CHAPTER FOUR
ARISTOTLE'S METAPHYSICS OF CONTINUITY

§ 0.   Introduction

In Chapter One we saw how Zeno's paradoxes were ultimately derived from a limited set of conceptions of a metaphysical nature: the primacy of parts over the whole, which is merely the sum of these parts; the homogeneity of bare objects; and the unlimited as a series without a last term. Because of the primacy of the parts over the whole, Zeno demanded in the Arrow that motion should occur in the indivisible and extensionless part of time, the now. Because of the same primacy of the parts over the whole, in combination with the possibility of dividing an object or a motion into a series of ever-decreasing parts without a final part, Zeno argued that there is no limit to an object or motion, so that it is unlimited. The notion of an unlimited series conceived as a whole seemed anyway impossible, since a whole would require a boundary dividing the whole from what does not belong to it, thus serving as a limit. The conception of objects as homogeneous lumps of stuff, finally, led Zeno to pose a dilemma: either an object is divisible everywhere, and thus consists of sizeless basic parts, or it is nowhere divisible.

In Chapter Two, we discovered through an analysis of Democritus' argument for the existence of atoms how Democritus showed that the primacy of parts over wholes, enshrined in his atomistic principle – no unity from a plurality, no plurality from a unity – would limit the force of the argument from homogeneity, so that the idea of a homogeneous physical object being divisible only at certain places presented no problem. On the other hand, where the argument from homogeneity still applied, in the case of mathematical objects, the primacy of part over whole was limited to already 'created' mathematical divisions, so that mathematical objects could be divisible everywhere, without actually already consisting of parts resulting from such a division everywhere. What Democritus did have problems with, however, was the idea that such a division everywhere could be completed, so that a whole would consist of sizeless limit entities. On the other hand, he did not refrain from referring to limits, so that the question of their status arose. They were not normal parts into which something could be divided, as Democritus may have tried to show in a number of arguments. Thus he had in fact the same problem as Zeno with limit entities.

The arguments and ideas I analysed in the second half of Chapter Two became increasingly technical and mathematical. The same can be said of the arguments dealt with in Chapter Three, which provided a kind of commentary by topic on the larger part of Aristotle's primary work about continuity and infinite divisibility, *Physica* 6. There I discussed arguments based on proportionalities, others dealing with the order of indivi-

sibles and again others developing the idea of motion as being from a terminus to a terminus, with a process bringing the object of motion to the end, where, the motion being completed, the object is in the resultant state. Time and again Aristotle was seen to demonstrate the unlimited divisibility of all kinds of magnitude and to work out the consequences for our conception of motion. In the thesis that magnitudes, including motion, do not consist of indivisibles or primary parts, but are ever-divisible, we could recognize the idea that the parts into which a whole is divisible are not more basic than that whole, for otherwise Aristotle would have held that the whole did not really exist either. On the other hand, the strict criterion of primacy which Aristotle adopted when he wanted to argue that there are no primary parts involved in motion, seemed to point in the opposite direction. In the end he seems to have thought that continua are infinitely complex, with all parts present at the same time.

The major innovation provided by Aristotle's discussion in *Physica* 6 of infinite divisibility, was the idea that magnitudes and motions are structured wholes consisting of limits limiting some homogeneous aspect. But that idea alone does not tell us what Aristotle's more developed thoughts are about considerations of homogeneity, about the relation between parts and wholes, the status of limit entities, or the relation between physical and mathematical divisibility. As we may gather from the fact that we were able to reconstruct Democritus' views on these metaphysical matters from Aristotle's testimonies, however, Aristotle was quite aware of the part played by these issues in thinking about continuity. In this chapter I want to discuss a number of arguments in which Aristotle goes much further in making his basic ideas explicit, and in which he employs them to set out a coherent theory about continuity and infinite divisibility. In these texts, while he does refer to the technical arguments we studied in the preceding chapter, he goes clearly beyond them, either by using them as a ground for rejecting alternative positions and justifying his own, or by qualifying them.

