

CHAPTER THREE

THE STRUCTURE AND IDEAS OF *PHYSICA* 6

§ 0. Introduction

In Chapter One the discussion of Zeno's dealings with issues of infinite divisibility was exclusively concerned with the metaphysical principles behind his arguments. I set out how Zeno's arguments and paradoxical conclusions were to be explained by the notions of the primacy of parts over a whole, of the homogeneity of bare objects, and of the idea that the now is independent of the past and the future, while excluding them both. In the first half of Chapter Two this discussion was continued, when I showed the important part the atomic principle – no unity from a plurality, no plurality from a unity – plays in Democritus' proof of the existence of atoms. I showed how he used it to ward off two objections of an Eleatic nature, namely that he ignored the homogeneity of atoms clustered together, and that, with his proof, he also unwittingly committed himself to mathematical atoms. In the second half of that chapter, however, the discussion became more technical and quasi-mathematical, when I dealt with Democritus' ideas about limit entities.

Democritus, being both a philosopher and a mathematician, must have been one of the first who combined a philosophical perspective with a more mathematical approach when treating issues of continuity and infinite divisibility. It is likely that in the Academy this interplay between mathematics and philosophy was developed further. This we may gather from the arguments we find in Plato's *Parmenides* and the small work *De lineis insecabilibus* (about the Aristotelian authorship of which opinions were already divided in antiquity, and which is now thought not to be by Aristotle himself), but also from what we know from other sources, especially Aristotle himself and the commentators on Aristotle, where they report on Plato, Xenocrates and unspecified atomists in the Academy.

In this dissertation, however, I shall not deal with these Academic developments. (There are only some references to passages from Plato's *Parmenides* in Chapter One). There are considerations of space and time behind this decision, but also interpretational reasons. The evidence as to the positions of other philosophers than Plato is so poor or so hard to interpret that it seems difficult to defend an interpretation with any great conviction. As far as Plato is concerned, more evidence is available, but I am reluctant to interpret his remarks in the *Parmenides* in isolation from its context. As is well-known, it is excessively difficult to determine what exactly Plato's purpose in this dialogue is. Moreover, it is an arduous task to combine this evidence with the evidence from other dialogues – notably the *Timaeus* and the *Philebus*, as well as those reports about Plato's ideas known from, among others, Aristotle – so as to produce a coherent

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picture. Moreover, it is unlikely that even if we knew more about the ideas of Plato and other Academics, we should be much wiser as to Aristotle's views on infinite divisibility. Rather it seems a better interpretational strategy to try to understand what we know of the Academic debate within the context of our knowledge of the ideas of Zeno, Democritus and especially Aristotle, both with respect to the overall picture of the discussion and with respect to the appreciation of the evidence. Aristotle and people working in his school are, after all, our most important sources.

While Aristotle's treatment of issues of continuity and infinite divisibility have received considerable attention over the last forty years or so, there is still much work to be done. The reason for this is that the focus has been on quite a limited set of texts. Of course the importance of these texts is not to be contested, but as I hope to show in the two coming chapters it will be fruitful to study them within a wider context of other texts, mostly taken from the works written by Aristotle himself, but occasionally also from the work already mentioned, *De lineis insecabilibus*. Again one may distinguish between two themes in these texts, a technical and quasi-mathematical theme and a more philosophical theme. In Chapter Four the latter type will predominate. There Aristotle's views on issues like the relation between wholes and their parts and the role played by consideration of homogeneity will be discussed. In the present chapter, however, I shall be concerned with the most important and extensive technical text on infinite divisibility, the sixth book of Aristotle's *Physics*, though a few other technical texts will be analysed as well, mostly in connection with arguments from *Physica* 6.

In this chapter I have two aims. The first is to give an analysis of the most important ideas and their developments as presented in *Physica* 6. To get a fuller understanding of these ideas it will sometimes also be necessary to quote and discuss arguments and statements Aristotle comes up with elsewhere. The second aim is to provide an extensive commentary on the whole of *Physica* 6, in order to get clear about the overall structure of the book as well as to solve many interpretational problems at the level of detail. I shall try to achieve these two aims at the same time in one running exposition, which will be ordered on the basis of questions asked about the concepts and ideas Aristotle uses, but which will also contain considerations of points of detail, usually necessary to answer the guiding questions. On a number of occasions, however, I shall not be able to achieve both aims at the same time, so that I shall be forced to provide an analysis of a passage without integrating it into the larger whole of the section. There are also a few passages which will not receive any attention at all, sometimes because they are very easy to understand, but mostly because they have nothing to do with the theme of infinite divisibility and continuity. Among these passages are those concerning motions over an unlimited distance taking an unlimited time.

Given its aims, this chapter will not make easy reading, especially in its opening sections. In the end, though, I hope to have shown a way through the labyrinth of *Physica* 6, so that its structure and ideas will be more easily recognized.¹

¹ To help the reader I shall quote extensively and have provided an index for this chapter alone, listing all passages quoted, discussed, or referred to.

§ 1. The labyrinth of *Physica* 6

Anyone who starts reading book six of Aristotle's *Physica* for the first time and manages to get to the end may well ask what it was all about. Those who do so will have read about everything continuous being only divisible into ever divisible parts, because nothing continuous can be made up of indivisibles; they will have read that Zeno erred, in that he assumed time to consist of indivisibles; they will have read that time is ever divisible if length is, and *vice versa*; but they will also have ploughed their way through a battery of arguments which will almost certainly have left many of them bewildered. Those who decide to retrace their steps, however, and make an overview of the contents of *Physica* 6, may well reach the conclusion that apart from a few minor infelicities there is a clear order after all. The issues addressed will then be seen to fall into the following pattern:

- 6.1 231a21-b18 Nothing continuous consists of indivisibles. Therefore everything continuous is divisible into ever-divisibles.
- 231b18-232a17 Either magnitude, time and motion all consist of indivisibles or they do not.
- 232a18-22 Two short statements, to the effect that time is divisible if and only if magnitude (as well as motion) is divisible.
- 6.2 232a23-233a12 Three theses about a situation in which one thing is moving faster than another thing which is slower. As these theses apply in every period of time, time and magnitude are ever divisible (together).
- 233a13-b15 'More usually advanced arguments' to the effect that if time is divisible without limit, so also is magnitude, and *vice versa*. Also unlimitedness in extension of time and magnitude moved over always go together. One should not confuse the two kinds of unlimited, as Zeno does.
- 233b15-32 Magnitudes, or more generally all things that are continuous, are not atomic, because theses about the faster and the slower apply to every period of time.
- 6.3 233b33-234a22 There is something indivisible in time: the now.
- 234a22-b9 It is impossible to move or to rest in the now.
- 6.4 234b10-235b5 Everything involved in motion is divisible: the moving object, the motion itself (both according to the moving object and to time), time itself, the moving, and the medium of motion. All are interrelated in their divisibility. By the same token, all are unlimited.
- 6.5 235b6-236b18 Introduction of the distinction between changing and having changed. There is no such thing as a 'primary time' in which something has

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changed, at least not in the sense that there is a first goal along the path of motion. There is no part of something changing which is the primary part to have changed.

- 6.6 236b19-237b22 There is nothing primary in which something is changing either. Therefore everything changing has changed for a prior part and everything which has changed changes for a prior part, for all kinds of change. What is changing has changed at every one of the unlimited nows in time.
- 6.7 237b23-238b22 It is not possible to take an unlimited time for a limited motion, to make an unlimited motion in a limited time, or for an unlimited object to move over whatever distance.
- 6.8 238b23-239b4 Also of coming to a halt and of resting there is no primary time: they do not occur in a now.
- 6.9 239b5-240a18 Zeno's arguments against motion and their solutions.
- 240a19-b7 Neither are change between contradictories and change in one place (by rotation) problematic.
- 6.10 240b8-241a26 Nothing indivisible can move by itself.
- 241a26-b20 No change is unlimited, not even locomotion.

As one can see, most chapters deal with one topic or with related topics. Perhaps one would have wished to read 6.4 and 6.7 immediately after 6.2, and to have read part of *Physica* 6.1 and 6.3 together with 6.5-6 and 6.8. In addition one may wonder how the second part of 6.10 is related to 6.2, 6.4 and especially 6.7. But these seem minor complaints.

However, once one starts analysing the individual arguments Aristotle gives for his theses, disorder returns again. There are a large number of incongruities which seem to throw into doubt the very unity of the book. These fall into three groups: there are passages which are just inconsistent with other passages; there are theses argued for twice; and there are passages which suggest an ongoing argument, but on a closer look appear to be without argumentative connection.

§ 1.1. *Disconnected arguments*

To start with the last group, the clearest example concerns the two first chapters. Let me summarize and comment on Aristotle's argument.

Aristotle starts with an argument that 'it is impossible that something continuous consists of indivisibles, e.g. that a line consists of points.'² This argument is based on the definitions of either of the two relations the indivisibles must be in order to make up something continuous, that is, something without gaps: either these indivisibles must be

² 231a24-25

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continuous, which is defined as having boundaries which are one, or they must be touching, which is defined as having their boundaries together.³ But within an indivisible one cannot distinguish the boundary from the rest, so that indivisibles cannot be in either of the relations required of them if they are to make up a continuum.

But then Aristotle continues: 'Further, it is necessary that the points of which the continuum is to consist be either continuous or touch one another.'⁴ For the impossibility of continuous points he refers back to the previous argument. The point of the argument for the impossibility of touching points making up a continuum is that points can only touch if they coincide. With this argument Aristotle seems to allow for a situation which he has ruled out just before, or to have suddenly changed the meaning of 'touching'.⁵

Next follows a rather obscure argument for the conclusion that 'a point will not even be successive to a point, or a now to a now, in such a way that length or time consists of them.'⁶ Aristotle seems to give three reasons for this. First, between two points or two nows there will always be a line or a period of time, so that they cannot be successive.⁷ One wonders how Aristotle thinks he is entitled to the claim that there is always a line between two points. Second, something continuous does not consist of indivisibles anyway, because it does not divide into partless things. Especially the form of the ultimate reason here: 'None of the continuous things *was* divisible into partless things',⁸ with the implied reference to something said before, seems strangely out of place. Third, something of another kind cannot be between the points or nows. This is presumably because what would be between them would still have to be of such a kind as to be (in)divisible.

This section Aristotle finally concludes with: 'It is also clear that everything continuous is divisible into ever-divisibles.'⁹ The reason he gives seems only to refer to the impossibility for touching indivisibles to yield more than one indivisible.

In the following section he purports to argue that 'it belongs to the same argument that magnitude, time and motion are composed of indivisibles and divide into indivisibles or that none of them is.'¹⁰ Aristotle takes it for granted that if the magnitude moved over consists of indivisibles, the motion also consists of indivisibles. Also moving¹¹ consists then of indivisibles. But there is no explicit argument that time consists in that case of indivisibles as well. Instead we get an argument that motion then consists of moves, and moving of indivisibles of having moved, without any moving. (This argument is based on the temporal distinction between moving and having moved: 'What moves from somewhere to somewhere is not moving at the same time as it has moved whither it was moving when it was moving.'¹²) This conclusion is subsequently reduced to the absurdity that everything moving is not moving.

³ These definitions one can find in *Physica* 5.3; 227a10-12 and 226b23.

⁴ 231a29-31

⁵ Cf. Waschkes, *Von Eudoxus* 355, and White, *Continuous* 29.

⁶ 231b6-8

⁷ Here Aristotle refers again back to a definition stated in *Physica* 5.3; 226b34-227a4.

⁸ 231b11-12

⁹ 231b15-16

¹⁰ 231b18-20

¹¹ Presumably the motion as performance, that is, as performed by the moving object; cf. *Metaphysica* Θ.7; 1049a33 and *Physica* 4.12; 220b32.

¹² 231b29-30

Only now do we meet an argument that ‘time is indivisible in a way similar to that of length and motion, that is, is composed ofnows which are indivisible.’¹³ The reason given is that if every motion is divisible, also the time will be divisible because there is a proportionality between the distance traversed and the time needed. That is a very different kind of reason, and one which seems ineffectual against the idea of composition from sizeless indivisibles, as well as against indivisibility of parts with size. At all events, it is presumably because of the same proportionality that Aristotle declares that if the time is divisible, so also the distance will be divisible. This seems hardly enough to conclude, as Aristotle does, that by the same argument magnitude, time and motion are divisible (or indivisible) together.

He continues with: ‘Since every [kind of] magnitude [like distance, time and motion] is divisible into magnitudes (for it has been shown that it is impossible that something continuous consists of atoms),’¹⁴ it is necessary that three theses about the faster and the slower hold: the faster moves over more in an equal time, over an equal distance in a shorter time, and over more in a shorter time. These theses are argued for extensively, the second one even twice; the ever divisibility of time and length are indeed assumed in the argument. One may be surprised, then, to hear that after Aristotle has declared motion (and thus moving faster and slower) to be possible in every time, he argues that ‘since these things are the case it is necessary that *also* time is continuous,’¹⁵ where ‘continuous’ now means ‘divisible into ever divisibles’. The addition of ‘also’ is puzzling as well. To make matters worse, Aristotle concludes the argument, in which only two of the three theses are used, with: ‘At the same time it is also clear that every magnitude is continuous.’¹⁶

There are also ‘commonly advanced arguments’ which make it ‘clear that if time is continuous, so also is magnitude,’¹⁷ arguments which are based on the proportionality between time and distance. We have seen a reference to such arguments above; they amount probably to nothing more than that this proportionality holds for every period of time and for every distance – which seems to make the arguments circular. But we do not get them. Instead we get a distinction between two kinds of unlimited, one ‘by extremities’ and one ‘by division’.¹⁸ The claim is that if magnitude is unlimited in either sense, time is unlimited in the same sense, and *vice versa*. As far as the unlimited in extension is concerned, this claim is partially argued for: if the magnitude is limited, the time is limited. The proof the other way round is declared to be the same. In between, Aristotle solves Zeno’s Runner-paradox by stating that it may not be possible to move over an unlimitedly extended distance, but that it is possible to move over an unlimitedly divided distance, as time will be unlimited in the same way.

¹³ 232a18-19

¹⁴ 232a23-24. As indicated by my addition between square brackets, I take Aristotle here to use ‘magnitude’ in a general sense, comprising both time and distance (as well as magnitudes in other dimensions). This not only conforms to his usage elsewhere, e.g. *Physica* 6.9; 239b9, but also saves him from an immediate mistake. For if one were to interpret ‘magnitude’ here in a more specified sense, as referring to the distance moved over, then one would have to say, as F.D. Miller Jr., ‘Aristotle against the Atomists’, in: Kretzmann, *Infinity and Continuity* 87-111, at 104-106, does, that Aristotle in the subsequent argument also presupposes, without telling us, that time is ever-divisible.

¹⁵ 232b23-24

¹⁶ 233a10-11

¹⁷ 233a13-14

¹⁸ 233a18-29

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In the end, it appears once again that Aristotle meant to argue all along for the categorical claim that ‘none of the continuous things will be atomic.’¹⁹ He refers to what has been said, but also gives a new argument in which one thesis about the faster and the slower is used to reduce to absurdity the idea that time and length consist of atoms. Needless to say, the argument tacitly presupposes the ever divisibility of time and length, in that it assumes the thesis about faster and slower to apply to every distance and period of time.

Aristotle therefore fails to fulfil his promises. On one occasion he announces that he is arguing for one thing, and later that he is arguing for another. He uses clearly inappropriate arguments, he reasons in a circle, and begs the question. He changes the meaning of his words and refers back to something that has not yet been stated. This is a really chaotic situation.

§ 1.2. *Inconsistencies and circularities*

In the rest of the book, Aristotle does not appear to have argued in such a disorderly manner. It is at least clear what he wants to establish, and the argument contradicts neither the previous argument nor that which follows. That does not mean, however, that he can maintain overall consistency of vocabulary or avoid circularity and contradictions. An example of inconsistency of vocabulary concerns the meaning of ‘moving over’ (κινεῖσθαι with accusative). When Aristotle wants to argue that an unlimited magnitude cannot move over a limited magnitude, *because* a limited magnitude cannot move over an unlimited one, Aristotle must assume that ‘moving over’ means: bringing the whole object from one side of the magnitude to be passed over to the other.²⁰ Commonly, however, he takes ‘moving over’ to consist in translating each point of the moving object over a certain magnitude. Usually this is not obvious, because it is not clear whether he considers only one limit of the moving object or the moving object as a point. But since in *Physica* 6.10 he argues that a point cannot move by itself, he must assume that the moving object has s. Moreover, the situation he imagines in *Physica* 6.1, where something moves over three indivisibles ABC composing an interconnected whole ABC, would be totally incomprehensible if moving over were to mean bringing over the whole body from one side to the other of the magnitude moved over. For if it had thus ‘moved over’ A, where would it then be? At indivisible B or to the left side of it? If the former, it cannot fully move over B any more, and if the latter it has not fully moved over A.

Perhaps one should rather classify this inconsistency of terminology as a mistake in reasoning on Aristotle’s part in the case where he must assume the uncommon meaning of ‘moving over’. This does not seem to be possible with regard to Aristotle’s use of the term ‘motion’ (κίνησις). In the situation of *Physica* 6.1 of something moving over three indivisibles ABC, he divides the whole motion required to move over them into three indivisible motions DEF.²¹ Thus he distinguishes on the one hand motion and magnitude moved over, but divides on the other hand the motion by reference to the magnitude moved over. In *Physica* 6.4, however, he states explicitly that ‘motion is divisible in two ways, in one way by time, in another according to the motions of the parts of what is

¹⁹ 233b17

²⁰ *Physica* 6.7; 238a36-b12. We encounter a similar use in *De Caelo* 1.5; 272a21ff.

²¹ 231b21-25

moving.²² It might be that he takes ‘motion’ here as synonymous with the (two-dimensional) path covered by the moving object,²³ though that seems less likely because further on in the same chapter he distinguishes motion from that in which there is motion²⁴ and mentions the divisibility of length separately from that of motion.²⁵ The inconsistency with *Physica* 6.1 is unavoidable.

There is an example of a circular argument in *Physica* 6.3, where Aristotle wants to argue for the indivisibility of the now. His argument runs as follows:

It is also necessary that the now, which is called thus not for something else but for itself and primarily,²⁶ is indivisible, and that such a now is present in every time. For there is some extremity of what has been, on whose side there is nothing of what is going to be, and again some extremity of what is going to be, on whose side there is nothing of what has been; we claim, then, that this is the limit of both. When just that has been proved, that it is thus, that is, the same, it will at the same time also be evident that it is indivisible.

It is, then, necessary that the now which is the extremity of both times is the same (τὸ αὐτὸ εἶναι τὸ νῦν τὸ ἔσχατον ἀμφοτέρων τῶν χρόνων). For if they are different, the one [extremity] would not be successive to the other because something continuous does not consist of partless things; and if the two are apart, there will be a time in between. For everything continuous is such that there is something synonymous between the limits. But then, (i) if what is in between is a time, it will be divisible. For every time has been proved to be divisible. Thus the now is divisible. (ii) If the now is divisible, there will be something of what has been in what is going to be and of what is going to be in what has been. For that at which [the now] is divided, will mark off (διοριεῖ) the past and the future. Moreover, (iii) the now thus would not be [the now] for itself, but [the now] for something else, for the division is [the now] for itself (ἢ γὰρ διαίρεσις καθ’ αὐτό).²⁷ In addition to that, (iv) one part of the now will have been and another part will be going to be, and not always the same will have been or be going to be. Nor will the now be the same. For time is divisible at many places.

Thus if it is impossible that these things are the case, it is necessary that the now in both [times] is the same. But if it is the same, it is evidently also indivisible. For if it is divisible, again the same things will follow as in the previous case.²⁸

This difficult passage requires elucidation. The main line of argument is clear: the now is between the past and the future, so that if one can prove that the limit of the past is the same as the limit of the future, this must be the now, from which it follows that the now is indivisible. The form of the argument is a *reductio*. If the extremities of past and future are not the same, they cannot be successive, because then time would, absurdly, consist of indivisibles.²⁹ It is thus assumed that these extremities, which on at least two occasions in this

²² 234b21-23

²³ *Physica* 6.7; 237b23-33 can be read in this way, if one takes the feminine accusatives with κινεῖσθαι as accusatives of internal object.

²⁴ 235a13-18

²⁵ 235a34-35

²⁶ That is, called ‘now’ because it does not comprise anything more than the present time, and not because it has merely a part which is really present (in the way the whole of 2002 would be now); cf. *Physica* 6.6; 236b20-22 and 6.8; 239a24-25. For further discussion of the distinction between ‘for something else’ and ‘for itself and primarily’, see § 6.1, especially § 6.1.2.

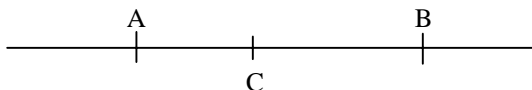
²⁷ Against the almost unanimous manuscript tradition, which reads ἢ γὰρ διαίρεσις καθ’ αὐτό, we should follow this reading, which is provided by manuscript H and, more importantly, reported by Simplicius, *In Physica* 958.24-26: ἔστι δὲ καὶ ἄλλη γραφή .. ἢ γὰρ διαίρεσις καθ’ αὐτό. καὶ λέγοι ἄν, ὅτι τὸ μεταξὺ τοῦτο καθ’ ἕτερον ἐστι νῦν· ἢ γὰρ διαίρεσις ἐστι τὸ καθ’ αὐτό νῦν, ἀλλ’ οὐ τὸ διαιρούμενον. See further note 32.

²⁸ 233b33-234a22

²⁹ This, of course, has been shown to be absurd in *Physica* 6.1; 231a18-b18.

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passage are called the now,³⁰ are indivisible. Suppose then that they are apart so that there is a period of time between them. We have then the following situation:



Aristotle makes a number of claims about this situation. First he states that (i) period AB, being between past and future, is the now and is divisible, say at C, because every period of time is divisible. Secondly he argues that (ii) part of the past is in the future, because past and future are divided by C. This can only be understood if we assume that now AB is at least either a part of the past or a part of the future, and that the past up to C thus has some overlap with the future (if the future starts at A) and the future from C has some overlap with the past (if the past lasts till B).³¹ So Aristotle somehow takes there to be two nows: the period AB and the division C. Aristotle's third statement is that (iii) the now is not the now for itself, but the now for something else. As already explained in note 26, the distinction between the now for itself and the now for something else is the distinction between the temporal entity which comprises the whole now and nothing but the now, and that temporal entity which is called 'now' because it contains the now for itself. The now for itself here is C, and the now which is not for itself, but for something else is AB.³² Again Aristotle takes there to be two nows, the period AB and the division C. He does the same in his final claim that (iv) the now AB can be divided into a past and a future part by C, but that as C may be situated anywhere, these parts will vary, just as the now in the sense of C.

In each of (the arguments for) the claims (ii)-(iv) Aristotle assumes that the now C is the unique, and therefore indivisible, extremity of both past and future. His complaint amounts in fact to nothing more than that this conception is incompatible with there being a divisible now AB.

We also find a circularity if we compare two places where Aristotle argues that there is no motion or rest in the now. The arguments he provides in *Physica* 6.3 are meant to justify the concluding that:

It is therefore necessary that what moves, moves in time, and what rests, rests in time.³³

³⁰ 234a5 and 20; see also later in *Physica* 6.3, at 234a35.

³¹ My interpretation comes very close to that of M. Inwood, 'Aristotle on the Reality of Time', in: L. Judson (ed.), *Aristotle's Physics. A Collection of Essays* (Oxford, 1991) 151-178, at 161, who interprets Aristotle as saying that AC is past with respect to CB and future with respect to A (and everything before A), so that the past AC is in the future from A. The subtle difference between our interpretations is that his requires two nows as divisions of a period (A and C), whereas mine only needs one (C); on my interpretation the other now involved is the whole period AB. This stays closer to Aristotle's words, which feature a now as a period and only one now in the sense of a division.

³² Cf. Inwood, 'Reality' 161. If we were to adopt at 234a15-16 the reading ἡ γὰρ διαίρεσις αὐτὴ καθ' αὐτό, as provided by most manuscripts and taken over by Ross, *Physics ad locum* and 645, we would be forced to understand Aristotle as saying that the division C is not the now for itself, but the now for something else, and implying thus that the period AB is the now for itself. The now for something else would therefore turn out to be a part of the now for itself, rather than the other way round. That use of the term 'for something else' does not fit with its use at *Physica* 6.6; 236b20-22 and 6.8; 239a24-25, nor with its use in the first lines of the present passage, 233b33-34.

³³ 234b8-9

But when we read Aristotle's argumentation in *Physica* 6.8 that there is no rest in an indivisible time, we come across the remark:

The reason for this is that everything rests and moves in time, but that there is no primary time, nor magnitude, nor generally anything continuous.³⁴

Apparently the proposition that everything rests or moves in time is used to establish the impossibility of there being rest in an indivisible time. But how can the proposition that everything rests or moves in a time in one context be a premiss for the divisibility of the time of rest or motion, while in another context it is the expression of that very thesis?

We encounter a last case of circularity when we compare Aristotle's solution of Zeno's Arrow in *Physica* 6.9 with an argument he gives in *Physica* 6.1. In the former passage Aristotle claims that Zeno's paradoxical conclusion, that what is in motion is not in motion, does not follow unless one assumes that time consists of nows.³⁵ In the latter passage, however, he seems to argue just the other way round. For having argued that something moving over a row of indivisibles ABC by making indivisible motions DEF does not in fact make motions, but 'moves' (κινημάτα), and does not make the motion over the row by moving but rather by having-moved (namely over each of the indivisibles), he continues:

If then it is necessary that everything either rests or moves, it rests with regard to each of the [indivisibles] ABC, so that there will be something continuously resting and moving at the same time. For it moved (ἐκινεῖτο) over the whole ABC and rests over every part, so also over the whole. And if the indivisibles of [motion] DEF are motions, it would be possible not to move but to rest while motion is present. If, on the other hand, they are not motions, the motion does not consist of motions.³⁶

This appears to be a *reductio ad absurdum* of the supposition that motion consists of indivisibles.³⁷ But as Aristotle holds that the time of the motion is equally indivisible if the length and the motion are indivisible,³⁸ this constitutes in fact also a *reductio* of the supposition that time consists of indivisible nows, on the ground that it is absurd that what is in motion is not in motion.

Finally, there is one very clear case of a contradiction between two passages. In *Physica* 6.2 and 6.7, as we saw, Aristotle argues several times that a motion over an unlimited magnitude requires an unlimited time, and *vice versa*. But in principle he does not have any objection against an unlimited time of change. Rather, he is concerned with establishing that the limited in one domain, e.g. time, corresponds to the limited in another, e.g. magnitude moved over, and the unlimited in one domain to the unlimited in another.³⁹ Matters are completely different in *Physica* 6.10. For there, after having argued that there is no unlimited change if the change is between contradictories or opposites, Aristotle says:

³⁴ 239a20-22

³⁵ 239b5-9; 30-33

³⁶ 232a12-17

³⁷ It cannot be a *reductio* of the supposition that everything either rests or moves, for the absurd conclusion would still follow if 'rests' were to be replaced with 'does not move.'

³⁸ *Physica* 6.1; 232a18-19; cf. 231b18-20.

³⁹ See, most clearly, *Physica* 6.4; 235a37-b5.

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Locomotion (φορά), however, will not be limited in that way. For not every locomotion is among opposites. But since what is impossible to be cut (τμηθῆναι), in that it cannot be cut (τμηθῆναι) (for 'impossible' is used in many ways) – [since] what is thus impossible cannot be *being* cut (τέμνεσθαι), nor in general [can] for what is impossible to become (γενέσθαι) *be* becoming (γίνεσθαι), what is impossible to change (μεταβαλεῖν) could not *be* changing (μεταβάλλειν) either to what it is impossible to change to. If then that which is in locomotion would be changing (μεταβάλλοι) to something, it will also be possible to change (μεταβαλεῖν). Hence the motion is not unlimited, nor will it be in locomotion (οἰσθήσεται) over an unlimited [path]. For it is impossible to traverse (διελθεῖν) [the unlimited].⁴⁰

There is no suggestion of a correspondence between things unlimited here: it is just impossible to move over an unlimited magnitude! The contrast with the approach of the other chapters is highlighted by the next issue Aristotle mentions:

It must be investigated whether it is possible that this is the case [i.e. that motion cannot be unlimited] in such a way that one and the same motion is unlimited in time.⁴¹

This can only be a real issue if there is no correspondence between the motion and the time with respect to being limited or unlimited.

§ 1.3. *Making the same point twice*

These cases of inconsistency in vocabulary, of circularity, and of contradiction undermine in a very direct way the unity of the book. The same effect is brought about in a more subtle way through the presence of theses which are mentioned or argued for twice. For some of them are argued for in very different ways.

An interesting example concerns Aristotle's denial that motion is possible in an indivisible now. In *Physica* 6.2 and 6.4 Aristotle does not argue for this denial. He just states it, by claiming that 'every motion is in [a period of] time'.⁴² Rather than arguing for this claim, he makes it through the applicability of proportionalities for the faster and the slower to every time (see p. 125), a crucial element in his demonstrations that no time is indivisible. Elsewhere Aristotle does refer directly to the now, and, more importantly, does argue for his thesis. A first argument is to be found in *Physica* 6.3, where he says that if there is motion in the now, the faster and slower apply in the now, so that the now will, *per impossibile*, be divided.⁴³ This argument Aristotle alludes to again in *Physica* 6.8,⁴⁴ but he also presents there a new argument:

⁴⁰ 241b2-11. With the last sentence Aristotle refers to his well-known doctrine that one cannot traverse the unlimited; see Chapter Four § 2.1.

⁴¹ 241b12-14

⁴² 232b20 and 235a11; cf. 233b19-20: 'In every time there is what is faster and slower', and also *Physica* 5.4; 227b26. That saying that 'every motion is in a period of time' for Aristotle is another way of saying that there is no motion in the now, may appear from *Physica* 6.3; 234b8-9, where Aristotle passes from the argument that there is no motion or rest in the now to the conclusion that 'whatever moves, moves in a time, and whatever rests, rests [in a time].'

⁴³ 234a24-31. The core of this *reductio* is in fact the same argument as Aristotle sets up in *Physica* 6.2 for the conclusion that every time is divisible, because in every time there can be motion (233b19-32).

⁴⁴ 238b29-30

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There is no motion in a partless [time] because [it would otherwise be the case that] it has moved [with respect to] some [part] of it (διὰ τὸ κεικινήσθαι τι ἄν αὐτοῦ).⁴⁵

The idea is that within each motion one can distinguish temporally between the end of the motion, which is reached when the moving object *has moved* (to the goal of the motion), and the rest of the motion, which is there when the moving object *is moving*, and is on its way (to that goal).⁴⁶

Aristotle has yet a third argument for his thesis that there is no motion in an indivisible now:

If the now in both [the past and the future] is the same, and it is possible to move over the one [time] as a whole and to rest over the other [time] as a whole, and that which moves over a time as a whole will move in any of those [parts] of that according to which it is of such a nature as to move, and what rests will rest in the same way, it will follow that the same thing rests and moves at the same time. For the now is the identical extremity of both times.⁴⁷

It is here not primarily the indivisibility of the now, but the fact that the now belongs to two periods which are divided from each other at this now, which makes it impossible for there to be motion in the now. This raises interesting questions, because here Aristotle rules out not only motion as involving actual movement in the now, but also the possibility of being in a *state of motion* (as well as of being in the state of rest) in the now. But equally, one might think, he rules out that what is first white and then not-white is either white or not-white in the now.

With this last reason Aristotle also banishes rest in the now. According to him, this reflects the general situation: rest is only possible if motion is possible.⁴⁸ But he also gives a reason specifically against the possibility of rest in the now: rest involves as a necessary condition that the object be in the same place at two different times.⁴⁹

The most conspicuous example of different arguments for the same thesis is one we have already met, in our summary of *Physica* 6.1-2. For whereas in *Physica* 6.1 the ever-divisibility of everything continuous seems to be based on the impossibility of building a continuum out of indivisibles, at the end of *Physica* 6.2 Aristotle argues explicitly that everything continuous is ever-divisible, using an argument that employs proportionalities for the faster and the slower.

Finally, there is a nice example of a case where Aristotle gives different arguments for the same thesis within one chapter. In *Physica* 6.10 he claims that a partless entity cannot move except in a derivative sense, together with an entity to which it belongs. He gives three different arguments. In the first he considers a partless object changing from AB to the next BC:

It is necessary that during the time it is changing it is either in AB or in BC or that one part of it is in the one, while another part is in the other. ... There will not be a [part] of it in each of them,

⁴⁵ 239a4-5

⁴⁶ See *Physica* 6.1; 231b28-232a1.

⁴⁷ 234a35-b5; see also note 295.

⁴⁸ *Physica* 6.3; 234a31-34; 6.8; 239a13-14. Only in this respect can I follow White, *Continuous* 48, who thinks the third reason against motion (as well as rest) in the now is a 'logical elaboration' of this general point. I must admit, though, that I do not understand what he means. To me it seems that the third reason against motion in the now, and the point that rest is merely possible if motion is, are completely independent of one another.

⁴⁹ *Physica* 6.3; 234b5-7; 6.8; 239a14-17; 27-29

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for [then] it would have parts. However, it will not be in BC either, for [then] it will have changed, whereas it is supposed to be changing. It remains then that it is in AB during the time it is changing. Therefore it will rest. For being in the same [state] during a period of time was resting. Hence it is not possible that the partless moves or, in general, changes.⁵⁰

Underlying this argument is a division of the change into changing and having changed, the stretch of change and the end of change. As an indivisible cannot be at the end during the change, it must be changing, along the track of change. But the argument is set up in such a way that it cannot be there, unless it is divided.⁵¹

The next argument Aristotle presents in *Physica* 6.10 is very different:

It is impossible that anything moving moves (κινήθηναι) over something larger than itself before (πρότερον πρὶν) [moving over something which is] either equal or smaller. If that then is the case, it is clear that also a point will move first (πρῶτον) over something smaller or equal. But since it is indivisible, it is impossible that it moves over something smaller before. Therefore [it moves first over a distance] equal to itself, so that a line will consist of points. For always moving over [a distance] equal [to itself], a point will measure (καταμετρήσει) the whole line. But if that [*viz.* that a line consists of points] is impossible, it is also impossible that what is indivisible moves.⁵²

Here we do not have a distinction between moving and having moved, nor a *reductio* to the *absurdum* that an indivisible is divided. Instead we have an appeal to a vague kind of proportionality between the distance traversed and the time needed for traversal: in some time traversal over something smaller, in a longer time over something equal and in an even larger time over something larger. However, this proportionality is only to a certain extent applicable to a moving point: being indivisible it cannot move over something smaller than itself. What is most remarkable about the present argument is that this in itself is not used as a reason to deny the possibility of motion to an indivisible. As we have seen, elsewhere in *Physica* 6 Aristotle argues from the non-applicability of a certain proportionality to the impossibility of motion, by way of a *reductio ad absurdum* that the indivisible should be divided if motion were possible. Here, by contrast, the merely partial applicability is accepted as far as it goes: a moving point first moves over a distance equal to itself. The picture of the point's motion which emerges from this is that it moves over the whole distance by moving successively over distances equal to itself; thus it would measure the whole distance.⁵³ But that means that the distance consists of indivisible points, which we know from the argument in *Physica* 6.1 to be impossible. Therefore the indivisible mover cannot move.

In the third and last argument against an indivisible mover presented in *Physica* 6.10 we do see the kind of *reductio* which was remarkably absent from the previous argument:

If everything moves in a time, and nothing in the now, and every time is divisible, then for any of the things moving there would be a time smaller than the time in which it moves over something as large as itself (ὄσον αὐτό). For there will be this latter time in which it moves

⁵⁰ 240b23-31

⁵¹ Though this argument is couched in terms of change and is also meant to cover change from one form to another (240b21-22), it is clear that it is construed on the model of locomotion (see 240b20 and 31).

⁵² 241a8-14

⁵³ Aristotle has borrowed the term 'measure' from Greek mathematics.

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because everything moves in a time. But every time has earlier on been demonstrated to be divisible. Therefore, if a point moves, there will not be a time smaller than the time in which it moved (ἐκινήθη) over itself. But that is impossible. For it is necessary that it moves over a smaller thing in a smaller time. Hence the indivisible will be divisible into what is smaller, just as a time into a time.⁵⁴

Here we have again the proportionality between times and distances traversed, now stated somewhat more clearly. But this time the fact that an indivisible cannot move over something smaller than itself, whereas the applicability of the proportionality would require that, is sufficient reason to deny that the indivisible can move.

Within one chapter we have thus already found a wide variety of arguments for the same thesis. But there are even more roads leading to Rome, for earlier in *Physica 6*, in chapters 4 and 5, Aristotle gives two related arguments. These purport to establish, first, that everything changing is divisible, and second, that of that which has changed there is no first part which has changed. Now these arguments concern change in general, and not just motion, but that does not detract from their interest as arguments, nor from the fact that they are comparable to the preceding three arguments. The argument of *Physica 6.4* is even very similar to the first argument of *Physica 6.10*:

Everything changing must be divisible. For since every change is from something to something, and [the changing thing], when it is in that to which it was changing (μετέβαλλεν), does not change any more, while it, when it is, both itself and all its parts, [in that] from which it was changing, does not change [yet], .. it is necessary that of the thing changing one [part] is in the one, while another [part] is in the other. For it is neither possible that it is in both nor that it is in neither. By '[that] to which it changes' I mean the first thing according to the change, for example [in the case of a change] from white: grey, not black. For it is not necessary that what changes is in whatever of the extremes.⁵⁵

With the clarification in the last two sentences, Aristotle ensures that there is no path between the two situations which are the extremes of the change. Thus the picture is almost the same as in the first argument of *Physica 6.10*, where the two extremes AB and BC did not have something between them either.⁵⁶ The only real difference between the two arguments (that the argument of *Physica 6.10* is spelled out in a little more detail does not count in this respect) concerns the vocabulary. For where Aristotle in *Physica 6.10* employs the pair changing – having changed, the second term of the pair is conspicuously absent in *Physica 6.4*.

Having changed is present in an argument in *Physica 6.5*, but here the argument is construed in a different way:

Of what has changed there is not something first which has changed. For let there be DF which is the first of DE to have changed. For everything changing has been demonstrated to be divisible. And let the time in which DF has changed be indicated by HI. If then DF has changed in the whole [HI], in half the time something smaller than and prior to DF will have changed,

⁵⁴ 241a15-23. For a justification of the translation, see § 3.1.1.2.

⁵⁵ 234b10-19

⁵⁶ For all practical purposes Aristotle has reduced the situation to be considered to that of change between contradictories, between F and not-F. For 'the first thing according to the change' is the start of not-F, and the next place the first part of that huge space which is the complement of the initial place.

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and again another [part] of that, and another of that, and always thus. Hence of what changes there will be no first which has changed.⁵⁷

The resemblance with the third argument of *Physica* 6.10 is clear. That argument, however, does not feature ‘having changed’.⁵⁸

What this variety of argumentation signifies, at the very least, is a lack of concern with the coherence and consistency of the several ideas and concepts involved in the arguments. There is certainly not a single deductive structure underlying *Physica* 6. One might take this to reflect a certain opportunism on Aristotle’s part, perhaps the opportunism of a dialectician who is prepared to argue for his thesis on the basis of whatever premisses his interlocuters are prepared to accept. But I am afraid matters are even worse. For we have evidence that in the case of two different arguments for the same thesis Aristotle himself took the arguments more seriously than just another way of establishing the same conclusion. To the first argument of *Physica* 6.10 for the impossibility of motion by an indivisible Aristotle attaches the following remark:

For in only one way (μοναχῶς) would there have thus been motion [of something partless]: if time had consisted of nows.⁵⁹ For it would always have been the case that in the now it has-moved and has-changed, in such a way that it would never be the case that it is in motion, but always that it has moved (αἰεὶ γὰρ ἐν τῷ νῦν κεινημένον ἂν ἦν καὶ μεταβεβληκός, ὅστε κινεῖσθαι μὲν μηδέποτε, κεινηῖσθαι δ’ αἰεί). But that such a thing is impossible has already been proved before. For neither does time consist of nows, nor [does] a line [consist] of points or a motion of moves (ἐκ κινήματων). For someone who claims [this] does not posit anything else than that motion consists of indivisibles, in the same way that time consists of nows or length of points.⁶⁰

In the preceding argument Aristotle has shown that something changing from AB to BC cannot be in BC, because it would then already have changed to BC and is thus not changing any more. While it cannot be in AB either, he has thus in fact shown that if it is to be in change, it must be partly in AB and partly in BC, so that it is, *per impossibile*, divisible. The escape from that argument imagined by Aristotle here, which he calls the *only* escape, is that something can move from AB to BC without being in motion, but merely by having moved to BC.⁶¹ Thus motion would consist of moves without moving. This account he has considered before, in *Physica* 6.1, where he has shown that if motion consists of moves rather than motions, time consists of nows.⁶² Since by claiming that no continuum can be composed of indivisibles,⁶³ he rejects time’s composition from nows, he

⁵⁷ 236a27-35

⁵⁸ I ignore here the point that the argument of *Physica* 6.5 does involve part which have changed before other parts, whereas such a partition is not possible in the third argument of *Physica* 6.10, since in the case of motion all the parts move and rest together.

⁵⁹ Ross, *Physics* 667, thinks that this statement follows from *Physica* 6.4; 235a13-b5, where Aristotle argues that if one thing involved in change is ever-divisible, everything is, including the object changing. Obviously Aristotle could have argued on that basis that if the moving object is indivisible, the time of motion is indivisible, but no such argument is referred to or assumed here. It simply does not fit Aristotle’s vocabulary in the present passage. Such an argument is more at home with the next passage to be dealt with – see below.

⁶⁰ 240b31-241a6

⁶¹ As pointed out before, note 51, we should not worry about the transition from change to motion, since the former is here clearly modelled on the latter.

⁶² 232a18-19

⁶³ *Physica* 6.1; 231b15-16

has already proved that it is impossible that something moving is never in motion, but always has moved.⁶⁴

To the third argument of *Physica* 6.10 for the same thesis, Aristotle attaches a similar remark. Its contents, however, are very different:

For in only one way could what is partless and indivisible move, if it had been possible for an indivisible to move in the now (ἐν τῷ νῦν κινεῖσθαι δυνατόν τῷ ἀτόμῳ). For that [something] moves in the now belongs to the same account as that something moves over an indivisible (ἀδιαίρετόν τι κινεῖσθαι).⁶⁵

Presumably Aristotle refers with his last sentence to the claim of *Physica* 6.4 that if one thing involved in change is ever-divisible, everything is,⁶⁶ of which the present sentence is a specific case (by contraposition): if the moving object is indivisible, the time of motion is indivisible. If the time of motion is indivisible, however, there would be motion in the now (as an indivisible time is called) – the escape imagined here by Aristotle.

By saying in each of these two passages that there is only one escape from the conclusion that there cannot be motion of something indivisible, Aristotle indicates that there is no other escape possible. But the two escapes are incompatible, as moving in the atomic now and never moving (but rather always having-moved) cannot both be true of something. Therefore Aristotle cannot have taken the two different arguments, to which these escapes are attached, as just two ways of arguing for the same thesis. Rather, he seems to assume that one argument is better, in whatever way, than the other. Thus the variety of argumentation in a subtle, but very real sense contradicts the supposition of the unity of *Physica* 6.

§ 2. Themes

In the previous section we have gone criss-cross through book six of the *Physics*, focusing on the many incongruities to be found there. The order which the overview of the contents of *Physica* 6, chapter by chapter, seemed to show, turned out to be deceptive. Looking at the text more closely, we encountered a veritable jungle of arguments. But perhaps the reader will have noticed that, despite this fact, there are a few recurring themes as well. Sometimes these themes are interwoven, but more often they appear in isolation. What is more, they are involved in many of the incongruities discussed in the previous section.

A first theme which one immediately recognizes is the use of proportional relations, mostly between the time of motion and the distance moved over. We encounter such proportionalities throughout *Physica* 6.2, 6.4 and 6.7, but they are much rarer outside these three chapters.⁶⁷ And if one goes over the list of incongruities drawn up in the previous section, one notices how often arguments based on (the applicability of) proportionalities are involved in the incongruities. One of the arguments against motion in the now is made to feature proportionalities (*Physica* 6.3), whereas the other two

⁶⁴ Cf. Wagner, *Physikvorlesung* 643; *contra* Ross, *Physics* 667, who thinks that the reference is to *Physica* 6.6; 237a17-b22.

⁶⁵ 241a23-26

⁶⁶ 235a36-37

⁶⁷ They appear also in *Physica* 6.1; 232a18-22, 6.3; 234a24-31, 6.5; 236a27-35, 6.6; 236b32-237a3, 6.8; 238b29-30 and 6.10; 241a8-23.

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appeal to the distinction between moving and having moved (*Physica* 6.8), or to the now that divides two periods from each other (*Physica* 6.3). There seems to be a wholesale clash between all the proportional arguments involving the unlimited in *Physica* 6.2 and 6.7, and the simple rejection of motion over an unlimited distance in *Physica* 6.10. Proportionalities appear in two of the three arguments provided in *Physica* 6.10 against motion of an indivisible; moreover, these two arguments are very different. The most conspicuous incongruities involving the proportionalities occur in *Physica* 6.2. At the end of that chapter there is an argument based on the proportionalities for the faster and the slower which is meant to establish that everything continuous, including time and magnitude, is ever-divisible. As Aristotle presents it there, he has been arguing all along for the same thesis, but if one looks at the preceding arguments, one finds arguments for the interdependence between the ever-divisibility of time and of magnitude, as well as arguments for the categorical claims that time and magnitude are ever divisible. However, the proportionalities on which most of these arguments are based, involving the faster and the slower, are declared at the beginning of the chapter to hold because of the ever-divisibility of time and magnitude.

