bodies*): that is to say, their existence as the ultimate principles of the natural bodies that we encounter in the sublunary world.

Though the expressions "fifth element," "fifth body," "fifth substance," and "fifth nature" are abundantly attested in the ancient testimonies concerning the celestial simple body,[6] there is no evidence that Aristotle coined or used any of them. To begin with, Aristotle never uses these expressions in the extant works. To claim that he did use these expressions, but only in his lost works, is to make a bold assumption for which there is no good evidence.[7] Secondly, and more importantly, Aristotle

6 Alexander of Aphrodisias is the exception to the rule. Alexander tends to avoid these expressions. Most of the time, Alexander refers to the celestial simple body as "the divine body" (*DA* 43.9 and 45.3; *Quaestiones* I 1, 4.2; I 10, 21.7; II 3, 47.30; III 12, 106.271) or "the body which moves in a circle" (*Quaestiones* I 1, 3.9, 3.14–15, 4.1; I 10, 20.10; I 25, 40.10).

7 Typically, this assumption is itself built of other assumptions: for example, that until Andronicus published his "edition" the lost works of Aristotle remained the chief source of information about Aristotle's thought. For a discussion of Aristotle's language (as opposed to the language we find in the doxography), see Moraux, (1964: 1171–3 and 1209–26); Easterling (1964: 73–85); and, more recently, Hahm (1982: 60–74).

developed his own language to refer to the celestial simple body. In the works that have come down to us, Aristotle consistently refers to this body as "the first element," *to prōton stoicheion* (or "the first of the elements," *to prōton tōn stoicheiōn*),[8] "the first body," *to prōton sōma* (or "the first of the bodies," *to prōton tōn sōmatōn*),[9] or finally "the first substance," *he prōtē ousia*.[10] It is routinely suggested that this language implies a value judgment about the celestial simple body. I do not deny that Aristotle conceives of the simple celestial body as a noble and divine body, and as such prior to any of the sublunary bodies.[11] But I do not think that this is the primary and most important message that these expressions are intended to convey. The study of Aristotle's conception of the natural world that I have conducted in chapter 1 suggests that there is more to this language than a value judgment about the superiority of the celestial simple body over the four simple bodies of the sublunary world. In all probability, the celestial simple body is the *first* element (or the *first* body, or the *first* substance) because it comes *first in the order of explanation*. Moreover, this element (this body, this substance) comes first in the order of explanation because Aristotle thinks of the natural world as a very special causal system in which the direction of the explanation is from the celestial to the sublunary world only.[12]

In antiquity, it was also common to refer to the celestial simple body as *aithēr* or as an aethereal body.[13] Interestingly enough, Aristotle systematically refrains from using the term *aithēr*. In the extant works, Aristotle does

8 *DC* 298 b 6; *Meteor.* 338 b 2, 339 b 16–17, 340 b 11.

9 *DC* 270 b 3, 22; and *DC* 291 b 32.

10 *DC* 270 b 11. In *Metaph. Zeta*, we are told that substance, *ousia*, is thought to belong most obviously to bodies (1028 b 8–9). The celestial bodies are substances, *ousiai*, and are made of a body which is itself a substance, an *ousia*. The case of the celestial simple body is not different from that of the four sublunary simple bodies. They too are called substances, *ousiai*. See chapter 2, "Bodies."

11 *DC* 269 b 13–16.

12 For a discussion of this claim, I refer the reader to chapter 1, "The unity, structure, and boundaries of Aristotle's science of nature."

13 On the celestial simple body as *aithēr*, see Stob., *Ecl.* I 196. 11–12 (= Arius Didymus fr. 9 = *Dox. gr.* 450. 13). *Aithēr* is often identified with the fifth body. Achilles, *Isagoge*: "a fifth body which is imperishable and pure, and which people call *aithēr*." On the fifth body as an aethereal body, see also Stob., *Ecl.* I 37. 16–18, and [Plutarch], *Placita* 881 E 10 – F 7 (= Aëtius I 7. 32). Stob., *Ecl.* I 128. 4, and [Plutarch], *Placita* 878 B 8–9 (= Aëtius I 3. 22). These testimonies are reported in footnote 1. Perhaps the most interesting piece of doxography comes from Stob., *Ecl.* I 195. 20 – 196. 2, and [Plutarch], *Placita* 887 D 7–11 (= Aëtius II 7. 5): "Aristotle: first unaffectable *aithēr*, some fifth body; next to it affectable fire, air, water, and lastly earth." At *De mixtione* 223. 10–11, Alexander of Aphrodisias refers to the celestial simple body as "the divine, aethereal body which moves in a circle."