A second theme clearly recognizable in *Physica* 6 appears in the arguments involving the impossibility of indivisibles being continuous, touching or successive. This impossibility is demonstrated in the very first argument of the whole book.⁶⁸ Elsewhere we encounter it in *Physica* 6.3, 6.5, 6.6, 6.9 (in the reply to Zeno's Arrow) and 6.10.⁶⁹ The category of passages sounding this theme can be enlarged with passages which feature limit entities, like points and nows, or mention the impossibility of composition from indivisibles, even though there is no reference to the impossibility of indivisibles ordered in one of these ways. Such passages we find in *Physica* 6.1, 6.3, 6.5, 6.6 and 6.8.⁷⁰ There are two passages of this category which seem internally problematical. As we saw in § 1.1, in *Physica* 6.1, there are questions about the consistency of the argument against the composition from indivisibles: is it by definition that indivisibles cannot touch, or do they touch, but without yielding any continuum? And in the first half of *Physica* 6.3 Aristotle seemed to beg the question in his argument for the indivisibility of the now. But the theme of limits and composition from indivisibles also appears in three further dissonant passages. In the second argument of *Physica* 6.10 for the impossibility of motion by an indivisible, Aristotle appeals to a proportionality, but he surprisingly accepts its merely partial applicability – something which he does not do elsewhere – in order to reduce motion by a point to the absurd composition from points. In *Physica* 6.9 Zeno's paradox that the moving arrow is at rest is solved by pointing out that the conclusion only follows if one assumes that time is composed of nows, whereas in *Physica* 6.1 the composition from indivisibles was reduced to absurdity because it would involve that something moving is not in motion. And in *Physica* 6.3 we saw an argument, mentioned in § 1.3, involving limits for the impossibility of rest and motion in the now which is not only different from, but also goes further than other arguments for the same conclusion.

⁶⁸ 6.1: 231a21-b18

⁶⁹ 6.3: 234a5-11; 6.5: 235b24-25, 236a16-17, b11-12; 6.6: 237a3-11, 17-18, 28-35, b7-9; 6.9: 239b5-9, 30-33; 6.10: 240b31-241a6, 6-14.

⁷⁰ 6.1: 231b18-232a17; 6.3: 233b33-234a20, a34-b5; 6.5: 236a10-13, a27; 6.6: 237a11-17; 6.8: 239a14-b4.

A third theme may not be as obvious, but is also recognizable in several passages and chapters. This is the distinction between moving and having-moved. It plays a part in *Physica* 6.1, throughout 6.5 and 6.6, in 6.8 and 6.10.⁷¹ (Elsewhere Aristotle also uses *perfecta*, but then without thematizing their use by contrasting them with *imperfecta*.⁷²) For the majority of these passages this distinction comes together, whether explicitly or implicitly, with a distinction between the period of moving and the moment, limiting the period of moving, of having-moved. (I shall discuss the exceptions below.)

This last point would lead one to expect no cases of incongruity involving both the third and the second theme. However, in the circularity between *Physica* 6.1 and 6.9 we do have an example: in the latter chapter Aristotle solves Zeno's Arrow by claiming that by rejecting time's composition fromnows, one can escape from Zeno's paradoxical conclusion that what is in motion is not, while in the former chapter the same paradoxical proposition appears in a *reductio ad absurdum*, employing the theme dominating the whole of *Physica* 6.1, that of the composition from indivisibles. Moreover, the third theme is also involved in cases where the same thesis is argued for in several different ways. Thus we have in *Physica* 6.8 an argument for the impossibility of motion in an indivisible time based on the third theme, while a more penetrating argument in *Physica* 6.3 is based on an investigation of the concept of boundary, which one would therefore classify with the second theme. There are further the arguments against the possibility of motion and change by an indivisible. In one passage in *Physica* 6.10 we find the distinction between changing and having-changed, but in another, almost identical argument, from *Physica* 6.4, the pair is missing, while in a third argument, again from *Physica* 6.10, we do encounter the impossibility of composition from indivisibles, but not the distinction between moving and having-moved.

Not only are these three themes involved in many of the incongruities listed in the previous section, there is also relatively little interaction between them. This is most obvious in the case of the theme of proportionalities on the one hand, by contrast with the other two themes. In the three chapters where proportionalities abound, *Physica* 6.2, 6.4 and 6.7, we have no occurrence of either of the other themes. Conversely, the occurrences of proportionalities outside these chapters are few, and in most cases concern passages which are not integrated within their environment: they are simply juxtaposed to other arguments.⁷³ Among the four passages featuring proportionalities together with either of the other two themes, there is one treating the proportionality in a deviant way,⁷⁴ and about the other three there is also something peculiar, as we shall see below.⁷⁵ Matters are less clear regarding the relation between the theme of limit entities and that of the distinction between moving and having-moved, because, as said above, the distinction between moving and having-moved tends to be accompanied by a distinction between the period of motion and the limit to that period. Thus we have in

⁷¹ 6.1: 231b18-232a17; 6.8: 239a4-5; 6.10: 240b20-241a6.

⁷² These *perfecta* occur in arguments involving proportionalities, in expressions like: 'A has changed (*μεταβέβληκεν*) from C to D'. There are cases in 6.2: 232a29, 32, b3, 28-29, 31-32, 233b2, b22, 28; 6.3: 234a26-29; 6.7: 237b30, 238a2-4, b8-9; 6.9: 240a11, 14. For the majority of these cases it is clear that they apply to *periods* rather than instants; that is, they go with phrases like 'in time E'. There are no cases among them which require that they should be completed with phrases like 'at now E'.

⁷³ *Physica* 6.1; 232a18-22; 6.3; 234a24-31; 6.8; 238b29-30; 6.10; 241a15-23.

⁷⁴ *Physica* 6.10; 241a8-14

⁷⁵ *Physica* 6.5; 236a27-35, 6.6; 236b32-237a3, and 6.6; 237a25-28; see § 6.2.2.

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the heartland of the third theme, *Physica* 6.5 and 6.6, many references to limits and to the impossibility of indivisibles being ordered consecutively. But these references are to something already agreed on, not to something developed in the argument. Moreover, if we look at the few passages sounding the third theme outside these two chapters, we see one case of a remark made in passing,⁷⁶ one involved in a circularity with Aristotle's solution to Zeno's Arrow (which is based on the second theme)⁷⁷ and only one which shows perfect harmony with the second theme.⁷⁸ Finally, the longer expositions of the second theme, like those in *Physica* 6.1, 6.3 and 6.8, all are without any trace of the third theme.

So we have the following picture. There are three themes in play in *Physica* 6 which are developed in relative isolation from each other. They are involved in many of the incongruities which give *Physica* 6 its labyrinthine appearance. What is more, the incongruities usually *depend* on there being two, and occasionally even three, themes involved. This picture suggests that the sixth book of Aristotle's *Physics* as we know it is the result of the work of an editor, whether or not Aristotle himself, who tried to integrate three independent sets of arguments into one book (even though one set may have presupposed results from another). The ordering he imposed on the material available we can see in the first overview of the contents of the book (see pp. 102-103). Quite plausibly, this ordering itself may also be responsible for at least some of the incongruities we encountered. The clearest case in this respect concerns the inconsistencies and circularities in *Physica* 6.2. The biggest problem there is that Aristotle starts the chapter by saying that certain proportionalities hold because of the ever-divisibility of every kind of magnitude, and then later applies these proportionalities to argue both for the categorical claim that time and magnitude are ever-divisible and for the hypothetical claims that if time is ever-divisible, magnitude is, and *vice versa*. We could 'solve' this problem by assuming that at least the introduction of *Physica* 6.2 is a later editorial addition. Thus the proportionalities of *Physica* 6.2 are disconnected from the arguments of 6.1 that nothing consists of indivisibles.

However, attractive though this game of finding traces of editing may be, we should not indulge in it. It is not my concern here to give a systematic account of how the text of *Physica* 6 was wrought into a whole from the material available – I shall restrict myself to some remarks in passing. I am interested rather in the ideas and *argumentative* structure of the book. Also on that score, however, the present section has provided us with a clear program: the three themes have to be studied in their *separate* developments. This investigation, moreover, will be geared to the main topic of this dissertation, the issue of continuity and infinite divisibility.

§ 3. Proportionalities

Within the group of arguments sounding the theme of proportionalities we have to make further distinctions, basing them on purpose and argumentative structure. Aristotle uses proportionalities to argue for categorical claims about the ever-divisibility of primarily time

⁷⁶ *Physica* 6.8; 239a4-5

⁷⁷ *Physica* 6.1; 231b18-232a17

⁷⁸ *Physica* 6.10; 240b20-241a6

and magnitude, but also to establish correspondences between time, magnitude and mover with respect to divisibility as well as with respect to being limited or unlimited. And there are two ways in which he employs proportionalities to these effects: he either invokes one proportional relationship, applying to *one* moving object, in most cases between the distance traversed and the time needed to traverse, or he uses two such proportionalities, one for the faster and one for the slower, thus involving two moving objects.⁷⁹ Aristotle himself indicates the difference between these two ways, when after a stretch of arguments using the manifold way he introduces the simpler way as ‘the usually advanced arguments.’⁸⁰ These two distinctions partly coincide, since the more elaborated proportionalities for the faster and the slower only appear in arguments for the ever-divisibility of some kind of magnitude, whereas the simple proportionality is used for the other two purposes. Though the arguments about the correspondences between the media of motion with respect to being limited or unlimited are of great interest to Aristotle’s dealings with proportions, I shall restrict myself to the arguments about unlimited divisibility, as they are the only ones which are important for a study of Aristotle’s ideas about continuity.

§ 3.1. Simple proportionality

A typical simple proportional argument for a divisibility-claim runs as follows:

Further, if something which has made a motion in half the time in which it moves over the whole distance will move over half the distance, and in a smaller time over a distance smaller than half the distance, [it follows] that (πάλιν εἰ τὸ κεκινημένον, ἐν ᾧ χρόνῳ κινεῖται τὴν ὅλην, ἐν τῷ ἡμίσει τὴν ἡμίσειαν κινήσεται καὶ ἐν τῷ ἐλάττονι ἔλαττον ἢ τὴν ἡμίσειαν, ὥστε..) ⁸¹ if, on the

⁷⁹ In two cases Aristotle does appeal to two moving objects which are moving with equal speed: see *Physica* 6.1; 232a20 and 6.6; 236b34-237a1.

⁸⁰ *Physica* 6.2; 233a13

⁸¹ My translation differs from all existing translations in that I take the whole clause from εἰ to ἢ τὴν ἡμίσειαν as the protasis, so that the apodosis starts with ὥστε (emending the stop before ὥστε into a comma). My reason for understanding the sentence thus is that there is a problem with the universally preferred translation:

If what has made a motion in half the time in which it moves over the whole distance, [moves] over half the distance, it will also move in a smaller time over a distance smaller than half the distance.
Hence ..

(cf. Joachim (transl. & comm.), *De lineis insecabilibus* [in: W.D. Ross (ed.), *The Works of Aristotle VI Opuscula* (Oxford, 1913)] ad locum, M. Timpanaro Cardini (ed., transl. & comm.), *Pseudo-Aristotele: De lineis insecabilibus* (Milan, 1970) 61, and W.S. Hett (transl.), *Aristotle: Minor Works* (London and Cambridge, Mass., 1936) 433). According to this translation, the proposition that in half the time the mover moves over half the distance, ends up in the protasis, while the proposition that in an even smaller time it moves over less than half the distance, forms the apodosis. However, in the subsequent argument (see also note 83), where the first proposition is again referred to, introduced by εἴπερ, these propositions both have the same status. Dividing them by the division between protasis and apodosis seems therefore rather unfortunate. (Also Aristotle typically puts them in the same clause, setting the two of them apart from the proposition that in the whole time it moves over the whole; see *Physica* 6.4; 235a20-28; cf. 6.5; 236a31-34.) There are three ways of solving these problems. The first alternative is to translate as I do, thus placing both propositions in the protasis. Its attraction is that it only needs a change in the punctuation, turning a stop before ὥστε into a comma. (An apodosis starting, in a somewhat anacoluthic way, with ὥστε occurs more often in Aristotle, for example in *Physica* 6.2; 233b10 – see Bonitz, *Index Aristotelicus* 873a31-41.) A possible drawback is that within one sentence we have a double reference to the proposition that in half the time the mover moves over half the distance, at the beginning of it and at the very end of it. This drawback is avoided by the second alternative: to emend εἰ into ἔτι. It turns the conditional clause into a categorical statement, so that we do not have to read the sentence from ὥστε onwards as the apodosis; at the same time we keep the two propositions in the same clause. Unfortunately I have not been able to find any parallel of a sentence starting with πάλιν ἔτι in this sense: ‘yet further’. The case closest to the

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one hand, the length is composed of an odd number of atoms, there will again be found⁸² a cut in the middle of atoms, if, that is, in half the time it will traverse half the distance. For both the time and the line will be cut in the same way. * * *⁸³ Hence none of the composing [atomic lines] will be cut into equal and unequal parts, nor will they be cut in the same way as the times, if⁸⁴ there are to be atomic lines.⁸⁵

This passage is not from *Physica* 6, nor from another work by Aristotle. But with this long argument in mind, we will immediately see that Aristotle employs a similar argument in *Physica* 6.4, when he argues that motion is divisible if time is divisible:

For let the time in which it moves be taken, indicated by A, as well as the motion, indicated by B. If then in the whole time it has made the whole motion, in half [the time it has made] a smaller motion, and, that time again being divided, a smaller motion than that, and always so.⁸⁶

Though the two arguments differ in style, the first being a *reductio* and the second a straight forward argument, they are the same in terms of content. Two corresponding magnitudes are set out, the time and the distance (or motion). The one medium is then divided, and it is assumed that the other medium will be divided *in the same way*. Thus it is assumed (i) that there is a proportionality involved in the motion between times and distances:

$$(p) \quad T_1 : T_2 :: x_1 : x_2.$$

use required here would be Eustratius, *In Aristotelis analyticorum posteriorum librum secundum commentarium* 146.9-10, where πάλιν ἔτι corresponds to an earlier προσεχῶς. The third alternative avoids the same drawback while retaining the conditional: by placing both propositions in the apodosis (again ending the sentence with ἢ τὴν ἡμίσειαν). If we were to add κινεῖται, the protasis would then be formed by the words εἰ <κινεῖται> τὸ κεννημένον alone, thus giving the translation: 'if something which has made a motion moves in the time in which it moves over the whole ...' The double occurrence of κινεῖται may be troublesome, however.

⁸² Reading ἀνωρετήσεται, with Joachim, *De lineis ad locum*, Timpanaro Cardini, *De lineis* 92, D. Harlfinger, *Die Textgeschichte der pseudo-aristotelischen Schrift Περὶ ἀτόμων γραμμῶν. Eine kodikologisch-kulturgeschichtlicher Beitrag zur Klärung der Überlieferungsverhältnisse im Corpus Aristotelicum* (Amsterdam, 1971) 122, and M. Federspiel, 'Notes exégétiques et critiques sur le traité pseudo-aristotélicien *Des lignes insécables*', *Revue des Études Grecques* 94 (1981) 502-513, at 509.

⁸³ As Joachim, *De lineis*, followed by Timpanaro Cardini, *De lineis* 92, and Federspiel, 'Notes' 509, observes, it is likely that there is a lacuna here, because we do not have the case that the length is composed of an even number of atoms. Presumably this case would again be reduced to the absurdity of the division of an atom, now by way of a division of the even number of atoms into two unequal parts, on the basis of the proposition that in an even smaller time the moving object moves over a distance smaller than half the distance.

⁸⁴ Reading εἰ with Joachim, *De lineis ad locum*, Timpanaro Cardini, *De lineis ad locum*, and Federspiel, 'Notes' 509.

⁸⁵ *De lineis insécabilibus* 970b1-9

⁸⁶ 235a18-22. That Aristotle argues for the hypothetical claim that if time is divisible, the motion is divisible, is clear for three independent reasons. First, from the context, notably 235a15-17, it appears that with regard to divisibility time is primary, and all the other things involved in change are secondary:

It is necessary that there are the same divisions of motion, moving, the moving object, and that in which there is motion, as of time. (ἀνάγκη τὰς αὐτὰς εἶναι διαιρέσεις τοῦ τε χρόνου καὶ τῆς κινήσεως καὶ τοῦ κινεῖσθαι καὶ τοῦ κινουμένου καὶ ἐν ᾧ ἢ κίνησις.)

(With τε .. καὶ a connection is made between on the one hand χρόνου and on the other hand all the other things involved in change. This connection, being stronger than in the case of just καὶ or even καὶ .. καὶ, should here be understood as one of dependence.) Second, in the next argument Aristotle argues for the converse claim (235a22-23). And third, in the argument itself the times precede the distance while in the next argument, by contrast, the order is reversed (235a23-24).

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The next assumption is (ii) that three of the four proportionals exist, in this case T_1 (the whole time), T_2 (half the time) and x_1 (the whole distance). From this it is inferred that the fourth proportional x_2 (half the distance) exists as well. This inference is an instantiation of a third assumption (iii) that if there are two magnitudes in a certain ratio, and a third magnitude, there is a fourth magnitude such that it is in the same ratio with the third as is the second with the first.

The second assumption, of course, is not an assumption in the sense of a tacit premiss, as it is equivalent to the hypothesis that time is divisible. This is in accordance with Aristotle's use of simple proportionality arguments for divisibility claims, as these are all hypothetical. Thus Aristotle states in *Physica* 6.2:

Further, it also appears from the arguments usually advanced that if time is continuous [that is, ever-divisible], so also is magnitude, since in half the time [something] moves over half, and generally in a smaller time over a smaller [magnitude]. For there will be the same divisions of time and of magnitude.⁸⁷

The fact that Aristotle does not derive a categorical conclusion solely on the basis of (i) and (iii)⁸⁸ can be explained if we ascribe to him the assumption that the existence of a smallest time, a smallest distance, or a smallest motion do not affect the truth of (p), because (p) does not have existential import. The same assumption may also explain why there is no argument based on a simple proportionality to be found for the absence of motion in the indivisible now. For the only thing one could thus derive is that because the time is indivisible, the magnitude or motion is indivisible. This is what Aristotle actually does in a short argument at the end of *Physica* 6.1:

It is necessary that time is divisible in the same way as length and motion, and is composed fromnows which are indivisible. For if every [motion] ($\pi\acute{\alpha}\sigma\alpha$) is divisible, [it is] in a smaller [time that] what is equally fast will traverse a smaller [length], also the time will be divisible. And if the time in which something made [the motion] A ($\phi\acute{\epsilon}\rho\epsilon\tau\alpha$ τὴν A), the [motion] (η τὸ A) will also be divisible.⁸⁹

As we in fact already know, from the passage from *Physica* 6.2 quoted in Chapter One where Aristotle discusses Zeno's Runner Paradox, Aristotle thought initially that appealing to proportionality between time and magnitude moved over would suffice for the solution of that paradox. As he came to realize later, as we shall see in the next chapter, Aristotle does not pay any attention in *Physica* 6 to what I argued to be the crux of the Runner Paradox, namely that the lack of last part, and thus of a limit, renders the

⁸⁷ 233a13-17

⁸⁸ Aristotle is very careful in stating (i) time and again explicitly as a premiss: see *Physica* 6.1; 232a20-21, 6.2; 233a14-16, 6.4; 235a12 (though not in 235a13-22), and 6.10; 241a21.

⁸⁹ 232a18-22. From my translation it appears that I think, like Wagner, *Physikvorlesung* 151, and unlike Ross, *Physics* 404, that Aristotle states in the second and third sentences a biimplication between the divisibility of motion and that of time. I take the feminine $\pi\acute{\alpha}\sigma\alpha$, τὴν and ἡ all to refer to motion. Though sometimes Aristotle uses feminine articles to indicate the path of motion, as distinct from the motion itself (e.g. *Physica* 6.1; 231b23-24), at other times he uses feminine words referring to motion and even the very word κίνησις as internal object with verbs of motion (notably *Physica* 6.4; 235a18-24, partly quoted above, p. 120, and 6.1; 231b23-24, 27-28 and 232a6-7, to be quoted in § 5.2, p.164). Since 'motion' is therefore a possible translation, we should opt for it, because it gives Aristotle a much better argument, since only from the biimplication does the conclusion of the first sentence follow.

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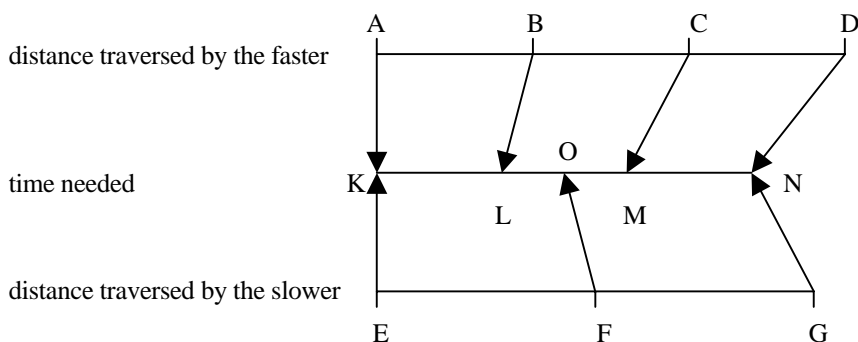
motion unlimited. Appealing to the ‘commonly advanced arguments’ he begins by drawing a distinction between the correspondence between two media with regard to unlimited divisibility and the correspondence with regard to unlimited extension. He is then naive enough to suppose that this is philosophically sufficient to rule out the idea that the unlimitedness of division, yielding an unlimited series of parts, entails the unlimitedness in extent of all the parts together.

§ 3.2. *Double proportionality*

Employing the twofold proportionalities for the faster and the slower Aristotle nevertheless believes that he can argue for the categorical claims that time and magnitude are ever-divisible. In *Physica* 6.2 he gives the following argument:

It is clear then from the arguments presented that neither a line nor a plane nor generally anything continuous will be atomic, not only because of what just has been said, but also because it will follow that the atomic divides. For since in every time there is the faster and the slower, and the faster traverses more in an equal time, and it is possible [for the faster] to traverse double the distance [of the slower], or one and a half [as much] (for that be the ratio of speed (ὁ λόγος τοῦ τάχους)⁹⁰) – let then the faster have moved (ἐνηνέχθη) over one and a half [as much] in the same time, and let the magnitudes have been divided, the one belonging to the faster into three atoms, indicated by AB, BC and CD, and the one belonging to the slower into two atoms, indicated by EF and FG. Then also the time will be divided into three atoms. For it will traverse an equal [magnitude] in an equal time. Let then the time have been divided into KL, LM and MN. But conversely, since the slower has moved over EFG, also the time will be cut into two. Therefore the atom will be divided, and [the slower] will traverse what is partless not in an atomic time, but in more time. It is clear then that none of the continuous things is partless.⁹¹

Represented in a diagram the argument involves two different mappings of the distance traversed on to the same time, one from the distance traversed by the faster and one from the distance traversed by the slower:



⁹⁰ The fact that Aristotle uses this phrase does not mean that he recognizes speed as an independent magnitude. As M. Caveing, ‘La proportionnalité des grandeurs dans la doctrine de la nature d’Aristote’, *Revue d’histoire des sciences* 47 (1994) 163-188, explains, speed is always unpacked in terms of moving over distance x in time T , so that ‘the ratio of speed’ between two moving objects is the ratio between the respective distances x_1 and x_2 moved over in the same time T .

⁹¹ 233b15-32

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The mapping of AB on to KL, *et cetera*, is done by invoking two simple proportionalities, one for the faster and one for the slower. The same simple proportionalities are also needed to establish that LM is both indivisible (because BC is indivisible) and divided at O (because indivisible KO corresponds to indivisible EF).⁹²

Thus using the idea that different motions have something in common, in that they involve the same time, Aristotle can give an argument for the categorical claim that time is ever-divisible. And once he has established the ever-divisibility of time, everything else involved in motion follow suit, as we saw above.

§ 3.2.1. *Underlying assumptions – I*

This is an impressive result. It will therefore be useful to state carefully what the underlying assumptions are. One obvious assumption is that there are differences in speed between moving objects, throughout the whole of time. That is a very natural assumption, since an account of motion which in general does not allow for the existence of the faster and the slower is not worth much. Moreover, to get the present argument going, Aristotle does not need to assume that all speeds are possible: as far as the argument is concerned, there may be just two possible speeds.

An apparently more interesting assumption is one we discover by considering an idea which, if correct, would invalidate the argument: that all the apparent differences in speed at the macro-level are due to different amounts of rest and motion at the micro-level of motion; all stretches of motion at this micro-level are at the same speed, that is, over the same distance taking the same time. Thus an object moving twice as fast as another object would actually move for twice as many atomic periods of time, while the slower object would rest during half of those periods. Aristotle seems never to have taken such an idea into consideration;⁹³ he assumes that every motion is really continuous, in the sense of uninterrupted.

Other assumptions are unearthed when one tries to construct further counterexamples to the present argument, counterexamples which would still allow for the existence of things moving faster and slower. There are three models in which the absurdity of the division of the indivisible is not reached, the first two of which are very similar. In the first model the step from the indivisibility of BC to the indivisibility of LM is disallowed. In order to make a distance like BC indivisible, without the time LM being indivisible, one has to posit a kind of physically atomic motion: during divisible time T the object moves over indivisible distance x , but it cannot stop within a shorter time than T , because x is indivisible. In this model one can allow for differences in speed by varying the time needed to traverse each indivisible distance. A second model targets the step from the divisibility of AD to the divisibility of KN. If a time like KN is to be indivisible, while a distance like AD is divisible, one needs again a kind of physically

⁹² It is worthy of note that the set-up of this argument is rather similar to that of the argument quoted from *De lineis* 970b1-9, both involving a *reductio* to the division of the indivisible. In *Physica* 6.2; 232b20-233a12 Aristotle presents an argument for the same claim without such a *reductio*, but with the recursive procedure. In this respect, that argument is comparable to the argument quoted from *Physica* 6.4 (see p. 120).

⁹³ Though he has the vocabulary to state the difference between a period during which an object moves because it really moves during part of that period, and a period during the whole of which an object moves. In *Physica* 6.6; 236b20-22 he calls the latter period 'the primary time of motion'.

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atomic motion so that the moving object cannot stop within a shorter time than KN, because that time is indivisible.

These first two models target Aristotle's claim that 'there are the same divisions of time and magnitude' by constructing a notion of division and (in)divisibility which is not transferable from magnitude to time or *vice versa*. It should be clear, however, that there is no place for such kinematic atoms unless both time and magnitude consist of indivisibles. For Aristotle divides magnitude and time by making assumption (iii) underlying his employment of simple proportionalities: that given the existence of three proportionals in a proportional relation (p), there exists a fourth proportional as well. But as this division mechanism does not discriminate between ways of being (in)divisible, the kinematic indivisibility posited in these two models inevitably brings with it times and magnitudes which are indivisible in the same way as the motions.

So there is no place for models blocking the transferability of divisions from one medium to the other. Moreover, Aristotle does not accept more than one notion of (in)divisibility anyway. As he indicates in *De Caelo* 3.4, the only way of being (in)divisible he thinks of here is conceptual or mathematical (in)divisibility:

It is necessary that those who posit atomic bodies are in opposition to the mathematical sciences and destroy many of the reputable beliefs and the perceptual phenomena (πολλὰ τῶν ἐνδόξων καὶ τῶν φαινομένων κατὰ τὴν αἴσθησιν), about which there has been a discussion before in the books about time and motion.⁹⁴

With regard to the contradiction with the mathematical sciences, one should think of arguments as offered in *De lineis*,⁹⁵ while 'the books about time and motion' refers to at least *Physica* 6. It is clear that the mathematical arguments are directed against the same indivisibles as those based on 'reputable beliefs and perceptual phenomena'. Therefore time, magnitude, and motion can only be safeguarded against division by conceiving of them as consisting of mathematically indivisible units, as they exist in the domain of arithmetic.

This is exactly what the third model tries to do. Just as the second model it tries to block the step from the divisibility of AD to the divisibility of KN, but now in a more radical way, by positing jumps from one place to another between two consecutive indivisible times. Thus during a first indivisible time, the faster would be at A, during a second at B, *et cetera*, while during the first indivisible time the slower would be at A, and during the second at B', where AB' is smaller than AB; both get from A to B and to B' respectively by a jump. In order to accommodate differences in speed, it is inevitable that the jumps are over intermediate positions. As far as it is meant to provide an example from which the absurdity of the argument of *Physica* 6.2 does not follow, it does not matter in this model whether the distance consists of atoms or not. If there are atomic magnitudes, the only consequence is that the number of possible jumps becomes much smaller, and that there will be a minimal speed.⁹⁶

What is challenged with this model is the assumption of what one might call the consecutiveness of motion: motion implies going through a number of consecutive stretch-

⁹⁴ 303a20-24

⁹⁵ 970a5-20, ending with: '[This idea of indivisibles] is contrary to, so to speak, all the [ideas] in mathematics.'

⁹⁶ Such a model cannot be constructed with the time divisible and the distance indivisible, because then the motion would be interlaced with divisible periods of rest. This objection does not apply to the present model, because one cannot say that something being somewhere during an indivisible time is for it to be resting.

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es, without any jumps over intermediate stretches. The consecutiveness of motion is the spatial analogue of the temporal uninterruptedness of motion.

When we try to find these assumptions stated or argued for in the arguments featuring proportionalities, the result is that Aristotle takes most of these assumptions for granted. He often does not even show any awareness of making them. He does not argue for the existence of differences in speed, though he does state it once as an assumption.⁹⁷ Most often he just presupposes it, as for example in the following argument:

That nothing moves in the now is clear from the following. For if [there is moving in the now] moving faster and slower is also possible. Let then there be the now, indicated by N, and let the faster have moved in [the now] over AB. Then the slower will move in [the now] over something smaller than AB, say over AC. But since the slower has moved in the whole now over AC, the faster will move [over it] in [a time] smaller than that, so that the now will be divided. But it was indivisible. Therefore it is not possible to move in the now.⁹⁸

Not only is there an immediate transition from motion in the now to the applicability of the proportionalities for the faster and the slower, but also the conclusion would not follow if that transition were not taken for granted. With the existence of these two different proportionalities, Aristotle assumes that there is a difference in speed.

The assumption of the existence of the fourth proportional is not discussed in any way in *Physica* 6. The only passage in Aristotle in which he seems to refer to this assumption occurs in his discussion of the unlimited in *Physica* 3:

On the other hand, it is possible for a magnitude of whatever size to have been cut in the same ratio as the largest magnitude (τῷ δὲ μεγίστῳ μεγέθει τὸν αὐτὸν ἔστι τετμηθῆσθαι λόγον ὀπηλικονοῦν μέγεθος ἕτερον).⁹⁹

However one interprets the function of this sentence in its immediate context, it is clear that two magnitudes are being compared here, one, called ‘the largest magnitude’, which apparently has already been divided, and another, whose possibility to be divided in the same ratio as the largest magnitude, is asserted. Thus neglecting the modal element we have here in fact for magnitudes:

- (a) For every x_1 , every part x_2 of x_1 , and every y_1 smaller than x_1 , there is a y_2 so that
- $$x_1 : x_2 :: y_1 : y_2.$$

If one were to leave out the qualification that y_1 be smaller than x_1 , one would have a fully general statement of the assumption of the existence of the fourth proportional.¹⁰⁰

⁹⁷ *Physica* 6.2; 232b21-22; cf. *Physica* 4.14; 222b31-33, where the assumption appears as a ‘phenomenon’.

⁹⁸ 6.3; 234a24-31. As R. Heinaman, ‘Alteration and Aristotle’s Activity – Change Distinction’, *Oxford Studies in Ancient Philosophy* 16 (1998) 227-257, at 251-252, has pointed out, Aristotle could have argued somewhat more economically by setting out that the *slower* has moved in the now over AB, over which the faster would move in a smaller time.

⁹⁹ *Physica* 3.7; 207b31-32. I have not translated ἕτερον, because its only function seems to distinguish the magnitude from the largest magnitude.

¹⁰⁰ B. Vitrac (transl. & comm.), *Euclide d’Alexandrie: Les Éléments II Livres V-VI: Proportions et similitude, Livres VII-IX: Arithmétique* (Paris, 1994) 132, n.21, thinks that it is a bold generalisation to all magnitudes of *Elementa* 6.10: ‘To cut a given uncut straight line similarly as a given cut line.’ But I fail to see how this problem, rather than theorem, can show that there is such a cut to be made, rather than showing how to make it.

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As far as I can see, the point Aristotle wants to make with this statement is that thanks to the unlimited divisibility of magnitude (a) comes out true, and that (a), according to Aristotle, is all that contemporary mathematicians need in their geometrical proofs. If that is correct, we have here, on the one hand, a recognition by Aristotle that the assumption of the existence of the fourth proportional, in the guise of (a), is a crucial assumption in geometry, an assumption worth saving. On the other hand, however, this passage should make us aware of an important restriction on Aristotle's use of the assumption of the existence of the fourth proportional. For in (a) all variables stand for comparable magnitudes, as y_1 is supposed to be smaller than x_1 . From (a) one could therefore easily prove that length or time is divisible without limit if one length or time is divisible at only one place – which is no surprise given my idea that according to Aristotle (a) is true because of the unlimited divisibility of magnitude. As such a notion of comparability between all four terms is lacking, however, from the simple proportional arguments of *Physica* 6, the assumption of the existence of the fourth proportional cannot be put to such unbridled use; instead its use is crucially dependent on (p), expressing the proportionality between times and distances, to provide the link between the ratio of division in the one medium and the ratio of division in the other medium.

The uninterruptedness and consecutiveness of a single motion are also taken for granted by Aristotle. They are in fact enshrined in the very use of proportionalities to represent motion. For even if there were indivisible times and distances, the proportionalities would, according to Aristotle, still be non-vacuously true of every motion taking more than one indivisible unit of time and being over more than one indivisible unit of magnitude. If there were gaps in either the time or the magnitude 'used' in the motion, there would be a time or a magnitude (consisting of more than one unit) for which the proportionality would not hold. In one passage, Aristotle's words make this somewhat more explicit, that is, in the second argument of *Physica* 6.10 against the possibility of motion by an indivisible (quoted at p. 112). After having appealed to a proportionality between times and distances to establish that an indivisible first moves over a distance equal to itself, Aristotle says:

[Hence] a line will consist of points [i.e. indivisibles]. For always moving over a [distance] equal [to itself], a point will measure the whole line.¹⁰¹

Just as measuring requires one not to skip over any stretch when measuring out with one's rod the non-overlapping consecutive parts of the whole, motion should not involve jumping over an intermediate stretch.¹⁰²

§ 3.2.2. *Underlying assumptions – II*

If we go over the results of the previous sub-section, it may appear that there is nothing problematic about the argument for the ever-divisibility of continua involved in motion. Its conclusion was shown to be the result of the interplay between three assumptions: the uninterruptedness and consecutiveness of motion, as enshrined in the proportionality between time and distance; the existence of the fourth proportional; and the existence of

¹⁰¹ 241a12-13

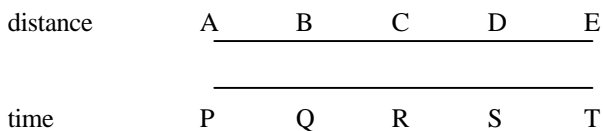
¹⁰² Cf. also the concept of measurement as employed in *Physica* 6.2; 233a31-b14 and 6.7; 237b23-238a31.

Proportionalities

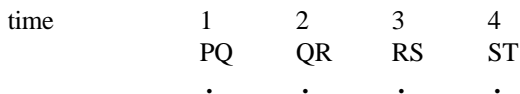
differences of speed, and thus of different proportionalities between time and motion. And since each of these assumptions has a natural appeal, they seem to make for a successful argument.

Things are not as they seem, however. For in order to be successful, the argument needs one further assumption. To see what it is, we need to have a closer look at the use of proportionalities in these arguments.

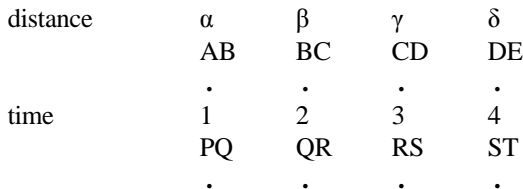
If we want to represent a proportionality between the time of motion and the distance moved over, we typically draw two lines representing time and distance and indicate a regular correspondence between points on the two lines. Nowadays we would almost automatically opt for a Cartesian graph, but two parallel lines with some representation of correspondence, as Aristotle himself uses, would do just as well:



There is nothing wrong with this representation as long as both the distance and the time are ever-divisible: to every division of the one medium a division of the other medium corresponds; when the time is R, the mover is at C, and so on. But now suppose at least one of the two media consists of atoms, and let it be the time. Then there is no time Q, no time R – we only have the indivisible periods (1) PQ, (2) QR, (3) RS and (4) ST. It may seem, therefore, that the time had better be represented as:



But where is the moving object in time PQ? To this question three kinds of response are possible. First we could, assuming that the distance is still ever-divisible, say that it has a certain position, e.g. A. If we follow the same pattern for the other times, we would say that in time QR it is in B, in RS in C, and in ST in D. Thus it turns out that it moves by jumps over intermediate positions. Alternatively, we could, assuming that the distance too consists of four atoms, say that the moving object occupies in those four times consecutively positions (α) AB, (β) BC, (γ) CD, and (δ) DE:



What these two answers have in common is that there is no motion *in* an indivisible time, since the moving object is in one position in each atomic time. This does not mean that it is completely senseless to talk about motion in an atomic time, but only if we understand it as

3. The structure and ideas of *Physica* 6

motion *during* an atomic time. For let us take the second case and suppose that in times 0 and 5 the object is in α and δ respectively: the time of motion would then be the number of jumps made, that is, the difference in number between the set of the units 1-4 and (the set of) the one unit 1. During this period of motion of 3 units, the object likewise makes three jumps and thus moves over three units, that being the difference in number between the set of units α - δ and the one unit α . Nevertheless, even though we can thus speak about motion during an atomic period of time, this way of speaking differs drastically from the way of speaking we adopt in the case that time and distance are ever-divisible, when we would say that in and during PQ the object moves over AB. This already appears from the length of the time of motion: in the case of the indivisible times it is 3 units, whereas in the case of the ever-divisible time, it is 4 units long.

To ensure the two cases, namely that time and distance are ever-divisible and that at least one of them consists of atoms, are comparable, then, we have to give a different answer to the question where the moving object is in time PQ: it should not in a time be in a certain position, but in that time move over a distance, e.g. in indivisible time PQ over stretch AB. In this way we can say, regardless of whether there are atomic times and distances or not, that in each time the object moves over a certain distance.

So if Aristotle's proportional arguments are going to work, he must assume this third picture. That he was aware of making this assumption can, I think, be shown if pay attention to something he often states as one of the premisses of these arguments:

(q) 'Everything moving moves in a time.'¹⁰³

For example, in *Physica* 6.4 he argues:

Since every motion [is] in a time, and every time is divisible, and in a shorter time the motion is shorter, it is necessary that every motion divides according to time.¹⁰⁴

What is the function of this premiss (q)? The quoted argument tells us only something negative, namely that (q) does *not* imply that motion cannot take place in an indivisible time. For if that were the case, Aristotle's second premiss here, that 'every time is divisible', would be redundant.¹⁰⁵ Moreover, Aristotle would then be guilty of a rather obvious circularity, for in *Physica* 6.2 he provides an argument which has for one of its premisses that 'every motion [is] in a time', while it concludes that time is ever-divisible.¹⁰⁶

So we must look elsewhere to determine positively the function of (q). There are several places to look. One would be the discussion of *Physica* 4.12, where Aristotle tries to determine what it means to be in a time. The results of that discussion seem to be:

¹⁰³ $\pi\acute{\alpha}\nu$ τὸ κινούμενον ἐν χρόνῳ κινεῖται. It appears exactly thus in *Physica* 6.7; 237b23 and 6.8; 239a23, but verbally only slightly different statements, all meant as a premiss, we encounter in *Physica* 6.2; 232b20-21, 6.4; 235a11 and 13-14, 6.6; 236b19, 6.8; 238b27-28 (cf. 29-30), 239a20-21, and 6.10; 241a15 and 18.

¹⁰⁴ 235a11-13

¹⁰⁵ The same juxtaposition of premisses we find in *Physica* 6.6; 236b19-27, 6.8; 239a20-22, and 6.10; 241a15-19. Also in the argument of *Physica* 6.8; 239a23-b4 the two propositions are treated as separate premisses.

¹⁰⁶ 232b20-233a12

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- (A) Being in a time consists in having its being measured by a time.¹⁰⁷
(B) Being in a time involves being surrounded by a time which is larger than that which is in a time as well as the time which measures its being.¹⁰⁸

The second point would not fit Aristotle's use of (q) as a premiss in *Physica* 6.7, where he accepts times of motion which are unlimited. The first point, however, makes very good sense in the context of proportionalities, for they are commonly conceived, both in Greek mathematics and by Aristotle himself, in terms of measurement.¹⁰⁹ Following (A), then, (q) should be understood as saying that the being of every motion is spread out in time, that is, has a temporal measure and size.¹¹⁰

A second place to look is *Ethica Nicomachea* 10.4, where Aristotle explains his distinction, also known from *Metaphysica* Θ.6, between motion (κίνησις) and activity (ἐνεργεία). Roughly speaking, this is the distinction between events which involve some kind of process directed towards some goal to be achieved at the end of the process, and events which are more state-like in that there is no internal development or anything like it in the event. Here it suffices to quote one point from the discussion:

It is clear then that [motion and an activity like pleasure] differ from each other, as well as that pleasure is something whole and complete [unlike motion, which is incomplete while occurring]. This would also appear from [the fact] that it is not possible to move not in a time, while [it is possible] to have pleasure [thus], as [in the case of pleasure] what is in the now is something whole.¹¹¹

Since the contrast here is between a period and a sizeless moment, 'being in a time' means again taking a time of some size.

The same conclusion can be drawn from another passage where 'in a time' is contrasted with 'in the now'. It occurs in *Physica* 6.10. Though it has already been quoted in two parts above, for purposes of reference I give it again:

If (q) everything moves in a time, and (a) nothing in the now, and (b) every time is divisible, then (c) for any of the things moving there would be a time smaller than the time in which it moves over something as large as itself (ὅσον αὐτό). For (d) there will be this latter time in which it moves (οὗτος μὲν γὰρ ἔσται χρόνος ἐν ᾧ κινεῖται), because (q) everything moves in a time, while (b) every time has earlier on been demonstrated to be divisible. Therefore, (e) if a point moves, there will be some time smaller than the time in which it moved (ἐκινήθη) over itself. But that is impossible. For (p) it is necessary that it moves over a smaller thing in a smaller time. Hence (f) the indivisible will be divisible into what is smaller, just as a time into a time.

¹⁰⁷ See 221a4-9, 221b5, 14-16 and 30-31.

¹⁰⁸ See 221a26-30 and b30-31.

¹⁰⁹ See also the following remark in *Physica* 4.8:

Of every motion there is a ratio to a motion. For it is in a time, and of every time there is [a ratio] to a time, both being limited. (216a9-11)

¹¹⁰ There may be a problem, though, if we look at the way Aristotle describes this measurement:

[T]he time measures the motion by determining some motion which will measure off the whole, just as the cubit [measures] a length by determining some magnitude which will measure off the whole. (*Physica* 4.12; 221a1-4)

Together with (q) this procedure implies the ever-divisibility of motion, for only motions which are divisible can be measured. But perhaps Aristotle would also accept the case where the result of measurement is that the motion is one unit long; cf. e.g. *Physica* 4.12; 220a28-29, where he seems prepared to say that the number of lines in the case that there is only one line, is one.

¹¹¹ 1174b6-9

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For (g) in only one way could what is partless and indivisible move, if it had been possible for an atomic thing to move in the now (*ἐν τῷ νῦν κινεῖσθαι δυνατόν τῷ ἄτόμῳ*).¹¹² For (h) that [something] moves in the now belongs to the same account as that something moves over an indivisible (*ἀδιαίρετόν τι*¹¹³ κινεῖσθαι).¹¹⁴

Of (q), (a) and (b), the three premisses with which the argument starts, (q) and (a) are clearly equivalent, making the same statement in a contrasting vocabulary. Since this contrast cannot consist in a time being divisible and the now being indivisible (for otherwise (b) could not have the status of an independent premiss), it must be that a time has size, while the now is sizeless.

In the subsequent argument the situation is envisaged that an indivisible of length D moves over a distance of the same length D . The argument starts with a double existential claim (c):

(c_{int}) For everything moving there is a time T_1 in which it moves over a distance equally long as itself, and there is a time T_2 which is smaller than T_1 .

The first part of this claim is defended in (d) by invoking (q), while the second part is based on (b). Next in (e), (c) is applied to our indivisible of length D :

(e_{int}) There is a time T_b such that T_b is smaller than time T_a in which an indivisible moves over D .

Because of the proportionality (p), however, the absurdity (f) follows:

(f_{int}) There is a distance D_b smaller than the indivisible distance D .

Then in (g) Aristotle tells us that this absurdity would not follow if we were to reject (a) and thus (q). His reason (h) is that moving in the now and moving over an indivisible distance belong together. We can understand this claim if we keep in mind that Aristotle does not think we need to reject (b), the divisibility of every time, in order that it be possible that an indivisible object moves. It will do to say that motion does not take a measurable time: it just happens in the now, by a jump. For if that were the case, during a divisible period before the now the indivisible is in one position and in a divisible period after the now in the next. Thus Aristotle is in fact arguing backward in (g) and (h): if the moving object is indivisible, distance D is indivisible; therefore (f) should not follow, so (e) should not follow; but (e) is an instantiation of the general statement (c), which according to (d) follows from (q) and (b). Therefore we should reject one of these – and Aristotle opts for (q) in the guise of (a). Thus we can say, with Aristotle in (h), the situation ‘that something

¹¹² Even though it is materially correct, one should not translate: ‘if it had been possible to move in the atomic now,’ as CWA 407, Ross, *Physics* 418, and Wagner, *Physikvorlesung* 177, all do, for the distinctive feature of the now is here not its indivisibility, but its sizelessness (see below).

¹¹³ With Wagner, *Physikvorlesung* 643, I take *ἀδιαίρετόν τι* to be an accusative of extent, but it could perhaps just as well be the subject with *κινεῖσθαι*. It all depends on whether one thinks it more likely that in (h) Aristotle in fact merely repeats (g), or makes a small step from the atomicity of the moving object to the indivisibility of the track (see below).

¹¹⁴ 241a15-26

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moves in the now belongs to the same account as that something moves over an indivisible.’

These passages, and especially the last, make it sufficiently clear that with premiss (q) Aristotle seeks to rule out motion by jumps, and that he thus assumes that even if the time of motion is indivisible, the moving object still *moves* over a distance during that indivisible time. He adheres consciously to the requirements for his arguments to work set forth above.

§ 3.2.3. *Trouble*

However necessary the assumption (q) that everything moves in a time, may be for Aristotle’s proportional arguments (namely the assumption that every motion, whether divisible or not, is in a time), it also points to problems with these proportional arguments for divisibility claims. An immediate problem is that in arguments for the idea (q) that motion does not occur by jumps, but takes time, Aristotle does not think of the contrast between the now and a time in terms of sizeless versus with size, but in terms of indivisible versus divisible. A first example concerns the argument from *Physica* 6.3 already quoted above at p. 125, where Aristotle tries to establish that it is impossible to move in the now, because if it were, there would be faster and slower motion in the now; and from that the divisibility of the now could be derived. The trouble with this argument is that it does not rely on the sizelessness of the now, but on the indivisibility of the now. So if this argument is used to justify (q), the time in which there is, according to (q), motion, is necessarily ever-divisible. Another example we find again in *Physica* 6.3:

Further we say that something rests which is in the same state, both itself and its parts, now and before. But in the now there is no before, so that there is no resting either. Therefore it is necessary that what moves, moves, and what rests, rests in a time.¹¹⁵

It is unclear whether the conclusion is meant to belong only to this argument or to the whole set of preceding arguments. But even if the latter is the case, we can easily supply an analogous definition of something moving: what is not in the same state now and before.¹¹⁶ Again it is the indivisibility of the now which is crucial to the argument, so that its conclusion (q) can only be understood as referring to a divisible time. Above, however, we saw that (q) must be free from the implication that the time in which something moves is divisible, for otherwise it cannot be used, as Aristotle uses it, as a premiss in an argument for the ever-divisibility of time, magnitude and motion.¹¹⁷ Moreover, Aristotle himself would then on several occasions be misleading in giving the ever-divisibility of time the status of a separate premiss.

One might be inclined to forgive Aristotle such a circularity, were it not the case that it is symptomatic of a far deeper problem with Aristotle’s proportional arguments for divisibility claims. To show which, let me compare the argument from *Physica* 6.10 (quoted on pp. 129-130), where Aristotle contrasts moving in a time with moving in the now, and the last argument from *Physica* 6.3, where Aristotle implies that motion is in a

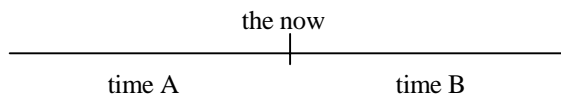
¹¹⁵ 234b5-9

¹¹⁶ Cf. *De Caelo* 1.11; 280b14-16 and especially *Physica* 5.1; 225a1-2. Usually Aristotle expresses this idea in primarily (quasi-)spatial terms, for which see § 5.1.

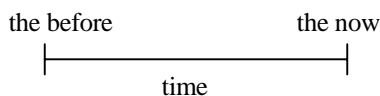
¹¹⁷ *Physica* 6.2; 232b20-26

3. The structure and ideas of *Physica* 6

time, because only within a time one can distinguish the now and the before. The former argument presupposes the following picture:



By assuming (q) that everything moves in a time, Aristotle denies that there can be a motion while in both A and B the moving object is without motion, instead making a jump in the now between A and B. With regard to the latter argument, it is not immediately clear what the picture presupposed is. There may be a time between the now and the before:



or such a time may be lacking:



However, if the second were the picture presupposed, motion would still occur by a jump, this time not in the now between two times, but between the now itself and the before. Thus one could not conclude then that motion is in a time, for lack of a time between the now and the before. Therefore the picture presupposed must be the first, where the now and the before are separated from each other by a time.¹¹⁸

Thus the pictures presupposed by the two arguments contain the same elements: moments and times. The way they are related to motion, however, differs crucially. In *Physica* 6.3, the motion is assumed to involve the now and the before as a kind of parts, as it is argued there that the temporal medium of motion cannot be indivisible, on the grounds that otherwise there would be no room for both the now and the before. Therefore the divisible time of motion contains the now and the before. In *Physica* 6.10, on the other hand, as in the proportional divisibility arguments, the now is left out of account. The times are structureless unit-periods of motion which may or may not be divisible; the now appears solely as what is between two times or as the place where a divisible time is divided.

This comparison reveals the deep-seated problem with the proportional arguments for divisibility claims. In order not to prejudge matters, they have to assume that there are times and motions which may or may not be divisible. As long as it is the case that every time and every motion is divisible, there is nothing wrong. Two ever-divisible times can meet each other and be divided from each other at a common boundary which is in a special way a part of both of them – we shall explain in § 4.1.3 how that is

¹¹⁸ We can see the assumption that there is something between the now and the before being made more or less explicitly in yet another argument for (q), presented in *Physica* 4.14; 222b30-223a15. It would take us too far, however, to analyse this difficult argument.

possible.¹¹⁹ And the motion in that time starts at the before which forms the one boundary of the time and ends at the now which forms the other boundary of the time, taking place in that time as a whole, including its boundaries. However, as soon as the times and motions are indivisible, the representation starts to crack. How could we talk about the places of division and contact of those indivisible times? They cannot be parts of the times, as these are indivisible. But they cannot be entities apart from the indivisible times either, for then there would be just another set of indivisible entities which have to meet and be divided from each other – but where? And how can we think of such an indivisible time as a time *in* which there is motion? This time must contain a now and a before as a kind of part, and be a time of motion ‘between’ them, if there is to be real motion, that is, motion without jumps. The only way of saving the indivisible motion is to return to the notion of a physically indivisible motion, one which cannot stop while taking place. As we saw above, p. 124, however, that is not Aristotle’s conception of (in)divisibility.

Thus it appears that built into the proportional arguments is the very conception of time and motion (as well as of magnitude) as ever-divisible. What is more, it is plausible that Aristotle came to be aware of this. In the next two sections we shall study closely arguments in which he not only distinguishes between magnitudes and their limits, between the time of motion and the now of completion, but also tries to clarify his thoughts concerning their relation. That makes it unlikely that he thought of the proportional divisibility arguments as getting to the heart of the matter. And it may even be the case that he admits as much. For he starts *Physica* 6.2 in the following way:

Since every [kind of] magnitude is divisible into magnitudes – for it has been demonstrated that it is impossible that something continuous consists of atoms, while every [kind of] magnitude is continuous –, it is necessary that the faster moves in an equal time over a larger [distance], in a smaller time over an equal [distance], and in a smaller time over more, as some define the faster. For let the [object] indicated by A be faster than the [object] indicated by B. Now since faster is what changes before, in the time in which A has changed from C to D, say [in time] FG, in that time B will not yet be at D, but fall short [of it], so that in an equal time the faster will traverse more.¹²⁰

It has been commonly supposed that Aristotle states the ever-divisibility of the media of motion in order to secure that there is a smaller time for the faster to move over the same distance and that there is a smaller distance for the slower to move over in the same time.¹²¹ Given the fact, however, that it is a reference back to *Physica* 6.1, where the arguments are primarily concerned with the distinction between line and point, time and now, motion and completion, it is much more likely that, when appealing to the impossibility of composition from indivisibles, he has in mind the conceptual machinery employed in arguing with proportionalities. The motion of the faster is ‘from [point] C to [point] D’, while temporal indicators like ‘before’ and ‘not yet’ refer primarily to moments,¹²² and the verbs are mainly in the perfect tense, signifying completion, or even denote a momentary state, as in ‘will be at D’ and perhaps ‘fall short [of D]’. I do not claim that Aristotle could not have used the vocabulary of proportionalities without being aware of its presuppositions – the two

¹¹⁹ For this conception see for example the argument from *Physica* 6.3; 234a5-24, quoted at p. 107.

¹²⁰ 232a23-31

¹²¹ Miller, ‘Aristotle against the Atomists’ 105-106; cf. White, *Continuous* 258.

¹²² Cf. e.g. *Physica* 4.14; 222b30-223a15.

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arguments from *Physica* 6.2 for categorical divisibility claims, which share much of this vocabulary, show that he could. When referring back, though, to other arguments in which he pays so much attention to these concepts, they can barely have escaped his notice. (For further remarks on this passage, see § 6.3.1.)

§ 4. The order of indivisibles

In the previous section we saw how Aristotle employs proportionalities in order to establish the possibility of dividing any magnitude moved over and any time during which there is motion. It appeared that the ever-divisibility of motion, time and magnitude was built into these arguments. As arguments, then, for the ever-divisibility of the continuum, they are therefore only to a limited extent successful. In *Physica* 6.1, however, Aristotle presents a more general argument for the same conclusion. It is a *reductio* of the assumption that something continuous ultimately consists of indivisible entities. This *reductio* is based on the idea that indivisibles cannot be ordered in such a way that they make up a continuum. Also in other arguments of *Physica* 6 this impossibility is referred to as a premiss. In the present section I want to discuss the underlying assumptions of these arguments and at the same time clear up some interpretational difficulties.

§ 4.1. Five questions about an argument

Aristotle starts book 6 of his *Physics* as follows:

- (1) If *continuous* (συνεχές), *touching* (ἀπτόμενον) and *successive* (ἐφεξῆς) are as they have been defined before¹²³ – continuous are those things whose extremities are one, touching whose [extremities] are together, and successive [those things] between which there is nothing of the same kind –, it is impossible that something continuous (τι συνεχές) consists of indivisibles (ἐξ ἀδιαίρετον εἶναι), for example that a line [consists] of points, if, that is, a line is [something] continuous and a point [something] indivisible. For the extremities of points are neither one (for an indivisible does not have on the one hand an extremity and on the other hand some other part) nor are the extremities together (for something partless does not have any extremity, since an extremity differs from that whose extremity it is).
- (2) Further it is necessary that the points of which the continuous is to consist are either continuous with each other or touching each other; and the same account applies to all indivisibles. They could not be continuous, however, because of the aforesaid reason. On the other hand, everything touches either whole to whole or part to part or part to whole. Since something indivisible is partless, they must touch whole to whole. But what touches whole to whole will not be continuous. For what is continuous has different parts (τὸ μὲν ἄλλο τὸ δ' ἄλλο μέρος), that is, it divides into things which differ in this way, *viz.* are separated in place.
- (3) Moreover, a point will not be successive to a point, or a now to a now, in such a way that length or time consists of them. For successive are those things which have nothing of the same kind in between, but what points have between [them] (στιγμῶν τὸ μεταξύ)¹²⁴ is always a line, and [what] nows [have between [them] is always] a time. They would further divide into indivisibles,

¹²³ The reference is to *Physica* 5.3; 226b23; b34-227a4; a10-12; cf. also 227a17-23. The definitions of *continuous* and *touching* will be discussed in § 4.1.5.

¹²⁴ I do not see any reason to delete, with Ross, *Physics* 639 and ad locum, τὸ. Also elsewhere in *Physica* 6 we encounter the phrase τὸ μεταξύ (τῶν ..): 6.3; 234a10 and 6.6; 237a5-6. Moreover, Ross' remark that there is no sign of τὸ in Simplicius, *In Physica* 928.13-14, is somewhat misleading, for in 929.33 we read, in a clear reference to the present line: τὸ μεταξύ ἦν ἡ γραμμὴ καὶ ὁ χρόνος. Cf. Waschkie, *Von Eudoxos* 354, note 2.

The order of indivisibles

if, that is, each divides into those things of which they consist. But none of the continuous things was divisible into partless things.

(4) Between the points and the nows there cannot be anything of a different kind (ἄλλο δὲ γένος οὐχ οἷον τ' εἶναι μεταξύ τῶν στιγμῶν καὶ τῶν νῦν οὐθέν).¹²⁵ For if there is going to be, it is clear that it will be either indivisible or divisible,¹²⁶ and if divisible, either into indivisibles or into ever-divisibles – but that is [something] continuous.

(5) It is also clear that everything continuous is divisible into ever-divisibles. For if [it is divisible] into indivisibles, an indivisible will touch an indivisible. For of continuous things the extremity is one and touches.¹²⁷

As already pointed out in § 1.1, this is by no means a fully perspicuous passage. I have already raised two questions: (i) How can Aristotle assume in (2) that indivisibles can touch, but only whole to whole, while in (1), and again in (5), he rules it out altogether? (ii) What is the point of (3) and (4), both within the context of the whole argument and with regard to its internal structure? Further consideration forces us to raise another three questions. (iii) It seems as if Aristotle is inconsistent when he denies that a line can be divided into points while requiring that something be divisible in order for it to have an extremity. He even phrases it in (1) and (2) in terms of parts: in (1) he distinguishes between the extremity and ‘some other part’, and according to (2) touching things at the very least touch part to part, so if they touch by their extremities being together, the extremities are parts.¹²⁸ But at the same time he holds that a continuum does not consist of these indivisible parts and cannot be divided into these parts. How is that possible? (iv) Why is it that Aristotle only considers these three relations – being continuous, touching and being successive – as possible ordering relations of indivisibles making up a continuum? Indeed, as appears from (2) and (5), he seems to consider only the first two. Why does he not take into account a non-successive, that is, dense ordering of the indivisibles making up a continuum?¹²⁹ It is not because he is not very familiar with such an ordering, for by denying that points are successive, he affirms that the points on a line are ordered densely. (v) One way of answering the previous question is to argue that Aristotle is not attacking here composition from sizeless indivisibles, but only composition from atoms, that is, indivisibles of some size. So what kind of indivisibles is Aristotle arguing against: sizeless points or atoms with size?

¹²⁵ Ross, *Physics ad locum*, deletes everything after μεταξύ, for reasons I do not know. In the critical apparatus he refers again to Simplicius, but if we read *In Physica* 930.1 we do see a phrase representing at least τῶν στιγμῶν καὶ τῶν νῦν: τῶν ἀδιαίρετων.

¹²⁶ Reading εἰ γὰρ ἔσται, δῆλον ὡς ἥτοι ἀδιαίρετον ἔσται ἢ διαίρετόν, with all manuscripts with only one exception. Again Ross, *Physics* 640 and *ad locum*, wants to emend, reading: ἢ γὰρ ἀδιαίρετον ἔσται ἢ διαίρετόν, following one manuscript. (His reference to Simplicius, *In Physica* 930.1-2, is inconclusive.) But if one were to follow Ross, the concluding remark: ‘but that is something continuous’ seems pointless, while on the manuscripts’ text it provides a fitting end to the argument: see my interpretation below, § 4.1.4. Cf. Waschkies, *Von Eudoxos* 354, note 4.

¹²⁷ 231a21-b18

¹²⁸ Sorabji, *TCC* 368, offers Aristotle an escape clause in the case of real atoms: if two atoms touch, they will only do so with part of their peripheries; and if their peripheries have parts, they must have parts as well – which is impossible. But this way out is constructible only in two or more dimensions, whereas Aristotle’s argument, applicable as it should be to time as well, is strictly confined to one dimension.

¹²⁹ This question is raised by Sorabji, *TCC* 369; cf. also Charlton, ‘Potential Infinities’ 136, and D. Bostock, ‘Aristotle on Continuity in *Physics* VI’, in: Judson, *Aristotle’s Physics* 179-212, at 185-186.

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§ 4.1.1. The fifth question

To start with the last question, the answer should be that, as far as this argument goes, Aristotle does not distinguish between the two kinds of indivisibles, even though from references elsewhere it is clear that he takes the argument to be about real points, indivisibles without size. Thus in *De Generatione et Corruptione* 1.2 Aristotle bases his distinction between two meanings of ‘divisible everywhere’ (already discussed in Chapter Two) on the premiss that ‘a point is not contiguous to a point’ or that they ‘are not successive’.¹³⁰ As he wants there to salvage divisibility everywhere in one sense by distinguishing it from divisibility everywhere in another sense, these points must be real points. Also in *Physica* 6 itself, there are passages in which the present argument is connected with real points. In *Physica* 6.3, for example, it is argued that the now which is the extremity of the past is identical to the now which is the extremity of the future, on the basis of the following argument:

If [these two nows were] different, the one could not be successive to the other, because [something] continuous does not consist of partless things; but if, on the other hand, each of them [were] apart, there will be a time in between. ... However, if what is in between is a time, it will be divisible, since of every time it has been shown that it is divisible; hence the now is divisible.¹³¹

Though the last ‘now’ refers to a period of time, the others must stand for sizeless moments, as they are contrasted with periods of time, which already have been shown not to be atomic.¹³²

The impression that the argument of *Physica* 6.1 is concerned with real points rather than atoms is of course due to the use of the word ‘point’ (στυγμή).¹³³ But if we go through all the passages in which Aristotle uses στυγμή or its temporal equivalent νῦν, it appears that for him the primary property of a στυγμή is not being without size, but being indivisible. It is only because Aristotle is not an atomist that most of the time στυγμή denotes a real point. In some passages, however, sizelessness cannot be part of the meaning of στυγμή.¹³⁴ In *De Caelo* 3.1, for example, he denies that a point has weight, since what has weight must be divisible, but ‘it is agreed that a point is indivisible’.¹³⁵ Similarly on the assumption that every magnitude is divisible, it would follow that a point is sizeless.¹³⁶ In another passage it is implied that if a line is made up of στυγμαί, these must have size:

¹³⁰ 317a2-3; a9

¹³¹ 234a6-11

¹³² Another passage where only sizeless indivisibles can be referred to is *Physica* 6.6; 237a3-11.

¹³³ This also explains why most scholars assume that the argument is only about real points; see Miller, ‘Aristotle against the Atomists’ 101; Furley, *Two Studies* 116; Waschkie, *Von Eudoxos* 266 and especially 299 note 15. Also Bostock, ‘Continuity’, seems to assume most of the time that the argument is about points, but in his discussion of Aristotle’s answer to the Arrow (207) he allows for an interpretation of the now as a ‘very short period’. White, *Continuous* 23-31, does not state that ‘indivisibles’ also cover atoms.

¹³⁴ Indeed, the definition of a point as ‘what is indivisible in every respect and has position’ (e.g. *Metaphysica* Δ.6; 1016b25-26) does not say anything about its lack of size.

¹³⁵ 299b6

¹³⁶ For similar arguments about the now, see *Physica* 6.3; 234a5-24.

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The void has no ratio by which it is exceeded by body, just as nothing does not stand in a ratio to a number. ... Therefore a line does not exceed a point either, *unless it is composed of points*.¹³⁷

If then a line is composed of points, there must be a ratio between the line and the point, so that the size of the point cannot be nothing.¹³⁸

Also Aristotle's contemporaries took the arguments of *Physica* 6.1 to be directed against indivisibles in general, irrespective of their size. That at least is suggested by the evidence from the pseudo-Aristotelian *De lineis insecabilibus*. In the very passage of that work in which an explicit distinction is drawn between indivisible lines and real points we see that, for all practical purposes, the distinction is obliterated. After having argued that 'there could not be an atomic line',¹³⁹ the author continues:

It is clear from these [arguments] too that a line could not consist of points. For really most of the arguments will apply as the same (σχεδὸν γὰρ οἱ πλείστοι τῶν λόγων οἱ αὐτοὶ ἀρμόσουσιν).¹⁴⁰

What is more, the very distinction is called into question:

And in general, in what will a point differ from a line [if there are indivisible lines]? For an atomic line will not have anything particular in comparison to a point, except its name.¹⁴¹

We also encounter a similar likening of *point* and *line* in the argument that 'if there will be merely one point present in a line, the line will be a point.'¹⁴²

With regard to the arguments themselves, the *De lineis insecabilibus* suggests furthermore that we should be wary of taking Aristotle's reference to the indivisibles with σιγμαί in both (1) and (2) as an indication that he wants to talk about real points only. For the author of *De lineis* gives an argument parallel to (1) in terms of indivisible lines,¹⁴³ and in an argument almost identical to that of (2) he focusses on the partlessness of a point and even thinks he needs to argue that two coinciding partless things do not have 'an extension' beyond the extent to which they coincide.¹⁴⁴

Finally the way in which the terms *line* and *point* are introduced in the argument of *Physica* 6.1 indicates that Aristotle is not so much concerned with lines and points as with indivisibles and continua:

¹³⁷ *Physica* 4.8; 215b12-19

¹³⁸ In *De lineis insecabilibus* 971a11-14 the fact that there is no ratio between excess and what is exceeded (between point and line) is used as a reason to discount composition from points.

¹³⁹ 971a5-6

¹⁴⁰ 971a6-8

¹⁴¹ 970b29-31

¹⁴² 970b15-16

¹⁴³ 970b23-29

¹⁴⁴ 971b1-2:

For if they are together and do not have any extension [beyond], just so far they have both the same place (τῶν γὰρ ἅμα ὄντων καὶ μὴ ἐχόντων ἐπέκτασιν, κατὰ ταῦτα ὁ αὐτὸς ἀμφοῖν τόπος).

In the next line these partless things are described as having no διάστασιν, but (*contra* Washkies, *Von Eudoxos* 297, note 7) something has dimension not primarily because it has size, but because limits and what is between them can be distinguished within it (cf. e.g. *De Caelo* 1.1; 268a24-25 and b6-7, where a dimension is defined as being divisible in one respect; cf. also *Physica* 3.3; 202b17) – which is not the case with partless things with size either.

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It is impossible that something continuous consists of indivisibles, for example that a line consists of points, *if, that is, a line is something continuous and a point something indivisible.*

Aristotle wants to avoid all the fuss about lines or points being indivisible, and more or less defines a point as that which is indivisible and a line as that which is continuous.¹⁴⁵

§ 4.1.2. *The fourth question*

It is now evident that the argument of *Physica* 6.1 is about neither points nor atoms, but about indivisibles in general. This has consequences for the answer we should give to the fourth of the five questions asked above: why does Aristotle not take into consideration the possibility of composition from densely ordered indivisibles? If the argument had only targeted composition from atoms, we should not have had to answer this question on behalf of Aristotle, since atoms can only be ordered successively. But now that it appears that Aristotle does not distinguish between kinds of indivisibles, the question becomes more pressing, for it seems to force one to draw at least some distinction between real points and atoms: points, unlike atoms, can be ordered densely.

As has already been said, Aristotle himself accepts that points are ordered densely. In fact he does so in the passage under consideration, when he states in (3) that what is between points is always a line, and then argues that this line cannot consist of indivisibles ordered successively. So Aristotle's defence should be to insist that indivisibles which are ordered densely are not in the right order to *make up* a whole.

Now if a line is made up of (densely ordered) points, it should be possible, according to Aristotle, to divide it into a point, as that which is exceeded, and the remainder of the line, as excess (and *vice versa*). This he states in the passage quoted above from *Physica* 4.8.¹⁴⁶ But having discussed so thoroughly the situation where a line is divided into a limit and its remainder without the limit, when we were dealing with Zeno's first paradox of plurality, we do not have any difficulty in explaining why Aristotle would then reject a dense ordering as a composing relation: the remaining part of the line, being limited, must have a limit, but this limit cannot be the point from which it has been divided, because the remainder of the line is a completely separate entity and should have a limit independently of other entities.

One may wonder whether it is possible to provide evidence that Aristotle shares the underlying conception of composing parts as independent parts, or at least evidence that goes beyond an inference to the best explanation as to why he does not accept a dense ordering as a composing ordering. Worse still, it has even often been supposed that elsewhere Aristotle recognizes the possibility of a limited magnitude without a final point, that is, without a limit of its own. This is when he argues in *Physica* 8.8 that 'the point of time dividing the earlier and later always [belongs to] the later',¹⁴⁷ from which it would seem to follow that the earlier part is without a last point. I shall consider the passage concerned later, in § 5.3.2, but let me point out here that on closer analysis the issue will appear to be much more complicated. We can certainly not take it as sufficient

¹⁴⁵ Cf. also *Physica* 6.3; 234a22-23: 'There is something indivisible in time, which we call the now.'

¹⁴⁶ 215b12-19; see p. 137.

¹⁴⁷ 263b9-10

indication that Aristotle would accept that a line be composed from a point and the remainder of the line without a last point.

To return to the question, then, I do think that there is independent evidence that for Aristotle composing parts are separate parts. A first piece of evidence is constituted by his response to Zeno's Arrow. According to Aristotle, this paradox fails if we refuse to grant Zeno the premiss that a period of time is made up of *nows*, while Zeno's conclusion would follow if we did.¹⁴⁸ As we saw in our analysis of the Arrow, the paradox depends on the idea that each *now* is ontologically prior to the whole period, so that what is true with respect to the whole made up of these *nows* must be true with respect to at least one separate *now*. If then Aristotle wants to block the Arrow by denying that a period of time is composed of *nows*, it seems plausible that he means to reject precisely this independent status of the *now*. Thus he assumes that if a whole is divisible into composing parts, these composing parts must be independent parts.

This is supported by the comparison Aristotle makes between the composition of motion from jumps (so that the thing in motion never moves, but always has moved) and the composition of a line from indivisibles.¹⁴⁹ So in order that something moves, the indivisible parts of which the motion is to be composed should be more than jumps, but should themselves consist in moving: the indivisible parts can only be composing parts if they contribute to the whole.¹⁵⁰ Elsewhere Aristotle himself makes the same point in terms of measurement:

The *now* is not a part [of time]. For a part measures and the whole must be composed from the parts.¹⁵¹

§ 4.1.3. *The third question*

With this justification for Aristotle's assumption that only successive orderings can be composing orderings, we have come to the third question asked above. Why does Aristotle call the extremities with which entities touch and are continuous, *parts*?¹⁵² For as they are indivisible, they should not be among the parts of which a continuum is composed. As we have seen, elsewhere this was reason to deny the status of parts to limit entities. On one occasion, moreover, Aristotle is prepared to call points parts, be it with hesitation and in clear distinction from parts with magnitude.¹⁵³

Obviously it should be Aristotle's reply that we must distinguish between independent, composing parts and dependent, non-composing parts. But that is not enough, for the real issue is what kind of *part* a dependent, non-composing part is: how is it related to the whole? It is one thing to say that if something is indivisible and inaccessible to analysis, we cannot assign to it a limit which does not coincide with the whole

¹⁴⁸ *Physica* 6.9; 239b8-9 and especially b31-33.

¹⁴⁹ *Physica* 6.10; 240b31-241a6

¹⁵⁰ *Physica* 6.1; 232a6-17

¹⁵¹ *Physica* 4.10; 218a6-8; cf. 4.11; 220a19-20.

¹⁵² Cf. Sorabji, *TCC* 368, as well as Furley, *Two Studies* 116, who thinks that Epicurus made a mistake in following Aristotle in taking an extremity to be a part.

¹⁵³ *De Anima* 1.3; 407a10-12

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indivisible,¹⁵⁴ but quite another to explain how something which is ever-divisible, that is, divisible into parts which are further divisible, can still have a part which is indivisible. Yet there is in (1) and (2) the suggestion that it is somehow *because* something is divisible that it has a limit with which it can touch or be continuous with its neighbour.

Within the framework of *Physica 6* this issue cannot be resolved – I shall return to it in the next chapter. But implicit in the argument of *Physica 6.1* there is already an idea (which we shall see being worked out elsewhere, in a conceptually richer vocabulary), which does go some way towards explaining how limit entities can be parts. For what this argument in fact does, is to reduce to absurdity the assumption that something continuous *has been* divided everywhere where it can be divided, into independent and thus consecutively ordered parts. Because this situation is inconsistent, it is shown that there are no ultimate independent parts. But if every part into which something can be divided were to have already separate existence, and thus any whole were nothing more than an aggregate of these parts, then there should be ultimate parts, if the whole is to be something at all. Therefore all these parts do not yet exist; they come into being by the whole being divided into them. Now just because there is no such ultimate, pre-existing, part, there is conceptual space for a part which is itself indivisible, but into which the whole cannot be divided. For every division results in further divisible parts, so that there is an unlimited series of them. The indivisible is, as it were, placed beyond the realm of the divisible. On the other hand, it is still related to it, as the series of divisible parts points to it: metaphorically we can understand the whole series of divisions as a search, in vain, for the indivisible.

Moreover, it is very important that there be such a conceptual place for indivisibles, as belonging to a whole without being a (possibly) separate part. For also in *Physica 6* Aristotle employs indivisibles, *in casu* extremities, as something which can belong to *two* parts. He says for example:

... the extreme now [of a time] (τὸ ἔσχατον αὐτοῦ νῦν) – for that is what marks off (τὸ ὀρίζον), while what is between the nows is a time. ... The division (ἡ διαίρεσις) is the extremity of the half.¹⁵⁵

Thus the indivisible is the place where two parts can come into contact and the boundary which separates *both* of them. A normal composing part cannot play this role,¹⁵⁶ but on the other hand an extremity, also conceived as a boundary shared with something else, does belong to a part.

¹⁵⁴ Sorabji, *TCC* 368, calls this a mistake, because it would commit Aristotle to limits being parts. I do not see why it would. (Of course, I too think that Aristotle is committed to limits being parts, but that is because of what Aristotle himself says, not because this argument would commit him to it.)

¹⁵⁵ *Physica 6.6*; 237a4-7

¹⁵⁶ As it is said in *De lineis*:

If points are successive, a line will not be cut *at* either (κατ' οὐδετέρων) of the points, but in the middle (ἀνὰ μέσον) (972a3-5) which is taken to be absurd.

§ 4.1.4. The second question

The most important step in answering the second question asked above, which concerned the point and structure of (3) and (4), is to find out what it is that Aristotle is arguing against. Sometimes he is taken to deny the thesis that real points are ordered successively,¹⁵⁷ but that does not seem very likely, for two reasons. First it has been shown that ‘point’ and ‘now’, in the context of the present argument, refer to indivisibles in general, and not merely to real points. Second, it does not do justice to Aristotle’s qualification ‘in such a way that length and time consist of them.’ Aristotle does not deny that points are successive, but merely that if they are, they do not build a continuum. But what would the situation be like in which indivisibles are successive in such a way as to make up a continuum?

The most plausible answer seems to be that Aristotle wants to argue against the idea that successively ordered indivisibles can make up a continuum without touching, but by just standing next to each other. One is reminded of the position Democritus was arguing against according to *De Generatione et Corruptione* 1.2,¹⁵⁸ in reply to which he insisted that such points touch and are together. Also Aristotle himself sometimes assumes this picture, for the sake of the argument, for example in the second half of *Physica* 6.1 (to be dealt with below) and in one of the arguments against motion by an indivisible in *Physica* 6.10.¹⁵⁹ Moreover, in *De lineis insecabilibus*, the alternative of being successive without touching is explicitly mentioned as a possibility to be dealt with, in an argument which is almost identical to the one in (3).¹⁶⁰ Thus Aristotle’s target does not seem to be immediately absurd and was taken seriously by others as well.

Against this position, in fact, Aristotle points out that if the indivisibles are not touching or continuous, the only way of being successive is to have something between them. Thus the relation between (1) and (2), on the one hand, and (3) and (4), on the other, is disjunctive: either indivisibles have nothing in between and are at least touching, or they are still successive, but do have something between them.¹⁶¹ In (3), Aristotle states that there is always a line or a time between indivisibles, so that it is immediately clear that a continuous line or time cannot merely consist of the successive indivisibles considered initially,¹⁶² and that the question of composition can be repeated for those intermediate continua.¹⁶³ It seems to be the thought behind the remainder of (3)

¹⁵⁷ Sorabji, *TCC* 367-368; Bostock, ‘Continuity’ 182; Ross, *Physics* 639; cf. also Waschkie, *Von Eudoxos* 355, and D.J. Furley, ‘The Greek Commentators’ Treatment of Aristotle’s Theory of the Continuous’, in: Kretzmann, *Infinity and Continuity* 17-36, at 28-29.

¹⁵⁸ 316a29-34; see chapter Two § 2.2.2, p. 82.

¹⁵⁹ 241a6-14, quoted at p. 112. Cf. also *Physica* 8.8; 263b28-264a4, where Aristotle even distinguishes, at least nominally, between atoms ordered contiguously (that is, touching each other) and atoms ordered successively. 971b26-972a1

¹⁶⁰ Cf. Miller, ‘Aristotle against the Atomists’ 99. Also Sextus Empiricus, *Adversus Mathematicos* 9.486 understands the argument in this way. Simplicius, *In Physica* 928.4-7, on the other hand, calls the argument of (3) and (4) ἐκ τοῦ μᾶλλον: if the indivisibles are not successive, they cannot touch and be continuous either.

¹⁶² Thus the point of the argument is not that because there is a line between any two points, points cannot be successive (even though that in itself is true), as Ross, *Physics* 639, and Bostock, ‘Continuity’ 182, think. Rather the problem Aristotle has with composition from points which are successive, but are not touching points, is that we get into a regress. For a parallel, see the next note.

¹⁶³ A similar strategy can be detected in a passage from *DGC* 1.2:

Again, even if something like sawdust comes into being with the division of the body, and thus some body disappears out of the magnitude, the same argument [applies]: for how is *that* divisible? (316a34-b2)

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that, in order to avoid endless repetition, this question can only be answered by letting these continua be composed from indivisibles which are successive in the touching or continuous way – which already has been shown to be impossible.

While Aristotle in (3) just assumes that there is a line or time between successive indivisibles, he has not said anything yet about the possibility that there is something completely different between the indivisibles. With this underlying issue Aristotle deals in (4), by arguing that this intermediate is not different in the relevant respect: it is either indivisible, in which case the indivisibles must at least touch, or it is further divisible and thus a continuum,¹⁶⁴ so that we can repeat the question.

§ 4.1.5. *The first and final question*

The final question to be addressed here concerns the relation between (1) and (2): how can Aristotle allow for touching indivisibles in (2) when he rejects this possibility in (1)? The issue has bothered many, for it seems as if Aristotle has two different conceptions of touching, one according to which things touch with their boundaries, and another according to which things touch by some kind of overlapping.¹⁶⁵ That, however, is a deceptive description of the difference between (1) and (2). For since in both (1) and (2) Aristotle implies that extremities are parts of a whole, there is no discrepancy between two entities touching with their extremities being together and between two entities touching extremity to extremity, that is, with their extremities coinciding (so that there is a kind of overlapping). The real difference between (1) and (2) lies elsewhere: in (1) it is assumed that an indivisible cannot as whole be an ‘extremity’ with which to touch, whereas in (2) that possibility is allowed for (though of course it is of no avail in the composition from indivisibles). And that difference could be explained by assuming that Aristotle in (1) only considers a way of touching which will indeed yield more than mere coincidence, concluding that there is none, whereas in (2) he wants to show that even if there is a way of touching, it will be one which gives nothing more than coincidence, so that the result will not be something continuous.

Though it may thus be possible to smooth out Aristotle’s argument, there remain a number of anomalies. For one, it is only in the part of (2) concerned with touching that Aristotle allows an indivisible ‘as a whole’ to be an extremity; in the part of (2) concerned with being continuous he refers back to (1). Moreover, if we go to (5), we can see that being continuous and touching are not clearly distinguished at all. First, Aristotle only alludes to the impossibility of indivisibles touching in order to conclude that something continuous is ever-divisible. Subsequently he does seem to distinguish between touching and being continuous, but in a rather garbled way: the extremities themselves are touching, not, as in (1), the entities whose extremities are together. The

¹⁶⁴ One should not, as Waschkie, *Von Eudoxos* 358-359, does, take this phrase: ‘But that is [something] continuous’ (231b15) in a very specific sense, referring only to the last alternative, that what is in between is ever-divisible. First of all, the phrase then does not contribute anything to the argument, and second, we would have to assume that Aristotle is ahead of his own argument, because he has not established yet that a continuum is ever-divisible.

¹⁶⁵ See White, *Continuous* 29, and Waschkie, *Von Eudoxos* 230 and 241; cf. Joachim, *On Coming-to-be and Passing-away* 82. Waschkie sets up an extensive argument that while the argument of (1) is Aristotle’s own idea, the approach of (2) goes back to Greek mathematicians working in the Academy. It may be true, though I disagree on many points of detail, as also appears from notes in the present chapter as well as chapter two. I shall not go into this intricate matter.

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extremities being one and the extremities touching are not distinguished as two disjunct possibilities, but rather as one conjunctive possibility; and the entities whose extremities are one and touching are called continuous, without mention of touching entities.

If we take into account other contexts in *Physica* 6 where the argument is based on the order of indivisibles, we see again that the distinction between touching and being continuous is ignored. The clearest case¹⁶⁶ is the argument in *Physica* 6.3 that the now which is the extremity of the past is identical to the now which is the extremity of the future:

It is necessary that the now which is the extremity of both times is the same. For if they are different, the one extremity would not be successive to the other because something continuous does not consist of partless things; and if the two are apart, there will be a time in between.¹⁶⁷

This argument would not work if it were possible that the two extremities are distinct but together, that is, if past and future were to touch each other without being continuous.¹⁶⁸

In *De lineis insecabilibus* we encounter the same obliviousness of the distinction between touching and being continuous. It is stated there that:

What touches whole to whole is one, because if [the whole] is <just> some [part, i.e. of the complex consisting of whole touching whole] or is not the other [whole], it would not touch whole to whole (εἰ γὰρ τι ἐστὶν ἢ θάτερον μὴ ἐστὶν, οὐκ ἂν ὅλον ὅλον ἄπτοίτο).¹⁶⁹

Though in the next few lines things touching without being one, but merely being together, are considered, the difference with the quoted passage is not thematized as one between things being continuous and things touching. There is one place¹⁷⁰ in *De lineis* where the word ‘continuous’ is used to describe a (rejected) relation between indivisibles:

If the now is the beginning and the limit of a [period of] time and the point [the beginning and the limit] of a line, and the beginning and the limit are not continuous, but have something in between, the nows or the points cannot be continuous to each other.¹⁷¹

Here ‘continuous’ is just a synonym for ‘touching’.¹⁷²

¹⁶⁶ Other arguments are *Physica* 6.3; 234a34-b5; 6.6; 237a21-25.

¹⁶⁷ 234a5-8; for the larger context, see p. 107.

¹⁶⁸ The vocabulary here differs from that of *Physica* 6.1, since ‘successive’ here is used as synonymous with ‘touching’. It may seem, then, that Aristotle is guilty of arguing in a circle, as the impossibility of composition from partless things according to *Physica* 6.1 is based on the impossibility of touch, whether without qualification or in such a way as to compose a continuum, while here he justifies the impossibility of successively ordered indivisibles. Perhaps, though, the reference to the impossibility of composition from indivisibles is not meant to give a real reason, but merely a reminder of an argument involving the same impossibility.

¹⁶⁹ 971a28-30. Thus translated, the text of most manuscripts (and the two exceptions read τῆς instead of τῆ) can be saved from emendation. Joachim, *De lineis ad locum*, followed by Timpanaro Cardini, *De lineis ad locum*, proposes to change ἢ into ἢ, so that one could translate: ‘if either of them is anything in any respect in which the other is not ..’. O. Apelt (ed.), *Aristotelis quae feruntur .. de lineis insecabilibus* (Leipzig, 1888) ad locum, emends τῆ into δὲς or δὲ, so that one could translate: ‘if they are two or [the one] is not the other ..’. Hett, finally, in his *Minor Works* 438-439, does not emend, but follows Joachim’s line in the translation.

¹⁷⁰ I do not count 970b28, where it is said that ‘of lines holding together (τῶν συνεχουσῶν γραμμῶν) there is the same limit’, as the present participle of the verb συνέχειν is used.

¹⁷¹ 971a18-21

¹⁷² Cf. also 972a27-28, where it is said that ‘there is nothing in the middle of touching things.’

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So it really does seem that the distinction between being continuous and touching is ignored most of the time, both by Aristotle and by the author of *De lineis*,¹⁷³ even to the extent that introducing the distinction would invalidate other arguments in *Physica* 6. Worse still, it can be shown that the distinction is out of place in the kind of argument in which Aristotle is involved in *Physica* 6. For if we consider the way the distinction is introduced in *Physica* 5.3 and the use it is put to in Aristotle's account of place, it becomes clear that the distinction belongs to the realm of physics, while the arguments of *Physica* 6 are primarily geometrical. In the passage introducing the distinction, its physical nature appears foremost from the explanation Aristotle gives of what it is to be continuous. After having defined touching and being successive in the already familiar fashion, Aristotle continues as follows:

Contiguous (ἐχόμενον) is that which, being successive, touches.

Continuous is a kind of *contiguous* – I use 'being continuous' (συνεχές) when the limit of both [entities] with which they touch becomes one and the same and, as the word indicates, is held together (συνέχεται). But that cannot be the case while there are two extremities. This having been defined, it is clear that the continuous holds among those things from which naturally comes to be one thing in accordance with intercontact (κατὰ σύνανθιν). And just as sometimes what holds together becomes one, so also the whole will be one, as by a nail, glue, touch (ἄφῃ) or growing together (προσφύσει).¹⁷⁴

The contrast drawn here is that between an aggregate of several units, which touch but remain separate, and a whole which itself is a unity and whose parts are no longer separate entities. It is also striking that Aristotle describes the situation of being continuous as a more intense kind of touching: first there are two separate entities, touching, and then their extremities as well as they themselves become one. In this way the identity of the continuous parts seems unproblematic, as they were separate before.¹⁷⁵ But what when they have disappeared into the whole? How to individuate them then? The only way is to mark them off by mentioning their boundaries, and thus to divide the whole geometrically. The continuity between the parts consists then in the fact that to the conceptual division no physical division into two separate entities corresponds. A similar picture is drawn in Aristotle's account of place as presented in *Physica* 4.1-5. According to that account a body's place is the extremity of the surrounding body, which coincides (is together) with

¹⁷³ This provides all the more reason to reject those interpretations which lay emphasis on the term 'continuous' in Aristotle's claim that 'it is impossible that something continuous consists of indivisibles', and take it to imply that only parts continuous to other parts can form a continuum (White, *Continuous* 29; Bostock, 'Continuity' 181, 183, 204, 205). As we saw in Chapter Two, note 73, Aristotle uses the monadic term 'continuous' both of a whole consisting of touching parts and of a whole consisting of continuous parts. 'Continuous' means then something like 'having no gaps in it.'

¹⁷⁴ *Physica* 5.3; 227a6; 10-17

¹⁷⁵ Here we also have the solution to an apparent inconsistency in Aristotle's account of touching and being continuous. In *Physica* 5.3 Aristotle insists that *continuous* is a kind of touching, or as he puts it in 227a23:

If there is continuity, there must be touching, while if there is touching, there is not yet continuity. For it is not necessary that their edges are one, if they were together; but if they are one, they must also be together.

But how could edges be together, if there is only one edge? Moreover, in (2) in *Physica* 6.1 Aristotle states that things making up a continuum *either* are continuous *or* touch. These problems disappear if one starts from a conception of two separate extremities, which even if together are distinct, the one being the left boundary of the one entity, the other the right boundary of the other entity. In that case one could maintain that when the entities are continuous, there are *nominally* still two boundaries, even though in fact there is only one.