not show the least inclination to call his celestial simple body *aithēr*. In the *DC* Aristotle refers to *aithēr*, but only as the traditional name for the upper part of the world (270 b 20–1). In other words, there is no appropriation of the name *aithēr*, in the *DC* or elsewhere. Why? In all probability, Aristotle felt that the use of this name would have been misleading at best. The early history of *aithēr* has been recently told by Peter Kingsley, to whom I refer for a very helpful discussion.[14] Here suffice it to say that in the earliest Greek poetic tradition the word *aithēr* was used to refer to the clear, bright, upper air, and as such *aithēr* was contrasted with *aēr*, the often misty air near the ground.[15] But "as the scope of the term *aēr* increased," Kingsley reflects, "the scope of the word *aithēr* decreased; by the early fourth century BCE it was only used to refer to the highest and most exalted region of air, up in the heavens."[16] In the *Timaeus* Plato registers the semantic modifications undergone by the term *aithēr*, which he uses to refer to a special type of air (*Tim.* 58 D 1–2). By this time, "instead of *aēr* being a particular example of *aithēr*, *aithēr* has become a particular example of *aēr*."[17] The successive history of the name *aithēr* is more complicated and has yet to be written. However, a crucial development in the career of this name was the identification of *aithēr* with fire. It is very hard to establish who was responsible for this important development. Three times Aristotle refers to Anaxagoras for the equation of *aithēr* and fire,[18] and Theophrastus credits him with the identification of *aithēr* with fire.[19] According to Simplicius, Anaxagoras misidentified *aithēr* with fire because he was relying on the wrong etymology (*aithēr* < *aithein*, that is to say *kaiein*, burning).[20] We do not have to agree with Simplicius that the etymology of *aithēr* from *aithein* is wrong (it is the one that Liddell, Scott and Jones (1940) adopt). But it seems to me possible that the identification of *aithēr* with fire might

14 Kingsley (1995a), in particular the chapters on *aithēr* and *aēr*.

15 *Iliad* XIV 288: "the fir-tree reached through the *aēr* to the *aithēr*." For a convenient discussion of this passage and the conception of the world that it presupposes, see Kirk, Raven and Schofield (1983: 9–10). For a convenient discussion of the Homeric use of the words *aithēr*, *aēr*, and *ouranos*, see Kahn (1960: 133–54). For a study of the use of *aithēr* in the Greek tragedians, I refer the reader to West (1982: 1–13). See also Egli (2003), who offers a good discussion of the way Euripides manipulates intellectual themes borrowed from Anaxagoras, Diogenes of Apollonia, and the "philosophers" of the time. For her discussion of *aithēr*, see in particular 79–120.

16 Kingsley (1995a: 17).

17 Ibid.

18 Aristotle, *DC* 270 b 24–5 (= *DK* 59 A 73); *DC* 302 b 2–5 (= *DK* 59 A 43); *Meteor.* 369 b 21–31 (= *DK* 59 A 84).

19 Theophrastus, *De sensibus* 59. 6–7 (= *Dox. gr.* 516. 6–7).

20 Simpl., *In DC* 112. 2 (= *DK* 59 A 73).

have been encouraged by this etymology.[21] The few extant fragments of Anaxagoras are not very helpful in this case.[22] From the form of Anaxagoras' reasoning, *aithēr* seems to be the rare, the hot, and the dry; by contrast, *aēr* seems to be the dense, the moist, the cold, and the dark. Moreover, *aithēr* and *aēr* seem to be mixtures, not elements. Aristotle himself reports that for Anaxagoras fire and air are mixtures of flesh and bones and the like.[23] Even if the identification of *aithēr* with fire is an interpretation by Aristotle, rather than a direct statement by Anaxagoras,[24] the (ab)use of the word *aithēr*, and the confusion that it could give rise to, was surely important to Aristotle. In the extant works, Aristotle is extremely reluctant to use the name *aithēr*. The only exception is the use of *aithēr* in a passage from the *Physics*, where Aristotle says that the earth is within the water, the water within the air, the air within the *aithēr*, and the *aithēr* within the *ouranos* (212 b 20–2). But in this case *aithēr* refers to the sublunary fire, not the celestial simple body. It is unfortunate that Aristotle's reticence in using the name *aithēr* is not appreciated enough. The fact that Aristotle avoids using this word is often overlooked, if not obscured and denied, by routinely referring to Aristotle's celestial simple body as *aithēr*.[25]