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the extremity of the surrounded body. Thus only separate bodies can have a place, as only separate bodies can have extremities which coincide with the extremity of a surrounding body:

If what surrounds is not divided (διηρημένον) but continuous [i.e. with what is surrounded], it is not said to be in [what surrounds] as in a place, but as a part in a whole. On the other hand, if [what surrounds] is divided [from what is surrounded] and touching [it], it is in the primary extremity of what surrounds. [This extremity] is neither a part of that which is in it nor larger than the distance, but equal [to it]. For the extremities of touching things are in the same.¹⁷⁶

And somewhat later, referring to this passage, Aristotle says:

As has been said, some things are potentially in a place, while others are actually [so]. That is why the parts are potentially in a place if what is homogeneous (τὸ ὁμοιομερές) is continuous, while [they are] actually [so] if they are separated but touch, like a heap.¹⁷⁷

So the picture which emerges is that there is a point everywhere. On the other hand, if there is a discontinuity between the two parts marked off from each other by that point, for example if the parts are not homogeneous with each other, there are two extremities together, rather than one. The extremities which are together owe their separate identity to the entities to which they belong, and have therefore just as much their home in the realm of physics as these physically divided entities. By purely geometrical means, however, they cannot be distinguished, for pure geometry abstracts from such features which could bring about discontinuities between entities. This geometrical identity is even provided with its own technical term by Aristotle: the extremities are 'in the same'.¹⁷⁸

This gives us our first reason to question the applicability of the distinction between touching and being continuous in the context of *Physica* 6.1. For that argument is not concerned with physical divisibility, but with geometrical or conceptual divisibility. The indivisibles which are shown to be unable to make up a continuum are not merely physically indivisible, but, as appears from their lack of limits, are impervious to any

¹⁷⁶ *Physica* 4.4; 211a29-34

¹⁷⁷ *Physica* 4.5; 212b3-6

¹⁷⁸ They are even 'in the same primary place', as Aristotle defines 'together' (ἄμα) in *Physica* 5.3; 226b21-22. Already in Antiquity there is discussion, continued by White, *Continuous* 24-26, and Furley, 'Greek Commentators', about the use of 'place' in this context, since it is clear from the quoted passages from *Physica* 4 that limit entities are not in place, not even potentially, as is affirmed in *Physica* 4.5; 212b14-26; 28. Now Aristotle elsewhere, as well as the author of *De lineis*, use 'place' in such contexts without any qualms. For example, in (2) of *Physica* 6.1 Aristotle states that only what divides into different parts, 'that is, is separated in place' (τόπω κειχωρισμένα) is continuous, from which it follows in the context that entities touching whole to whole, among them real points, have the same place. In *De lineis* it is even more explicit: points which are together, occupy the same place (971a32-b2; b8-10). Therefore we should not follow Simplicius (*In Physica* 871.3-15) and attempt to reconcile the two uses of 'place'. But it might go too far to characterize the difference between them as the 'analytical concept of place' and the 'pre-analytical concept', as White (26) does (cf. also Algra, *Concepts* 121-189, who distinguishes between a "refined" physical concept of *topos* and 'a common sense conception of *topos*' (187)). I should prefer the pair 'physical' and 'geometrical' here: the physical concept of place has to be described with the help of a geometrical concept, but not *vice versa* (I am not convinced by the criticism of my nomenclature by Algra, *Concepts* 187). In this respect the suggestion by Alexander of Aphrodisias (*apud* Simplicium, *In Physica* 870.24-26; he is followed by Philoponus, *In Physica* 791.25-26) that ἄμα (and thus being in the same primary place, though Alexander would not agree with that) should be understood in terms of the mathematical concept of ἐφαρμόζειν (to fit), seems correct, as is borne out by the use of ἐφαρμόζειν in *De lineis* 971a24.

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kind of division. Any extra information, to the effect that the composing relation between two indivisibles could also be one between touching, but yet physically divided entities, rather than one between merely geometrically distinguishable entities, would be pointless in such an argument.

However, though this is correct as far as it goes, it does not explain what exactly is wrong with the application of the distinction between touching and being continuous. It is this: the distinction does not make any sense if a continuum is to consist of indivisibles, presupposing as it does the ever-divisibility of the continuum. For if a continuum is made up of points, two touching entities consist themselves of points. But if they are composed from points, their extremities constitute, as was explained above, separate parts of them and thus should be able to stand alone. But two such independent extremities together in the same place cannot be distinguished, as their ontological independence implies that they are severed from the entities which lend them their individuality. The only way to tell them apart is to keep them apart: touching without coinciding. But we have seen already how Aristotle in (3) assumes, and the author of *De lineis* argues, that that is not possible either, since they, being indivisible, either coincide or have something between them.

We shall come back to the issue of conceptual versus physical division in the next chapter. For the moment, however, there is another point left to clear up: if the distinction between touching and being continuous cannot be applied in the argument of *Physica* 6.1, why then does Aristotle invoke it? The answer is, I suspect, that Aristotle has in mind a distinction which also appears in *De lineis insecabilibus*. There things touching whole to whole are either one or merely together.¹⁷⁹ Thus there are two perspectives on touching in the case of indivisibles: either one looks at them from the perspective of the complex of the indivisibles touching whole to whole, in which there are no parts to be distinguished, or one looks at them from the perspective of the ingredients going into the complex, which at first are two.¹⁸⁰ This distinction is very similar to the one between extremities being one and them being together. Its import differs, however, as it seems simply to be meant to provide an exhaustive classification of possibilities, not to contrast physical division and merely conceptual division. That would also explain why in the rest of *Physica* 6 Aristotle does not consider the possibility of coinciding but distinct points, but just assumes there is only one point everywhere. It would only be in the context of the present argument that the distinction is relevant; after it has been shown that even if there are several indivisibles in one place, a continuum cannot be made out of them, we may just forget about the possibility of there being more than one point everywhere.

Thus it becomes understandable how Aristotle came to apply the distinction in (1). We must regretfully conclude that it is a mistake.

§ 4.1.6. *The argument evaluated*

As appears from the answers given to the five questions, there is not much wrong with the argument of *Physica* 6.1 against the composition of continua from indivisibles. It is an argument which is completely based on the ordering of the indivisibles in such a composite.

¹⁷⁹ 971a28-b2; cf. Joachim, *De lineis ad locum* note 3.

¹⁸⁰ Cf. note 175.

Therefore the size of the indivisibles does not matter, and it equally applies to indivisibles with size as to real points. With the distinction between composing parts and dependent parts in mind, we can also understand why Aristotle talks about limits as parts, and why he does not accept a dense ordering as a composing relation. The only real problem is the reference to the definitions of touching and being continuous from *Physica* 5.3, as these definitions presuppose the conclusion of the present argument. On the other hand, the idea behind the introduction of these two definitions can be understood, and their presence does not spoil the argument itself nor other arguments in *Physica* 6.

The most important point to notice, though, is that this argument introduces in a surreptitious way the idea that there are no separately existing parts before a division into these parts is effected. It does so by proving that there are no primary parts of a continuum, for if there are separately pre-existing parts, they must be primary parts. Thus Aristotle rejects for conceptual divisions the principle that a whole of parts is nothing more than those parts, which in the guise of the Atomistic Principle was used by Democritus in his argument for the existence of atoms and which was invoked in the Academy as well. As we shall see in §§ 5 and especially 6, Aristotle wants to establish the same thesis for motions, but then on the basis of completely different concepts.

§ 4.2. *Other arguments*

As said in the introduction to the present section, Aristotle also refers on other occasions, both in *Physica* 6 and elsewhere, to the impossibility of composition from points or, more specifically, to the impossibility of a consecutive ordering of indivisibles. Some of these passages we will have occasion to refer to in § 6; in this section I want to discuss two of them, one from *Physica* 6 and one from outside that book. The first one shows the themes of proportionality and the order of indivisibles interfering with each other, and the other should tell us more about Aristotle's conception of the relation between points and lines. What they have in common is that Aristotle says something more about what would be the case if a continuum were to consist of consecutively ordered indivisibles.

§ 4.2.1. *Incidental parts*

Earlier in this chapter, in § 1.3, I quoted an argument, the second of three, by which Aristotle tries to establish that an indivisible cannot move (see p. 112). It is based on the idea that for something moving over a distance greater than itself there must be a smaller time in which it moves over a distance which is either equal to or smaller than itself. As with an indivisible there is no distance smaller than itself, it must move first over a distance equal to itself. 'Hence a line will consist of points.'¹⁸¹ To us, used as we are to moving points in the idealizations of physics,¹⁸² this conclusion does not seem to follow, even not if we take into consideration Aristotle's intermediate step, that something repeatedly moving over a distance equal to itself will measure the whole line. For why in the first place should we assume that the size of the moving object be on a scale of smaller – equal – greater in

¹⁸¹ *Physica* 6.10; 241a12

¹⁸² Though also in ancient times the idea of a moving point was familiar, namely in the proposed construction of a line from a moving point (see *De Anima* 1.4; 409a3-5). It is likely that this construction is among the targets of Aristotle's argument.

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comparison to the distance traversed? An Aristotelian answer would be that the moving indivisible, by subsequently being at different positions, isolates these positions from the rest of the track, thus turning them into separate parts. And all separate parts should contribute independently to the whole, so that even the smallest among them will in multiplication equal or exceed the largest: they are in a ratio. Thus Aristotle would be allowed the conception of moving as measuring as well as the idea that for everything moving there is a move over a distance equal to itself.

This defence of Aristotle's argument leads to a further clue that Aristotle identified composing parts with independent parts, and contrasted them with dependent parts. For Aristotle qualifies his thesis that something indivisible and partless cannot move:

except incidentally (κατὰ συμβεβηκόσ), as by being present [in it] (τῷ ἐνυπάρχειν), when a body or magnitude moves, just as if something in a boat would be moved by the locomotion of the boat or a part through the motion of the whole.¹⁸³

This incidental motion is contrasted with motion 'for itself' (καθ' αὐτό),¹⁸⁴ which is one of the terms Aristotle uses for indicating independence. Thus Aristotle does have the vocabulary to distinguish between two kinds of parts, even though he only applies them in this context. The author of *De lineis*, however, provides us with another context, when he says:

A point cannot be taken away from a line. ... But though it is not possible for itself (καθ' ἑαυτήν), it is possible to take away a point from a line incidentally, by being present (τῷ ἐνυπάρχειν) in the line taken away.¹⁸⁵

The distinction, then, seems to have wider application, and therefore to coincide with that between independent and dependent parts.

§ 4.2.2. *Impossible ordering*

The argument discussed in the previous sub-section was in fact a *reductio* to the composition from indivisibles, not to the underlying impossibility of a composing ordering as it was demonstrated in the argument of *Physica* 6.1. Such a *reductio*, however, we do encounter in an argument from *DGC* 1.2. Unlike the argument of *Physica* 6, it is not meant to prove that composition from points is impossible, but to show that division into points cannot occur:

(1) Since there is no point contiguous with a point, there is a sense in which being everywhere divisible does belong to magnitudes, but also one in which it does not. However, (2) it seems that, when [being everywhere divisible] has been posited, there is a point both anywhere and everywhere, so that a magnitude must be divided into nothing – for (3) there is a point everywhere, so that it either consists of contacts or of points (ὥστε ἢ ἀφῶν ἢ ἐκ στιγμῶν εἶναι). (4) There is, though, a sense in which [being divisible] belongs everywhere, because there is one [point] anywhere and all [points are] like each; but (5) there is no more than one [anywhere] (πλείους δὲ μᾶς οὐκ εἶσιν) (for they are not successive), so that [it is] not [divisible]

¹⁸³ *Physica* 6.10; 240b9-12

¹⁸⁴ 240b19-20

¹⁸⁵ 972a13-14; 18-20

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everywhere. For (6) if it is divisible in between (κατὰ μέσον), it will also be divisible at a contiguous point (κατ' ἐχομένην στιγμῶν). But (7) that is not possible, for a position (σημεῖον) is not contiguous with a position or a point with a point, but that is division or composition.¹⁸⁶

Of course this argument occurs in a context: it is meant to reveal the fallaciousness of the argument for the existence of atoms we studied in Chapter Two. How Aristotle achieves this goal, however, is a question which will be discussed in the next chapter. Here we should, in keeping with the aim of the present section, try to understand Aristotle's elaboration on the thesis that points are not successive or contiguous, and thus to find out more about Aristotle's conception of the relation between points and continua. By thus taking the argument out of its argumentative context, and bringing it back to its conceptual home, we might be able to get a better grasp of the internal structure of the argument.

The general framework of the argument is stated by Aristotle himself in (1): because of the fact that points are not successive, it is not possible that a magnitude is everywhere divisible in one sense, though that fact does not interfere with the divisibility everywhere of that magnitude in another sense. (For the time being we may think of this distinction as that between 'possibly divided everywhere' and 'everywhere possibly divided', as set out in Chapter Two § 1.1.) It should be clear from the discussion of § 4.1 that Aristotle himself fully accepts this fact and holds that points on a line are ordered densely.¹⁸⁷ Similarly it should be clear in outline why Aristotle thinks he can base the impossibility of being everywhere divided on the impossibility of a successive ordering of points. As we saw in §§ 4.1.2 and 3, with further confirmation in the previous sub-section, Aristotle holds that parts into which something can be divided and from which something can be composed, are separate parts. If a magnitude is divisible into its limiting point and the remainder, the remainder should have its own limit, and so forth. Therefore if a magnitude is divided into points, these points are ordered successively, or, by contraposition and modalization, if points cannot be ordered successively, a magnitude cannot be such that it may be divided everywhere. Conversely, since points are ordered densely, the series of divisions to be made is without a last member, so that the series cannot be completed.

Later on we shall have somewhat more to say about the precise nature of the step from the impossibility of a consecutive ordering of points to the impossibility of a magnitude being divided everywhere; first it is more important to get to an understanding of Aristotle's characterization of the – impossible – contiguous ordering of points. For the above leaves unexplained what he means when he denies in (5) that 'there is no more than one [point anywhere]' and in (6) that 'if it is divisible in between, it will [not] also be divisible at a contiguous point.' There are two questions to be asked: (i) How could there be two successive points somewhere, apparently at the same place, even if we were to assume a magnitude to consist of successively ordered points? And (ii) how could a magnitude be divisible *at* a point, if it is to consist of successively ordered points?

There are three possible answers to these questions, it seems to me. A first attempt would be to import the distinction between touching and being continuous as defined in

¹⁸⁶ 317a2-12

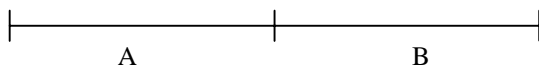
¹⁸⁷ This obvious link with *Physica* 6.1 seems to have been missed by Charlton, 'Potential Infinities' 136-137, who proposes to qualify this acceptance, by reading Aristotle as saying that though a body cannot be divided at adjacent points, 'there are adjacent points on an undivided body.'

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Physica 5.3 into the argument.¹⁸⁸ For in the case of touch according to that definition there are *two* points together, that is, at the same primary place, which could then also serve as the one point at which the magnitude is divisible. Attractive though this answer may be, providing an immediate as well as Aristotelian solution to the first puzzle, it will not do. As we saw in § 4.1.5, the application of this distinction presupposes the impossibility of composition from points, whereas here the distinction is invoked to explain Aristotle's characterization of the situation in which there *is* a composition from points. Moreover, in order to solve the second puzzle, we would have to assume that Aristotle switches without any warning from a conception of a point as a physical extremity which can be together with another physical extremity *at* one geometrical position, to a conception of a point as that geometrical position *at* which it is divisible and to which there is – *per impossibile* – a contiguous position. For the successiveness of the coinciding extremities, which can only be ordered successively by reference to the bodies to which they belong, does not imply the successiveness of the places of coincidence. But there must be a contiguous place of coincidence if division 'at a contiguous point' is to be possible.

Therefore we should try to find another way of answering the two questions. To that purpose we must start from the observation that Aristotle is characterizing an impossible situation with concepts which ultimately can only be applied to a situation in which points in a magnitude are ordered densely. In the latter kind of situation divisions take place *at* a point, but if points are ordered contiguously, they occur 'in the middle' (ἀνὰ μέσον) of points, as it is expressed in *De lineis* (see note 156). Now in the present argument we encounter a similar phrase: κατὰ μέσον. This phrase should be understood in a similar way: a division is possible in the middle of two points. This may also appear from the fact that the phrase is κατὰ μέσον and not κατὰ τὴν μέσην (στιγμὴν).

Building on this idea, we can provide a second answer to the two questions asked. Ad (ii): when a division has been made between (κατὰ μέσον) two points, we could characterize the division between one of them and its other neighbour as κατ' ἐχομένην στιγμὴν. Ad (i): when we try to picture a magnitude which is composed from successively ordered points, and to determine the relation between two successive points, we immediately get into the troubles which Aristotle presents so forcefully in *Physica* 6.1. One way of picturing that situation would be to represent the points as a kind of non-coinciding magnitudes, while at the same time keeping in mind their indivisibility:



Parts A and B then touch, and at the place of touch there are *two* points: A and B. Of course this is an illegitimate characterization, for there is no place of touch between two non-coinciding points; either they touch and coincide or they do not touch. But how else to describe this impossible situation? Do we not similarly talk about the division *at the place* between A and B?

Despite its attractiveness, I do not think that this answer to the two questions is correct. One reason is that it is somewhat contrived, especially as far as (ii) is concerned.

¹⁸⁸ One of the reasons for mentioning this answer is that I myself used to think it to be the correct answer.

But my main reason for thinking so is that there is a more precise answer available. Moreover, this answer does not come out of the blue, but is suggested by a passage in *De lineis insecabilibus*. There we find the following argument:

(I) Further, if [a line] consists of points, a point will touch a point. When then from K [lines] AB and CD are drawn, both the point [B] in AK and the point [C] in KD will touch K. Hence [B and C will] also [touch] each other. For a partless [thing] touches a partless [thing] whole to whole, so that they will occupy the same place and the points touching K [are] in the same places each other.¹⁸⁹ And if they are in the same [place], they also touch [each other], for things which are in the same primary place¹⁹⁰ must touch [each other].

(II) And if that is so, a straight [line] will touch a straight [line] at two points (κατὰ δύο στιγμάς). For the point [B] in AK touches both the [point] KC¹⁹¹ and the other point,¹⁹² so that AK touches CD at several points (κατὰ πλείους .. στιγμάς).

(III) Further also the [circumference] of a circle will touch a straight [line] at several points (κατὰ πλείω). For both the [point] in the circle and the [point] in the straight [line] touch the intercontact (τής συναφῆς) as well as each other.¹⁹³

Here, just as in *DGC* 1.2, there is talk of there being ‘two’ or ‘several’ points at which something happens to two entities, there division, here touch. Here, however, we have an argument justifying such talk, an argument which suggests an underlying picture. Having

¹⁸⁹ Instead of the text as emended by most scholars:

τὸ γὰρ ἀμερὲς τοῦ ἀμεροῦς ὅλον ὅλου ἐφάπτεται. ἦστε τὸν αὐτὸν ἐφέξει/ἐφέξουσι τόπον τῷ K, καὶ <τοῦ K> ἀπτόμεναι <αἱ> στιγμαὶ ἐν τῷ αὐτῷ τόπῳ ἀλλήλαις.

(two related manuscripts: ἐφέξουσι τόπον τῷ K. αἱ γὰρ ἀπτόμεναι στιγμαὶ – all other manuscripts: ἐφέξει τόπον τοῦ K, καὶ ἀπτόμεναι στιγμαὶ – see Joachim, *De lineis ad locum*, Timpanaro Cardini, *De lineis ad locum*, Harlfinger, *Textgeschichte* 329, and Federspiel, ‘Notes’ 511), I propose to read:

τὸ γὰρ ἀμερὲς τοῦ ἀμεροῦς ὅλον ὅλου ἐφάπτεται, ὥστε τὸν αὐτὸν ἐφέξει τόπον, τοῦ K δ’ αἱ ἀπτόμεναι στιγμαὶ ἐν τῷ αὐτῷ τόπῳ ἀλλήλαις.

I have two reasons for adopting this text. First of all, this is the most economical emendation, merely changing τοῦ K καὶ into τοῦ K δ’ αἱ, thus also saving the letters αἱ read by the two divergent manuscripts. The place of the particle may seem surprising, but in pseudo-Aristotle, *Mechanica* 23; 855a21-22 there is a parallel. Secondly, the text which is most commonly adopted, contains an imbalance. For by reading τῷ K after τόπον, we are obliged to understand the points B and C to be the subject with ἐφέξει – reason enough to emend that to ἐφέξουσι. But since these points are not mentioned there as the subject, they have to be supplied from the context, either from the previous sentences or from the next clause. The former alternative does not work, as then the sentence would go: ‘So that [the points previously mentioned] occupy the same place as K, and, by touching K, the points are in the same place as each other.’ Why mention these points again in the next clause? The latter alternative does not make for a smooth sentence either: ‘So that [the points] occupy the same place as K, and, by touching K, [...] are in the same place as each other.’ The postponement of αἱ στιγμαὶ seems awkward. Moreover, a defect both alternatives have in common, is that the phrase ‘by touching K’ is out of place, since one would expect ‘by occupying the same place as K’ or even ‘thus’. All these problems disappear if we take τὰ ἀμερῆ, to be supplied from the previous clause, to be the subject with ἐφέξει. Then we can understand the sentence up to τόπον (‘For a partless .. same place’) as a kind of law about partless things in general. The further consequences of this law are stated then in the next clause in terms of the particular case involving the two points B and C touching K – which explains why they are introduced there again.

¹⁹⁰ Following Joachim, *De lineis ad locum*, note 1, and Harlfinger, *Textgeschichte* 329 (with reference to two manuscripts) in reading ἐν τῷ αὐτῷ τόπῳ .. πρώτῳ.

¹⁹¹ Reading here for the time being, with Joachim, *De lineis ad locum*, and Harlfinger, *Textgeschichte* 330, τῆς KΓ where most manuscripts have τῆ KΓ. Other proposed emendations are <τῆς ἐν> τῆ KΓ (Apelt, *De lineis ad locum*, and Hayduck) and <τῆς ἐν> τῆ KΔ (Timpanaro Cardini, *De lineis ad locum*). Later on, however, I shall propose my own emendation.

¹⁹² Reading, with most manuscripts, τῆς ἐτέρας instead of Apelt’s ἐτέρας, which until Harlfinger, *Textgeschichte* 399, was accepted by everyone.

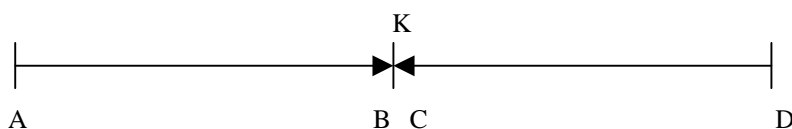
¹⁹³ 971b5-18

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reconstructed this picture, we might try it out on the argument of *DGC* 1.2, to see whether it fits there.

As I showed above, in the argument of *DGC* 1.2 we have a place of touch, as distinguished from two contiguous points, referred to by the phrase *κατὰ μέσον*. In the present argument we have the same situation: K is the place where lines AB and CD touch; it is not a full member of the successively ordered series of points. This appears first of all from the switch from AB and CD to AK and KD in (I). If K were a full member of AK, then ‘the point in AK’ would be a misleading way of referring to the last point B of AB, as clearly it must. This is confirmed by the parallel case in (III) of a circumference and a straight line, where in each of them there is a point meeting at ‘an intercontact’.

Thus we should represent the situation as:



Having said that, however, I must add immediately that matters are rather complicated. First of all, at one stage in (I) the argument crucially treats K as being just the same kind of indivisible as the points making up the lines. Moreover, it is not immediately clear how (II) is related to (I): is the other, second, point referred to in (II) different from K and C or not? From (II) as it stands it may appear that K and C count as one, but then two difficulties arise. The first is that there is no argument on offer that there is such a different point, even though the phrase ‘the other point’ seems to imply that we have already encountered it. The second is that in (III) the intercontact, which is analogous to K, and the point in the straight line seem to be enough to count two points at which the circumference touches the straight line.¹⁹⁴ In order to solve these two difficulties we should take (III) as given and try to accommodate (II) in order to fit its scheme. This scheme seems to be as follows:

- (α) Line x touches line y at intercontact p – implied in (III)
- (β) The point a in x ¹⁹⁵ touches p – see (III)
- (γ) The point a in x touches the point b in y – see (III)
- (δ) Therefore x touches y both at p and at b – cf. the conclusion of (III)

Applied to the example of (I) we get:

- (α_1) $AB = AK$ touches $CD = KD$ at K – starting point of (I)
- (β_1) The point B in AK touches K – assumed in (I)
- (γ_1) The point B in AK touches the point C in KD – argued for in (I)
- (δ_1) Therefore AK touches CD both at K and at C

¹⁹⁴ These two problems have been noticed before, by Timpanaro Cardini, *De lineis* 99-100. The basic outline of my solution is also the same as hers.

¹⁹⁵ That is, the final constitutive point in line x (which by hypothesis consists of points), and thus the one ‘closest to’ p .

The order of indivisibles

Now in (II) we do read that AK touches CD at two places, but as the text stands there is no reference to K and C separately in (II), even though we do have separate statements with regard to K – cf. (β₁) – and C – cf. (γ₁) – in (I). Therefore I propose to emend the text and to read in (II):

ἡ γὰρ ἐν τῇ AK στιγμῇ καὶ τῆς Γ καὶ τῆς ἐτέρας ἄπτεται στιγμῆς.¹⁹⁶

For the point [B] in AK touches both the [point] C and the other point [*scil.* K].

Thus the picture is that AB touches CD both at the first ‘real’ point C *contiguous* with the last point B of AB and at the intercontact K *between* AB and CD. By phrasing it in this way, I have made it already clear that this picture fits the argument of DGC 1.2. The only adjustment we have to make is to read ‘x is divisible from y at p’ where in *De lineis* we have ‘x touches y at p’. Moreover, we have seen how it is argued in *De lineis* that both B and C as well as K are in the same place, so that there are more points than one everywhere.

To see even more clearly how neat this answer to the two questions (i) and (ii) asked above is, we must stand back a little and compare the argument of *De lineis* with the argument of *Physica* 6.1.¹⁹⁷ What both arguments have in common is the assumption that in order for a continuum to consist of points or to be divisible into points, these points must be ordered successively. Above I explained this idea by reference to our discussion of Zeno’s first paradox of plurality, which turns on the separate and independent status of composing or dividing parts: if a limit can be divided from an entity, the remainder of this entity must have a different limit, because the limit of the whole entity, being, like the remainder, a separate part, cannot serve as a limit to the remainder as well. Now what Aristotle does in the argument of *Physica* 6.1, is to show that with merely separate points at one’s conceptual disposal, one cannot build a continuum, because one cannot specify how the points are to be related in order to make up a continuum. Either the points have gaps, that is, already continuous stretches, between them, or they touch each other. But on the former alternative one uses continua to build continua, while the latter alternative is not feasible for lack of the means to describe intercontact without coincidence. For since the points are indivisible, one cannot find these means *inside* the indivisible, and since the points are the only parts available, one cannot find these means *outside* them.

In the argument of *De lineis*, however, the restrictions are not so tight: beside the separate points, also intercontacts are available for the building of continua. But to no avail: these intercontacts are just another set of indivisible parts separate from the real

¹⁹⁶ Thus I emend the phrase τῇ ΚΓ of the majority of the manuscripts to τῆς Γ. Timpanaro Cardini, *De lineis ad locum*, has proposed another emendation in order to secure the same interpretation, by reading <τῆς ἐν> τῇ ΚΔ. Not only is my emendation more economical, but it also explains why the dative τῇ (in the manuscripts τῇ) appeared: ζ was read as Κ and added to Γ.

¹⁹⁷ After all, both are arguments against composition from points. For the argument of *De lineis* this appears from the conclusion drawn in 971b18-20:

But if that [*scil.* lines touching each other at more than one point] is not possible, neither is a point touching a point possible. But if touching is not, neither is a line consisting of points.

One might think that there is a problem here for my drawing on the argument from *De lineis* to elucidate the argument of DGC 1.2, since the former is a *reductio* of the successive ordering of points on the basis of the absurdity of touch at more than one point, while the latter rejects there being more than one point anywhere on the ground that points are not ordered successively. However, there are also other arguments against the successive ordering of points, so that there is no danger of circularity here.

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points, so that the contact between them and the real constitutive point can only occur by coincidence. Therefore any point touches both the intercontact by which it is to be in contact with the next point, and the next point itself, because that point and the intercontact coincide. Any point (and thus also the entity whose last constituent it is) therefore touches the next point (and thus also the next entity whose first constituent that is) at the intercontact and at the next point itself.

So the distinctive feature of the argument of *De lineis* in comparison to that of *Physica* 6.1 is that there are two kinds of indivisibles: constitutive points and intercontacts. It is because of this that we could give such a neat answer to the questions (i) and (ii) about the argument of *DGC* 1.2: there is more than one point everywhere and there is both a division *κατὰ μέσον* and a division at the next point for the same reason, because there is at least one constitutive point and one intercontact at every place of division.

What is more, with this picture in mind we can also get a better grasp of the argument (1)-(7) of *DGC* 1.2 as a whole, because it also allows us to understand some other clauses. On Aristotle's own model, being divisible everywhere means having a point anywhere, where a point is a possible place of division and touch and by which magnitudes are marked off from each other. If being divisible everywhere is understood, however, as the possibility of being divided everywhere, there is, as Aristotle says in (2), not only a point anywhere, in the sense that it is possible to be divided there, but also everywhere, in the sense that it is possible to be divided at all of them. But if that is the case, we face a problem. On the one hand we assume that if a magnitude is divided everywhere, there are some ultimate building blocks without size *into which* the magnitude is divided. Thus the magnitude would consist of nothing but constitutive points. On the other hand, all of these constitutive points must be divided from each other. To that purpose we need points as places *at which* the magnitude is divided. A magnitude with a point everywhere is then a magnitude divided at all of them, so that it consists of nothing but intercontacts. This would explain the exclusive disjunction in (3) that if there is a point everywhere, a magnitude 'either consists of contacts or of points': the points which are everywhere cannot fulfil both functions, being an intercontact as well as being an ultimate constituent.

This problem, however, is not developed by Aristotle. Instead he continues in (4) and (5) the argument with a reformulation of the distinction between a healthy and a pernicious sense of divisibility everywhere. Again, if there is one point, only in the sense of a (possible) place of division anywhere, there is no problem. However, if it is to be possible that a magnitude is divided everywhere, there must be both an intercontact and a constitutive point everywhere. For if two constitutive points are divisible at the intercontact between them, they are, by the argument of *De lineis*, also divisible at one of the two constitutive points, which is contiguous to the other and coincident with the intercontact. This whole construction is impossible, Aristotle declares in (1), (5) and (7),¹⁹⁸ because points are not successively ordered. Since in (5) this impossibility of successively ordered points is used to rule out there being two points anywhere, he must be referring to the intercontact and the constitutive point as the two points which would be successive. This is in line with the argument of *De lineis*, where the intercontact is treated as just another indivisible, belonging to the same group as the constitutive

¹⁹⁸ And he repeats it in *DGC* 1.2; 317a15-16.

points. However, in (6) and (7) he seems to switch, now referring to the two kinds of points *separately* as the points which cannot be successive. As I explained earlier, ‘in between’ in (6) refers to an intercontact, while ‘at the contiguous point’ indicates the constitutive point which is contiguous to the constitutive point ‘at the other side’ of the intercontact. Similarly, in (7), Aristotle distinguishes between σημεία and στιγμαί, neither of which is successive. This distinction, which seems more than a verbal variation, is perhaps best explained as the distinction between intercontacts and constitutive points.¹⁹⁹ Moreover, this would also explain the distinction between division and composition drawn in (7), which seems to correspond to that between σημεία and στιγμαί: points involved in division are σημεία and intercontacts, whereas points from which a magnitude is thought to be composed are constitutive points, στιγμαί. There is nothing wrong with such a switch, however, since the contiguity between an intercontact and a constitutive point implies and is implied by the contiguity of two intercontacts or two constitutive points.

§ 5. The end of motion

The third theme distinguished within *Physica* 6 in § 2 was Aristotle’s use of the contrast between present and perfect tenses, notably for the verbs μεταβάλλειν and κινεῖσθαι. This theme is of great interest, because with it Aristotle has a way of conceptualizing the difference as well as the relation between the ever-divisible continuum and the indivisible point in the field of change and motion. He introduces it in *Physica* 6.1:

[I]t is necessary [of] something moving from here to there (τὸ κινούμενον ποθέν ποί) that it is not at the same time moving and has moved whither it was moving when it was moving (μὴ ἅμα κινεῖσθαι καὶ κενεῖσθαι οὐ ἐκινεῖτο ὅτε ἐκινεῖτο) – for example if something walks to Thebes, it is impossible that [it is] at the same time [the case that] it is walking to Thebes and [that] it has walked to Thebes.²⁰⁰

This distinction between moving and having moved is also, as we shall see in the present section, a distinction between what can be the case during a period and not at a moment, and what can be the case at a moment. So everything Aristotle says about the relation between moving and having moved has repercussions for his ideas about the relation between continua and indivisibles, especially in the domain of time.

In this section we will first study some of the basic ideas behind this distinction, also tracing these to other arguments which do not feature the contrast between present and perfect tenses. These ideas are applied in the argument from the second half of *Physica* 6.1, where it is shown how the hypothesis that continua consist of indivisibles would interact with the tense distinction. Moreover, with the help of these ideas I shall also try to make sense of what Aristotle has to say about the moment of transition between two contradictory states. Nothing incoherent with the results of the previous section will come out of that. Things are different with two sets of arguments, from *Physica* 6.5-6

¹⁹⁹ As far as I know, there is no passage in Aristotle where he talks about composition from σημεία; he does call points σημεία, but only if they are (possible) places of division and touch. On the other hand, he uses στιγμαί for both, just as he here implies that there are two στιγμαί everywhere, one intercontact and one constitutive point.

²⁰⁰ 231b29-232a1

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and from *Physica* 8.8, for there Aristotle seems to break the rules laid down by himself. Discussion of the latter passage, however, is best postponed to the final chapter, because it is involved with other matters discussed there. The former set of arguments shall be taken up in the next section.

§ 5.1. *Aristotle's uses of tense and aspect within the basic scheme of motion*

As indicated in the passage quoted above introducing the distinction between the present and the perfect tense, this distinction is based on the conception of a motion as not just something amorphous and continuous, possibly without a start or a finish, but as something structured and discrete: motion is from somewhere to somewhere. Though this is a crucial Aristotelian doctrine,²⁰¹ Aristotle did not always adhere to it, as appears from *Physica* 6.2 and 6.7, where he allows for motion taking an unlimited time over an unlimited stretch. He even admits this inconsistency between the idea that motion is from something to something and the acceptance of an unlimited motion. He does so almost explicitly in *Physica* 7.1, where he says that: 'every motion is from something to something, and not unlimited by extremities.'²⁰² Also in most proportional arguments this conception of motion is absent. As I explained in § 3.2.3, it is crucial for the divisibility arguments based on proportionalities, that motions can only have a structure in so far as they consist of motion-parts, and that there may be motions which do not have such an internal structure.²⁰³

The idea that every change is from something to something is in its presentation a quasi-spatial one: there is a place or state A, there is a place or state B, and the object changes from A to B. But of course there is temporal dimension to it, since there is an order: first the object is in A, then in B. So in its barest outline the idea involves two states or places correlated to two times – I shall call these two states and times in their correlation the termini of the change. On the basis of the order between these two correlated states or places and times, we may further say that at the first time in A the change is inceptive, while at the second time in B the change is completed – by which nothing more is implied than that at any time later than the first time the object is not in A 'anymore', and that at any time earlier than the second time the object is not in B 'yet'. In addition, this skeleton is normally fleshed out with a path of change correlated with a period of change from the one terminus to the other.

It is within this framework that Aristotle draws the distinction between present and perfect tense as introduced in *Physica* 6.1. And there is more than the distinction between present and perfect there, as we shall see: he also uses the aorist and imperfect tenses in distinct ways within this framework. There is nothing remarkable about that, for it is exactly the same framework which appears time and again in Greek grammars,

²⁰¹ It provides the foundations of Aristotle's account of change and becoming in *Physica* 1.7, his classification of kinds of change in *Physica* 5.1 and his discussion of the identity conditions of changes in *Physica* 5.4. It appears throughout Aristotle's works. In *Physica* 6 we find it in 6.4; 234b10-11, 6.5; 235b6-7, 6.8; 239a23-24 and 6.10; 241a27; cf. 6.2; 232a29.

²⁰² 242a65-66; cf. also *Physica* 6.10; 241b11-12 in combination with 241a27.

²⁰³ To this it may be added that proportionalities do play a part in *De lineis insecabilibus*, e.g. 968a25-26 and 970b1-6, but that there is there no sign of a from to structure of motion.

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when they set out the role of aspect in the Greek tense system.²⁰⁴ One might distinguish between three aspects, as determined within this framework:

- (1) the durative aspect, focusing on the process of change by which during the time of the change the path of the change is being traversed, and prescind from the termini of the change;
- (2) the punctual aspect, taking the change as a whole sealed off from further inspection, just registering that the object is first here then there: as far as this aspect is concerned, there is nothing more to the change than its termini;
- (3) the stative-terminative aspect, forgoing the comparative element of being and not being in the same state, which the two other dynamic aspects of change have in common, whether these concern the process of change (1) or the mere fact of change (2), but rather characterizing a certain state related to the terminated change – most commonly the state at the end-terminus of the change, that is, the state which is the result of the whole change.²⁰⁵

For the verb κινεῖσθαι the different aspects of the different tenses – only for the present and the past – may be set out as follows:

	stative-terminative	dynamic	
		punctual	durative
present	κεκίνηται	(κινήθη)	κινεῖται (κινεῖσθαι)
past	ἔκεκίνητο	ἔκινήθη	ἔκινεῖτο

Only the present indicative may be ambiguous between two aspects: in many contexts it is obviously durative, but there may be contexts where one cannot tell.

The dynamic durative aspect of the present and imperfect tenses as used by Aristotle is very clear in the following passage:

Since every change is from something to something and when it is in that to which it was changing (μετέβαλλεν), it does not change any more (οὐκέτι μεταβάλλει), while when [it is in that] from which it was changing, it does not change (οὐ μεταβάλλει)²⁰⁶ – it is necessary then that some [part] of the changing object is in the one while another [part of it is] in the other.²⁰⁷

²⁰⁴ I follow the account of Y. Duhoux, *Le verbe grec ancien. Éléments de morphologie et de syntaxe historiques* (Louvain-la-Neuve, 1992) 136-148.

²⁰⁵ Perhaps it is possible to describe the difference between the stative-terminative aspect *when taken to indicate the result of the change*, and the dynamic aspect in terms of emphasis: whereas with the dynamic aspect the two termini which define a change or between which there is a process of change, have equal status, with the stative-terminative aspect one terminus (the later) is primary and from that terminus one looks back, as it were, to the earlier terminus.

²⁰⁶ Ross' emendation of οὐ into οὐπω (see *Physics ad locum*), though natural, is not necessary.

²⁰⁷ *Physica* 6.4; 234b10-16

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Most of the time the durative aspect seems to dominate, but there are cases where it is not stressed; then the present has a neutral aspect. There is one in the very passage quoted above introducing the distinction between present and perfect:

εἰ Θήβαζέ τι βαδίξει, ἀδύνατον ἅμα βαδίζειν Θήβαζε καὶ βεβαδικέναι Θήβαζε.²⁰⁸

As it refers to the whole walk, including its termini and not just the process, βαδίξει should be taken in a neutral way.²⁰⁹ In line with the grammars, Aristotle does not use the present tense to denote changes which exclude a process of change; for then the present tense would have a punctual aspect (see below for his use of the aorist tense).²¹⁰

As said, most commonly the perfect denotes the state which is the result of the change. But when Aristotle introduces the distinction between present and perfect tenses, he seems to be primarily thinking of them as opposed in respect of being stative-terminative or dynamic, and not in terms of the result of change versus the lack of a result. This one may gather from the fact that he actually sets out to prove, in *Physica* 6.5, that what has changed, when it first has changed, is in that to which it has changed. That is a strange thing to do if one has already a clear understanding of the perfect as denoting the result of change. If, on the other hand, one has merely the vaguer idea that the present denotes something dynamic, and the perfect a state without its own internal change, but is still related to the change in that it obtains when the change is over, then it is understandable that one thinks there is something to prove.

The two arguments, though, which Aristotle offers by way of proof, are not easy to understand. Both of them are based on the idea that changing involves leaving:

²⁰⁸ 231b30-232a1

²⁰⁹ Another clear example can be found in *Physica* 6.8; 239a3-6, where it is argued that the time in which something moves (κινούμενον), cannot be indivisible because in part of that time it must have moved, so that for the other part it will be moving. For the interpretation of this passage, see p. 174.

²¹⁰ In saying this I go against the very persistent view in the literature that on three occasions Aristotle does acknowledge the possibility of instantaneous change, namely in *Physica* 1.3; 186a10-16, 8.3; 253b21-26, and *De Sensu* 6; 446b28-a8 (see e.g. R. Heinaman, 'Alteration and Aristotle's Activity-Change Distinction', *Oxford Studies in Ancient Philosophy* 16 (1998) 227-257, at 243 and 252, R. Wardy, *The Chain of Change. A Study of Aristotle's Physics VII* (Cambridge, 1990) 330, note 41, S. Waterlow, *Nature, Change, and Agency in Aristotle's Physics. A Philosophical Study* (Oxford, 1982) 97 and 155, N. Strobach, *The Moment of Change. A Systematic History in the Philosophy of Space and Time* (Dordrecht, 1998) 59 and 255 note 39, and D. Graham (transl. & comm.), *Aristotle's Physics Book VIII* (Oxford, 1999) 7 and 68; cf. Sorabji, *TCC* 53 and 411). In all three of these passages Aristotle claims that it is possible that change or alteration occurs (present tense) 'all at once' (ἄθροῶν or ἅμα πᾶν). If that were to mean that no time should be needed for such a change, we would have three passages in which the present tense is used to describe a change without a process of change. However, as A. Gregory, 'Aristotle, Dynamics, and Proportionality', *Early Science and Medicine* 6 (2001) 1-21, at 12-13, has already indicated, the point in all these passages is that alteration need not involve one part of the object to be altered before the other – ἄθροῶν should be taken to mean 'simultaneous', not 'instantaneous' (cf. W. Charlton (transl. & comm.), *Aristotle's Physics Books I and II* (Oxford, 1970) 5 and 59). And there is no problem with alterations occurring in all parts in the same period, as long as the respect in which there is alteration involves a continuous medium. That condition seems to be fulfilled for the only example mentioned by Aristotle, solidification, if we may believe his account in *Meteorologica* 4.5-7 (cf. also *Analytica Posteriora* 2.12; 95a16-21, where the present tense is applied to solidification and contrasted with the application of the perfect tense). Moreover, as we shall see below, § 5.3.2.1, according to Aristotle even changes between contradictory states are not instantaneous.

Finally, I should already point out that I do not think that γίγνεται as used in *Metaphysica* B.5; 1002b2 denotes an instantaneous generation. For an interpretation of this very difficult passage, see the next chapter § 3.1.

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[W]hat changes retires from whence it changes, or leaves it, and either changing (τὸ μεταβάλλειν) and leaving (τὸ ἀπολείπειν) are the same or leaving accompanies changing. But if leaving [accompanies] changing, having left (ἀπολειπόμενοι) [accompanies] having changed (μεταβεβληκέναι). For either is similarly related to either.²¹¹

There is a serious threat of circularity here. For how can one say that having left accompanies having changed unless one understands having left in terms of its result, namely not being that which it was before? However, for the time being such a circularity can be avoided, if we take Aristotle as arguing in the following way. If change involves first being this and then being that – and this premiss has been repeated just a few lines before²¹² – then first being this and then not being this follows as a matter of course; thus leaving accompanies change.²¹³ And from *Topica* 7.3 we know the principle of reasoning based ‘on cases and coordinated series’ (ἐκ τῶν πτώσεων καὶ τῶν συστοίχων):

It is necessary that the genera accompany the genera and the definitions the definitions. For example if forgetting is the loss of knowledge also to forget will be to lose knowledge, and to have forgotten to have lost knowledge (καὶ τὸ ἐπιλανθάνεσθαι ἀποβάλλειν ἐπιστήμην ἔσται καὶ τὸ ἐπιλελήσθαι ἀποβεβληκέναι ἐπιστήμην).²¹⁴

We may interpret the conclusion that having left accompanies having changed then as the result of the application of that formal principle, so that having left being this need not be understood immediately as entailing the result of not being this.

However, when we come to the actual arguments for the thesis that what has changed, when it first has changed, is in that to which it has changed, we do see that Aristotle assumes that having-left from somewhere involves the result of not being there any more:

Since then one of the changes [is] that according to a contradiction (ἢ κατ’ ἀντίφασιν), [it is the case that] when [something] has changed from not-being to being (ἐκ τοῦ μὴ ὄντος εἰς τὸ ὄν), it has left not-being. Therefore it will be in being (ἐν τῷ ὄντι). For it is necessary that everything either is or is not. It is clear then that in change according to a contradiction what has changed will be in [that to] which it has changed. But if [that is the case] in that [change], it [is] also [the case] in the other [changes]. For it will be similar in the case of one [change] and of the other [changes].²¹⁵

Here we do see the step from *having left not being* to *being in being* – so that the whole argument has the appearance of a *petitio principii*. I think, however, that we can save Aristotle from such a fallacy by giving him the following argument, inspired by an argument from *Physica* 6.10²¹⁶:

- (1) When it has left not-being, it is either in not-being or in being or somewhere in between.

²¹¹ *Physica* 6.5; 235b8-13

²¹² 235b6-7

²¹³ Also elsewhere Aristotle connects change and motion primarily with retiring and leaving: see e.g. *Physica* 4.12; 221b3 and 4.14; 222b16 and 21.

²¹⁴ 153b25-29

²¹⁵ 235b13-19

²¹⁶ 240b23-30; cf. also the remark in *Physica* 6.1; 232a3-4.

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- (2) There is nothing in between not-being and being.
- (3) If it has left not-being and is in not-being, then while it leaves not-being, it is in not-being, thus staying in not-being.
- (4) Therefore it is in being when it has left not-being.

And we only have to supply (3), for (1) and (2) are at least implicit in the argument as quoted. The idea behind (3) is that from the level of having left we return to the level of leaving, which, as we have already seen above, involves first being in this, then not being in this. As leaving is incompatible with staying, and it must stay if it is first this and then still in that, it cannot be in not-being when it has left not-being.

It may seem that Aristotle takes here the change between contradictory states as an instantaneous change, with nothing between the two termini of the change. I shall explain below, § 5.3.2.1, that this appearance is deceptive and depends on an incorrect assumption. In a sense, though, it is true that there is nothing between the termini, as the object can only be or not be. In this respect, change between contradictories differs from the more complicated cases of alteration, growth and deminution and locomotion,²¹⁷ as these, at least most of the time,²¹⁸ involve a state between the two termini, so that it is not possible to argue immediately that if the object is not in the one terminus, it is in the other. Nevertheless Aristotle thinks that he has in fact already proved the thesis that what has changed is in that to which it has changed for those other changes as well. This statement is perhaps best explained by reference to the idea that any change between contraries involves a change between contradictory states, because each contrary implies the contradictory of the other.²¹⁹ This similarity should then suffice for the generalization of the result obtained for change between contradictories to all kinds of change.

It seems difficult to understand Aristotle's confidence.²²⁰ And indeed he goes on to give a different argument for one of these other changes, locomotion:

Further, it is also clear [that what has changed, when it first has changed, is in that to which it has changed] for those who try to establish it for each [kind of change], if, that is, it is necessary that what has changed is somewhere or in something. For since it has left that from which it has changed and it must be somewhere, it will either be in that [to which it has changed] or in something else. If then what has changed to B is in something else, say in C, [then] from C it is changing further to B (*πάλιν ἐκ τοῦ Γ μεταβάλλει εἰς τὸ Β*). For B was not contiguous [to C], and change is continuous. Hence what has changed, when it has changed, is changing to that to which it has changed. But that is impossible. Therefore it is necessary that what has changed is in that to which it has changed.²²¹

²¹⁷ In *Physica* 5.1 Aristotle argues that there is a difference between these three changes, also called *κίνησεις*, on the one hand, and generation and destruction (*γένεσις* and *φθορά*), on the other, in that the former involve two positively stated termini which do exclude each other (are contrary), while the latter involve one negatively stated terminus.

²¹⁸ Not always, as appears from *Physica* 6.4; 234b14-18.

²¹⁹ Cf. Wagner, *Physikvorlesung* 626.

²²⁰ It may be that Aristotle weakens his generalization at the end of the next argument, when he restates it in terms of mere clarity of the proof:

[This thesis] has in general been put forward about every [kind of] change, and most clearly in the case of change according to a contradiction. (235b29-30)

However, it is also possible that Aristotle presupposes here a certain account of change according to which something has only left the one terminus when the whole change is over.

²²¹ *Physica* 6.5; 235b19-27

The end of motion

Again the assumption is that the object when it has moved is not in the starting point, but elsewhere. But if it is not in B, it is still in the process of changing to B, so that because of the incompatibility of the stative-terminative aspect of the perfect and the dynamic aspect of the present, it has not changed to B.²²² Thus we see how Aristotle derives a more precise conception of the perfect as denoting the result of the change from a vaguer conception of the perfect as denoting a state of termination.

This immediate incompatibility between present and perfect tenses, without there being a clear idea that it is the incompatibility between the result of a change and the change itself, also appears from three other passages. In *Physica* 6.10 Aristotle says:

[When something changing is in that to which it was changing] it will be the case that it has moved, while it has been supposed that it was moving (μεταβιβληκός ἔσται, ὑπόκειται δὲ μεταβάλλειν).²²³

It is not the fact that it is in the end-terminus of change which yields the incompatibility with the present tense, but the fact that it is then in the *state* of having changed. We see the same idea at work in *Physica* 6.5:

It is necessary that [something] either has changed or is changing.²²⁴

Similarly Aristotle remarks in *Physica* 6.6:

[W]hat is changing continuously and is not destroyed and has not stopped with the change must in any [part of the time] either be changing or have changed.²²⁵

Elsewhere, however, Aristotle just takes the resultative aspect of the perfect for granted.²²⁶

The function of the aorist tense in Aristotle's discussions becomes most clear when it is contrasted with the present tense. A nice example we find in *De Caelo* 1.11:

'Ungenerable' (ἀγέννητον) is used in one way in the case that something is now while not being before, without [there being] generation and change (ἄνευ γενέσεως καὶ μεταβολῆς), as some say is the case with touching and with moving.²²⁷ For they say that it is not possible to be coming

²²² There has been some confusion about how to interpret the core of the argument – cf. Ross, *Physics* 409, Wagner, *Physikvorlesung* 161, and Strobach, *Moment of Change* 61. Adopting a distinction between times and nows which Aristotle has perhaps here not yet taken up with regard to present and perfect tenses, I take Aristotle to be arguing as follows:

(1) If the object is, in the now in which it has changed, in C, it is moving from C to B during the period between this now_C and now_B.

This is underpinned by two points:

(2) There is a period between now_C and now_B because C and B are not contiguous, as we know from *Physica* 6.1.

(3) A change is continuous in that it does not occur by a jump, without any process.

From (1) it follows that:

(4) The now at which the object has changed falls in the period of the change, so that the going-on change is, absurdly, already over.

²²³ 240b27-28

²²⁴ 235b37-236a1

²²⁵ 237a12-14. Cf. also *Physica* 6.5; 236a22-25.

²²⁶ *Physica* 6.6; 237a23-24, and elsewhere e.g. *Physica* 8.8; 263b28-264a4 and *Metaphysica* B.4; 999b11-12

²²⁷ This may be a reference to Plato, who in *Parmenides* 156c-e has Parmenides arguing that there is 'this queer thing ... the sudden,' in which an object switches from rest to change. But also Aristotle himself thinks that there

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to be touching, nor moving (οὐ γὰρ εἶναι γίνεσθαι φασιν ἀπτόμενον, οὐδὲ κινούμενον).²²⁸ [It is used] in [another] way in the case²²⁹ that something which can be coming to be or come to be (γίνεσθαι ἢ γενέσθαι), is not.²³⁰

Here γένεσθαι clearly corresponds with the absence of a process of change, so that there can be nothing more to the change than first being here, then being there.²³¹ Another striking passage, from *Physica* 6.10, will be quoted below, p. 163. That does not mean, though, that if the aorist does not appear in contrast with the present, it *must* indicate the absence of a process of change – it may just not be considered important.

In connection with Aristotle's use of aspects within the from-to conception of change, we should also say something about Aristotle's use of nouns like κίνησις, γένεσις and μεταβολή within that framework. The situation is comparable with that of the present indicative tense, in that κίνησις is not free either from ambiguity with respect to inclusion or exclusion of the termini of motion. As appears from the passage quoted from *De Caelo* 1.11, Aristotle uses words like γένεσις and μεταβολή to refer to the process of change alone. Also in his arguments in *Physica* 5.2 that

there is no κινήσεως κίνησις nor γένεσεως γένεσις nor in general μεταβολῆς μεταβολή,²³²

the nouns can only have a durative aspect. On the other hand, in arguments that there is no motion in the now, because motion entails there being at least two termini, so that the now would be divisible, the noun must include the two termini. See for example the following:

There is no motion in a partless [time] because it would [otherwise be the case that it] has moved with respect to some [part] of it (διὰ τὸ κεκινήσθαι τι ἂν αὐτοῦ).²³³

Here the motion has the having moved for a part, and does not only comprise the moving. Thus the terminus of completion is included in the motion, and the aspect of the noun is neutral. (For a justification of this interpretation, see below, § 5.3.1, p. 174.)

In addition to this already familiar ambiguity, there may be a context in which Aristotle uses κίνησις to denote the mere fact of first being here, then being there, thus giving it a punctual aspect. The passage, which will be discussed more fully below, is from *Physica* 6.10, where Aristotle, after he has argued that an indivisible cannot move because it cannot be moving, tries to state what should be the case in order that an indivisible can have motion:

is no generation in these cases. With respect to moving he argues the point at length in *Physica* 5.2. With respect to touching this appears from *De Caelo* 1.11; 280b26-28.

²²⁸ I follow Allan, *De Caelo ad locum*, in reading γίνεσθαι instead of Moraux' γενέσθαι (*De Caelo ad locum*). Both have equal manuscript support, but from the sentences quoted next, it is clear that the present tense, with durative aspect, is required.

²²⁹ In which case 'ungenerated' would be a better translation of ἀγένητον.

²³⁰ 280b6-10

²³¹ As it is also described a few lines later on: 'without [a process of] coming to be, [that is,] at one time being not and then being' (*De Caelo* 1.11; 280b16).

²³² 225b15-16

²³³ 239a4-5

The end of motion

There could only have been *motion* of [an indivisible] in this way: if time had consisted of nows. For in the now it would always have [been the case] that it has moved and has changed, so that [it would have been the case that] it is never changing and always has moved.²³⁴

So apparently there can still be motion without a process of moving, so that motion would just consist of the termini. On the other hand, this is a counterfactual situation, and Aristotle does use κίνησις in the neutral sense, with the assumption of a process of moving, when he, only a few lines above, denies that an indivisible can move. Moreover, as will appear below, in *Physica* 6.1 he does not want to call this counterfactual situation really motion.

So Aristotle, in his use of tense and aspect within the framework set by the from-to conception of motion, follows the textbook rules perfectly, providing very clear and distinct examples of those rules. Most of this will have come naturally to him. About his use of the perfect tense, however, he seems to be more self-conscious, introducing it by way of an example, giving proofs about its implications, and repeating the incompatibility between perfect and present tenses several times. To this it can be added that there are many passages clearly presupposing the from-to conception of motion, both inside and outside *Physica* 6, where he could have used the perfect tense, but fails to do so. Take the following three passages:

(I) [I]t is not possible that anything is moving spatially to the unlimited (εἰς ἄπειρον μὴ ἐνδέχεσθαι φέρεσθαι μηθέν). For just as nothing impossible [ever] is, so also it is not coming to be (ὥσπερ γὰρ οὐκ ἔστιν οὐθὲν ἀδύνατον, οὕτως οὐδὲ γίγνεται). But locomotion is a [kind of] coming to be from somewhere to somewhere (ἢ δὲ φορὰ γένεσις ποθὲν πρὸς).²³⁵

(II) [S]ince what is impossible to be cut (τμηθῆναι) ... cannot be being cut (τέμνεσθαι), nor in general what is impossible to become (γενέσθαι) be becoming (γίγνεσθαι), neither could that which is impossible to change (μεταβαλεῖν) be changing to what it is impossible to change to (μεταβάλλειν εἰς δὲ ἀδύνατον μεταβαλεῖν). If then that which is in locomotion were to be changing (μεταβάλλοι) to something, it will also be possible to change [to it] (μεταβαλεῖν). Hence the motion is not unlimited, nor will it be moving spatially over an unlimited path. For it is impossible to traverse that (διελθεῖν αὐτήν).²³⁶

(III) Further, if there is a coming to be and motion, it is necessary that there is also a limit. For no motion is unlimited – rather of every [motion] there is an end (τέλος), and what is impossible to come to be cannot be coming to be (γίγνεσθαι τε οὐχ οἷόν τε τὸ ἀδύνατον γενέσθαι.) And it is necessary that what has come to be *is* when it first has come to be. (τὸ δὲ γεγονός ἀνάγκη εἶναι ὅτε πρῶτον γέγονεν).²³⁷

There are two ways of looking at the differences between these three passages. One way is to take the addition of the aorist and perfect tenses to the basic argument appearing in (I) as argumentatively redundant and a kind of embellishment. A more plausible way, however, is to see them as evidence of Aristotle's development, both in jargon and in contents, of the basic idea that motion is always from somewhere to somewhere. Especially with the introduction of the perfect tense he has availed himself of the vocabulary needed to express

²³⁴ 240b31-241a1

²³⁵ *De Caelo* 4.4; 311b31-33

²³⁶ *Physica* 6.10; 241b3-11

²³⁷ *Metaphysica* B.4; 999b8-12

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a kind of causal relation between the motion and its result, the object being at the goal of the motion. Thus the account of motion has become philosophically more informative.

§ 5.2. *Moving over indivisibles in indivisible times*

Aristotle introduces the distinction between present and perfect tense in an argument by which he wants to show that ‘it belongs to the same account that magnitude, time and motion are composed of indivisibles and divide into indivisibles, or [that] none [of them is composed of such]’:

(1) [The conclusion] is clear from the following. For if the magnitude is composed of indivisibles, also the motion related to it (ἡ κίνησις ἢ τούτου) will consist of equal indivisible motions, for example if ABC consists of the indivisibles A, B [and] C, the motion indicated by DEF, which Z made in relation to ABC (ἦν ἐκινήθη τὸ Ω ἐπὶ τῆς ABΓ), contains for each part an indivisible (ἕκαστον τὸ μέρος ἔχει ἀδιαίρετον).

(2) If then with the presence of motion [something] must move over something, and in the case it moves over something, motion must be present (εἰ δὴ παρούσης κινήσεως ἀνάγκη κινεῖσθαι τι, καὶ εἰ κινεῖται τι, παρεῖναι κίνησιν),²³⁸ also the moving (τὸ κινεῖσθαι) will consist of indivisibles. Z then moved (ἐκινήθη) over A making motion D (τὴν τὸ κινούμενον κίνησιν), over B [making motion] E, in the same way over C [making motion] F.

(3) If then it is necessary of something moving from here to there that [it is] not at the same time [the case that it] is moving and has moved whither it was moving when it was moving (for example, if something walks to Thebes, it is impossible that [it is] at the same time [the case that] it is walking to Thebes and [that] it has walked to Thebes), and Z was moving (ἐκινεῖτο) over partless [magnitude] A, by which motion D was present – then (ὥστε) if, on the one hand, it has traversed later (ὔστερον) than it was traversing [the partless magnitude A]²³⁹ would be divisible (for when it was traversing, it neither rests nor has traversed, but was in between), while if, on the other hand, it is traversing and has traversed at the same time, something walking, when it is walking, will have walked there and have moved whither it is moving.

(4) But if something moves over the [magnitudes] ABC as a whole, and the motion which it makes is DEF, and over the partless [magnitude] A nothing is moving, but rather has moved, the motion would not consist of motions, but of moves (ἐκ κινήματων) and [occur] by something having moved without moving. For it has traversed A without traversing [it]. Hence it will be possible that something has walked while never walking. For it has walked over that [sc. A] without walking over that.

(5) If then it is necessary that everything either rests or moves, it rests with respect to each of ABC (καθ’ ἕκαστον τῶν ABΓ), so that there will be something continuously resting and moving at the same time (ἔσται τι συνεχῶς ἡρεμοῦν ἅμα καὶ κινούμενον). For it was moving over ABC as a whole (τὴν ABΓ ὅλην) and rests for whatever part (ὅτιοῦν μέρος),²⁴⁰ so that it also rests for the whole. And if, on the one hand, the indivisibles of DEF are motions it would be possible not to be moving but to rest while motion is present. If, on the other hand, they are not motions, [it would be possible] that the motion does not consist of motions.²⁴¹

In this sub-section I shall first of all try to give a detailed commentary on this long and sometimes unclear argument. In the course of doing so, several further issues will be addressed. These include the connection between magnitude, motion and time with respect

²³⁸ For a justification of the translation, see note 244.

²³⁹ For a justification of the translation, see p. 167.

²⁴⁰ Aristotle seems to use ‘resting κατὰ ..’ and ‘moving/resting .. (accusative)’ interchangeably. Ideally one should translate both constructions in the same way: ‘for/with regard to ..’. With ‘moving’, however, the accusative is most naturally translated with an accusative of extent ‘over ..’, as in (2).

²⁴¹ *Physica* 6.1; 231b20-232a17

to their (in)divisibility; the possibility of motion over indivisible magnitudes and in indivisible times; and issues pertaining to Aristotle's answer to Zeno's Arrow.

§ 5.2.1. *Connecting magnitude, motion and time*

After giving paragraphs (1)-(5), Aristotle continues with a simple proportional argument for the correspondence with respect to (in)divisibility between time and motion and possibly length – it has already been quoted in § 3.1, p. 121. Thus the second half of *Physica* 6.1 has the appearance of a single argument for the initial thesis, that the three media of motion: motion, time and magnitude, are either all divisible or all indivisible.²⁴² In paragraph (1) he does indeed state part of that thesis, namely that if the path consists of indivisibles, the motion over the path consists of indivisibles. But if we look for an argument, we have difficulty finding one. There is no indication in the form of γάρ or the like that (2) is meant to support this statement. Rather, it introduces yet a fourth medium involved in motion, the moving, and a way of speaking, 'motion being present', which seems to make (2) a preparation for (3)-(5). Moreover, even if (2) were to contain an argument for the statement of (1), we would only have part of the initial thesis. The rest would have to be supplied by the proportional argument coming after (5). But as there is no trace of a proportionality in (2), the style of arguing for the two parts of the thesis would then be quite different. Finally, in (3)-(5) there is not the slightest indication that Aristotle is concerned to establish his initial thesis. Gone is the appearance of a single argument.²⁴³

If we look carefully at the argument of (2), however, it seems possible to extract from the paragraph an argument for the initial thesis. Aristotle starts there by assuming a biimplication:

- (a) When a motion m is present, then and only then x moves over a path p .

He claims that from (a), together with the proposition that the motion DEF, which an object Z makes in relation to the path ABC consisting of indivisibles A, B and C, consists of indivisibles D, E and F, it follows that the moving also consists of indivisibles. Thus (a) is used as a principle to transport indivisibility from one medium of motion to another. Now if we look at the next sentence in (2), we see that he in fact applies the same scheme there. For we may take:

- (b) Z moves over A [by] making motion D

as an instantiation of one half of the biimplication (a):

- (b_a) When x makes motion m , then x moves over p .

What Aristotle seems to be doing in (b) is to establish a correspondence between the motion and the magnitude moved over, with *the moving (over p)* as a connector.²⁴⁴ But if (b) is

²⁴² Thus Ross, *Physics* 640

²⁴³ Thus notably Furley, *Two Studies* 117; cf. Bostock 'Continuity' 189, and White, *Continuous* 253 and 262.

²⁴⁴ Of course this is only correct if one translates as I do, taking τι in the phrase κινεῖσθαι τι as an accusative of extent, indicating the path moved over, rather than as the subject of κινεῖσθαι, as most translators do, or as

say that ‘when it was traversing, it neither rests nor has traversed, but was in between’? Is it not obvious that something traversing does not rest? And in between what? To understand the argument we have to go to the only related argument in *Physica* 6. It concerns the first argument against moving by an indivisible in *Physica* 6.10, in which he considers a partless object changing from AB to the next BC:

It is necessary that during the time it is changing it is either in AB or in BC or that one part of it is in the one, while another part is in the other. ... There will not be a [part] of it in each of them, for [then] it would have parts. However, it will not be in BC either, for [then] it will have changed, whereas it is supposed to be changing. It remains then that it is in AB during the time it is changing. Therefore it will rest. For being in the same during a period of time was resting. Hence it is not possible that the partless moves or, in general, changes.²⁴⁶

Adopting the lettering of *Physica* 6.1, the situation here is that at one time (i) the moving object Z is in A, and then at another, later, time (ii) either (a) in A or (b) in B or (c) partly in A, partly in B:

(i) Z	(ii) (a) Z	(b) Z	(c) Z
A B	A B	A B	A B

And if (a), Z will be at rest in A at the time of (ii) with regard to the time of (i); if (b), Z will have traversed to B; and if (c), Z will be in between A and B, being in the process of traversing from A to B – which we may call traversing A. Thus ‘rests’ and ‘has traversed’ serve, just as ‘in between’, as indicators of a position at a certain time.

The situation (c) of Z being ‘between’ A and B, however, is impossible, because it involves the divisibility of A²⁴⁷ – in the same way as being partly in AB, partly in BC involves the divisibility of the moving indivisible in *Physica* 6.10. Since it is assumed that Z moves, (a) is ruled out as well, so the only conclusion left is that Z moves over A merely by having moved over A, without a process of moving over A, which proposition Aristotle mentions in (4) as a premiss.²⁴⁸

On the basis of that premiss, Aristotle withholds in (4) the predicate ‘motion’ from motions which occur by a jump from one place to the next – he calls them ‘moves’ (κινήματα). He then goes on to argue from what applies to each indivisible magnitude to what applies to the whole series of indivisible magnitudes: the motion over it occurs not by moving but by having moved, and only consists of moves. The principle on which this step is based will be recognized to be the whole-part principle from Chapter One, which says that what is true of a whole is true of each of its parts and *vice versa*, and is based on the ontological priority of the parts over the whole. I shall discuss the limitations set by Aristotle to the applicability of this principle in § 5.2.3.2; but it will be clear that it does apply to all constitutive parts and therefore also in this case.

²⁴⁶ 240b23-31

²⁴⁷ Contra Furley, *Two Studies* 119, White, *Continuous* 253-254, and CWA 391, who all take the divisible indivisible to be motion D. The only one to give the correct interpretation is Wagner, *Physikvorlesung* 150 and 618.

²⁴⁸ This interpretation also absolves Aristotle from the accusation made by White, *Continuous* 256, that he has not shown that it is impossible that D, E and F are really movings, and not having-moveds.

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Though the very distinction between moving and having moved is drawn in temporal terms (these conditions do not occur at the same time, but the one later than the other), the medium of time itself is not a theme in this argument. It is also the assumed indivisibility of the spatial medium of motion, not that of its temporal medium, which is the basis of the ruling out of a process of motion. On the other hand, if he had assumed time to consist of indivisibles, Aristotle could have given an argument for the same conclusion, on the ground that it is impossible to have both moving and having moved in the indivisible time taken by each indivisible motion. That there was such an argument around, appears from Aristotle's remarks following the argument against motion by an indivisible quoted above:

[I]n only one way (μοναχῶς) there would have thus been motion [of something partless]: if time had consisted of nows.²⁴⁹ For it would always have been the case that in the now it has moved and has changed, so that it would never be the case that it is in motion, but always that it has moved (αἰεὶ γὰρ ἐν τῷ νῦν κεινημένον ἂν ἦν καὶ μεταβεβληκός, ὥστε κινεῖσθαι μὲν μῆδέποτε, κεινηῖσθαι δ' αἰεὶ). But that that is impossible, has already been proved before. For neither does time consist of nows, nor a line of points nor motion of moves (ἐκ κινήματων). For someone who claims [that motion consists of moves] does not posit anything else than that motion consists of indivisibles, exactly as time would consist of nows or length of points.²⁵⁰

Here time, not magnitude, is the basic medium, and it is assumed that there can only be having moved and no moving in each indivisible now. If then time consists of nows, we may apply what is true of each now to the whole series of nows, that is, to the whole time of motion, and conclude that the motion consists merely of moves.

Thus it does not matter whether one starts from the indivisibles in magnitude or in time: motion as a process will not be possible in either way. But not only that. For since, for Aristotle, motion by an indivisible necessarily implies motion over a magnitude consisting of indivisibles, and motion by an indivisible is only said to be possible if time consists of nows, we have here in fact an argument interconnecting (in)divisibility in the spatial medium with (in)divisibility in the temporal medium of motion, an argument which is independent of the one I extracted from paragraph (2) of *Physica* 6.1. It is based on the idea that moving takes both a divisible time and is over a divisible distance, because it involves two termini between which it occurs. On the other hand, if motion consists of nothing more than moves, and jumps over intermediate positions, or moves interlaced with rest, are ruled out,²⁵¹ there is no room for such divisible media of motion, as each move merely involves there being two termini, two coordinated times and positions. Whether Aristotle had this argument in mind, however, when he made his initial claim in *Physica* 6.1, seems doubtful.

²⁴⁹ Ross, *Physics* 667, thinks that this statement follows from *Physica* 6.4; 235a13-b5, where Aristotle argues that if one thing involved in change is ever-divisible, everything is, including the object changing. Obviously Aristotle could have argued on that basis that if the moving object is indivisible, the time of motion is indivisible, but no such argument is referred to or assumed here. It simply does not fit Aristotle's vocabulary in the present passage. Such an argument is more at home with the next passage to be dealt with – see below.

²⁵⁰ 240b31-241a6

²⁵¹ That moves interlaced with rests are ruled out appears at two places in the argument of *Physica* 6.1. In (5) Aristotle says that 'there will be something *continuously* resting and moving at the same time.' And in (4) and (5) Aristotle holds on to talking about the whole motion as divided into three parts, D, E and F. Therefore for rests alternating with moves there is no place.

§ 5.2.3. The absurdity of motion without motion

§ 5.2.3.1. Returning to a different perspective

After having established in (3)-(4) that motion over a series of indivisibles does not occur by moving and by motion, but by having moved and by moves, Aristotle makes it clear in (5) that it is impossible that motion should occur without motion. He does so in two ways. First he argues that because there is no moving over an indivisible, something moving must be resting with regard to all of them and therefore with regard to the whole of them at the same time as moving over them. Second, he sets up a dilemma, clearly implying that both horns are unacceptable: because there is no moving over an indivisible, either motion consists of indivisible motions, but without moving, or motion does not consist of motions.

In the light of the preceding two paragraphs, the second point is puzzling. To take the second horn first, why should it be unacceptable that motion does not consist of motions, but, as in (4), of moves? Elsewhere Aristotle does accept that some things change in the sense of being at one time and not being at another, without a process of change, like touch and change itself – why not enlarge this category? It may be said that motion consisting of having-moveds implies that time consists of nows, which Aristotle holds to be absurd (see the passage from *Physica* 6.10). But the point is that Aristotle does not say that here. He just assumes that if motion is to consist of indivisibles, these should be motions. It is as if we have returned to a conception of motion as having no internal structure, without two termini, but as being just a stretch of motion. As pointed out above, this conception was present in (2), but exchanged for a discrete perspective in (3).

This impression is reinforced by the first horn. The absurdity of motion without moving is there pointed out by reference to principle (a) of paragraph (2) that when there is moving, there is a motion present and *vice versa* – so we have again the structureless notion of motion. Moreover, if Aristotle had stuck to the conclusion he draws in (3)-(4), he would not even have considered the first horn, for in (4) he states that motion over indivisibles does not consist of motions. Since this conclusion follows straight from the discrete from-to conception of motion,²⁵² Aristotle must be presupposing the continuous perspective.

The same thesis would also explain the basic premiss for the first point Aristotle makes in (5),²⁵³ that everything either rests or moves. If one thinks of moving as involving a structureless stretch of motion over a structureless stretch of magnitude in a structureless stretch of time, even if these stretches are indivisible, then the absence of moving is resting: staying in the same position in a structureless stretch of time.²⁵⁴

Thus it seems plausible that in (5) Aristotle does not look at motion from the perspective according to which each motion is a whole structured by two termini. However, given the difference in perspective between (5) and (3)-(4), where the discrete conception of motion reigns, what could be then the relation between them? It may be

²⁵² One does not even need the contrast between present and perfect tense for the argument.

²⁵³ Which is also assumed in the first horn of the dilemma, in the remark that ‘it would be possible not to be moving but to rest.’

²⁵⁴ Thus we need not assume, with White, *Continuous* 257, that this premiss only holds in case of divisible periods of time. In fact, even if the explanation given in the text is not correct, one would still not need to resort to this view. It would suffice to say that the premiss is true for any *constitutive* part of time, so also for nows if time were to consist of them.

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that Aristotle, having in (3)-(4) secured the result that there is no moving over an indivisible, returns to the continuous perspective. On the other hand, it is also possible that in (5) Aristotle had in mind a different argument for the impossibility of moving over an indivisible, say an argument resembling the third argument against motion by an indivisible in *Physica* 6.10 (see pp. 130-131). The second alternative is conceptually neater, but as we saw at the end of § 3.2.3, Aristotle also justifies premisses he needs for his proportional arguments (which presuppose the continuous perspective), with the help of concepts like ‘A has changed from C to D’, which we now recognize to belong to the from-to conception of motion. The matter remains open.

§ 5.2.3.2. Answering Zeno’s Arrow

Apart from paragraph (5) of the argument of *Physica* 6.1 there is only one other clear passage in *Physica* 6 where the conclusion that what moves does so without moving, is deemed to be intrinsically unacceptable. This passage is Aristotle’s discussion of Zeno’s paradox of the Arrow. Let me quote it again:

And Zeno argues fallaciously. For if everything always rests or moves when it is over against what is equal, and the thing in locomotion is always in the now, the arrow in locomotion, he claims, is motionless. But that is incorrect, for time is not composed of indivisible nows, no more than any other magnitude.²⁵⁵

The situation envisaged in Zeno’s Arrow is rather similar to that of *Physica* 6.1 and 6.10 (quoted at the end of § 5.2.2). Also here we find the absence of moving, though now not because it is over an indivisible or by an indivisible, but because there is no space for it. And just as in *Physica* 6.10 this is the case in every indivisible now. Both in *Physica* 6.1 and 6.10, however, Aristotle drew the conclusion that therefore there was no moving over the whole distance or in the whole time, applying thus the whole-part-principle (WP) familiar from Chapter One. Since the only difference between the situation envisaged there and the one here in Aristotle’s discussion of the Arrow is that there Aristotle assumes for himself that the distance and the time consist of indivisibles, whereas here he points to this incorrect assumption as the source of all the trouble, we may conclude that Aristotle limits (WP) to (possibly) constitutive parts, excluding limit entities as real parts, just as he does in the first half of *Physica* 6.1.²⁵⁶

Just before Aristotle’s discussion of the Arrow, however, there is a passage featuring a proposition held to be unacceptable which resembles the conclusion that what moves does so without moving:

(v) For if it is not in that way [*viz.* in different nows], but only in one of the nows (εἰ γὰρ μὴ οὕτως ἀλλ’ ἐν ἐνὶ μόνῳ τῶν νῶν) [that it is true to say that something changing is in the same], it

²⁵⁵ *Physica* 6.9; 239b5-9; cf. also 6.9; 239b30-33:

The third [of Zeno’s arguments against motion which provide difficulties for those who try to solve them] is the one just mentioned, that the arrow in locomotion is at a standstill. It follows on the basis of accepting that time is composed of nows. For when that is not granted, there will not be a deduction.

²⁵⁶ We do not need to assume, with Vlastos, ‘Zeno’s Arrow’ 208 and 210, note 21 [5-6 and 8, n.20a] and Bostock, ‘Continuity’ 207, that Aristotle accuses Zeno of taking the now to be an atomic period of time. Cf. also S. Waterlow, ‘Instants of Motion in *Physica* VI’, *Archiv für Geschichte der Philosophie* 65 (1983) 128-146, at 129-130, who seems to equate in general constitutive parts with commensurate parts (though she does not do so merely in order to describe Aristotle’s point of view).

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will not be over against something for any time (οὐκ ἔσται χρόνον οὐδένα κατά τι), but at the limit of a time. (vi) In the now, however, it is always over against something in the sense of being (μὲν ὄν)²⁵⁷ – but it does not rest. (vii) For there is neither moving (κινεῖσθαι) nor resting (ἡρεμεῖν) in the now. (viii) Rather, though it is correct [to say] that in the now it does not move and is over against something, really it is not possible that it is over against something in a time, resting. (ix) For it follows [then] that what is in locomotion rests (τὸ φερόμενον ἡρεμεῖν).²⁵⁸

This passage has been almost universally interpreted as an attack on Zeno's paradox of the Arrow, probably because it shares with it the vocabulary of φερόμενον and being κατά τι. According to this view Aristotle is saying here that as soon as one is prepared to apply 'resting' to something which is over against something in the now, one gets into Zeno's paradox. Taking this as a *reductio*, it is held to be an attack on Zeno's proposition that in the now something over against what is equal rests, an attack which is independent of his main solution of the Arrow, based on the idea that Zeno falsely assumes that time consists ofnows.²⁵⁹

However, our analysis of Chapter One § 2.1 gives us reason to doubt this interpretation. A first point is that Zeno does not need the arrow to rest in the now. His paradox works equally well if the arrow is merely motionless.²⁶⁰ Aristotle may be taken to acknowledge this when he uses the term 'motionless' in the conclusion of the Arrow. Moreover, as I proposed to reconstruct Zeno's Arrow in § 2.2, the proposition that what is over against what is equal in the now, rests, is not a premiss of the argument, but a proposition deduced in the course of the argument from its real premisses. It is pointless to attack such an intermediate proposition; only attacking the real premisses or the inferences will do.

But not only these philosophical considerations should make us wary of that interpretation; an analysis of the passage itself also provides grounds for doubt. For what exactly is Aristotle arguing for? After all, our passage starts with 'For' – for what conclusion is a reason advanced? To answer that question we need to have a careful look at the preceding argument:

(i) Since everything moving moves in a time and changes from something to something, it is impossible that in the time in which for itself it is moving, that is, not because [it is moving] in some part of that, something moving is over against something primary (κατά τι πρῶτον).²⁶¹ (ii) For resting is being in the same for some time, both the thing itself and each of its parts. For thus we use 'resting', when in differentnows it is correct to say that it is in the same, both itself and

²⁵⁷ Thus I follow Ross, *Physics ad locum*, who himself adopts an emendation of the manuscripts' μόνον proposed by Prantl. The alternative μόνον, apparently read by Themistius and Simplicius, is however also possible. In *CWA* 404 another way of construing Ross' text seems suggested. For 'It is true that at any now it is always over against something' can only be a faithful translation if ἀληθές is supplied, so that ὄν can be read as a participle subordinated to ἀληθές ἔστιν. I doubt whether that is possible.

²⁵⁸ 239a33-b4

²⁵⁹ Vlastos, 'Zeno's Arrow' 213-215 [12-13]; Owen, 'Zeno' 158-159; Barnes, *Presocratic Philosophers* 279; White, *Continuous* 177-178; Bostock, 'Continuity' 206; J. Lear, *Aristotle: The Desire to Understand* (Cambridge, 1988) 85-87; Makin, 'Zeno' 850; and F.R. Pickering, 'Aristotle on Zeno and the Now', *Phronesis* 23 (1978) 253-257, at 255.

²⁶⁰ Cf. Makin, 'Zeno' 850

²⁶¹ By the addition of 'primary', and later on, 'as a whole', Aristotle means to leave out of account the possibility that something moving can be over against something by being over against some part of it. For if that possibility is taken into account, something moving can be over against something by being always over against a different part of that.

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its parts.²⁶² (iii) If that is resting, it cannot be the case that something changing is over against something as a whole (κατά τι ὅλον) over a primary time. (iv) For every time is divisible, so that in different parts of it it will be true to say that it is in the same, both itself and its parts.²⁶³

The argument can be divided into four parts. In (i) Aristotle makes the claim to be argued for. In (ii) he spends quite a few words on the meaning of ‘resting’. In (iii) he repeats the claim of (i) and indicates that (ii) is relevant for the truth of that claim. And then finally in (iv) he gives the only real argument to be found for that claim. The only way to make sense of all the parts of this passage is to supply a conclusion left implicit: ‘Thus something changing rests’, taking this as the *absurdum* to which the thesis denied in the claim of (i) and (iii) is reduced. For in this way we can understand what the function of (ii) is in the whole.²⁶⁴

Thus we have here a finished argument. Why then does Aristotle continue with ‘for’ in what follows, that is to say, in (v)? The most plausible explanation, it seems to me, is that in (v) Aristotle is answering some imaginary objector, who agrees that something changing cannot be over against the same primary thing in two different parts of time, but still thinks it is possible for something changing to be over against something at some time, namely at one now – surely the now is a part of time?²⁶⁵ That this objector has not fully understood matters, Aristotle explains when he answers in (v) by pointing out the difference between a period of time and the now, which is merely a limit of a (period of) time: of course something changing can be over against something, but not for any time – and the claim of (i) and (iii) concerned being over against something in a time. Interpreted in this way, (v) does constitute further support for the claim of (i) and (iii), as it takes away a possible misunderstanding of that claim. Thus we can understand Aristotle’s ‘for’.

In (vi)-(ix) Aristotle elaborates on this distinction between a period of time and a limit of time. In (vi) and (viii) he declares that there is nothing wrong with saying that something changing is over against something in the now, but he also warns in (vi) that one should not be led into thinking that it then rests. The reason he gives in (vii): that there is no moving or resting in the now. It may seem that in (viii) he merely repeats this warning, but there is an important difference: instead of denying, as in (vi), that something being over against something in the now rests, he denies that it is possible that something (namely a changing object) is over against something *in a time*, resting. This is not a repetition of the warning of (vi), but for the largest part a repetition of the claim laid down in (i) and (iii). With the addition in (viii) of ‘resting’ and (ix) we also get the same argument as in (iv) as to why it is not possible that something moving is over against something in a time: because by (ii) what is over against something in a time, rests, so that the absurd conclusion follows that what moves rests.

²⁶² This sentence strikes me as an interpolation, because it is superfluous. Moreover, in the rest of *Physica* 6 Aristotle does not use ‘different nows’, but ‘now and earlier’ (6.3; 234b7; 6.8; 239a15-16), ‘in different parts of a period of time’ (6.8; 239a31-32), or ‘for some period of time’ (6.8; 239a26; 6.10; 240b30).

²⁶³ 239a23-33

²⁶⁴ Moreover, it also explains why Aristotle starts (i) with a characterization of something moving: that on the one hand motion occurs in a time, just as rest does according to (ii), but that on the other hand motion, in accordance with the from to conception of motion, involves two different places, while rest by contrast involves one and the same place.

²⁶⁵ It may be significant that Aristotle himself talks in (iv) about ‘different parts of [time]’, rather than about ‘different nows’, as in 239a28.

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Thus we have here neither an argument for the impossibility of rest in the now nor an attack on Zeno's Arrow. We merely find a denial of rest (as well as motion) in the now in (vii), based on the familiar argument that rest requires two nows, as stated in (ii). The impression that Aristotle was attacking Zeno is caused especially by (ix), which seems at first sight to give the ultimate reason why there cannot be rest in the now. Only after careful analysis does this impression disappear, so that (ix) can be restored to its home in the argument, that is, the previous argument as given in (iv).

This does not mean that Zeno's Arrow has nothing to do with the passages we are considering here. For the mistake against which Aristotle warns in (vi), confusing a period of time and a limit of time (the now), is in fact the same as the mistake of which he accuses Zeno: that nows make up a period of time, thus being real parts of time and a kind of period themselves.

§ 5.3. *The times of present and perfect motion*

§ 5.3.1. *The time of perfect motion*

In his introduction of the distinction between present and perfect tense, Aristotle expresses their incompatibility in temporal terms: they do not apply 'at the same time'. Are there then distinct times at which they apply? It seems so, for in *Physica* 6.5 Aristotle continues after the previously discussed argument that what has changed, when it has changed, is in that to which it has changed, with the following argument:

Now that what has changed, when it first has changed, is in that, is clear. But the primary [time] in which what has changed, has changed, must be atomic. I mean by primary that which is not such because one [part] of it is [such] (τὸ ἕτερον τι αὐτοῦ εἶναι). For let AC be divisible, and let it have been divided at B. If then it has changed in AB or again (ἢ πάλιν) in BC, it would not have changed in AC as a primary [time]. If, on the other hand, it was changing in each [of them] (for it is necessary that it either has changed or is changing in each of them), it would be changing in the whole. But it was [the case that it] has changed. The same argument also [applies] if it is changing in the one and has changed in the other. For there will be something prior to what is primary. Hence [the time] in which it has changed could not be divisible.²⁶⁶

We shall return to the details of this argument shortly; now the important point is that Aristotle talks about a primary time in which something has changed, which is indivisible, but which can be imagined to be divided, thus apparently being on an equal footing with a period of time.²⁶⁷

Another passage suggesting that there are two distinct times, one of changing and one of having-changed, we encounter in *Physica* 6.8:

There is no motion in a partless [time] because it would [otherwise be the case that it] has moved with respect to some [part] of it (διὰ τὸ κενιῆσθαι τι ἂν αὐτοῦ).²⁶⁸

²⁶⁶ 235b30-236a5

²⁶⁷ The existence of such a primary time in which something has changed, Aristotle may be taken to have proved in the immediately preceding passage.

²⁶⁸ 239a4-5

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It may not be immediately clear how exactly this argument works. It has been supposed that Aristotle presupposes his thesis, to be discussed below in § 6.3, that ‘everything moving must have moved for a prior part.’²⁶⁹ The trouble with that is that it ascribes to Aristotle a circular argument, for when one reads Aristotle’s reasons for that thesis, one notices that all of them presuppose the ever-divisibility of the time of motion.²⁷⁰ But here in *Physica* 6.8 the assumption (to be reduced to absurdity) is that the time of motion is partless, so that a thesis which is derived on the opposite assumption naturally cannot apply. To make matters worse, in the last of the arguments for the thesis mentioned Aristotle even assumes that ‘it is not possible to change in the now’,²⁷¹ so that the circularity would be blatant.

I propose, therefore, to understand ‘with respect to some part of it’ as referring to the end of the time of motion. Thus Aristotle would be giving a very simple argument: because the two aspects of motion, having moved and moving, cannot be true at the same time, there must be a part of the time of motion at which it is true to say that it has moved; as in an indivisible now there is no room for such a distinction, there cannot be motion in an indivisible now.

Finally we have the dilemma presented in *Physica* 6.1 (paragraph (3) of the passage quoted in § 5.2) according to which something either has traversed later than (ὕστερον ἢ) it was traversing, or is traversing and has traversed at the same time (ἄμα). Since the second horn is clearly unacceptable, it seems as if Aristotle holds that first there is a period of moving and then, later, there is a separate time of having moved.

Obviously this cannot be right. For if there were two separate times, one for moving and one for having moved, the time in which the object is moving, and with it the process of moving, would be completely independent. Thus the present tense κινεῖται would be really ambiguous: in one sense it is only true for the period of moving and in another sense for the period consisting of both the time in which it is moving and the time in which it has moved. If that were the case, however, Aristotle would not be entitled to jump from what is true for the one sense to what is true for the other. But that is exactly what we see him doing. On the one hand he argues:

If something which is changing continuously and is not destroyed nor has stopped with the change must either be changing or have changed in any [time], and in the now it is not possible to be changing, it is necessary that it has changed at each of the nows.²⁷²

where changing is contrasted with having changed and is thus used in the limited sense. On the other hand, Aristotle’s arguments for there not being changing in the now, which he presupposes in this argument, employ the verb in the broader sense. If one argues that it is only possible to change in a divisible time because only such a time comprises both termini of change, then one assumes that the time of having changed should be included in the time of changing. This is even stated explicitly in the two lines quoted from *Physica* 6.8 in the present sub-section.

An even more immediate problem is that if there were a process of changing separated from the state of having changed, it would be impossible to understand the

²⁶⁹ *Physica* 6.6; 236b33-34. This interpretation has been proposed by Ross, *Physics* 654. For the translation ‘for a prior part’ for πρότερον, see below, § 6.1.

²⁷⁰ 236b34-237a17

²⁷¹ 237a14

²⁷² *Physica* 6.6; 237a12-15

very notion of a time of changing. For how could we within the from-to conception of motion conceive of that process except as a process directed towards the terminus? But the process now would be assumed to be independent from that terminus and should therefore not refer to it. The time of changing reduces to a time of merely not being at the terminus.

This problem plays a role in an argument from *Physica* 8.8 in which Aristotle actually argues against the idea that the time of moving and the time of having moved are two separate times:

[I]f something which, while earlier not being, is ($\delta\ \alpha\nu\ \eta\ \pi\rho\acute{o}\tau\epsilon\rho\omicron\nu\ \mu\eta\ \acute{\omicron}\nu$), must be becoming being ($\gamma\acute{\iota}\gamma\nu\epsilon\sigma\theta\alpha\iota\ \acute{\omicron}\nu$), and [it is the case that] when it is becoming, it is not, it is not possible to divide time into atomic times. For if in A it was becoming white, and it has become at the same time as it is in a different, but contiguous time, in B – if in A it was becoming, it was not, while in B it is -, there needs to be some becoming ($\gamma\acute{\epsilon}\nu\epsilon\sigma\iota\nu\ \tau\iota\nu\delta$) in between, so that there [is] also a time [*sc.* in between] in which it was becoming.²⁷³

Though this argument is directed against time-atomism, the problematic feature it focuses on is also inherent in the idea we are concerned with: there being two separate but contiguous times in which something is changing and has changed, respectively. It is important to notice what Aristotle's starting points are in this argument. On the one hand, by postulating that during the process of change the object is still not, he performs a kind of reduction of the gradual change to a change from not being at the terminus of the change to being at that terminus. On the other hand he sticks to the idea that every change needs a process of change. It may seem that these points are incompatible: how could a change from being not at the terminus to being at the terminus ever involve a process of change? I shall discuss this matter more fully below, § 5.3.2.3. In the present context, however, it is clear that we should follow Aristotle. For if the process of change is isolated from its terminus, it is nothing more than a state of not being there. And if we want to avoid the absurdity of motion composed of moves, brought home to us in *Physica* 6.1 and 6.10, we must assume there to be somehow a process of change by which the terminus is reached.