21 I owe this point to Bob Sharples. There is a probable allusion to the etymological connection between *aithēr* and *aithein* in Euripides, *Tr.* 1079–80: *"aithēra te poleos olomenas/ an puros aithomena kateluse horma."*

22 Here are the relevant fragments. In the original mixture "*aēr* and *aithēr* enveloped all things" (*DK* 59 B 1). At a very early stage of the separation initiated by the *nous*, "*aēr* and *aithēr* were separated off" (*DK* 59 B 2). Moreover, "the dense, the moist, the cold and the dark gathered where earth is now, while the rare, the hot and the dry receded to the further <region> of *aithēr*" (*DK* 59 B 15).

23 *DC* 302 a 31 – b 2 (= *DK* 59 A 73). Cf. *GC* 314 a 28 – b 1, where we are told that fire, air, water, and earth are seed-aggregates, *panspermiai*.

24 Kingsley (1995b: 26–9).

25 A complication: from Cicero we learn that in the third book of his *On Philosophy* Aristotle attributed divinity to a number of different things, including the *caeli ardor* (Cicero, *Nat. deor.* I 33, = *Dox. gr.* 539. 15 = *On Phil.*, fr. 26 Ross (1955b)). Admittedly, the Latin word *ardor* could be used to translate the Greek term *aithēr*. See, for example, Cicero, *Nat. deor.* II 41: *"In ardore celesti qui aether vel caelum nominetur."* In this case the Stoic identification of *aithēr* with fire could hardly be avoided (*aithēr* < *aithein*, and *ardor* < *ardere*, burning). But Aristotle (like Plato) does not seem to be interested in the association of *aithēr* with heat and burning and, ultimately, fire. This association becomes prominent in the Hellenistic and post-Hellenistic tradition, and especially in Stoic sources. We should also bear in mind that Cicero is not copying from Aristotle's *On Philosophy* but from a doxographical report which is tainted by anti-Aristotelian bias (the Epicurean Phaedrus?). Prejudiced misunderstanding, deliberate adaptation, and contamination with later views, cannot be excluded in this case. For a recent discussion of this testimony as evidence for Aristotle's alleged doctrine of *aithēr* in the *On Philosophy*, see Hahm (1982: 60–74). I have learned a lot from this excellent article, even though I do not share its conclusion, namely that in the dialogue *On Philosophy* Aristotle could have argued that the celestial bodies are made of fire.

But how did the celestial simple body come to be associated with *aithēr*? In the *DC* Aristotle records an etymology which does not presuppose the identification of *aithēr* with fire but emphasizes the mobility of *aithēr* (*aithēr* < *aei thei*, always running).[26] The same etymology is recalled by Plato in the *Cratylus* (*aithēr* < *aei thei peri ton aēra rhēon*).[27] In the light of the relevance given to the mobility of *aithēr*, it is not difficult to see how the simple celestial body came to be regarded as an aethereal body; that is, a body which is never stationary and forever moving in a circle. The Aristotelian treatise *De mundo* provides us with a vivid example of how acceptance of the Platonic/Aristotelian etymology *aithēr* < *aei thein* (always running), and rejection of the alternative etymology *aithēr* < *aithein* (burning), leads to the association of *aithēr* with the celestial simple body. The author of the *De mundo* endorses the division of the natural world into a celestial and a sublunary realm. As for the celestial realm, he argues that the substance of the heaven and the stars is *aithēr*. Significantly enough, the author of the *De mundo* feels like adding that he uses this term not because the heaven and the stars are made of a fiery stuff (as some people do), but because the heaven and the stars are forever moving in a circle (392 a 5–9).