It is anyway clear from other passages that Aristotle does not think of the time of changing and the time of having changed as two separate times, but rather as a period of time and the now that terminates that period. For example, immediately after the argument against time-atomism quoted above, Aristotle continues:

For there will not be the same argument too for those who deny that there are atoms. Rather in the last point of the time itself in which it was becoming, it has become and is – to which point there is nothing contiguous or successive. Atomic times, however, are successive. And it is clear that if in the whole time A it was becoming, there is not a time in which it has become as well as was becoming [which is] greater than [the] whole [time] in which it was only becoming.²⁷⁴

(The issue as to why there is not the same problem for a continuist like Aristotle I shall take up below, also in § 5.3.2.3.) The same doctrine can be recognized in the remarks immediately following the proof of the indivisibility of the primary time in which something has changed:

²⁷³ 263b26-264a1

²⁷⁴ *Physica* 8.8; 264a1-6

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‘The primary [time] in which [something] has changed’ is used in two ways, one [being] the primary [time] in which the change came to an end (ἐπιτελέσθη) – for at that time (τότε) it is correct to say that it has changed ... The [primary time in which something has changed] as used according to the primary end of the change (τὸ μὲν οὖν κατὰ τὸ τέλος τῆς μεταβολῆς πρῶτον λεγόμενον),²⁷⁵ then, is present and exists, for it is possible that the change comes to an end and there is an end of change, which, moreover, has been proved to be indivisible because it is a limit (πέρας).²⁷⁶

One would first be inclined to take the proof to which Aristotle alludes to be the immediately preceding passage, quoted above.²⁷⁷ Nevertheless, I am not fully certain that that is correct, because there we do not find any talk about limits and ends. Certainly there is a connection with a passage from *Metaphysica* α.2:

This comes to be from *this* in two ways (διχῶς γίγνεται τόδε ἐκ τοῦδε) .. [one of them being] in the way a man [comes to be] from a boy changing (ἐκ παιδὸς ἀνὴρ μεταβάλλοντος). .. By the way, then, a man comes to be from a boy we mean the way that what has come to be [comes to be] from what is coming to be or what has come to an end from what is coming to an end (ὡς ἐκ τοῦ γιγνομένου τὸ γεγονὸς ἢ ἐκ τοῦ ἐπιτελουμένου τὸ τετελεσμένον). For just as a coming to be is always between being and not-being, so also what is coming to be is always between what is and what is not (ἀεὶ γὰρ ἐστὶ μεταξύ, ὅσπερ τοῦ εἶναι καὶ μὴ εἶναι γένεσις, οὕτω καὶ τὸ γιγνόμενον τοῦ ὄντος καὶ μὴ ὄντος). For the one who is learning is one becoming knowledgeable, and what is said is this: that knowledgeable comes to be from learning. .. [Because the thing from which it comes to be is not perishing] these things do not change back into each other (οὐκ ἀνακάμπτει εἰς ἄλληλα), nor does a boy come to be from a man. For what comes to be does not come to be from the coming to be, but *is* after the coming to be (οὐ γὰρ γίγνεται ἐκ τῆς γενέσεως τὸ γιγνόμενον ἀλλ’ ἔστι²⁷⁸ μετὰ τὴν γένεσιν). For in this way also the day [comes to be] from the dawn, in that after that [it is]. That is why the dawn [does] not [come to be] from the day either. .. Of the things which are in between there must be an end (τῶν .. ὄντων μεταξύ ἀνάγκη τέλος εἶναι).²⁷⁹

Here we do find the verb ἐπιτελεῖσθαι and the word τέλος, which a few lines later on is even glossed as πέρασ.²⁸⁰ More importantly, the process of change as well as the object which is changing are characterized as being *in between*, which necessarily implies that there is a limit or end, as is stated in the final sentence. Thus the picture of the process of change is again that of a line between limits, one of them being the end-state of having changed. From this picture the indivisibility of the end follows automatically. The time of having changed will consequently be related to the time of the process of change in the same way, as limit to a line.

²⁷⁵ Alternatively one could perhaps take πρῶτον λεγόμενον together as qualifying τέλος, but that would not really change the meaning.

²⁷⁶ *Physica* 6.5; 236a7-13

²⁷⁷ As Wagner, Physikvorlesung 628, does.

²⁷⁸ Both Ross, *Metaphysics ad locum* and 217-218, and Jaeger, *Metaphysica ad locum*, follow Christ in emending into ἀλλ’ <δ> ἐστὶ. Also other emendations have been proposed, like omitting ἐστὶ (Bonitz, purportedly following Alexander, *In Metaphysica* 157.8 – though on that evidence we cannot be sure that Alexander’s text did not have ἐστὶ) and adding τι after ἐστὶ (Lasson and Rolfes). The reason for these emendations seems to be that τὸ γιγνόμενον is taken to refer to the boy in the process of coming to be a man, as in 994a25-26 and 28. But there is no reason why it should: it may just as well refer to the man or, to use the other example, the day, which *comes to be* from the boy or from dawn respectively. Thus τὸ γιγνόμενον is used in a broader sense than merely denoting the process, as is γίγνεσθαι in 994a21, 25 and 30.

²⁷⁹ 994a22-b5, with omissions.

²⁸⁰ 994b16

These two passages may not be concerned immediately with the relation between the time of changing to the time of having changed, but it will be clear that because the end of a change, which obtains when something has changed, is indivisible, and related to the process of change, as a limit to a line, the time of changing and the time of having changed are related in the same way.

Consequently the three passages mentioned at the beginning of this section, which suggest that there is a separate time of having moved, ought to be interpretable in terms of the line-point model. With the short passage from *Physica* 6.8 that is not a problem at all, for the phrase ‘with respect to some [part] of it’ (where actually the word ‘part’ is avoided altogether)²⁸¹ may be used to refer to point-like ‘parts’ as well – we saw parallels in § 4.1.3. Also for the argument for the indivisibility of the primary time of having changed (quoted at p. 174) such an interpretation is possible, indeed even compulsory, given the existence of a primary time of having changed. For the argument there is set up as a dilemmatic *reductio*: if the primary time of having changed is divisible, either it has changed in one of the parts, or it has changed in none of the parts into which it is divisible. The first horn is in obvious contradiction with the hypothesis that the whole time is a *primary* time of having changed. The second horn, however, is more interesting, for Aristotle imagines the alternative situation that it has not changed in any part, but still has changed in the whole time. Given that in any time something either is changing or has changed, he argues, it follows that it is changing in every part, and therefore in the whole. But from that it follows that since every period of time is divisible, there is no period of time at all in which something has changed: things are always changing and never have changed, in so far as *periods* of time are concerned. To stress this point, we may understand, Aristotle ends the argument with a point which formally he may have made before, when dealing with the first horn, but which because of its implications is worth making again: the situation where in one part of a time something is changing and in another real part it has changed, is not one where the whole time is the primary time of having changed. For because of the addition that in any part in which it has not changed, it is changing, it follows that every divisible time is one in which there is merely changing and no having changed.²⁸² Therefore the relationship between changing and having changed must be that between a line and its end-point – a part into which the line cannot be divided.

The most difficult case is the third passage adduced, the statement made in *Physica* 6.1 that the having moved is *later* (ὕστερον) than the changing. To this passage we can now add the remark implied in *Metaphysica* α.2 that it is *after* (μετά) the process of coming to be that what has come to be is.²⁸³ I propose to understand these terms in a derived way, namely from the state obtaining later than and after the change, which state obtains already in the first now of that later period. In that sense, then, both ὕστερον and

²⁸¹ For the construction, cf. *Physica* 4.4; 211a1, where Aristotle gives as one of the demands on a correct definition of place that it should make place ‘nothing belonging to the object [in the place]’ (μηδὲν τοῦ πράγματος). Hereby he also wants to rule out that the place of an object is the limit of the object itself.

²⁸² Ross’ accusation (*Physics* 649) that ‘Aristotle by oversight adds this as if it were a separate case’, therefore does not seem fair.

²⁸³ Cf. also *Metaphysica* B.5; 1002a30-32:

For it seems that a substance, when it, while earlier not being, now is, or, while earlier being, now is not, undergoes these things after [a process of] coming to be and ceasing to be (μετὰ τοῦ γίνεσθαι καὶ φερίεσθαι).

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μετά could still refer to the moment in which the change terminates, since the first now of the later state is also the final now of the change.

§ 5.3.2. The time of present motion

The last paragraph of the previous sub-section might not seem to offer a very convincing interpretation of Aristotle's talk about having changed being ὕστερον than and μετὰ the process of changing. Such doubts may be reinforced when one considers another argument in which Aristotle appears to isolate the moment of having changed from the time of changing, so that the time of changing would become a period without a final now:

(I) It is clear as well that unless one posits the point of time dividing the earlier and the later always for the object [as belonging] to the later (τοῦ χρόνου τὸ διαίρουσιν σημεῖον τὸ πρότερον καὶ ὕστερον ἀεὶ τοῦ ὕστερου τῷ πράγματι), the same thing will at the same time be being and not-being, even when it has come to be not-being (καὶ ὅτε γέγονεν οὐκ ὄν). The point, now, is common to both, to the earlier as well as to the later, and is one and the same in number, but in account it is not the same, since of the one it is the end, while of the other it is the beginning. For the object, however, it always belongs to the later affection. The time is indicated by ACB, the object indicated by D. This is in time A white, and in time B not-white; therefore it is in C white and not-white. For in whatever [part] of A it is correct to call it white, if it was white over this whole period of time, and in B it [was] not white, while C is in both. Therefore one should not concede that [D is white] in the whole [time], but with the exception of the final now, indicated by C – that already [belongs for the object] to the later [affection] (τοῦτο δ' ἤδη τοῦ ὕστερου).²⁸⁴

(II) And if [D] was coming to be not-white and was ceasing to be white (ἐφθείρετο λευκὸν)²⁸⁵ in A as a whole, it has come to be [not-white] or has ceased to be [white] in C. Hence if it was white, it is either correct to say that [it is] not-white in that [now] first, or it will not be [not-white] when it has come to be [not-white], and it will be [white] when it has ceased to be [white], or it must be at the same time white and not-white and generally being and not-being (ὥστε εἰ ἦν²⁸⁶ λευκὸν ἢ μὴ λευκὸν ἐν ἐκείνῳ πρώτον ἀληθὲς εἰπεῖν, ἢ ὅτε γέγονεν οὐκ ἔσται, καὶ ὅτε ἐφθάρται ἔσται, ἢ ἅμα λευκὸν καὶ οὐ λευκὸν καὶ ὄλωσ ὄν καὶ μὴ ὄν ἀνάγκη εἶναι).²⁸⁷

²⁸⁴ *Physica* 8.8; 263b9-21. All our manuscripts read τὸ ὕστερον, but Ross, *Physics ad locum* and 715, emends to τοῦ ὕστερου to bring it in line with b10 and 15, invoking as support Simplicius, *In Physica* 1295.23-24, and Philoponus, *In Physica* 845.31-32. I do not see how Philoponus' ἐν τούτῳ [sc.Γ] γὰρ οὐκέτι οὐ λευκὸν, ἀλλὰ λευκὸν ἐστὶ τὸ Γ τῆ ὑστερᾶ διαθέσει δοτέον τῆ κατὰ τὸ λευκὸν could justify specifically a change to the genitive. Also Simplicius' τὸ δὲ Γ ἀρχὴν τοῦ ἐν τῷ δευτέρῳ χρόνῳ ὄντος τοῦ οὐ λευκοῦ ποιητέον is too far from the construction appearing in Aristotle to be of any real help. The analogy with b10 and especially b15 does provide an argument for emendation, but perhaps it is possible to defend the text of the manuscripts by taking τοῦτο to refer not to C, but to D: 'D is [then] already the later [affection, sc. not-white].' Alternatively one could even think of emending τοῦτο into τότε and translate: 'Then the later affection is already there.'

²⁸⁵ Ross, *Physics ad locum* and 715, adds τὸ before λευκὸν, because he wants <τὸ> λευκὸν to be the subject with ἐφθείρετο, as in 264b3 and 5; but λευκὸν alone can be used predicatively in this context, as appears from *Physica* 8.3; 254a12-14: εἰς δὲ μὲν γὰρ μεταβάλλει, γίγνεται τοῦτο ἢ ἐν τούτῳ, ἐξ οὗ δὲ μεταβάλλει, φθείρεται τοῦτο ἢ ἐντεῦθεν, where the last τοῦτο must stand for a predicate, just as ἐντεῦθεν stands for a position.

²⁸⁶ We definitely should follow manuscript E and insert εἰ ἦν after ὥστε, as already suggested by Cornford in his additional notes in Ph.H. Wicksteed and F.M. Cornford (transl.), *Aristotle: The Physics II* (Cambridge, Mass. and London, 1955) 384-385, note b. For a justification, see the next note.

²⁸⁷ *Physica* 8.8; 263b9-26. To justify my deviation from Ross' text and my translation of the last few lines, let me consider two alternative translations. Graham, *Physics Book VIII* 28, following Ross, *Physics* 449 and 715, and Wagner, *Physikvorlesung* 257, takes the clause 'white or not white' in b23 as including a reference to the opposite change from not-white to white, and translates:

Moreover, also in the subsequent passage against time-atomism there is a similar suggestion that there is a time of the process of change alone. For the sake of reference I repeat the argument:

(III) But if something which, while earlier not being, is ($\delta \delta \nu \eta \eta \pi \rho \acute{o} \tau \epsilon \rho \nu \mu \eta \delta \nu$), must be becoming being ($\gamma \acute{\gamma} \nu \epsilon \sigma \theta \alpha \iota \delta \nu$), and [it is the case that] when it is becoming, it is not, it is not possible to divide time into atomic times. For if in A it was becoming white, and it has become at the same time as it is in a different, but contiguous time, in B – if in A it was becoming, it was not, while in B it is –, there needs to be some becoming ($\gamma \acute{\gamma} \nu \epsilon \sigma \tau \iota \nu \alpha$) in between, so that there [is] also a time [sc. in between] in which it was becoming.

(IV) For there will not be the same argument too for those who deny that there are atoms. Rather in the last point of the time itself in which it was becoming, it has become and is – to which point there is nothing contiguous or successive. Atomic times, however, are successive. And it is clear that if in the whole time A it was becoming, there is not a time in which it has become as well as was becoming [which is] greater than [the] whole [time] in which it was only becoming.²⁸⁸

What does it mean to say, as Aristotle does in (I): ‘in the whole [time] .. with the exception of the final now, indicated by C’? And the same question can be asked about the phrase ‘[the] whole [time] in which it was only becoming’ in (IV). A frequently given answer is that here Aristotle is assigning ‘in reality’, as $\tau \acute{\omega} \pi \rho \acute{\alpha} \gamma \mu \alpha \tau \iota$ is often translated, the point which divides two periods and limits a period of changing in relation to the next period, to the later period. Thus Aristotle would conceive here of something like a half-open interval.²⁸⁹ And even if one does not translate $\tau \acute{\omega} \pi \rho \acute{\alpha} \gamma \mu \alpha \tau \iota$ as ‘in reality’, but as referring to the state of the object, as I do,²⁹⁰ the point remains that for the object the dividing point C belongs to the later affection, for in that point it has first become and therefore is *F*, just as in the period starting from C; and that the object is not changing any more when it is in that

And if not white was coming to be and white was perishing in the whole period of A, not white *has* become, and white *has* perished at C. So it was first true to say that it was white or not white at that time; otherwise, when it has come to be, the white [this should be: *the not-white* – P.S.H.] will not exist, and when it has perished, it [sc. the white] will exist; or it must be white and not white at the same time, and in general existent and non-existent.

The problem is that such a reference is very much out of place. Hence the alternative offered in CWA 440, which gets rid of the reference to a reversed change by ingeniously omitting $\lambda \epsilon \upsilon \kappa \acute{o} \nu$ at line 23:

[A]nd if in the whole of A not white was becoming and white perishing, at C it had become or perished. And so either that is the first moment at which it is true to call the thing not white; or a thing may not be at the moment when it has become and may be at the moment when it has perished; or else things must at the same time be white and not white and in general be and not be.

Against the latter alternative, it should be said that one had better insert words which are attested in the manuscript tradition than omit a word. Against the former alternative, one may point out that adding $\epsilon \iota \eta \nu$ has the further advantage of making possible a translation along the lines proposed by Wicksteed and Cornford, *Physics* 384–385: instead of a dilemma, there is here a trilemma, of which the first alternative is the one to be accepted, while the other two are clearly absurd. (Graham’s criticism (*Physics Book VIII* 145) is based on his erroneous translation of the second alternative – see above.) The addition of $\epsilon \iota \eta \nu$ makes it possible to take some underlying object to be the subject of the change, not specifically ‘[the] white’, as Wicksteed and Cornford actually translate.

²⁸⁸ *Physica* 8.8; 263b26–264a6

²⁸⁹ This interpretation one can find in Graham, *Physics Book VIII* 28 and 144, Charlton, ‘Potential Infinites’ 136–137, Bostock, ‘Continuity’ 184 note 10, White, *Continuous* 57, W. Wieland, *Die aristotelische Physik. Untersuchungen über die Grundlegung der Naturwissenschaft und die sprachliche Bedingungen der Prinzipienforschung bei Aristoteles* (Göttingen, 1970) 313, and Ross, *Physics* 448; cf. CWA 440 at 253b21: ‘C already belongs to the later period’; cf. also P. Bartha, ‘Monstrous Neighbors or Curious Coincidence: Aristotle on Boundaries and Contact’, *History of Philosophy Quarterly* 18 (2001) 1–16, at 4, 8 and 11.

²⁹⁰ Following older translations and commentaries, like Ross, *Physics* 714, Wagner, *Physikvorlesung* 256, CWA 440, and Wicksteed and Cornford, *Physics* 383; cf. also Strobach, *Moment of Change* 55–56.

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point, but it is changing up to that point. Still the process of changing and of the earlier state of the object seem to exist over a period of time without a final point.²⁹¹

To understand what is going on in these paragraphs, we had best start with two allegedly remarkable features of Aristotle's argument here. First, it is sometimes said that in (I) Aristotle allows for the possibility of instantaneous change²⁹² or that in (II) and (III) he conceives of a process of change without any real change happening, so that the only real change occurs at the moment of transition.²⁹³ Thus Aristotle would be deviating from his doctrine developed in *Physica* 6 that a change between contradictory states requires a process during which the changing object gradually, part by part, changes from the one state to the other.²⁹⁴

A second point on which the argument of *Physica* 8.8 is often taken to depart from what Aristotle has said in *Physica* 6 is that in (I) and (II) he holds that in the now dividing two states the object must be in one of these two states, whereas in *Physica* 6.3 he rejects this principle:

If the now in both times is the same, and it is possible to move over the one [time] as a whole and to rest over the other [time] as a whole and that which moves during a time as a whole (τὸ ὅλον κινούμενον τὸν χρόνον) will move in any of the [parts] of that according to which it is of such a nature as to move (ἐν ὅμοιῳ κινήσεται τῶν τούτου καθ' ὃ πέφυκε κινεῖσθαι),²⁹⁵ and what rests will rest in the same way, it will follow that the same thing rests and moves at the same time. For the now is the identical extremity of both times.²⁹⁶

For what is the difference between a state of being white or not-white and a state of being in motion or at rest?²⁹⁷

§ 5.3.2.1. Change between contradictory termini

To start with the first of these two points, I do not think that there is any reason to assume that Aristotle envisages in (I) and (II) a change which in effect only takes place at an instant. For one, Aristotle himself uses in (II) the imperfect ἐγίγνετο and ἐρθεῖρετο, so that he must envisage a process of change. Second, also in (I) a process of change seems

²⁹¹ Cf. White, *Continuous* 51.

²⁹² Waterlow, *Nature, Change, and Agency* 155; cf. Heinaman, 'Alteration' 254; cf. Graham, *Physics Book VIII* 146.

²⁹³ Sorabji, *TCC* 411 and 423.

²⁹⁴ In *Physica* 6.4; 234b10-20 Aristotle proves the divisibility of the changing subject on the basis of this doctrine. In *Physica* 6.5; 236b4-8 he is apparently referring to the same idea when he remarks that though the quality may not be divisible, that to which it belongs is.

²⁹⁵ As Wagner, *Physikvorlesung* 622-623, points out, if the final clause καθ' ὃ πέφυκε κινεῖσθαι is understood as referring to ὅμοιῳ and thus restricting the application of moving to periods (as it does in *Physica* 6.3; 234a32-34 and 6.8; 239a13-14), it appears to be out of place. Nevertheless, he himself (157) as well as CAW 395, Cornford and Wicksteed, *The Physics* 123, Ross, *Physics* 407, Simplicius, *In Physica* 961.25-962.13, and Philoponus, *In Physica* 805.9-12, do take it to be restrictive in this way. The best solution, however, would be to translate as I do and then to understand 'that according to which it is of such a nature as to move' as one whole clause which does not refer anaphorically to χρόνον, but constitutes an independent clause. In this way there is no problem with the fact that ὃ is a neuter form, for a τούτου which does not refer to χρόνον need not be masculine. The clause can thus be understood as pointing out that it is part of the meaning of the premiss that the object moves in any of the parts of the whole time of motion, that it is of such a nature as to move in such a part.

²⁹⁶ 234a34-b5. As we saw on p. 111, this argument is meant as a *reductio* of the supposition that there is rest or motion in an indivisible now. Aristotle takes the conclusion that it both 'rests and moves at the same time' as absurd.

²⁹⁷ See Waterlow, *Nature, Change, and Agency* 155, Bartha, 'Monstrous Neighbors' 9-10, Bostock, 'Continuity' 211; cf. Sorabji, *TCC* 412.

The end of motion

presupposed, because only the presence of a chain of being white – changing to not-white – having changed to not-white – being not-white can take away the arbitrariness of assigning the boundary C to the later affection. For only jointly do the two aspects of a change, the one indicating the process, the other its result, ensure that it follows that the object is not-white at C, since without process there might not be a first instance of having changed at all.

Moreover, we have Aristotle's own word for it that even a change between contradictory states is not instantaneous:

Nor then will there be anything impossible for us with regard to change in a contradiction, for instance that if [something] is changing from not-white to white and is in neither [state], it will therefore be neither white nor not-white. For it is not the case that if it is not as a whole in either [state], it will not be called white or not-white. For we call [something] white or not-white, not because it is as a whole thus, but because most of its parts or its most proper parts [are thus]. But it is not the same not to be in that and not to be in that as a whole.²⁹⁸

One should be careful in interpreting this passage. It ought not to be understood as saying that a change between contradictory states is in fact not a change between contradictory states at all, but one between the contrary states of being to some extent not-*F* and being to some extent *F*.²⁹⁹ First, this would destroy altogether Aristotle's distinction between the two types of change, and, second, it would contradict Aristotle's representation of a change from not-being to being as one without something in between, on which he relies in *Physica* 6.5³⁰⁰ and *Physica* 5.1. On the other hand, one should also avoid an interpretation according to which something changing from not-white to white has already come to be white as soon as it has reached the point at which it can be called white for the most part or for the most proper part,³⁰¹ and according to which nothing really happens with respect to changing from not-white to white both up to the point of transition and from that point. For then Aristotle would in fact be conceding that such a change, including a process of change, is troublesome for him. Moreover, in *Metaphysica* α.2 Aristotle makes it quite clear that 'what is coming to be is always between what is and what is not.'³⁰²

Thus there seems to be a dilemma here: in order that there be a process of coming to be from not-white to white, there must be something in between the termini, but there cannot be anything between two contradictory termini. And as shown, there is evidence for both horns elsewhere in Aristotle's works. Also in the passage itself we may discern the same dilemma. On the one hand Aristotle wants there to preserve the general framework of a change from not-white through an intermediate process to white, so that he must hold what is in process to be in neither terminus. On the other hand, he must maintain that there is nothing in between and that during the process the object must be in one of the two contradictory states. He does so by explaining that at the termini the object is wholly white or not-white, while in between it is still either white or not-white, but not in the same way as in the termini. For it is not wholly white or not-white, but to such an extent that it can be called white or not-white, by whatever criterion. However,

²⁹⁸ *Physica* 6.9; 240a19-26

²⁹⁹ As Bostock, 'Continuity' 198-199, does.

³⁰⁰ 235b6-17, discussed above pp. 159-161.

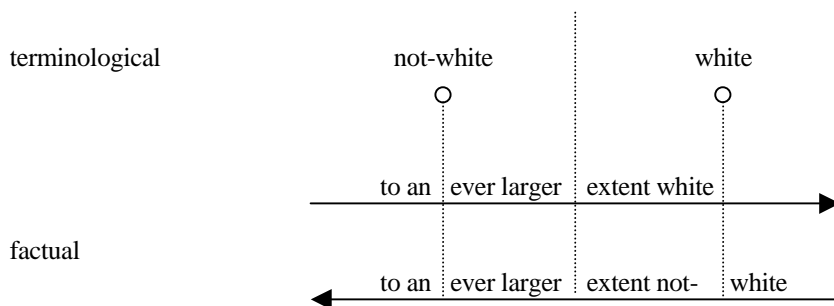
³⁰¹ As Heinaman, 'Alteration' 237, construes it.

³⁰² 994a27-28; for the full context, see above p. 176.

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such an explanation seems to undermine the very conception of a change between contradictory termini.

The only way to escape from this dilemma, it seems to me, is to distinguish between two levels of description, which one may call the factual level and the terminological level. On the factual level it is completely clear how Aristotle envisages this change. First the object is wholly or to a large extent not-white, then gradually a larger and larger part of it becomes white, until finally it is to a large extent or even wholly white. On top of this factual level, so to speak, there is a terminological level, which is the level on which the change is described as being between contradictory states. These two levels are related to each other by way of a cut-off point, which is *stipulated* (according to some criterion) on the factual level. Up to this cut-off point the factual terminus of the change can be characterized terminologically as not-white, and from this cut-off point the factual terminus of the change can be characterized terminologically as white. Thus the situation may be represented as follows:



The dilemma then arises by confusing the two levels. If one mistakes the terminological level for the factual level, one wonders what kind of change is going on up to the cut-off point or from that point. If, on the other hand, one mistakes the factual level for the terminological level, one is forced to conceive of a change between contradictory termini as one which in reality is between contrary termini.

There is evidence that also Aristotle implicitly draws this distinction between two levels. For example, he mentions two alternative criteria for calling something white or not-white. This indicates that it does not matter where the cut-off point is, as long as there is one. The criterion could just as well be that something is white when and only when it is wholly white. And it is such a criterion, which lets the cut-off point coincide with the end of the change, which Aristotle seems to have in mind in *Physica* 8.8, when he *stipulates* in (III) that 'when it is becoming [white], it is not [white].'³⁰³ This relative independence of the terminological level from the factual level, which must always stay the same, provides enough basis for ascribing the distinction between the two levels to Aristotle himself. Further support is provided by the consideration that drawing this

³⁰³ For unlike the proposition that 'something which, while earlier not being, is, *must* be becoming being,' this part of the antecedent is not modally qualified.

distinction is the only sensible way to explain how Aristotle can assume in (III) that during the whole process of becoming white the object is actually not-white.³⁰⁴

Drawing the distinction between the two levels, however, will in itself not be enough. For does Aristotle himself not say that ‘what is coming to be is always between what is and what is not’? Where is it then, if it can only be in what is or in what is not? Moreover, is this distinction not some kind of trick to get rid of the problem, without any real contents? For had we not better stick to the facts, rather than let ourselves be beguiled by terminology? And on the factual level there is merely a change between contraries, not between contradictories.

To answer these objections, we must back this distinction up by making two points. First, we could repeat the whole discussion for a change from *not wholly* white to *wholly* white, where the cut-off point is determined by the facts and not by some external criterion. Then we would still have to posit on the factual level a process of becoming to an ever larger extent white. For it is the nature of changes between contradictories that at least one of the termini as phrased on the terminological level (e.g. not (wholly) white) is underdetermined on the factual level (to what extent not (wholly) white?). Secondly, and more importantly, we must draw a further distinction, in order to explain where the object which is coming to be is, if not in what is or in what is not, namely a distinction between two ways of being somewhere or in some state. In the example of (III), in one sense the object is up to the end of the change, both when the change is going on and before, in the state of not being white. In another sense, however, it is only in that state up to the time of change itself, and not in that state from the moment the change started, for if we consider the period before, it is in that state for some period of time and not for just an instant. Conversely, for the same reason it is only from the end of the change onwards that the object is in the state of being white, and not before, even if the cut-off point is somewhere in the middle.

That Aristotle does indeed draw this further distinction, I shall document in § 5.5. But it will be clear that with this distinction in hand, Aristotle can defend the thesis – which is at first sight paradoxical – that during a process of change an object can still be in the state it is changing from. Thus full-blown change between contradictory termini becomes a real possibility, even if, as in *Physica* 8.8, the transition only occurs at the end of the change.³⁰⁵

§ 5.3.2.2. Between rest and motion

The second problem raised concerned the thesis of *Physica* 8.8 that the object is white or not-white, and not neither, at the instant of transition. How can Aristotle then in *Physica* 6.3 in an apparently completely parallel case assume that an object, since it cannot be both in motion and at rest at the instant of transition, it is neither in motion nor at rest at that instant? To get a grip on this problem, it will be fruitful to consider two other arguments

³⁰⁴ Waterlow’s solution (*Nature, Change, and Agency* 157), to locate the process in the preparations made by the agent before bringing about the instantaneous change, seems contrived.

³⁰⁵ We also have here a possible explanation as to why Aristotle in *Physica* 6.5; 235b17-19 feels justified in generalizing the result that what has changed is in that to which it has changed, obtained in the case of a change between contradictories, to all kinds of change. For on this account every kind of change is like a change between contradictories in that the object either is in the one terminus or in the other, since it cannot really be, in a full-blown sense, in between.

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where similar issues play a part, couched in terms of bodies having colours. The insights derived from their discussion can then be applied to the arguments of *Physica* 6.3 and 8.8.

§ 5.3.2.2.1. Coloured indivisibles

The first of these analogous arguments is one which does not actually occur in Aristotle, but is a translation of the argument of *Physica* 6.3 into terms of bodies having colours:

If the plane of contact of the two bodies is the same, and the one body as a whole is yellow while the other body as a whole is blue, and that which is yellow as a whole will be yellow in any of its parts, and what is blue will be blue in the same way, it will follow that the same thing is yellow and blue. For the plane of contact is the identical extremity of both bodies.

However, in this case Aristotle could not have agreed with the implied conclusion that the bodies are neither yellow nor blue at the plane of contact, for as he himself often repeats, colour inheres in the surface of a body.³⁰⁶ For the same reason he could not have opted either for the approach of *Physica* 8.8, assigning the plane of contact to one of the colours, as it would give one of the bodies a surface which is differently coloured. Moreover, there would be no reason to opt for the one colour rather than the other. Following these considerations, then, Aristotle must have thought that there are two incompatible colours inhering in one plane of contact. But how could he ever have maintained such a self-contradictory position?

To add to the mystery, Aristotle himself presents in *De Sensu* 7 an argument with the same structure as that of *Physica* 6.3, now with the predicates *visible* and *invisible*, in which he endorses the conclusion that indivisibles, like planes, are not suitable for either being visible or being invisible:

That everything perceptible is a magnitude, and that [something] indivisible is not perceptible, is clear. For the interval from whence it cannot be seen is unlimited, while [the interval] from which it is seen, is limited (ἔστι γὰρ ὅθεν μὲν οὐκ ἂν ὁφθεῖται ἄπειρον τὸ ἀπόστημα, ὅθεν δὲ ὁράται, πεπερασμένον). .. There is then some extremity of the interval from whence it is not seen, and a first from whence it is seen. This must then be indivisible, and if [the object] is in [the interval] beyond it, it cannot be perceived, while [if it is] in [the interval] on hither side of it, it must be perceived. If then something indivisible is perceptible, [then] when one places it at the extremity from whence as a last [point] it is not perceptible and as a first [point] it is perceptible, it will follow that it is at the same time visible and invisible. But that is impossible.³⁰⁷

But surely it is because of being coloured that objects are visible, and colour inheres in indivisible surfaces. As Aristotle should apparently therefore not agree with the assumption that from the impossibility that an indivisible is both visible and invisible, it follows that it is neither visible nor invisible, this argument does not seem sound.³⁰⁸

So there are in fact two arguments, both of the same pattern as that of *Physica* 6.3, which seem to make it impossible for Aristotle to hold on to his idea that colour inheres in the indivisible surface of a body. Nevertheless Aristotle is very explicit in stating this doctrine that colour inheres in a limit-entity, even though in *Physica* 6.3 he rejects the analogous position, which would allow for being at rest and being in motion at an

³⁰⁶ E.g. *Metaphysica* Δ.18; 1022a30-31 and *De Sensu* 3; 439a31-32; cf. *Metaphysica* Ζ.4; 1029b16-18.

³⁰⁷ 449a20-31

³⁰⁸ The charge is Sorabji's, in *TCC* 416.

instant. What is so special about coloured objects, which does not apply to rest and motion in a time?

The only place to look for an answer is the discussion of colour in *De Sensu* 3. There Aristotle expounds the theory that both light and colour are manifestations of the same nature, which he calls ‘the transparent’ (τὸ διαφανές). This nature is present in all bodies, both really transparent and opaque, or to use Aristotle’s terms, both indeterminate (ἀόριστα) and determinate (ὀρισμένα).³⁰⁹ The former kind of bodies, like air and water, can be light or dark, and do not have a colour of their own, but change their colour depending for example on the distance. The latter kind do have a colour of their own. But in both kinds of bodies colour belongs to them at the extremity³¹⁰:

Since the colour (ἡ χρώα) is in a limit, it would be in a limit of this [sc. the transparent to the extent it is present in the bodies]. Hence colour (χρῶμα) would be the limit of the transparent in a determined body. But both the transparent [bodies] themselves, like water and if there is anything else like that, and [the bodies] to which a proper colour (χρῶμα ἴδιον) appears to belong – to all [of them colour] belongs in the same way at the extremity (κατὰ τὸ ἔσχατον ὁμοίως πᾶσιν ὑπάρχει).³¹¹

The most important point here is that colour is defined not in terms of the limit of the body, but in terms of the limit of the transparent. And it is the transparent which is primarily responsible for the colour of an object (and in the case of really transparent objects, also for it being light):

Colour is either in the limit or is a limit. .. For on the one hand (μὲν) it is in the limit of the body, and [is] not the limit of the body [itself]. Rather one should take the very same nature which is coloured on the outside, also to be coloured inside (ἀλλὰ τὴν αὐτὴν φύσιν δεῖ νομίζει ἥπερ καὶ ἔξω χρωματίζεται, ταύτην καὶ ἐντός). On the other hand (δὲ), also air and water are in their appearance coloured (φαίνεται χρωματιζόμενα). For also their gleam (ἡ ἀγλή) is like that. However, in that case, because of the [transparent present] in an indeterminate [body], neither air nor the sea have the same colour from close up, for those approaching, and from further away, while in the case of the [other] bodies the appearance of the colour (ἡ φαντασία τῆς χρώας) is determined, unless what surrounds makes it change. Therefore it is clear that both in the former and in the latter case the same [sc. the transparent] is receptive of the colour. Therefore the transparent, to the extent it is present in the bodies (for it is present to a higher or lower degree in all), makes them participate in colour.³¹²

³⁰⁹ It may be that Aristotle calls the transparent objects indeterminate because he is only thinking of water and air. For these are ‘wet’, which according to *DGC* 2.2; 329b30-31 is ‘indeterminate in its own boundary, though easily determinable’ (τὸ ἀόριστον οἰκείῳ ὄρω εὐόριστον ὄν). But that does not mean, as Bartha, ‘Monstrous Neighbors’ 11, thinks, that indeterminate bodies altogether lack their own limit, only that their boundary, which they clearly do have, is easily malleable. Indeed, in his own discussion of place in *Physica* 4.1-5 Aristotle gives water and air as examples of bodies which are in place, and thus are bodies whose limits are together with the limits of the surrounding body. Moreover, it is not certain that the pair ‘indeterminate’ – ‘determinate’ of *De Sensu* 3 returns in the passage of *DGC* 2.2. First, did Aristotle not know of hard transparent objects? Yet *indeterminate* in *De Sensu* 3 seems to coincide with *transparent*. Secondly, in *DGC* 2.2 dry, the opposite of wet, is not called ‘determinate’ but ‘easily determinable in its own boundary, while difficult to determine (δυσόριστον) [sc. from outside]’ (b31-32).

³¹⁰ It is this point which Bartha, ‘Monstrous Neighbors’, has missed, so that he thinks there is room for ascribing to Aristotle the account that only determinate bodies have a coloured limit.

³¹¹ 439b10-14

³¹² 439a30-b10

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And if the transparent has a limit, it has extension, being coextensive with the body in which it is present. Though it is only visible at the surface of the body, it is not the limit of the transparent at that surface which *for itself* is responsible for the colour, but only incidentally, through the extended quantity of the transparent in the body whose limit it is. Thus the transparent magnitude is primary and the limit which is the colour secondary.

This result justifies Aristotle's assumption in the argument of *De Sensu* 7 that from the impossibility that an indivisible is both visible and invisible, it follows that it is neither visible nor invisible. For in that argument the indivisible object is not an indivisible entity like a surface or a boundary belonging to a body, but an indivisible which is independent of any body. Thus a body whose nearest surface coincides with the line of demarcation would be invisible, whereas a body which only for the tiniest part crosses that line, would be visible.

The same result also makes it possible to deal with the other argument, the translation of *Physica* 6.3 into terms of two differently coloured objects. For if colour does not inhere in just any indivisible, but only in the limits dependent on the whole body (just as colour itself is dependent on the transparent in the body), then the way is open to apply to this case Aristotle's conception of two touching, but not continuous bodies: they have their separate boundaries together in one plane of contact. Thus it is not the plane of contact in which two incompatible colours inhere, but the separate, though coinciding, surfaces.

§ 5.3.2.2.2. *The limit of rest and motion*

Bringing to bear this distinction between indivisibles taken as independent of bodies and indivisibles which are limits dependent on the whole body to which they belong, we can assess the argument of *Physica* 6.3 (quoted on p. 180) in the following way. Just as in *De Sensu* 7 Aristotle assumes here for *reductio* that the now which is common to both periods is an independent entity which happens to be part of both periods, and in which therefore the same states can obtain as in the whole period. This assumption leads to a contradiction, so that there cannot be motion or rest in the now *considered as an independent indivisible*. But there is nothing further to be derived from the argument, in particular nothing about the possibility of motion or rest in a derivative sense, that is, the possibility of being in a *state* of motion or rest, in the now.³¹³

However, the very same distinction obliges us to ask two further questions. (a) Would it be possible for Aristotle to argue, just as he does in the case of two coloured surfaces coinciding at one plane of contact, that at the now there are two coinciding temporal limits in which the object is both in a state of motion and a state of rest (in a derivative sense)? (b) Given that in *Physica* 8.8 (quoted on p. 178) the argument of (I), and in a less obvious way that of (II), exhibit the same pattern as that of *Physica* 6.3, but draw the different conclusion that at the moment of transition the object is one of two states, what constitutes the difference between the arguments?

The answer to the first question must be a clear *no*. The reason is that two periods of time cannot be related in the way two contiguous objects are related, as having their boundaries together without them becoming one. For in order to distinguish the two surfaces one must refer to the separate bodies to which they belong. The two periods of

³¹³ As Sorabji, *TCC* 408, and Bostock, 'Continuity' 211, think.

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time, however, are not separate in that way, but form one continuous whole. Aristotle states this very clearly:

[Different motions] are contiguous and successive because the time is continuous. But [there is only one] continuous [motion] because the motions are continuous, i.e. when the extremities of both become one.³¹⁴

And in general Aristotle holds time to be continuous and one, being merely potentially divided by a now, and whose parts are united by the same now, which is the limit of both.³¹⁵ Probably one of Aristotle's most important considerations for holding that time is continuous is that it is shared as a medium by many events 'at the same time', which all have beginnings and endings and a continuous stretch in between, but whose termini do not necessarily coincide. Yet if the time of one event were divided by the ending of another, it would not be one continuous event any more.³¹⁶

So stretches of rest and motion may be successive, and thus divided from each other, but the time is not really divided in this way, forming an underlying continuum. Later, in Chapter Four § 1.2, we shall see that in similar circumstances Aristotle uses the language of 'using one point as two', namely as end-point of one stretch and as starting-point of another stretch; we may imagine this use to be accompanied by the use of the one continuous stretch in two different, consecutively ordered, ways. In (I) in *Physica* 8.8 Aristotle expresses this by insisting on the point common to the period of being white and the period of not being white being one in number, though two in account, as end-point for the one event and starting-point for the other event. Similarly the basic premiss in the argument of *Physica* 6.3 is that the now is the one limit of both. Thus the one point is prior and its (possible) function as end- or starting-point secondary. With independent bodies the situation is the reverse: each body has its own boundary which only belongs to that particular body. These boundaries may coincide without becoming one – as we saw above, p. 144, this is called 'touch'.

For the same reason, the option that the now of transition between being white and not being white is a now in which both states coincide, is closed. But what then is the reason to assign that now to the second state? And why can the same strategy not be followed in the transition from motion to rest?

In fact I have already given the answer to the first question. For on pp. 180-181 I stated that in (I) a process of change seems presupposed, because only with such a process is there a reason to assign as a general rule the boundary C to the later affection rather than to the earlier. On the from-to conception of change, which involves a process of change to a state of completion in which the result of the change obtains, the now which is com-mon to both periods is one in which the goal of the change has been reached: the later affection. We also have Aristotle's own word for it in terms of the extremity, that is, the limit of a change:

The contrary is the extremity of the change,³¹⁷

³¹⁴ *Physica* 5.4; 228a30-b1; cf. b7-9 and perhaps *Physica* 8.8; 264b6-7.

³¹⁵ *Physica* 4.13; 222a10-20

³¹⁶ See *Physica* 4.10; 218b10-13, 4.12; 220b5-12 and especially 4.14; 223a33-b12.

³¹⁷ *Physica* 5.3; 226b26-27

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the contrary being the state at the end-terminus of the change.

With the transition from motion to rest, on the other hand, there is no such ground for assigning the instant to the rest alone, because there is no real change with a process between two termini involved. There is nothing more than a period of motion followed by a period of rest. For this thesis Aristotle argues extensively, though not always very clearly, in *Physica* 5.2. Of the several arguments he provides there, two deserve special mention. The first is that if there were a change to a change, there would be an infinite regress, the change ultimately meant to be brought about being postponed for ever.³¹⁸ The second is simply that change cannot serve as one of the termini of a change.³¹⁹ Both of these arguments are just developments of the basic from-to conception of change, which on the one hand requires there to be instantaneous states to serve as termini, and on the other hand rules out that changes are such instantaneous states.

§ 5.3.2.2.3. *Three objections considered*

Finally I should discuss three arguments which seem to suggest that Aristotle himself did not adhere to the ideas as set out above. Thus these arguments could serve as objections to my account as to why the argument of (I) in *Physica* 8.8 cannot be translated into terms of a transition between motion and rest.

The first argument appears in a passage in *Physica* 6.5, where Aristotle might seem to accept rest at the last instant of a period of rest:

Let there be a primary [part of time in which something was changing], indicated by AD. On the one hand, this [part of time] is then not indivisible, because it will follow that the nows are contiguous. Furthermore, on the other hand, if it rests in the time CA as a whole (let it be supposed that it rests), it also rests ($\eta\rho\epsilon\mu\epsilon\iota$) in A, so that if AD is partless, it will rest and will have changed at the same time. For it rests in A, while it has changed in D.³²⁰

This passage has been interpreted as evidence that Aristotle is attracted after all to the view that the instant of transition, at least from rest to motion, is one of rest itself.³²¹ On the other hand, there have also been attempts to explain the passage in such a way that that remarkable conclusion is avoided. It has been proposed, for example, to take it as an *ad hominem* argument against a time-atomist, so that the assumption that the instant A, which Aristotle takes to be the common boundary of the atom of rest CA and the atom of motion AD, is an instant of rest, would not be Aristotle's but that of his opponent.³²² This attempt, however, does not go far enough in two respects. First, it leaves intact the inference from rest over a period to rest at an instant – an inference, moreover, a real time-atomist is not very likely to make. Second, it assumes that Aristotle is only arguing against there being a primary time of change with real size, and not more generally against there being any indivisible primary time of change. But in Aristotle's actual argument the size does not play

³¹⁸ 225b33-226a6

³¹⁹ 225b20-21

³²⁰ 236a15-20

³²¹ R. Sorabji, 'Aristotle on the Instant of Change', in: J. Barnes, M. Schofield and R. Sorabji (eds.), *Articles on Aristotle* 3. *Metaphysics* (London, 1979) 159-177, at 172-173. Cf. also Ross, *Physics* 650, who thinks that a more correct translation of $\eta\rho\epsilon\mu\epsilon\iota$ here would be: 'is not in motion in A', on the grounds that according to Aristotle there is neither rest nor motion in an instant, thus in fact acknowledging that as it stands, Aristotle does say here that there is rest at an instant.

³²² Thus Sorabji, recanting, in *TCC* 415, note 17, followed by Bostock, 'Continuity' 193.

any part, so that it may even be read as an independent argument for the impossibility of motion in an indivisible now.

Rather than arguing *ad hominem* against a time-atomist, Aristotle seems to me to be applying his own scheme in order to establish by reduction the thesis he wants to prove. I present my interpretation in three steps. (i) Saying that there is a primary, indivisible time of change implies that there are two indivisible times next to each other, as Aristotle says in his first point: before the indivisible time of motion there must be an indivisible without motion. That does not mean, however, that Aristotle assumes that the time CA is itself indivisible; that is not very likely, since he is talking about about that time 'as a whole'. But that time must have a last indivisible part – let us call this part C'A. (ii) These two indivisibles Aristotle then *represents* as a kind of atoms, because he wants to talk, in line with the argument from *De lineis* discussed in § 4.2.2, about the intercontact A between the two consecutive indivisibles AD and C'A. (iii) Moreover, he seems to use ἡρεμεῖ and μεταβεβληκός in the same way as he does in paragraph (3) of the second argument of *Physica* 6.1, quoted at the beginning of § 5.2 and explained in § 5.2.2: the object rests or has changed in relation to a point of a reference, so that ἡρεμεῖ and μεταβεβληκός function as terms indicating the place of the object. If then indivisible C'A is one of rest, the object will be after that indivisible and before the next indivisible AD, still be in the same position: in A it rests.³²³ The next indivisible AD is one of motion, so the next intercontact D is one of having changed,³²⁴ that is, not being any more in the same state as before. But since A and D are intercontacts of the same indivisible, they must coincide, with the absurd consequence that at the same time something is and is not in the same state as before.

Interpreted in this way, the argument applies to indivisibles in general, just as in the two parallel passages referred to. And even more importantly, there is no inference from rest over a period to rest at an instant, but merely the inference to still remaining in the same state after a time of staying in the same state.

A second problem is that Aristotle himself in *De Caelo* 1.11 accepts that coming into touch is not a change involving a process, but is merely a matter of one time not being and at another time being (see p. 162). But surely there is a first moment of being in touch? So why would we need a process of change to take away the arbitrariness in assigning the now to either state?

In response to this objection it should be pointed out that coming into contact involves a transition from an underdeterminate state of not being in touch to a determinate state of being in touch: there are many positions, ordered along a continuum, which are a state of not being in touch, and only one specific state of being in touch. It is because the end-state is determinate that there is a first moment of being in touch, so that we may assign the moment of transition to that state. The same applies to all transitions to a state specified determinately, like being equal to something else or being half white, but not to transitions to states like exceeding something else or being more than half white. So not all transitions involve a first moment of the later state. Yet in (I)

³²³ Such an explanation probably also guides Wicksteed and Cornford, *Physics* 143, and Wagner, *Physikvorlesung* 162, in translating ἡρεμεῖ with 'being unchanged' (or later 'will not have begun to change') and 'unverändert' respectively.

³²⁴ It should be noted that only thus the shift in the discussion from a primary time in which the object *was changing* to the fact that in D it *has changed*, can be explained.

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of *Physica* 8.8 Aristotle defends the general thesis that with transitions between contradictory states the moment of transition belongs to the later state. This generality can only be maintained if we suppose that he is talking about real changes. Moreover, within this account of a real change between contradictory states there is room for a changeless transition to the later state – it will be that transition Aristotle is thinking of when he conceives of coming into touch as a transition without change. For we have to distinguish between, on the one hand, a real change from not being in touch to being in touch on the terminological level, with an underlying change on the factual level between being so far away from the other object to being in touch with the other object, and, on the other hand, the transition on the factual level to being in touch. As long as they are imbedded in this way in a continuous change, Aristotle can allow for any instantaneous transition between states (not between motion and rest).

The first two arguments, then, can be interpreted in such a way that they cohere with the account given in the previous sub-sections. Things are different, however, with the third argument, which appears in *Physica* 6.8. For there Aristotle countenances *coming to a halt* (ἴστασθαι) as a process, taking place during the motion and resulting in a state of rest. (Aristotle even uses ἡρεμῖζεσθαι as a synonym for ἴστασθαι and describes the object at the end as ἡρεμοῦν.³²⁵) With this conception in hand, he might be thought to have the means to argue that at the moment of transition the object is at rest, having come to a halt and having come to rest. And we could easily imagine what such a coming to a halt amounts to: gradually losing its velocity until it has come to a standstill.³²⁶ However, not all is as it seems, as appears from what Aristotle says in *Physica* 5.6:

There is a puzzle whether there is coming to be of every rest (πάσης ἡρεμίας) which is not permanent, and [whether] that constitutes coming to a halt (ἴστασθαι). Of something remaining against its nature, e.g. of earth [remaining] up, there would then be a coming to be. Therefore when something was moving upward by force, it was coming to a halt. However, what is coming to a halt always seems to be moving faster,³²⁷ while the contra[happens to] what [is moving] by force. Therefore [what is moving by force] will be resting without that it came to be resting (οὐ γενόμενον ἄρα ἡρεμοῦν ἔσται ἡρεμοῦν).

Further, coming to a halt seems either to consist altogether in moving to its own place, or to happen together [with it].³²⁸

Aristotle reserves here the term ‘coming to a halt’ for a body’s motion to its natural place, e.g. a clod of earth going to the centre of the universe, distinguishing it from forced motion. And rather than gradually losing its speed the object which is coming to a halt is moving faster. Indeed, one may even think that it is *because* it is gradually losing its speed that an object moving against its nature, like a clod of earth thrown up, is not coming to a halt or coming to rest. And in *Physica* 6.8 one can recognize the same conception of ἴστασθαι and ἡρεμῖζεσθαι, as is shown in the introductory clause of the chapter:

³²⁵ 238b23-26

³²⁶ Thus Strobach, *Moment of Change* 63; cf. Lear, ‘Zeno’s Arrow’ note 10; cf. also Sorabji, *TCC* 406, who argues on his own behalf that this is a reason to ascribe the moment of transition from motion to rest or *vice versa* as a moment of rest.

³²⁷ For the same doctrine, see also *De Caelo* 1.8; 277a28-29.

³²⁸ 230b21-28

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Since everything which has a certain nature either moves or rests when, where, and in a way it is of this nature (.. πᾶν .. τὸ πεφυκὸς ὅτε πέφυκε καὶ οὐ καὶ ὄζ), ...³²⁹

Why there is no coming to be of rest in the case of forced motion is not immediately clear. Equally remarkable is that Aristotle does accept the coming into being of rest in the case of natural motion, for that would entail that rest, at least in a natural place, is a state which can serve as a terminus of motion, or, to follow the qualification that coming to a halt may also ‘happen together’ with the motion, as a kind of secondary change, with a secondary terminus.³³⁰

We shall see later on, in Chapter Four, that elsewhere Aristotle demands that a state, in order to function as a terminus of change, be a state in which the object rests. But there he does not call the change a coming to rest, nor is there any other terminus than being in a certain state. Moreover, none of this would explain why only in the case of forced motion is there no coming to be of rest. Presumably Aristotle has other grounds in mind, of natural motion being directed from within to some goal, and of forced motion going against this inclination. In a sense, then, a body not in its natural place would not be at rest, as it has within itself a source of ‘unrest’. Likewise these grounds would explain why something going to its natural place goes faster and faster, while to something undergoing forced motion the opposite happens. The conclusion must therefore be that ‘coming to a halt’ and ‘coming to rest’, as well as ‘the coming to be of rest’ as used in *Physica* 5.6 and 6.8, have a special meaning which goes beyond Aristotle’s general account of change and rest and the transitions between them.³³¹

§ 5.3.2.3. No times without limits

In the previous two sub-sections we discussed Aristotle’s conception of change between contradictory termini and his ideas about the states which can and cannot obtain at the moment of transition. It appeared that in the case of a change from being white to not being white, we have to distinguish between the factual level, at which a change takes place from being to some extent white to being to some extent not-white, with all the intermediate stages (including a cut-off point) in between, and the terminological level at which the one terminus is termed ‘white’ and the other ‘not-white’ and the object while in change is in neither terminus, and therefore neither white nor not-white. This last point remains the case even though the object is factually still either on the one side or on the other side of the cut-off point, and thus would terminologically have been called ‘white’ or ‘not-white’ if there had actually been a terminus of the change at that point. Thus there are in a sense two transitions to not being white, which may or may not coincide: at the factual level at the cut-off point, and at the terminological level at the end of the process, when finally the object has become not-white. It also appears that because of this process and the resultant perfective state of not being white, the moment of transition at the terminological level belongs to the later state. In the case of a transition between motion and rest, however, there is no such process and therefore no resultant perfective state, so that the moment of

³²⁹ 238b23-24

³³⁰ Cf. *Physica* 5.6; 230a4-5 about all kinds of change, not just natural motion:

The motion to that itself in which it has come to a halt (ἢ εἰς αὐτὸ κίνησις ἐν ᾧ ἔστηκεν) is rather a coming to rest (ἡρέμησις), or at least happens to occur together with the motion.

³³¹ Perhaps we do therefore not have to suppose, as Wagner, *Physikvorlesung* 613-614, does, that the passage from *Physica* 5.6 represents an older stratum in Aristotle’s thinking.

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transition does not belong to rest or motion. Motion and rest, being conditions definitionally derived from states obtaining at moments (the termini), are themselves not such states.

This should give us enough ground to understand what exactly is going on in the four quoted paragraphs (I)-(IV) from *Physica* 8.8 (see pp. 178-179), and especially to answer the question whether Aristotle conceives of something like a half-open interval.

This last question already demands an immediate answer when we take up (I). For there Aristotle seems to be saying that the period in which something is white does not have a last limit, because at that limit it is already not-white. However, being white or not being white are not states which, like motion or rest, obtain primarily at the level of periods. They obtain primarily at moments, so that they can serve as termini of a change and be the instantaneous states resulting from the perfection of a change. The sense, then, in which we can talk about a period of being white or not being white, is secondary (unless we are in fact thinking of being white or not-white in terms of being at rest in such a state). Therefore we are allowed to talk about the whole period with the exception of its last now as the time-span in which something is white. The period itself keeps its last limit, and as a period is still of a period of being white, since any real part is a period of being white (in the secondary sense). But the now of transition, which also limits the later period of being not-white, is a now of being not-white (in the primary sense).

The context of change, which is implicit in (I), with the exception of a reference to the state of having come to be not-being, is fully explicated in (II). Aristotle takes it for granted that in the now of transition C between being white and not being white through a process of becoming not-white and of ceasing to be white, the object has come to be not-white and has ceased to be white. Then he sets up a dilemma: either (i) it is in C not-white and not white, or (ii) it is in C still white and is not not-white, even though it has come to be not-white and has ceased to be white, or (iii) it is both white and not-white in C. It will be clear that only (i) is acceptable.

If we then go over to (III) and (IV), we see an argument whose ostensive purpose is to show, on the basis of the premiss that any shift from not-being to being requires a process of change, that time-atomism is impossible, because it cannot meet that requirement, as well as that Aristotle's own account can accommodate this requirement. The problem with time-atomism, Aristotle argues, is that there is *last* indivisible time of not-being. Given that there is a first indivisible time of being (on that score the atomist and Aristotle are in agreement), there must be a process of change between that last now to that first now – which is impossible on the atomistic hypothesis of time consisting of consecutively ordered nows. On the other hand, Aristotle's continuist view of time rules out such a last indivisible time of not-being, and actually entails there being a process of change between any now in which the object is not and the first now at which it is. This process can only be provided by positing a gradual change on the factual level, along the lines of *Physica* 6.9.

Thus Aristotle defends an assumption underlying (I) and (II), that there is a unique now serving as a limit to both periods, that of not-being and that of being, and not two consecutive non-coinciding limits. Aristotle almost says this explicitly so in (IV). But that is in fact not the most important point of (III) and (IV), for if it were, Aristotle would not already in (III) have called so much attention to there being a time of becom-

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ing before there is a time of being. The issue he is concerned with is primarily that of the temporal relation between the process of change and its resultant terminus: can they occur in separate, consecutive times, so that there may be a process of change which is complete (in the sense of not going on any further) without including the state arrived at through the process? By way of the added stipulative premiss that during the process the object is not, Aristotle reduces this shift from process to resulting state to a shift between not-being and being: if there is a last now of the process, and thus a last now of the not-being, there must be, *per impossibile*, a process in between, that is, a process from not-being to being and therefore from process to resulting state. For Aristotle, however, there is no such problem, because for him there is no last now of not-being, or of the process in isolation from its resulting state.

Together with this point comes another point: a process of change requires a divisible period, for otherwise there is a last now of process. Thus the relation between the process of change and its resultive state is as that between a period and its limiting now. This allows us to answer whether Aristotle's way of expression in (IV): 'there is not a time in which it has become as well as was becoming which is greater than the whole time in which it was *only* becoming,' refers to a half-open interval. Just as with the time of being white in (I), this is not the case, though not for exactly the same reason. There was no half-open time of being white because being white is something which primarily obtains in nows and only secondarily in periods. Here there is no half-open time of the process because a process is something which only obtains in a period and not even secondarily in a now. Thus there is no problem with a period of a process including something which is not a process, but its resulting state. It is impossible to isolate the process from its resulting state, though as long as one remains on the level of a period, without distinguishing the termini from it, it is *only* a time of a process.

§ 6. Three themes together?

In § 2 I distinguished between three themes present in *Physica* 6: the appeal to proportionalities, the arguments based on the ordering of indivisibles, and the use of the perfect tense. In §§ 3-5 I have dealt with all three of these themes separately. In § 3 it was shown how, and on the basis of what assumptions, Aristotle employed proportionalities to establish correspondences between the media of motion with respect to (in)divisibility and being unlimited. Also Aristotle's categorical arguments for the ever-divisibility of these media were analysed. It was concluded that they tacitly presupposed the ever-divisibility of these media, by representing these media as line-segments bounded by points, and by assuming that every motion takes time and does not occur by jumps, an assumption which could only be justified by distinguishing nows within times. Both these presuppositions contaminate idea on which the proportionality-arguments are based, that motion consists in moving over structureless stretches of magnitude in a structureless stretch of time. In §§ 4-5, Aristotle's arguments about the relation between points and line-segments, nows and periods, and the completion of change and the preceding process were discussed. It appeared in § 4 that by insisting on the need for indivisible boundary-entities as entities different in kind from divisible magnitudes, Aristotle could argue for the ever-divisibility of all magnitudes (including time). In § 5 the from-to conception of motion as involving two termini, one of them being the terminus of completion, between which a process of motion

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occurs, served as Aristotle's ground for establishing that every motion takes a divisible time and does not occur by a jump. Thus Aristotle himself provides the arguments for the presuppositions of the use of proportionalities. As already indicated at the end of § 2, one may interpret this fact as a sign of awareness on Aristotle's part that the proportional arguments do not go to the heart of the matter with respect to the issue of the ever-divisibility of the media of motion.

Now the arguments discussed in § 4, based on the order of indivisibles, as well as the arguments dealt with in § 5, concerning the temporal relation between process and completion, are developed in almost complete isolation from each other. One could of course point out that the from-to conception of change can only be a base for the distinction between process and completion if the termini cannot be consecutive, but that is not something Aristotle makes explicit in these arguments. As is shown by the argument against time-atomism in *Physica* 8.8, Aristotle takes the relation between process and completion to be an independent ground for drawing the same conclusion as he does elsewhere on the basis of the order of indivisibles. For the rest, this lack of interaction between the two types of argument is hardly surprising, for the arguments based on the order of indivisibles are not about motion and change, but about the ever-divisibility of all kinds of magnitude in general, while the arguments concerning the relation between process and completion are primarily about motion and change, and hardly about the ever-divisibility of their media, let alone the ever-divisibility of motion and change themselves.

So as far as the arguments discussed in §§ 3-5 are concerned, the situation is that there are three isolated sets of arguments, one giving a sophisticated account of change, one establishing that magnitudes are ever-divisible and that indivisible limit entities are a special kind of parts, and one which, despite its bringing together the issues of change and of divisibility, does not take into account the results of the first two sets. However, in *Physica* 6.5, 6 and 8, we find a string of arguments which do seem to bring the three themes together. There we encounter arguments featuring proportionalities, frequent allusions to the impossibility of consecutively ordered indivisibles, and the from-to conception of change and motion, to some extent even worked out in the form of a distinction between the process of change and its completion.

None of these arguments, however, is very perspicuous, both in points of detail and in their interrelations. What actually holds these arguments together is that they are all concerned with the issue whether there is something primary to be found in change and rest or in their media. In order to appreciate them, it is necessary first to know what exactly it would mean to say that there is something primary. Having thus understood what is common to them, we must then study how the three themes distinguished in § 2 contribute to these arguments and how they are related to each other. To that purpose I shall discuss many of these arguments and try to analyse the concepts involved in them, doing so against the background of the results of the previous sections.

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§ 6.1. *Πρῶτον and πρότερον*

§ 6.1.1. *No temporal connotations*

With a few exceptions, most of these arguments are meant to secure the conclusion that there is nothing πρῶτον in change or one of its media (the ‘path’ of change, the time of change, and the object of change).³³² Occasionally this conclusion is phrased in terms of there being always something πρότερον in them.³³³ Up to now I have translated these terms in a rather non-committal way as ‘primary’ and ‘prior’. One way to understand them, even if translated in this way, would be as terms indicating a temporal order, that is, as ‘first’ and ‘before’, ‘previously’ or ‘earlier’. Indeed, that seems to be the most common interpretation. For example, a conclusion Aristotle draws in *Physica* 6.6:

ἔσται τοῦ μὲν μεταβάλλειν τὸ μεταβεβληκέναι πρότερον, τοῦ δὲ μεταβεβληκέναι τὸ μεταβάλλειν, καὶ οὐδέποτε ληφθήσεται τὸ πρῶτον³³⁴

has been translated as:

A process of change is preceded by a completion of change and a completion by a process; and we can never take any first stage.³³⁵

A first problem with such a translation is that with terms like ‘preceding’ one cannot refer to a relation obtaining between a whole and a part of that whole, but only to two independent entities. At the same time, however, it is clear from the context that the thing to which something is prior is assumed to be a larger whole of which the prior thing is a part. To meet this objection, one could, just as the quoted translation does when rendering τὸ πρῶτον, supply a term like ‘stage’, ‘stretch’ or ‘part’, e.g. ‘there will be having-changed during an earlier stage of the changing.’ Thus ‘*x* being πρότερον to *y*’ should in fact be understood as being true if *x* is a part of *y* whose beginning coincides with the beginning of *y*, but whose end is earlier than that of *y*. Similarly ‘*x* being πρῶτον’ would mean that *x* is πρότερον to *y* while there is no part of *y* which is πρότερον to *x*.

It might seem that such an interpretation makes sense in many contexts in which Aristotle uses πρῶτον and πρότερον. For example, at one stage in *Physica* 6.5 he states that ‘there is no beginning of change [in the sense of a first stage] nor a primary part of time in which it was changing.’³³⁶ However, there are also many contexts in which it is clear that what is prior is not prior to the whole because it constitutes an earlier stage, but just because it is a proper part of the whole. Thus Aristotle often talks about ‘whatever of the parts [of the whole time]’ and infers that because the same applies to

³³² *Physica* 6.5; 236a14-15 and a26-27, a27-28 and 34-35, a35-36, b8-10 and 15-16, 6.6; 237b6-7, a21-22, 6.8; 238b36-239a2, 239a8-10, a10-11 and 20-22. Cf. *Physica* 6.8; 239a25-26 and 30-31.

³³³ *Physica* 6.5; 236b12-15 and 6.6; 237b3-7. Cf. *Physica* 6.6; 237a28 and a34-35. Cf. also the absurdity that ‘there will be something τοῦ πρώτου πρότερον, to which Aristotle in *Physica* 6.5; 236a4 reduces a hypothesis.

³³⁴ 237b5-7

³³⁵ Thus CWA 401. Similar translations or paraphrases one can find in Cornford and Wicksteed, *The Physics* II 155, Ross, *Physics* 412, Wagner, *Physikvorlesung* 166; cf. Bostock, ‘Continuity’ 195, and White, *Continuous* 103.

³³⁶ 236a14-15. Similar, though far less explicit, seem to be the arguments in *Physica* 6.5; 236a27-35, b10-16, 6.6; 236b32-237a3, a25-28, a32-34.

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them as to the whole, the whole time cannot be primary.³³⁷ There is no concern at all about the temporal order of the parts. The same lack of concern with temporal order appears from the fact that in an argument meant to show that there is no primary time in which something was changing, Aristotle has to add the stipulation that in the time preceding such a purported primary time there was rest.³³⁸ Such a stipulation would not have been necessary if the primary time had been the first time.

A further objection against an interpretation of *πρῶτον* and *πρότερον* in terms of temporal order is that Aristotle applies these terms also in arguments in which the temporal medium of change does not play any part. Thus *after* having concluded that something changing changes *πρότερον* because every time of change can be divided,³³⁹ Aristotle continues as follows:

Further what has been stated is more obvious in the case of magnitude, because of the being continuous of the magnitude in which something changing changes. For let there be something which has changed from C to D. Then if CD is indivisible, a partless thing will be contiguous to a partless thing. But since that is impossible, it is necessary that what is in between is a magnitude and divisible into an unlimited [number of parts] (*εἰς ἄπειρα διαιρετόν*). Hence it changes to those [unlimited number of parts] by priority (*εἰς ἐκείνα μεταβάλλει πρότερον*).³⁴⁰

If *πρότερον* in this conclusion meant ‘during an earlier stage’, this would not be an argument independent from the previous one. As it is, however, Aristotle says that he gives two arguments, based on the ever-divisibility of time and magnitude, drawing the same conclusion from them. The most likely explanation is that he considers change as a kind of separate quantity, next to time and magnitude,³⁴¹ with regard to which the question of there being something *πρότερον* or *πρῶτον* can be asked in its own right.

Not even in the argument discussed in § 5.3.1, that the primary time in which something has changed is indivisible, does ‘primary’ mean ‘first in the temporal order’. For in fact that primary time is the *last* moment of the time of change, and is assumed from the outset to be part of that time. Thus there is no room for a later time in which something has changed – which should have been there if ‘primary’ were to be interpreted in terms of temporal order.

To these observations we may add that the two characterizations of *πρῶτος* Aristotle provides in *Physica* 6, are not concerned either with the idea of temporal order. It is rather the idea of ontological order of parts and wholes which is expressed in them. In *Physica* 6.5 Aristotle explains:

By ‘primary’ I mean that which is such, not because one [part] of it is [such],³⁴²

while in *Physica* 6.6 he remarks about things changing:

Something is said to change in a time both in the sense of in a primary [time] and in the sense of for something else (*καθ’ ἕτερον*), for example in a year because it changes in a day.³⁴³

³³⁷ *Physica* 6.5; 236a21, 25, 6.6; 237a8, 6.8; 239a6 and 8, and a17-20. Cf. *Physica* 6.6; 237a4 and 6, b12-13.

³³⁸ *Physica* 6.5; 236a17-18, discussed at pp. 188-189.

³³⁹ *Physica* 6.6; 237a25-28

³⁴⁰ *Physica* 6.6; 237a28-34. The problematic final clause is discussed at p. 213.

³⁴¹ As he also does in *Physica* 6.4; 235a25-34

³⁴² 235b33-34

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‘Not because of something’ and ‘not for something else’ express ontological independence. Similarly the comparative term *πρότερον* should in these arguments not be understood in terms of temporal order, but in terms of ontological order: *x* is prior to *y* if and only if *y* depends on *x* and not *vice versa*. The only order which can be detected in the arguments of *Physica* 6, therefore, is that between parts and the wholes made up of them.³⁴⁴

§ 6.1.2. Two senses of primacy

Though both explanations of *πρῶτον* quoted above are concerned with ontological priority, there may seem to be a difference between them. The second explanation is only appealed to in order to rule out something which is *F* as primary if not all its parts are *F*. Thus the second explanation occurs in the context of the following argument:

Since everything changing changes in a time, and [something] is said to change in a time both in the sense of in a primary [time] and in the sense of for something else, for example in a year because it changes in a day, [it is the case that] what changes changes in whatever part of the primary time in which it changes. This is on the one hand clear from the definition (for we were using ‘primary’ thus). But surely it also appears from the following. For let the primary time in which the moving object moves, be indicated by XR, and let it have been divided at K. For every time is divisible. In the time XK, then, it either moves or does not move, and again in KR the same applies. Then if it moves in neither, it would be at rest in the whole (for it is impossible to move [in the whole] while moving in none of the parts of it. If, on the other hand, it moves in only one of them, it would not move in XR as in a primary [time], for the motion is [then in XR] for something else. Therefore it is necessary that it moves in whatever part of XR.³⁴⁵

The pattern of this argument is as follows: if the primary thing which is *F* (in the case above *being a time for moving*) is divisible, it is neither the case that *F* applies in neither of them, for then it would not be in the whole at all, nor that *F* applies in merely one of them, for then the whole would not be primary with respect to *F*; therefore *F* applies in any part of the primary thing whatsoever. Exactly the same pattern occurs in two other arguments, with *being a time for having changed* and *being a time for coming to a halt* for *F*.³⁴⁶ The second of them contains a clear back-reference to the quoted passage.³⁴⁷ Also in two further passages we may recognize a similar use of the contrast between ‘primary’ or ‘for itself’ and ‘for something else’. Thus in the argument that what moves cannot be over against something primary, already analysed in § 5.2.3.2, one of the premisses is that the discussion should be confined to ‘the time in which for itself it is moving, that is not because [it is moving] in some part of that’ (ἐν ᾧ χρόνῳ κινεῖται καθ’ αὐτὸν καὶ μὴ τῷ ἐν ἐκείνου τινί).³⁴⁸ The reason for this is clearly that otherwise it would be possible to be over against something for some time in the time of motion, namely in that part of it in which it would be at rest, there being another part of it because of which the whole is a time of motion ‘for

³⁴³ 236b20-22

³⁴⁴ With the above, I go further than Strobach, *Moment of Change* 63-75, who at 64-65 allows for a temporal meaning of *πρῶτος* and *πρότερος* in the arguments of *Physica* 6.5; 236a27-b19, 6.6; 236b32-237b22 and 6.8; 239a20-22, and who at 65 argues that Aristotle is ‘interested in basing the temporal meaning of *πρῶτον*, belonging in the realm of physics, on a hierarchic meaning of the word belong in the realm of metaphysics.’

³⁴⁵ *Physica* 6.6; 236b19-32

³⁴⁶ *Physica* 6.5; 236a20-26 and 6.8; 238b31-36 together with 239a7-8.

³⁴⁷ *Physica* 6.8; 238b35-36

³⁴⁸ 239a24-25

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something else'. The distinction between 'the now for itself' and 'the now for something else' invoked in *Physica* 6.3 (see p. 107 for the argument) has the same import.

The first explanation, on the other hand, appears in the context of an argument, quoted on p. 173, which might seem to need a stricter criterion of primacy. In this argument, which was discussed above, p. 177, Aristotle argues for the indivisibility of the primary time in which something has changed, which goes further than the conclusion that in every part of the primary thing *F* applies. Moreover, in this argument there appears the inference that 'if [something] has changed in [the one part] or again (ἢ πάλιν) [in the other part], it would not have changed in [the whole] as a primary [time].'³⁴⁹ As the protasis does not seem to contain an exclusive disjunction, but to leave open the possibility that the thing has changed in both parts, the inference can only be correct if the criterion of primacy rules out that a whole of parts all of which are *F* is primary with respect to *F*.

It is, however, possible to interpret this argument in such a way that it does not need a stricter criterion of primacy. One should object, in the first place, that the inclusive interpretation of the protasis of the quoted inference is not mandatory. More importantly, suppose that one were to add to the argument the tacit presupposition that of a period of time in which a change takes place, there is only one part in which something has changed, and in all the other parts it is changing. In that case, the more lenient criterion of primacy would suffice. Just as the obvious presupposition that there is a primary time in which something has changed, this presupposition might be derived from the preceding arguments, for example from the idea that only when being at the end-point of the change, of which there is just one, the object has changed, while before it is changing.³⁵⁰ Since it is difficult to interpret the first explanation in such a way that it also rules out something which is *F* being primary if both its parts are *F*, because the phrase 'one part of it' (ἓτερόν τι αὐτοῦ) cannot bear the sense of 'one or more parts of it', we should opt for the interpretation with the more lenient criterion.

So the two explanations of what it means to be primary are identical, both saying that that is primary in being *F* which does not contain any part which is not *F*. As appears from the first explanation, this criterion of primacy cannot be strengthened in such a way as to rule out as primary something all of whose parts are *F*. However, since in most arguments of *Physica* 6.5-6 and 6.8, Aristotle is concerned with establishing that there is nothing primary in change or one of its media, on the mere ground that each change or each distance moved over or period of time used to move is ever-divisible, there is also a stricter criterion of primacy at work in these chapters. According to this criterion, something is primary in being *F* if and only if it itself does not have a proper part which is also *F*. In order to prove, then, that there is nothing primary which is *F*, Aristotle only needs to show that everything to which *F* applies is divisible, and that if *F* applies to such a whole, it also applies to all its parts. As we shall see below, Aristotle is indeed making the first point over and over again, and one way or another argues for or assumes the second point as well. He clearly deems this to be sufficient to establish the non-existence of something primary, thus presupposing the stricter criterion.

Since everything which is a most basic *F*-thing, is also as a whole *F*, the stricter criterion entails the more lenient criterion. There is, however, no indication whatsoever

³⁴⁹ 235b35-37

³⁵⁰ Cf. *Physica* 6.5; 235b22-27

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that Aristotle is consciously applying a different criterion. He never formulates an explanation of the stricter criterion, but just applies it. Moreover, in three passages this leads to rather abrupt transitions. Thus he offers the following argument:

This has been shown before, that in whatever part of the primary [time] in which [something] comes to a halt, it comes to a halt.³⁵¹ Since, then, that in which as a primary thing it comes to a halt (ἐν ᾧ πρῶτον ἵσταται) is a period of time, and not atomic, and every period of time is partitionable into unlimited [parts], there will not be [something] primary in which it comes to a halt.³⁵²

First he allows, for the sake of the argument, for the existence of something primary which is *F*, argues that it has parts which are all *F*, and then states that there is nothing primary because of the infinite divisibility of any possibly primary thing. He is only entitled to this conclusion if he assumes, employing the stricter criterion, that he has already shown that what was originally supposed to be primary, is not primary any more because its *F*-parts are prior to it.³⁵³ Why then does he not argue immediately that something which is *F*, but has at least one part which is *F*, is not something primary with respect to being *F*, but does instead take a more circuitous route by invoking a more lenient criterion of primacy in order to establish that every part of a primary thing which is *F*, is also *F*? After all, he often employs such an immediate strategy, for example in the following argument:

Nor is there something primary which has changed of what changes. For let DF be of DE the primary [part] which has changed. For everything changing has been shown to be divisible.³⁵⁴ If it has changed in the whole time DF, in half the time something smaller than and prior to DF will have changed, and next another part of it, and a different part of that, and always thus. Hence there will not be any primary part which has changed of what changes.³⁵⁵

There is no place whatsoever for the more lenient criterion of primacy in this argument. First, any part of the whole which is still *F*, is immediately assumed to be prior to the whole, which therefore cannot be primary any more. Second, the primary part DF of DE, whose existence is supposed for *reductio* at the beginning, is not a part which can be primary merely in the sense of the quoted explanations, that is, of being the largest stretch which as a whole is *F*, without any parts which are not *F*. For DE as a whole is something changing, and therefore will have changed as a whole too, thus according to the more lenient criterion qualifying as primary in that respect.

³⁵¹ Aristotle is referring to the kind of argument invoking the second explanation of 'primary' set out above, in *Physica* 6.8; 238b31-36.

³⁵² *Physica* 6.8; 239a7-10

³⁵³ The same can be recognized in the argument of *Physica* 6.5; 236a14-27, namely in the transition from a20-26 to a26-27. Similar is the transition in *Physica* 6.6; 236b32-237a2.

³⁵⁴ Usually this is taken to be a reference to *Physica* 6.4; 234b10-20 (see Ross, *Physics* 650, and Wagner, *Physikvorlesung* 629), but it seems more likely that Aristotle refers to the arguments on offer in *Physica* 6.10, because he there actually shows that everything changing is divisible. One should also compare *Physica* 8.5; 257a33-b1:

Now it is necessary that everything moving is divisible into ever-divisibles. For it has been shown before in the general books on nature that everything moving for itself (τὸ καθ' αὐτὸ κινούμενον) is continuous.

The reference is to the first argument of *Physica* 6.10; 240b8-241a6.

³⁵⁵ *Physica* 6.5; 236a31-35

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Not only does the more lenient criterion seem rather out of place in arguments meant to establish that there is nothing primary, there is also one context in which the use of ‘primary’ is virtually incompatible with the stricter criterion. This occurs in the argument, already analysed in § 5.2.3.2, that what moves cannot be over against something primary in a time in which it moves for itself. At a certain stage Aristotle rephrases this claim as: ‘[I]t cannot be the case that something changing is over against something as a whole over the primary time (οὐκ ἐνδέχεται τὸ μεταβάλλον κατὰ τι εἶναι ὅλον κατὰ τὸν πρῶτον χρόνον).’³⁵⁶ If ‘primary’ were to be interpreted according to the stricter criterion, Aristotle would be saying that there is no *smallest* period of time during which something changing can be over against something. However, in the context it is completely irrelevant that there is not a *smallest* period; what Aristotle wants to show is that there is no *period of time* at all during which something changing can be over against something, *except* in the sense of a period which has some kind of part, namely a now, in which something changing is over against something. (He hints already at this secondary sense of being over against something in a period ‘with respect to something else’ at the beginning of the argument.)³⁵⁷ Thus Aristotle can only be saying here that over a period of time *as a whole* something changing cannot be over against something, not that over some smallest time something changing cannot be over against something.³⁵⁸

My hypothesis is that at least the passages in which Aristotle puts forward the explanations of what it means to be primary represent an independent set of arguments, independent, that is, from the arguments based on the stricter notion of primacy. In the case of two of these passages there has been an attempt to incorporate them into latter arguments meant to establish that there is nothing primary. This hypothesis would go some way towards explaining the two observations just made, that there are passages in which an abrupt transition occurs from the explicit application of the more lenient criterion to an implicit application of the stricter criterion, and that there are also passages in which the use of the more lenient criterion is incompatible with the stricter criterion. Moreover, in two passages in which there is a transition from the more lenient criterion of primacy to the stricter, there are also other incongruities. In *Physica* 6.8 these appear when we have a look at the argument as a whole:

It having been demonstrated [that when something comes to a halt it moves], it is clear that it must also come to a halt in a time, for what moves, moves in a time, and what comes to a halt has been shown to be moving, so that it is necessary that it comes to a halt in a time. Further, [the same conclusion follows] provided we apply the faster and slower in a time, and coming to a halt is faster and slower.

In whatever part of the primary time in which what comes to a halt comes to a halt, it must come to a halt, For the time having been divided, if it comes to a halt in none of the parts, it does not [come to a halt] in the whole either, so that what comes to a halt would not come to a halt. If on the other hand [it comes to a halt] in one [of the parts], it would not come to a halt in the whole as a primary [time]. For it comes to a halt in that [time] for something else, exactly as has also been said before in the case of something moving.

However, just as there is no primary [time] in which what moves moves, so [there is] no [primary time] either in which what comes to a halt comes to a halt. For neither of moving nor of coming to a halt there is something primary. For let there be a primary [time] in which it comes to

³⁵⁶ 239a30-31

³⁵⁷ In 239a24-25

³⁵⁸ Compare the switch from ‘over against something primary’ in 239a25 to ‘over against something as a whole’ in a30.

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halt, indicated by AB. That then cannot be partless, for there is no motion in a partless [time] because it would [otherwise be the case that it] has moved with respect to some [part] of it. However, if it is divisible, it comes to a halt in whatever of the parts of it. For that has been shown before, that in whatever part of the primary [time] in which [something] comes to a halt, it comes to a halt. Since, then, that in which as a primary thing it comes to a halt is a period of time, and not atomic, and every period of time is partitionable into unlimited [parts], there will not be [something] primary in which it comes to a halt.³⁵⁹

In fact we have here two independent arguments, first one for the conclusion that every part of a primary thing which is *F*, is *F*, and then a new one that there is nothing primary. In the course of the second argument the result of the first argument is referred to, not only yielding the sudden shift mentioned between two criteria of primacy, but also an interesting discrepancy. To see which, we have to turn to the first argument. There it may seem obvious that if in neither of the two parts of time there is coming to a halt, there is no coming to a halt in the whole, just as it may seem obvious that if there is only coming to a halt in one of the parts, there is no coming to a halt in the whole as primary. Both of these inferences, however, as well as the conclusion Aristotle draws, are only legitimate if one assumes that the coming to a halt or motion taking place in the whole time is divisible according to time. If, for example, the motion taking place in the whole time were merely to consist in being at two different places in each of the two halves of the whole time, the two inferences and the conclusion could not be validly put forward. This is exactly the assumption we saw Aristotle making when using proportionalities to establish the ever-divisibility of time and magnitude, which we may call the assumption of the smoothness of motion. What is more, in this argument it is also stated explicitly, in the same vocabulary as that we find in many proportional arguments: ‘what moves, moves in a time.’³⁶⁰ In addition to such a repetition of this premiss, we read in the second sentence a justification for it. This justification refers to an argument in *Physica* 6.3 where it is established that motion takes place in a time because it can be faster and slower,³⁶¹ and which is closely related to proportional arguments occurring in *Physica* 6.2.

In the second argument, where it is inferred that there is nothing primary, we see a pattern which Aristotle follows in most arguments for this conclusion, namely that he first establishes that the phenomenon at issue (usually change) must take something divisible, then argues or assumes that it occurs in both parts, and finally through the assumption of unlimited divisibility concludes that there is nothing primary. As far as the first step is concerned, this procedure in fact constitutes a repetition of some sort of the point he makes in the first argument of this passage. For together with the assumption that every time is divisible, which Aristotle clearly makes in the first argument, the premiss that everything moves in a time entails that motion cannot occur in an indivisible time. It seems therefore clear that we have two independent arguments, with the result of the first argument, taken out of its argumentative context, inserted into the second argument.

In the case of *Physica* 6.8 the result obtained on the basis of the more lenient criterion of primacy is at least explicitly used in the subsequent argument using the stricter

³⁵⁹ 238b26-239a10

³⁶⁰ 238b27-28

³⁶¹ 234a24-31

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criterion. In *Physica* 6.6 the connection is really obscure. In *Physica* 6.6 the transition takes place as follows:

Now that has been proven [namely that in whatever part of the primary time of motion there is motion], it is clear that everything moving must have moved for a prior part. For if in the primary time XR it has moved over magnitude KL, in half the time something which moves just as fast and started at the same time, will have moved over the half.³⁶²

This previously established result, based on the more lenient criterion of primacy, is not referred to in the later argument at all, although it must be presupposed, as I shall show below. The lettering is inconsistent, as K in the previous argument is a point in time dividing the primary time XR, not a point limiting the magnitude moved over. To this one may add a discrepancy in style between the two arguments which is similar to the one to be noticed in *Physica* 6.8. For in the preceding argument, quoted at p. 197, we encounter the equivalent premiss that ‘everything changing changes in a time.’³⁶³ Moreover, in keeping with the results obtained in § 3.2.2, this assumption is independent from the divisibility of the time of motion, for that divisibility is mentioned as a separate premiss of the argument.³⁶⁴ In the subsequent argument, on the other hand, we find considerations about changes being terminated by their end-points, and the difference between present and perfect tenses, even though there is a kind of indirect appeal to a proportionality.

All this, however, does not mean that it is impossible to integrate an argument relying on the more lenient criterion of primacy into an argument concerned with proving that there is nothing primary. After all, as I have already explained, the stricter criterion on which such arguments are based entails the more lenient one. Thus we read in *Physica* 6.5 the following argument:

There is no beginning of change, nor [is there] of the time [of the whole change] a primary part in which it was changing (οὐδ’ ἐν πρώτῳ τοῦ χρόνου μετέβαλλεν). For let there be a primary thing indicated by AD. Now that is not indivisible. ... Since it is not partless, it is necessary that it is divisible and that in whatever part of it it has changed. For AD having been divided, if it has changed in neither [of the parts], it has not changed in the whole either (while if it changes in both, [it] also [changes] in the whole), while if (εἰ δ’)³⁶⁵ it has changed in one [of them], it has

³⁶² 236b32-36

³⁶³ *Physica* 6.6; 236b19

³⁶⁴ 236b26-27

³⁶⁵ Ross, *Physics ad locum* and 650, emends into εἰτ’, saying that he otherwise cannot understand the point of the bracketed clause; with the emendation he proposes to translate: ‘if it changes in both, that is, in the whole, as well as if it has changed in one of them, it has not changed in the whole as primary.’ In support he refers to Simplicius, *In Physica* 985.26-27: εἰ μὲν ἐν ἀμφοτέροις ἢ ἐν τῷ ἐτέρῳ, οὐκ ἐν τῷ ὅλῳ πρώτως μεταβάλλειν. Simplicius’ paraphrase of the argument, however, is couched completely in terms of changing, not of having changed; only at the end of it he adds that ‘though the argument is concerned with changing by primacy (περὶ τοῦ πρώτως μεταβάλλειν) (for the beginning of a motion was a motion), [Aristotle] himself uses “having changed”, since what changes has changed by going to the end of changing’ (985.32-986.2). In the text as we have it, though, there is a difference in tense between the parenthesized clause and the rest of the argument, so that Simplicius is not completely correct in his added remark. Ross’ reference to Simplicius is therefore not fully appropriate. Ross is surely right in suggesting that there is a problem about the parenthesized clause, but his proposed solution does not make much sense either. For since Ross follows Simplicius in not seeing a difference between the present and perfect tenses which is relevant to the argument, Aristotle would be saying on Ross’ translation that if there is change in both parts, the object has not changed in the whole period as a *primary* period (thus presupposing the stricter criterion of primacy). Then it seems puzzling, however, how Aristotle could draw the conclusion he does draw, namely that in every part of the primary period the object has changed. I

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not changed in the whole as primary. Hence it is necessary that it has changed in whatever part. It is clear now that there is no primary thing in which it has changed, for the divisions are unlimited.³⁶⁶

One recognizes the pattern of the other two passages: not in neither part, for then not in the whole, but not in one part only, for then not in the whole as primary. What are missing, however, is the premiss that motion occurs in a time. Instead we have, in conformity with many other arguments directed against there being something primary, a statement that motion requires a divisible medium. Moreover, to make the integration most successful, there is no explanation of the more lenient notion of primacy, unlike in the two other arguments.

Finally, as shown above, in the only remaining passage in which the more lenient criterion is used, the argument from *Physica* 6.5 that the primary time in which something has changed must be indivisible, the stricter criterion is not needed in any way. Therefore my hypothesis that the passages explicitly referring to the more lenient criterion of primacy represent an independent set of arguments, some of which Aristotle has later attempted to integrate into arguments requiring the stricter criterion of primacy, would both explain the noted discrepancies and be justified by them.

§ 6.2. *Arguing against there being primary things*

The issue whether there is something primary is the issue whether there are ultimate *F*-parts of a whole which is *F*, parts which by their being *F* explain why the whole is *F*. This question may be asked for all kinds of wholes which are *F*, including phenomena like 'having length'. It will be recognized that in both the categorical arguments based on proportionalities, dealt with in § 3.2, and the arguments from the order of indivisibles, Aristotle has already addressed the question with regard to spatial and temporal magnitude, arguing that they are ever-divisible and are not made up of ultimate parts. Similarly in the arguments based on the distinction between process and completion of change, at one stage Aristotle infers that a change cannot consist of primary elements called κινήματα. These conclusions, however, he does not draw in terms of there being nothing primary. In *Physica* 6.5-6 and 8, on the other hand, we do not find the question asked with regard to such properties. There is no mention at all of the possibility of change consisting of κινήματα, and time and magnitude are rather *assumed* to be divisible without limit, an assumption which is sometimes justified with reference to the arguments based on the order of indivisibles,³⁶⁷ but in other arguments is just stated³⁶⁸ or even left implicit.³⁶⁹ The phenomena with regard to which we do find arguments in *Physica* 6.5-6 and 8 are the following: time of change,³⁷⁰ time of rest,³⁷¹ magnitude moved over,³⁷² changing part of the object chang-

must admit, though, that I cannot answer the question of what the purpose of this clause is. For a further remark about the argument as a whole, see note 416.

³⁶⁶ 236a14-27

³⁶⁷ *Physica* 6.5; 236a16-17, b11-12, 6.6; 237a19-25, a31-32, b2, b7-9; cf. 6.6; 237a3-25.

³⁶⁸ *Physica* 6.5; 236a29-30, b4-5, b7-8, 6.6; 236b26-27, 237a25-28, a29-30, b11, b20-21, 6.8; 239a8-10, a21-22; cf. 6.8; 239a31.

³⁶⁹ *Physica* 6.5; 236a31-34, 6.6; 236b35 and 6.8; 238b32

³⁷⁰ *Physica* 6.5; 236a14-27, 6.8; 238b36-239a1 and 239a2-10

³⁷¹ *Physica* 6.8; 239a10-22

³⁷² *Physica* 6.5; 236b8-16

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ing,³⁷³ and the motion or change itself.³⁷⁴ In their turn these arguments are not based on the strict opposition between the process of change and its completion; as we shall see later on, in some contexts Aristotle even seems to use the present and perfect tenses almost interchangeably.

In all of these arguments, Aristotle uses, with some variations, more or less the same ideas and follows more or less the same strategy. One can identify the following three steps in a typical argument that there is nothing primary with respect to *F*: (1) *F* takes something divisible; (2) all parts of that divisible thing are *F*; (3) every part is divisible without limit, so that there is nothing primary with respect to *F*. The variations consist in the way (1) is argued for, what concepts are used and how explicit it is, whether or not (2) is made explicit and how it is established, and how (3) is phrased.

For purposes of clarity as well as reference I give an overview of the three steps as they occur in all the arguments one may distinguish in these three chapters. I have listed the phenomenon *F* the argument is concerned with, the basic ideas involved in establishing (1), the grounds, explicit or implicit, for (2), and the formulation of (3). In *Physica* 6.5 and 8 the arguments are readily identifiable, but things are a little different in *Physica* 6.6. That chapter is for the largest part set up as one big argument that there is nothing primary in change. The premisses of this big argument are argued for separately, but with the exception of one, all of these sub-arguments are strong enough to show on their own that there is nothing primary in change. Therefore I shall list both the big argument and those sub-arguments. Some of the descriptions appearing in the list may seem mysterious, but they will become clear later on.