We must bear in mind that the celestial simple body is not just different from earth, water, air, and fire; for Aristotle, this body cannot be reduced to earth, water, air, and fire. It follows that Aristotle is committed to the existence of *material discontinuity* in the natural world. By calling the celestial simple body *aithēr*, Aristotle would have obscured this crucial aspect of his doctrine. Most people would have thought of the celestial simple body as a type of air or fire, and as such reducible to air or fire. The post-Aristotelian history of the word *aithēr* is particularly instructive on this point.[28] The Stoics accepted the identification of *aithēr* with fire. Zeno of Citium, for example, argued that the celestial bodies are intelligent, living beings, and are made of fire. He also distinguished between creative fire and destructive fire, and identified the celestial fire with creative fire, *pūr technikon*.[29] Zeno referred to the celestial fire as *aithēr*.[30] So did Chrysippus, and later on Posidonius.[31] By the time of

26 *DC* 270 b 20–3.
27 *Crat.*, 410 B 6–7.
28 For the use of the name *aithēr* in the *Epinomis* in connection with the fifth regular polyhedron (the dodecahedron), see chapter 3, "Motions."
29 Stob., *Ecl.* I 214. 1–3 (= Arius Didymus fr. 33 = *SVF* I 120).
30 Achilles, *Isagoge* 5 (= *SVF* I 115).
31 On Chrysippus and his view that the outermost part of the world consists of *aithēr* and is populated by stars, see Stob., *Ecl.* I 219. 19–25 (= Arius Didymus fr. 31 = *SVF* II 527). On

Posidonius, there is no doubt that the view that the celestial bodies are made of *aithēr* is intended to secure the material unity of the natural world.

By now it should be clear that a never stationary, fire-like *aithēr* could account for the mobility of the celestial bodies. But Aristotle's celestial simple body is not just a never stationary body which is naturally moving in a circle. There is more to this simple body than the capacity to perform eternal circular motion.[32] For Aristotle, the celestial simple body is not subject to growth and decline. By positing a celestial simple body with such extraordinary features Aristotle is not only affirming the division of the natural world into a celestial and a sublunary part, he is also introducing an important discontinuity within the natural world which few in antiquity were prepared to accept. By briefly looking at the ancient views on the topic of celestial nourishment we might come to appreciate what is remarkably unique about Aristotle's conception of the natural world. The Hippocratic author of *Breaths*, for example, claims that air is the nourishment for the sun, the moon, and the rest of the stars; without air these celestial bodies could not live.[33] He is obviously committed to the view that the celestial bodies are alive and made of fire. But fire, as it is experienced on earth, cannot exist without nourishment. Fire burns as long as it has fuel, and thereby grows or diminishes. For the author of *Breaths*, the celestial bodies enjoy an eternal life because they are continuously nourished by the surrounding air, which he calls *pneuma*. It would be a mistake to dismiss celestial nutrition as a piece of bizarre primitivism. The view that the celestial bodies are fed with the exhalations of the sea was not only quite old but also largely accepted in antiquity, before and

Posidonius and his view that the divine bodies are composed of *aithēr*, radiant and fire-like, never stationary but forever moving in a circle, see Stob., *Ecl.* I 206. 19–24 (= Arius Didymus fr. 32 = Edelstein and Kidd, fr. 127).

32 Aristotle often refers to the celestial simple body as "the body moving in a circle," *to kuklōi pheromenon sōma* (269 b 31), or *to kuklōi sōma* (270 a 33 and 279 b 3), or finally *to egkuklion sōma* (286 a 12 and 286 b 7). Yet it would be a mistake to think that the fact that the celestial simple body naturally performs circular motion is the only thing that really matters in the controversy over its existence. I refer the reader to chapter 3, "Motions," and the discussion of Xenarchus' arguments for the view that fire can move forever in a circle once it has reached its natural place. The fortune that these arguments enjoyed in antiquity documents the fact that there is no need to posit the existence of a wholly distinct simple body, if mobility is the only feature that really matters in the account of celestial motion. From very early on, however, mobility became *the* feature of the celestial simple body. See, for example, Sextus Emp., *HP* III 30–2. Here Aristotle is singled out because he took the view that the material principles are "fire, air, water, earth, <and> the body which is revolving in a circle [*to kuklophorētikon sōma*]." Cf. also [Galen], *Hist. philos.* 18 (= *Dox. gr.* 610. 17–18), who reports the very same piece of doxography.