<i>Passage</i>	<i>F</i>	(1) not in indivisible	(2) all parts <i>F</i>	(3) nothing primary
1. 236a14-27	time of change	no consecutive order of nows, completion <i>after</i> start	not in none not in one	unlimited divisions
2. 236a27-35	part having changed	'everything changing divisible', cf. <i>Ph.</i> 6.10	assumed in proportionality	'always so' in proportionality
3. 236b8-16	magnitude moved over	from-to conception + no consecutive order	follows from divisibility	always earlier point as end
4. 237a3-11	change/motion 'having changed'	from-to conception + no consecutive order (implicit in use perfect)	time of change defined by any two nows	every time divisible

³⁷³ *Physica* 6.5; 236a27-35

³⁷⁴ *Physica* 6.6; 236b32-237a3, 237a17-28, a28-35, b3-9, b9-22; cf. *Physica* 6.6; 237a3-17, 237a35-b3 and 6.8; 239a2.

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5. 237a11-17	change ‘having changed’	from-to conception + no consecutive order (implicit in use perfect)	---	unlimited nows
6. 237a19-28	change ‘changing’- ‘having changed’	from-to conception + no consecutive order (explicit in use perfect)	assumed in proportionality	‘always so’ in proportionality
7.a. 237a28-35	change – medium magnitude	from-to conception + no consecutive order	follows from divisibility	unlimited divisibility
7.b. 237a35-b3	change – medium time	back-reference to 7.a.		
8. 237b3-9 (‘the big one’)	change: present – perfect	present always prior to perfect perfect always prior to present		unlimited divisibility – no consecutive order
9. 237b9-22	coming to be and passing away: present – perfect	present always prior to perfect perfect always prior to present		continuum – time and magnitude divisible
10. 238b36-239a10	time of coming to a halt	distinct parts for present and perfect	back-reference to not in none, not in one	unlimited divisibility
11. 239a10-22	time of rest	rest is like motion rest involves two moments	back-reference to not in none, not in one	unlimited divisibility

In addition, there is one further argument, at 236b32-237a3, which is apparently meant to establish a premiss for the big argument of *Physica* 6.6. I shall deal with it separately, just as with argument 8, the big argument of *Physica* 6.6, and with argument 9, which seems a condensed version of that big argument. They merit special treatment because they do not follow the regular pattern of the other arguments listed above, and because they raise problems about Aristotle’s use of the perfect tense in these chapters.

§ 6.2.1. *Not in something indivisible*

If one looks at the table provided above, one will notice immediately that all of the arguments somehow involve the from-to conception of motion or the corresponding conception of rest as involving two nows at which the object is in the same state. In most arguments this is explicit, but in a few it appears in the garb of ideas about the completion of motion or the difference between present and perfect tenses. Only in argument 2 is there nothing like that at all, but as I already indicated in note 354, when quoting that argument, there is a reference to the arguments from *Physica* 6.10, notably to the first one where Aristotle shows on the basis of the from-to conception of motion and the impossibility of a consecutive ordering of indivisibles that everything changing for itself, and not accidentally, must be divisible. Thus indirectly argument 2 also presupposes the from-to conception of motion. Similarly the idea that there is no consecutive ordering of indivi-

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sibles like points and nows, also recurs in most of the arguments. Only arguments 10 and 11 do not presuppose this idea.

That the same concepts often appear in these arguments does not mean, however, that the reasoning is identical. For example, in argument 6 Aristotle states very carefully why a change cannot have occurred in an indivisible now:

[E]verything which has changed from something to something, has changed in a time. For let it have changed from A to B in the now. Then it is, on the one hand, not the case that in the same now in which it is in A, it has changed, for it would then be at the same time in A and in B. For it has been shown before that what has changed is not in that [*scil.* in A] when it has changed.³⁷⁵ If, on the other hand, [it has changed] in another now, there will be a time in between, for nows were not contiguous.³⁷⁶

The idea is that since something cannot be in two places at the same now, something changing from A to B must be in B in a now that is different from A, so that, because these nows cannot be consecutive, there must be a divisible period of time between them. Allowing for some modifications, the same argument can be detected in the second reason given in argument 1, which was analysed in § 5.3.2.2.3, though there the point that there is a magnitude between two boundaries is not made, perhaps because the point that the nows cannot be consecutive (so that there must be a magnitude between them) is provided as a first, independent, reason (see pp. 188 and 208). The same combination of the from-to conception of change and the impossibility of a consecutive ordering of indivisibles we may recognize to be behind two far less explicit arguments, the first of which is argument 4:

[I]f we say that [something] has moved in the whole time XR, or in general in whatever time, by taking the final now of it (for this is what determines [the time], that is, what is between the nows is a time), it could equally be said that it has moved in the other [times]. The division, however, is the final [now] of the half. Hence it will also have moved in half [the time] and in general in whatever of [its] parts. For together with the cut a time is always defined by the nows. If, then, every time is divisible, and what is between the nows is a time, everything changing will have made an unlimited number of changes (*ἅπαν τὸ μεταβάλλον ἅπειρα ἔσται μεταβεβληκός*).³⁷⁷

Behind the phrase ‘taking the final now’ of a period to determine the time in which something has moved, lurks the idea that, given some first now at the one terminus, there is a final now for the other terminus of the motion. Clearly it is presupposed, and almost stated explicitly in the last sentence, that these nows are not consecutively ordered, for otherwise there would not always be a time half of the whole time, defined by its own final now.

With some effort we may detect the same ideas in the next argument 5:

[I]f it is necessary that something which changes continuously and has not perished or has stopped with the change, either is changing or has changed in any [part] (*ἢ μεταβάλλειν ἢ μεταβεβληκέναι ἀναγκαῖον ἐν ὅτῳδὺν*), and [if] in the now it is impossible to be changing, [then] it is necessary that it has changed at each of the nows. Hence if the nows are unlimited [in

³⁷⁵ The reference could only be to *Physica* 6.5; 235b6-13.

³⁷⁶ 237a19-25

³⁷⁷ *Physica* 6.6; 237a3-11

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number], everything changing will have made an unlimited number of changes (πᾶν τὸ μεταβάλλον ἅπειρα ἔσται μεταβεβληκός).³⁷⁸

To understand this argument we have again to assume that nows are densely ordered and that any two nows can serve as termini of a change. The distinction between the present and perfect tenses can only be understood, as was shown in § 5, within the context of the from-to conception of motion. It may seem that with ‘in the now it is impossible to be changing’ we find here nothing more than the mere assertion of step (1), but that impression is misleading, for just as in the previous argument, the phenomenon of which there is, according to this argument, nothing primary, is ‘having changed’, not ‘time of changing’ – as appears from the final sentence. For the rest, though, it must be acknowledged that this argument does not adhere in any way to the common pattern of the arguments discussed here. This is mostly due to fact that this argument uses the perfect ‘having changed’ as applying to indivisible nows, so that strictly speaking there is no place for a conclusion that there is no primary *part* of the whole change. This feature also makes the argument rather difficult to interpret, for the conclusion does seem to be stated in terms of ‘changes which have been completed’ – of these changes there is an unlimited series of ever smaller terms, and therefore, we are allowed to conclude, nothing primary. There are two reasons for thinking that this is how we should understand the conclusion: the conclusion is identical to that of the previous argument, which certainly must be taken in this way; and, as presented, this argument serves as a sub-argument for a premiss of the ‘big argument’ of *Physica* 6.6, namely for the point that ‘what changes must have changed [for a prior part].’³⁷⁹ The problem of such a switch I shall address in § 6.3.

In these four arguments (1, 4, 5 and 6) the phenomenon of change was classified according to its temporal medium. Aristotle offers similar arguments where magnitude is the medium by which divisions take place. Thus in argument 7.a, quoted already in full at p. 196, we read:

Let there be something which has changed from C to D. Then if CD is indivisible, a partless thing will be contiguous to a partless thing. But since that is impossible, it is necessary that what is in between is a magnitude and divisible into an unlimited [number of parts].³⁸⁰

What are the partless things contiguous to each other if CD is indivisible? From the next sentence, it appears that they are the points C and D, for it is between them that there is a magnitude if they are not contiguous. Apparently Aristotle’s conception of CD as indivisible is of its two defining points being together, perhaps each serving as boundary to one side. The idea that there are these two points is in this argument derived from the from-to conception of motion. Thus in its basic features this argument is identical to that offered in argument 6.

With this interpretation in mind we can also understand two more abbreviated versions of step (1), offered in arguments 3 and 1. In argument 3 we read:

³⁷⁸ *Physica* 6.6; 237a12-17

³⁷⁹ *Physica* 6.6; 237a17. The added ‘for a prior part’, which translates πρότερον, can be supplied from the next part of the sentence (a18-19). That it must be supplied appears from 237b5 ‘having changed will be prior to changing’, which refers back to a17, as well as 236b33-34 ‘everything moving must have moved for a prior part.’

³⁸⁰ 237a30-34

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Let there be a magnitude, indicated by AB, and let it have moved from B to C as primary (ἐκ τοῦ Β εἰς τὸ Γ πρῶτον). Then if, on the one hand, BC is going to be indivisible, there will be a partless thing contiguous to a partless thing³⁸¹

– which is clearly absurd. The same point recurs in the first reason given in argument 1:

Let there be a primary [part of the time of change], indicated by AD. This [part of time], then, is not indivisible, because it will follow that the nows are contiguous³⁸²

as well as in a kind of appendix to the big argument of *Physica* 6.6:

The reason for this [that there will never be taken something primary with regard to change] is that a partless thing is not contiguous to a partless thing. For the division is unlimited, just as in the case of increasing and decreasing lines.³⁸³

Aristotle singles out the dense ordering of indivisibles as the most important premiss of the big argument. (The reference to ‘increasing and decreasing lines’ presumably is to a pair of line-segments, one of which increases at every step of the procedure by the same amount as the other decreases, whereby the procedure determining the decrease and increase takes place in a Zenonian way: first half of a unit-line, then a quarter, and so on.)

As explained above, only arguments 10 and 11 fail to refer in any way to the impossibility of a consecutive ordering of indivisibles. In the case of argument 10, it is concluded that there is no indivisible time of coming to a halt or of motion on the basis of a distinction within every motion of something to which the present tense applies and something to which the perfect tense applies (see p. 174 for the interpretation). In that case one might think that this absence can be explained by the brevity of the argument, but that the idea is nevertheless presupposed, just as in so many arguments in these chapters. However, as the argument of *Physica* 8.8 against time-atomism suggests, Aristotle could just as well have taken this to be an independent argument, based solely on the distinction between the tenses. In the case of the second reason given in argument 11, however, it is the counterpart for rest of the from-to conception of change which has to bear the argument on its own:

Further we also use ‘resting’ then, when it is in the same state now and before, since we do not judge by [only] one thing, but by at least two (δοῦν τοῖν ἐλάχιστον). Hence that in which [something] rests, will not be partless.³⁸⁴

This argument is identical to the argument given at the end of *Physica* 6.3 for the impossibility of rest in the now (see p. 131).

§ 6.2.2. *All parts, unlimited parts*

That these last two arguments do not refer to the impossibility of consecutively ordered indivisibles is of lesser interest with regard to step (1) than to steps (2) and (3). In them-

³⁸¹ *Physica* 6.5; 236b10-12

³⁸² *Physica* 6.5; 236a15-17

³⁸³ *Physica* 6.6; 237b7-9

³⁸⁴ *Physica* 6.8; 239a14-17

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selves these two arguments are sufficient to establish that phenomenon *F* requires something divisible, but they leave open the possibility that the phenomenon does not apply to each part of that divisible whole, and therefore are not sufficient to derive the absence of anything primary from the ever-divisibility of that whole. In the case of the arguments which, together with the from-to conception of change, do mention, imply, or presuppose the dense ordering of indivisibles, there is no problem in this respect, for any of the unlimited indivisibles between any two may serve as termini of a separate change. As it is actually stated in argument 4 (quoted at p. 206), there is thus change in any part, defined as it is by those termini, so that it is immediately clear that there is no primary part.

As noted in the table, arguments 2 and 6 invoke a proportionality to show that there is always a smaller part to which *F* applies. Argument 2 was quoted above, p. 199; in argument 6 Aristotle says:

Since then it has changed in a time, and every time is divisible, in half [the time] it will have changed over another [part] (ἐν τῷ ἡμίσει ἄλλο ἔσται μεταβληκός), and again in the half of that over another, and always so.³⁸⁵

In the introduction to this section I wrote that it seems as if with such a use of proportionalities the first theme distinguished in § 2 is present in these chapters. It is true that we have here an argument which is very similar to the hypothetical divisibility-arguments, as they appear for example in *Physica* 6.4. We should bear in mind, however, that in these chapters, which in this respect are unlike the arguments analysed in § 3, both the ever-divisibility of one medium of the change and the applicability of the proportionality itself, can be justified by appeal to the from-to conception of change and the dense ordering of potential termini. There is in fact such a justification to be found in argument 4. Such a possibility is lacking in the context in which the arguments analysed in § 3 appear.

I pointed out earlier that arguments 10 and 11 were the only two in which there was no appeal to the impossibility of a consecutive ordering of indivisibles. However, it is precisely this point which, in combination with the from-to conception of change, makes it a matter of course that every part of a whole which is *F* is itself also *F*, and that there is an unlimited series of ever smaller parts and therefore nothing primary. Thus steps (2) and (3) follow immediately from the argument for step (1). Is it then a coincidence that in both arguments in which this impossibility is not referred to, Aristotle employs a different argument to establish as step (2) that every part of a whole which is *F*, is *F* as well? We know this argument (number 10 in our table) from § 6.1.2, as it appeals to the more lenient criterion of primacy: every part of a primary whole which is *F*, is itself *F*, for it cannot be the case that none of the parts is, for then the whole is not, or that only one of the parts is, for then the whole is not primary. Above I presented reasons for supposing that this type of argument was originally set up as independent, being by style more at home with the proportional arguments discussed in § 3, since it contains the typical premiss that everything changes in a time. If we look at argument 11, we may recognize the same style:

If [that in which something rests] is with parts, it would be a time, and it will rest in whatever of its parts. For that will be shown in the same way as in the previous cases. Hence there will be nothing primary. The reason for this is that everything rests and moves in a time, while there is

³⁸⁵ *Physica* 6.6; 237a25-28

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no primary time, nor magnitude or in general anything continuous. For everything is with an unlimited number of parts (*ἅπαν γὰρ εἰς ἄπειρα μεριστόν*).³⁸⁶

The reference to the previous cases is to the not-in-none, not-in-only-one arguments, employed for example in the preceding passage in *Physica* 6.8.³⁸⁷ According to the ultimate explanation which Aristotle subsequently provides as ground of the whole argument, the premiss that everything (rests and) moves in a time, appears again. In this respect there is marked difference with the similar explanation, quoted above, p. 208, offered at the end of the big argument, for there the ultimate ground mentioned is the dense ordering of indivisibles. Again, is it a coincidence that in an argument in which there is no reference to the dense ordering of indivisibles, we encounter this language associated with the proportional arguments of § 3?

To the last question I should answer that it is not a coincidence. With regard to the first question, I am more hesitant, as in argument 2 (quoted on pp. 113-114) we have an argument which includes a reference to the dense ordering of indivisibles, in which it is argued in the same way that every part is *F*. Appealing to a strict standard of neatness, however, I am inclined to propose what is in fact the same hypothesis as put forward in § 6.1.2, that argument 2 stands out as a successful integration of an independent line of argument, which originally was developed in a context closer in style to the arguments based on proportionality.

§ 6.3. *An anomalous use of the perfect?*

In the introduction to this section, I wrote that it seems that in these arguments concerned with the issue of primacy, there is a blend of the three themes distinguished in § 2, since proportional arguments are associated with appeals to the impossibility of contiguous indivisibles, and frequent use of the perfect tense. One result of the preceding sub-section, however, is that the use of proportionalities in these chapters may have nothing to do with the use they are put to in the arguments dissected in § 3. On the other hand, we did identify a few arguments which were in style closer to the those sounding the theme of proportionality, as they featured, instead of an appeal to the dense ordering of indivisibles, the premiss that change occurs in a time. My hypothesis was that they still stand apart from most of the arguments in these chapters, which do rely heavily on the impossibility of contiguous indivisibles. So rather than a real blend of the three themes, we seem to have some arguments with one theme, and others with the two other themes.

Again things may not be completely as they seem, however. As introduced in *Physica* 6.1, the use of the perfect tense contrasts sharply with the use of the present, as the perfect tense, signifying the completion of the change, applies only to instants, namely the end-terminus of the change, while the present tense denotes the process of change towards that end and thus applies during a period of time. There are clear examples of this use of the perfect in the arguments of *Physica* 6.5-6 and 8, namely in arguments 5 and 10. Quite a few other arguments also seem to imply a contrast between the perfect and the present tenses, notably the big argument of *Physica* 6.6. There we read:

³⁸⁶ *Physica* 6.8; 239a17-22

³⁸⁷ Cf. Ross, *Physics* 655, and Wagner, *Physikvorlesung* 636.

Three themes together?

Hence it is necessary that what has changed is changing and what is changing has changed (ὥστε ἀνάγκη τὸ μεταβεβληκὸς μεταβάλλειν καὶ τὸ μεταβάλλον μεταβεβληκέναι), and there will be, on the one hand, having changed prior to changing, and, on the other hand, changing [prior to] having changed (καὶ ἔσται τοῦ μὲν μεταβάλλειν τὸ μεταβεβληκέναι πρότερον, τοῦ δὲ μεταβεβληκέναι τὸ μεταβάλλειν), and never will the primary [thing] be taken.³⁸⁸

This passage would be meaningless, if there were no difference in import between the perfect and the present tenses. However, as already pointed out in passing in the discussion of argument 5, the perfect tense as used here does not apply to nows, but to periods of time. Indeed, throughout the arguments in which it is argued that there is nothing primary this use of the perfect tense predominates over the use as applied to a now.³⁸⁹ Since the perfect tense as applied to a period of time cannot refer, by exclusion of the process of change, to the moment of completion of change, we are thus confronted with the question what Aristotle thought to be the difference in meaning between the two tenses. This problem is even aggravated by the observation that on some occasions Aristotle switches between the two tenses without any indication that there is a difference in meaning. A good example is the following passage:

It is clear now that there is no primary [time] in which something **has changed** (μεταβέβληκεν), for the divisions are unlimited.

Nor, then, is there something primary which has changed, of what has changed (τοῦ μεταβεβληκόντος). For let DF be a primary [part] which has changed, of DE. For it has been proved that everything changing (πάν τὸ μεταβάλλον) is divisible. Let the time in which DF has changed be indicated by HI. If then DF has changed in the whole [time], in half [the time] there will be something smaller than and prior to DF which has changed, and again another [prior to] this, and another to that. Hence there will be nothing primary which has changed, of what changes (τοῦ μεταβάλλοντος).

That then there is neither anything primary of what changes (τοῦ μεταβάλλοντος) nor [any primary] time in which it **changes** (ἐν ᾧ μεταβάλλει χρόνος), is clear from what has been said.³⁹⁰

The phrases which are underlined or set in bold refer or apply to the same thing, but first using the perfect, and then the present.³⁹¹ The tenses seem to be intersubstitutable *salva veritate*. How are we then going to draw a distinction in meaning?

§ 6.3.1. Having-changed in a secondary way

In order to answer the question as to how we should draw a distinction in meaning between the present and perfect tenses as applied to periods of time, we must first know how to

³⁸⁸ *Physica* 6.6; 237b3-7

³⁸⁹ *Physica* 6.5; 236a22-27, a27-35, 6.6; 236b32-237a3, 237a3-11, a16-17, a17-21, a25-27, 237b2, 237b9-22. Anticipating the discussion below, I also want to mention *Physica* 6.2; 232a29-b3. There are also a few perfect tenses applying in a period of time appearing in the parts of *Physica* 6 which feature divisibility arguments based on proportionalities: *Physica* 6.2; 232b28-29, b31, b32, 233a2, b2, 6.4; 235a20, 6.7; 237b35, 238a2, a3, a4, b8, b9, and 6.9; 240a11. In none of these passages, however, there is any connection with a resulting state at the end of the change or a contrast with the present tense, as there is no from-to conception of change detectible there. One may compare the use of the perfect participle in *De lineis insecabilibus* 970b1, from which work the from-to conception of change is also completely absent. For that reason I shall ignore those passages.

³⁹⁰ *Physica* 236a25-36

³⁹¹ Similar shifts occur between 236a7, 14-15 and 26-27; 236b33-34 and 34-35; 237a26-27 and 28, and 237a28-30 and 30-31.

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understand the periodical conception of the perfect tense. Is there no passage in Aristotle with a clue to the right answer? The whole string of arguments we are concerned with in this section is preceded by the following introduction:

‘The primary [time] in which [something] has changed’ is used in two ways, one [for] the primary [time] in which the change came to an end – for at that time it is correct to say that it has changed -, the other [for] the primary [time] in which it began to change (ἐν ᾧ πρότω ἤρξατο μεταβάλλειν). ... The [primary time in which something has changed] according to the beginning (κατὰ τὴν ἀρχὴν) does not exist at all, for there is no beginning of a change (ἀρχὴ μεταβολῆς), nor a primary [part] of the time in which it was changing (ἐν ᾧ πρότω τοῦ χρόνου μετέβαλλειν).³⁹²

If ‘the primary time in which something has changed’ in the second sense is ‘the primary time in which it began to change’, ‘having changed’ would be synonymous with ‘beginning to change’, thus indicating the initial part of a change. However, this does not fit very well with Aristotle’s own use of the perfect tense in the very same passage. It is not the case for all contexts featuring having-changed in a period of time, that in that period the object *begins* to change. For example, in the course of the subsequent argument for the conclusion already mentioned in the last line of the present passage, Aristotle establishes the intermediate conclusion that something ‘has changed in *whatever* [part of a period of change].’³⁹³ Similarly it appears that it would constitute a *further* assumption if the primary time of change would be immediately preceded by a period of rest.³⁹⁴ This would be impossible if it were built into the meaning of ‘having changed’ that it applied to the initial stage of a change. Moreover, also in other passages Aristotle often uses the perfect, even though he wants to talk about more than the initial stage of a change. Indeed, he can talk about the whole period of a change as the time in which something has changed.³⁹⁵

A more fruitful interpretation of the perfect tense as applied to a period of time starts with a passage I have quoted before, but which deserves to be quoted again:

[W]e say that [something] has moved .. in whatever time by taking the final now of it (κεκινήσθαι λέγομεν .. ἐν ὅποσιν χρόνω τῷ λαβεῖν τὸ ἔσχατον αὐτοῦ νῦν). For this is what determines the time, that is, what is between the nows is a time.³⁹⁶

There is here a transition from the final now of a period to the whole preceding period (a first now is apparently assumed as given), as the perfect tense applies to a period because of something about the final now of that period. From the concept of the perfect tense as set out in the arguments dealt with in § 5, we already have an inkling of what this something about the final now might be: that the object has changed in the sense of ‘has completed a change’. Thus the idea is that:

Something has changed in some time T because it has completed a change at now t limiting T .

³⁹² *Physica* 6.5; 236a7-15

³⁹³ *Physica* 6.5; 236a20-26, quoted above pp. 202-203.

³⁹⁴ 236a17-19, discussed at pp. 188-189.

³⁹⁵ For example, *Physica* 6.6; 236b34-35, 237a3-4, a25-26 and b2.

³⁹⁶ *Physica* 6.6; 237a3-6

Three themes together?

A lot is left implicit here, for every change is determined by its termini. A full version of this principle (PT) for use of the perfect tense would be:

(PT) Something has changed from x to y in time T from t_1 to t_2 because it has completed a change from x to y at now t_2 .

This principle can be recognized in other arguments too. For example in the part of argument 6 in which it is argued that something cannot have changed from A to B in a now, but in a period of time (quoted above, p. 206), Aristotle first argues that the *moment* that it has changed to B differs from the moment that it is in A, and then concludes that therefore it has changed from A to B in a *period of time*. The same step is made in the second reason provided in argument 1 for the divisibility of the time in which something has changed (for my interpretation, see pp. 188-189).³⁹⁷ Because the *now* D in which the object has changed differs from the now A in which it has not made a change yet, the object has changed in a period of time, as we are clearly supposed to conclude. As already indicated above, p. 207, in argument 5 too we see the effects of this principle (PT), for there Aristotle argues from the established point that an object has changed in any of the (unlimited number of)nows to the conclusion that it has ‘changed’ an unlimited number of changes, where these changes, the internal object of the perfect tense μεταβεβληκός, are parts of the whole change, each requiring a period of time.

All of this shows that the transition from the momentary conception of having-changed to the periodical conception comes quite naturally to Aristotle. A possible explanation may be that he does not distinguish strictly between the two ways there are of referring to a moment or to a point in space, the one in absolute terms and the other in relative terms, namely by giving the distance from a point of reference (which then serves as the time *in* which something has changed or the magnitude *over* which it has changed). Consider the passage from *Physica* 6.1 introducing the distinction between the present tense as denoting the process of change and the perfect tense as denoting the completion of the change. Already there we see that the perfect ‘has traversed’ is used to indicate a position relative to an earlier position (see p. 167). In a similar way Aristotle also refers sometimes to the goal of a motion in terms of the distance traversed over, or *vice versa*. Thus in argument 7.a, already quoted above at p. 196, we read that since, in the case of something which has changed from C to D, the magnitude CD is ‘divisible into an unlimited number of parts’ (εἰς ἄπειρα), it follows that ‘it changes to those for a prior part’ (εἰς ἐκεῖνα μεταβάλλει πρότερον),³⁹⁸ where ‘those’ can only refer to the unlimited number of parts into which CD is divisible. The expression ‘changing to x ’, however, seems only comprehensible if x stands for a position, not for a part changed over. The other way round, Aristotle argues in argument 3 that for something which has moved from B to C, there is always something prior for it to have changed to. ‘Hence there will be nothing primary to which it has changed.’³⁹⁹ Yet the point of the argument is to show that ‘also among the things which for themselves, and not accidentally, are called divisible there will be nothing primary, e.g. among magnitudes,’⁴⁰⁰ and therefore

³⁹⁷ *Physica* 6.5; 236a17-20

³⁹⁸ *Physica* 6.6; 237a34

³⁹⁹ *Physica* 6.5; 236b16-17

⁴⁰⁰ *Physica* 6.5; 236b8-10

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nothing indivisible.⁴⁰¹ The primary thing whose absence the argument is thus supposed to demonstrate, is a magnitude moved over, not a point. A similar switch can be seen in a passage from *Physica* 7.5:

[W]hat causes to move always causes to move something and in something and up to something (μέχρι του) – I mean by ‘in something’ that [it causes to move] in a time, by ‘up to something’ that [it causes to move] over a length of such quantity (ποσόν τι μήκος).⁴⁰²

The motion up to something is thus even paraphrased as a motion over something.

We encounter no better example of Aristotle’s vacillation between referring in an absolute way and in a relative way, than in *Physica* 6.2, when he argues that in an equal time something faster traverses a greater distance than something slower, and even that there is a time smaller than that in which the faster traverses a greater distance than the slower:

Let the thing indicated by A be faster than the thing indicated by B. Since now faster is that which changes before (τὸ πρότερον μεταβάλλον), in the very time in which A has changed from C to D, say [time] FG, in that time B will not yet (οὐπω) be at D, but will fall short of it, so that in an equal time the faster will traverse more. However, also in [some] shorter [time it will traverse] more. For let B, the thing which is slower, be at E in the [time] in which A has got to D (ἐν ᾧ γὰρ τὸ A γεγένηται πρὸς τῷ Δ, τὸ B ἔστω πρὸς τῷ τὸ βραδύτερον ὄν). Then since A has got to D in the whole time FG, it will be at H in a [time] smaller than that. And let it be [there] in [time] FK. The [distance] CH, then, which A has traversed, is larger than CE, while the time FK is shorter than the whole [time] FG, so that in a smaller [time] it will traverse a greater [distance].⁴⁰³

As already stated at the end of § 3.2.3, ‘before’ and ‘not yet’ refer primarily to moments in time. Also the vocabulary of ‘being at *x*’, which clearly is assumed to be the state resulting from having changed to *x*, should apply to moments. Nevertheless B is said to be not yet at D in a period of time, and at E in some other period of time, namely in the time A has got to D.

As far as the temporal medium of change is concerned, the switch from a momentary conception of the perfect, at least with the final now indicated in relative terms, to the periodical conception of the perfect, is even embedded in Greek usage. For ‘in a time’ as used in the passage from *Physica* 6.2 may in most sentences be taken not so much as referring to the time in which the change occurs, but rather to the time, starting from now, *after* which a change has been completed. In Greek, as in English, ‘in’ (ἐν) is often used in this way. This construction would facilitate the transition to the use of the perfect as really applying ‘in a time’, in the sense of ‘during a time’, as Aristotle for example already adopts in *Physica* 6.2 when he says that ‘in [time FG] A has changed from C to D’ – this phrase cannot be really be interpreted in terms of ‘after’, because that would have required the point of reference to be understood indexically, with reference to the *present* moment, and not specified explicitly in a non-indexical way, as it is in a phrase like ‘in time FG’.

⁴⁰¹ Cf. *Physica* 6.5; 236b17-18

⁴⁰² 249b27-29

⁴⁰³ 232a27-b5

Three themes together?

It may be that this way of referring in relative terms to the final terminus of a change, at which it is completed, explains the ease with which Aristotle switches from the momentary conception to the periodical conception of the perfect tense. This explanation, however, is of a psychological nature, since it fails as a full justification. The reason for this is that Aristotle uses the perfect tense ‘in a time’ in cases where there is no starting point given, so that the final terminus can only be referred to in absolute terms.⁴⁰⁴ Moreover, also in general I have the impression, for example from all the arguments dealt with in § 5, that for Aristotle the strict, momentary conception of the perfect tense is the more basic one. Therefore I think that the mentioned explanation, though psychologically certainly enlightening, has things the wrong way round; rather than understanding the final terminus in terms of the distance to a given starting point, one should, as in (PT), take the final terminus, the momentary state of completion, as primary, and derive the application of the perfect tense to a period of time from that use. This is in fact also the order which is suggested by Aristotle’s own vocabulary. In the first half of *Physica* 6.5 he quite consistently refers to the moment of completion as the time ‘when *primarily* [something] has changed’ (ὅτε πρῶτον μεταβέβληκεν) or the ‘*primary* time in which [something] has changed’ (ἐν ᾧ πρῶτω μεταβέβληκεν).⁴⁰⁵ Now as appears from the argument that this primary time is indivisible,⁴⁰⁶ ‘primary’ should be understood with the more lenient criterion in mind, merely excluding that time in which there is no having-changed. A period of time which would include such a primary time could thus be called ‘secondary’ On the other hand, not every period of time in which there is a moment of completion may be called a time of having-changed in a secondary sense, for in that same argument this primary moment is assumed to fall within a period of time in which there is no period of rest. This means in effect that only the time of change terminated by the moment of completion may be called a time of having-changed in a secondary sense. The pair of terms ‘secondary’ – ‘primary’ thus conceived seems to be excellently suited to describe the relation between the two halves of the principle (PT).

§ 6.3.2. *The building of change*

In the previous sub-section I explained the meaning of the periodical use of the perfect tense in terms of the momentary state of completion – which is indicated by the perfect tense in its primary sense – of a change from *x* to the state of completion (being at *y*). As set out at the beginning of § 5, within the context of the from-to conception of change, the present tense either signifies the whole change in a neutral way, that is, not in contrast to the perfect tense but in an inclusive way, or it denotes specifically the process of change, as distinguished from the completion of change. Now the secondary, periodical, use of the perfect tense we encounter in *Physica* 6.5-6 seems to be close in meaning to the inclusive present tense, since with the extension of the perfect tense from the final moment to the whole period of the change, it includes the time of the process as well, and thus the whole change. Thus it could still be contrasted with the present tense as indicating the process of change, for as used in that way the present tense merely denotes the smooth going on of the

⁴⁰⁴ E.g. *Physica* 6.5; 236a21-26 and 6.6; 237a6-8.

⁴⁰⁵ 235b7-8, b31, b32, 236a7-9; cf. 236a10-11

⁴⁰⁶ 235b32-236a7, quoted at p. 173, discussed at p. 177.

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change from the one terminus to the other, without any notion of completeness. On the other hand, though close in meaning to the inclusive present tense, the secondary perfect tense, being derived from the strict concept of the perfect, seems to stress more the completeness of the change, that is, the resulting change or displacement, than does the neutral present. For as appears from the fact that Aristotle never uses the present tense, but the aorist, in case there is no process of change, the neutral present still retains an emphasis on the durative aspect of process.

According to this scheme of the semantics of the tenses we can both understand why Aristotle thinks he is allowed to substitute the perfect for the present tense and *vice versa*, and how he could still maintain that there is a difference in meaning between them. Within a given change from x to y in time T we may distinguish between the completeness of the change as a whole together with the result of the change, and the smooth, ongoing process of the change. At the same time, however, the process of change and its completion are two inseparable aspects of the whole, so that also the completeness of the change as a whole and the process 'within' the change as a whole are inseparable: the one involves the other and *vice versa*. Therefore there is no problem with their intersubstitutivity.⁴⁰⁷

All this applies naturally to a *whole* change over a *whole* time achieving a *whole* result. Aristotle also wants to argue, however, that every *partial* process involves completeness and result. We can actually see Aristotle demonstrating this in the first sub-argument for a premiss of the 'big argument' of *Physica* 6.6. After having proved that something moving moves in whatever part of the time of motion, he continues:

Everything moving must have moved for a prior part. For if in the whole primary time XR it has moved over magnitude KL, in half the [time] something which moves equally fast and has started at the same time (*ἅμα ἀρξάμενον*), will have moved over half the [magnitude]. But if that which is equally fast has moved in the same time over something, also the other thing must have moved over the same magnitude. The result will be that something moving has moved.⁴⁰⁸

The point of this argument is to break into a stretch of moving, as it were, and to argue that for every part of that stretch of moving it is also the case that the object has changed, that is, some result is brought about. It is in this way, without the addition of 'for a prior part', that we have to read the conclusion. This conclusion Aristotle arrives at by comparing two moving objects, in everything the same except that the one apparently stops at half time. This object must have moved over something, that is, there must be some resulting displacement. Because the second object is also in motion during that same part of the whole time, as Aristotle has shown just before, and thus does not differ from the first object as far as its process is concerned, the second object should also have achieved some result, that is, some displacement. (The premiss needed for the big argument, announced at the beginning of this passage, that everything moving must have moved *for a prior part*, follows then without any problem, for obviously it is in process of motion for the whole time.)

With the help of the scheme of Aristotle's use of the tenses in these chapters, including this thesis of general coincidence for changing and having-changed (and not merely for a whole change), we can also understand what he is actually arguing for in the 'big argument' of *Physica* 6.6. Aristotle argues there:

⁴⁰⁷ Just as there was no problem with the intersubstitutivity of the neutral present and the durative present.

⁴⁰⁸ *Physica* 6.6; 236b33-237a3

Three themes together?

What has changed must change and what changes must have changed, and having-changed will be prior to changing and changing prior to having-changed, and never will the primary thing be taken.⁴⁰⁹

The first two points we recognize to be the thesis of general coincidence for changing and having-changed. The two further points, about the mutual relative priority of changing and having-changed, are of course what Aristotle is really after, and which he has argued for before (in arguments 4, 5, 6 and 7). With them he can argue that there is nothing primary in the realm of change, since every completed change and every result involves not only a whole process, but also partial, prior, processes, and every process involves partial, prior, results and complete sub-changes, *ad infinitum*.

It is easy to see, however, that these two further points depend on the general coincidence thesis for changing and having changed, for process and result obtained. As we saw in the argument for this general thesis, the point that having-changed is prior to changing follows without any problem, given the divisibility of the process of changing. The same dependence we encounter again in arguments 6 and 7 for the other premiss of the big argument, that changing is prior to having-changed. To quote the relevant part of 6 again:

Since then it has changed in a time, and every time is divisible, in half [the time] it will have changed over another [part], and again in the half of that over another, and always so. Hence it would move for a prior part.⁴¹⁰

First the having-changed side of the change is divided into more primary things, and then one of these prior having-changeds is assumed to coincide with a stretch of process. The importance of the general coincidence thesis also appears in two other arguments. The first of them is argument 9, which I called a condensed version of the big argument:

It is clear, then, that what has come to be must come to be for a prior part, and that what comes to be must have come to be, with regard to the things which are divisible and continuous... Similarly also in the case of what ceases to be and has ceased to be. For in what comes to be and what ceases to be there is immediately present something unlimited, at least in so far as it is continuous, and it is not possible to come to be without having come to be something or to have come to be without coming to be something, and similarly in the case of ceasing to be and in the case of having ceased to be.⁴¹¹

We see that the mutual priority of coming to be and having come to be is based on a version of the general coincidence thesis for them in combination with the ever-divisibility, in this case of thing which something else comes to be, that is, the result of the coming to be.⁴¹²

The second passage is a rather mysterious argument from *Physica* 7.5, from which above already a few lines were quoted:

Since what causes to move always causes something to move and in something and up to something – I mean by ‘in something’ that [it causes to move] in a time, by ‘up to something’

⁴⁰⁹ *Physica* 6.6; 237b3-7

⁴¹⁰ *Physica* 6.6; 237a25-28

⁴¹¹ *Physica* 6.6; 237b9-17, with one small omission.

⁴¹² Here indicated by ‘what comes to be’.

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that [it causes to move] over a length of such quantity. For it is always the case that it causes to move and has caused to move at the same time (ἀεὶ γὰρ ἅμα κινεῖ καὶ κεκίνηκεν), so that there will be some quantity over which [the moved object] moved (ὁ ἐκινήθη), and in so much [time], ... [some proportionality holds].⁴¹³

This argument has puzzled commentators,⁴¹⁴ for how, from the thesis that causing to move and having caused to move apply at the same time, could one derive the conclusion that there will be some quantity over which the object moved? This thesis is commonly explained as saying that whatever causes movement, has done so before, and the reference is always to the big argument of *Physica* 6.6. The problem with this interpretation is that it seems as if ‘at the same time’ refers to a moment, a moment at which, moreover, there is supposed to be a process of motion⁴¹⁵ – something ruled out by Aristotle. This problem can be avoided, however, by assuming that he is referring, not to some priority thesis, but to the thesis of a general coincidence (‘at the same time’ in a durative sense) of present tense and perfect tense stated there. The process of causing to move, occurring in some time, is aimed at some goal (‘up to something’). Because every process involves a completed change and a result, this goal is therefore also reached in that time, that is, in that time the mover has caused the object to move over some distance, and this displacement is the result of the action. Thus there is a distance the object moved over. Moreover, this is sufficient to base the existence of a proportionality on, as long as one presupposes the ever-divisibility of time and that in every time the mover is in process of causing to move.

Aristotle thus uses the contrast between the present and the perfect tense, even though both of them apply in a period of time, for an argument meant to show that every stretch of process and activity is accompanied by some result and constitutes a completed change. Every act of building yields some building. In this way he has guaranteed the continuity of change in every respect.⁴¹⁶

§ 7. Conclusion

It is difficult to write a conclusion to a chapter which basically is a commentary on the largest part of the longest text in which Aristotle discusses matters of continuity and infinite divisibility. Commentaries typically have an end, but no conclusion, as they are primarily concerned with describing and explaining arguments in all their details. However, since this commentary has been thematically ordered, it will be possible to give an overview of some

Physica 7.5; 249b27-30

⁴¹⁴ Ross, *Physics* 683-684, Wagner, *Physikvorlesung* 664-665, and Wardy, *Chain of Change* 311-313, who provides the most critical exposition.

⁴¹⁵ See Wardy, *Chain of Change* 312.

⁴¹⁶ Finally I want to remark that from the above it follows that the second characterization of ‘the primary time in which something has changed’, quoted at the beginning of § 6.3.1 (*Physica* 6.5; 236a7-15), can only be something to be derived from the ideas used and worked out in the big argument of *Physica* 6.6. For by defining it as ‘the primary time in which something began changing’ there is already a switch from the present to the perfect tense for parts of a change. Also the subsequent argument that there is no beginning of change and no primary time in which it was changing, quoted at the end of § 6.1.2 (*Physica* 6.5; 236a14-27), seems to presuppose the same ideas, by assuming that if a time in which something has changed is divided, one can ask for each part separately whether the object has changed in it. It is difficult, though, to state exactly the conceptions behind this argument are.

Conclusion

of the main findings concerning the structure and ideas of *Physica* 6 and to link them to issues discussed in the previous chapters.

From a long list of inconsistencies, circularities, repetitions and variations to be found among the arguments of *Physica* 6, it became clear that the order which one could detect in the subject-matter of the separate chapters was to a large extent merely apparent. The unity in the order of exposition fell apart into a sometimes chaotic collection of separate arguments. In this collection, however, three themes could be discerned. In a first set of arguments, Aristotle invokes proportional relations, as involved in motion, between time and magnitude, in order to establish the infinite divisibility of time and magnitude. He does so by postulating two proportionalities, one for a faster mover, and another for a slower mover. In a given time, the slower divides the magnitude moved over by the faster, simply by traversing a shorter distance in that time; the faster, for his part, must have taken a shorter time to traverse that shorter distance, so that the given time is also divided; and so forth. In a second group of arguments, Aristotle tries to establish in a more general way that every kind of magnitude is infinitely divisible, by reducing the supposition that it ultimately consists of indivisibles to absurdity. This reduction is based on the idea that indivisibles can only compose a magnitude if they are successively ordered, each indivisible touching two others; since it is impossible to distinguish boundaries within an indivisible, they cannot touch, and therefore cannot compose a magnitude. Instead, they are ordered densely, so that between every two points there is a magnitude. A third theme which could be distinguished is Aristotle's use of the contrast between present and perfect tenses in describing aspects of motion. Instead of motion as a proportionality between time and magnitude, in these arguments he conceives of motion as being between termini, from somewhere to somewhere. Within each motion, he distinguishes between the process of motion, taking place between the termini of the motion, and the completion of motion, which occurs at the arrival at the end-terminus. This contrast he employs to derive the infinite divisibility of motion from the infinite divisibility of time and magnitude. Within a given motion, being over a certain distance and taking a certain time, every period of time and every distance involves a process, to which a completion and therefore a result corresponds, and every moment in the time and every point along the way involves a completion, to which a process corresponds.

In *Physica* 6, these three themes are developed in relative isolation from each other. Especially the use of proportionalities seems to represent an earlier strand in Aristotle's thinking about matters of continuity, to judge from the incongruities which appear in the cases that the editor of the book has tried to connect arguments in this style with arguments belonging to the second and third themes; such discrepancies are rare when the other two themes are combined. This would coincide with a conceptual difference between the theme of proportionalities and the other two. In the proportional arguments, motion is conceived of as a structureless stretch, just a process going on, involving structureless stretches of magnitude and of time, without any limit inherent in the motion. What bothers Aristotle is merely that such stretches might still have some hidden internal structure, by consisting of indivisible, but still structureless, stretches. In the arguments employing the distinction between process and completion, by contrast, he conceives of motion as having a unified structure, by having a beginning, an end, and a process in between. Similarly, according to the second theme, he sees a magnitude as

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being between two points serving as its limits and thus delimiting it. In both cases the limits play the leading role, defining a unit of magnitude or motion.

Aristotle may think of motions and magnitudes as existing in units, but these units remain infinitely divisible and are described by him as consisting of ever-divisible parts, without basic parts. Thus he is committed to rejecting the modalized version of the priority of parts over a whole. For the rest, however, he is vague about the relation between parts and whole. He calls a part of a motion prior to the whole motion, suggesting that the whole is merely a sum of these parts, while at the same time he denies the existence of primary parts, so that there are no entities to which the whole could be ultimately reduced. It seems as if Aristotle is not interested in the issue of metaphysical priority, but merely wants to establish that there is an unlimited number of possible ways to conceive of a magnitude or motion, as consisting of two parts, of three, and so forth, or indeed as one whole.

The existence of this unlimited number of possible ways of conceiving of a magnitude or motion is guaranteed by the dense ordering of the indivisible points on any continuum, so that between any two limits there are infinitely many possible limits, each pair of which determine a unit. In the argument to this effect, Aristotle assumes the existence of indivisibles in any magnitude, but shows that they cannot be normal parts out of which a magnitude is to be composed, because they do not meet the criterion for a normal part that it should be able to touch other parts in order to form one uninterrupted whole. This criterion for being a normal part in fact amounts to having a unified structure determined by two limits limiting some stretch of magnitude in between them, for only such entities can touch with their boundaries while remaining separate. Since thus a consecutive ordering of the indivisibles is impossible, they must be ordered densely.

Thus here again Aristotle assumes that any magnitude, just as any motion, has the structure of having two limits and some stretch of magnitude or process in between. He is keen to emphasize that these two aspects are inextricably linked. In the case of magnitude he does so by showing that limits cannot be separate parts, while in the case of motion he points out that the transition from process to completion is not a normal motion itself. About the status of these limits, Aristotle does not say anything. Also about the other aspect, the stretch between the limits, we do not hear much, but from the argument that a motion which consists merely of completions without a process is not a motion, it is clear that he holds on to its irreducible reality. However, in most of *Physica* 6 Aristotle seems to conceive of this aspect, which, in Chapter One, I called the homogeneous aspect of a bare object, in terms of its infinite divisibility and its consisting of ever-divisible parts. It seems as if the conception of motion and magnitude as existing in structured units is so strong that the homogeneous aspect of such units can only be understood with the help of this conception. Rather than as purely structureless, as in the proportional arguments belonging to the first theme, Aristotle analyses the stretch between the limits later as structured in an infinite number of ways, none of which has priority. Nowhere is this more obvious than in the arguments for the ever-divisibility of motion, which he takes to justify the smoothness of motion and thus the proportionality between magnitude and time, rather than the other way round.