33 Hippocrates, *Breaths* III, 3.

after Aristotle. Consider the case of the Stoics. For them, the celestial bodies are made of fire of a special type, celestial fire or *aithēr*. But again, fire requires nourishment. The Stoics did not think that celestial fire was an exception to the rule. So they extended this feature of fire to celestial fire: no fire, including celestial fire, could continue to exist without some kind of nourishment. Therefore the sun and the other celestial bodies, being composed of fire, have to take in nourishment. For the Stoics, they are nourished by exhalations of the ocean (= the great sea).[34] This doctrine has important repercussions in the Stoic system. It plays a role in the explanation of the mechanism of cyclical destruction of the world by conflagration (the Stoic technical word for this phenomenon is *ekpurosis*). It also commits the Stoics to the view that *exchange of material* takes place between the different parts of the natural world, on the crucial assumption that there is *material unity* in the natural world. By admitting material exchange between the heavens and the rest of the natural world, the Stoics put themselves in direct continuity with the pre-Platonic investigation of nature.[35] The view that there is material exchange between the different parts of the natural world was largely accepted in antiquity. Anaximenes seems to have thought that the celestial bodies come into existence when moisture rising from the earth is rarefied so far as to become fire.[36] Heraclitus held that the celestial bodies are fire, and fire is maintained by moist evaporations ascending from the sea.[37] Against this background, Aristotle emerges as an extraordinary exception. In the *Meteorology* he argues against the pre-Platonic idea that the celestial bodies are nourished by the moisture arising from the sea. His criticism is directed primarily against Heraclitus,[38] but it can be extended to all cosmologies and cosmogonies that are based on the idea that the celestial bodies are made of fire, and fire is nourished by moisture drawn from the

34 For Zeno, the sun is an intelligent entity, kindled by exhalation from the sea (*Etymol. Gud.* s. v. *Helios* = *SVF* I 121). For Cleanthes, the sun is nourished by the exhalations from the ocean (Cicero, *Nat. deor.* II 40 = *SVF* I 504). Jaeger (1948: 139) argues that Cleanthes took this view over from Aristotle's dialogue *On Philosophy* and made it at home in the Stoic system. This is very unlikely. To begin with, this view was held by Zeno, the founder of the school. Secondly, and more importantly, Cleanthes (as well as Zeno) did not have to take this view over from Aristotle. It was commonly held in antiquity and went back, ultimately, to the pre-Platonic *physiologoi*. There is evidence that Chrysippus endorsed this view. See Chrysippus *apud* Plutarch, *De stoicorum repugnantiis* 41 (= *SVF* II 579).

35 The connection did not escape the doxographers. See Aëtius II 17. 4: "Heraclitus and the Stoics held that the stars are nourished from the terrestrial exhalations."

36 Hippolytus, *Refutatio omnium haeresium* I 7 (= *DK* 13 A 7.5).

37 Diog. Laert., IX 1.9 (= *DK* 22 A 1. 9 10); Stob., *Ecl.* I 209. 5–10 (= Aëtius II 20. 16 = *DK* 22 A 12).

38 *Meteor.* 355 a 14.

sublunary world. Against all his predecessors, Aristotle is persuaded that the celestial bodies are materially different from the sublunary bodies, and no exchange of material is possible between the celestial and the sublunary world. Aristotle introduces a material discontinuity within the natural world that few in antiquity were prepared to accept. There is little but clear evidence that some of them even felt that Aristotle was speaking about two disconnected worlds (or two disconnected *kosmoi*).[39] But this is emphatically not Aristotle's view. His view is that the celestial and the sublunary world form one single causal system which admits an important discontinuity within itself. In this book, I have tried to shed light on the nature of the discontinuity as well as the reasons that may have led Aristotle to take this view.

39 Consider, for example, the following passage from Epiphanius, *Adversus haereses* III 31 (= *Dox. gr.* 592. 12–14): "<Aristotle> says that there are two *kosmoi*: the up there and the down here; and the up there is imperishable, whereas the down here is perishable."

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