§ 1.   The unity of motion

In § 6 of the previous chapter I discussed arguments from *Physica* 6.5-6 in which Aristotle argued that every change can be divided without limit into stretches of changing as well as of having-changed. In one of the arguments he even claimed that at every now during a change the object that is changing has changed, and thus has changed an unlimited number of times during the change. In *Physica* 6.5-6 Aristotle finds no problem with that. He is merely thinking in terms of changing and having-changed to whatever *x*, and holds that for a part of the whole change the changing object is just in change and has just changed, without any further qualification in terms of 'to some *x*'. The same lack of concern is also evident from the only passage where he explicitly states that these partial changes and their results are not identical to each other:

> It is clear that both what has come to be must come to be for a prior part and what comes to be must have come to be – [that is,] all the things which are divisible and continuous, though [it is] not always the thing which comes to be [which must have come to be], but sometimes something else, for example one of the parts of it, like the foundation [as part of] the house. (φανερὸν οὖν ὅτι καὶ τὸ γεγονὸς ἀνάγκη γίγνεσθαι πρότερον καὶ τὸ γιγνόμενον γεγονέναι, ὅσα διαιρετὰ καὶ

συνεχῆ, οὐ μέντοι αἰεὶ ὃ γίγνεται, ἀλλ᾽ ἄλλο ἐνίοτε, οἷον τῶν ἐκείνου τι, ὥσπερ τῆς οἰκίας τὸν θεμέλιον.)[1]

As appears from the qualification 'sometimes', and from the qualification just a little later: 'in so far as [the thing coming to be] is continuous' (συνεχεῖ γε ὄντι),[2] Aristotle is not thinking of real, individual things, but of homogeneous things or the homogeneous aspect of things, so that the thing coming to be is the same during the whole coming to be and only differs quantitatively. That this homogeneous aspect may be parcelled out into individuated parts is merely a complication which in that context does not interest him

The issue which fails to arouse Aristotle's interest in in *Physica* 6.5-6 can be explained by posing a problem for the ideas employed by Aristotle in the arguments of those chapters. Especially in the big argument of *Physica* 6.6 he derives the conclusions that for every part of the whole change the object is in change or has changed and that for every part there is a prior part according to which the object is in change or has changed. He does so starting from the thesis that what is in change or has changed *to B* is for a prior part in change or has changed *to C* (where C is closer than B to the starting point A). When is it then that the object is in change or has changed to B, if for all the unlimited prior parts of the change which do not terminate in B it is in change or has changed to something else?[3]

This issue is the issue of the unity of motion. Given the unlimited divisibility of change and its media, how can there be a unity in a change, so that we can talk about one change instead of an unlimited series of separate changes, without any primary change?

In the previous chapter we did encounter one context in which it was very important for Aristotle to insist that during the whole unified change the object is changing to the final terminus, and not to some earlier terminus. This concerned the question how Aristotle can maintain that even change between contradictory termini is a change involving a process of change, without reducing a contradictory change to a change between contraries. According to the interpretation I proposed Aristotle distinguishes between the factual level, at which there is indeed continuous progress, and the terminological level, at which some cutting-off point is stipulated which divides the underlying continuous progress into an area which is terminologically *F* and an area which is terminologically *not-F*. In this way it is possible that the changing object is not in either of the contradictory termini, while, obeying the principle of excluded middle, still being either *F* or *not-F*. It is even possible that it is already *F* while it has not yet changed to *F*! This whole scheme would be in jeopardy if the object also were to have changed for a prior part of the whole change, e.g. starting from the same terminus, but

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[1]   *Physica* 6.6; 237b9-13. As appears from the masculine accusative form of τὸν θεμέλιον, we have to supply a verb, the whole clause being dependent on ἀνάγκη. This verb can only be γεγονέναι.

[2]   237b15

[3]   Cf. the objection raised against the account of *Physica* 6 by Waterlow, *Nature, Change, and Agency* 145-146, that according to that account there is no single change which ends at the terminus of the whole change, since for every possible starting point of this change there is a later starting point. Graham, Physics *Book VIII* 191, argues that this accusation misses the point, as Aristotle in practice distinguishes between complete motions, which are from somewhere to somewhere, and incomplete processes, which do not include the termini. All the changes which are part of a whole change, then, are according to Graham merely processes. As well shall see below, while Aristotle does indeed draw a distinction of a similar kind, it does not save him from the accusation, as in *Physica* 6.5-6 he clearly uses the perfect tense, denoting completion, to refer to parts of changes.

ending just before the terminus of the whole change, in the same terminological area as that terminus. For in that case the object would for the prior part have already changed terminologically to *F* while, absurdly, continuing to be in change to *F* afterwards.

In the discussion of this question of change between contradictory termini, I did not bring in the metaphysical issue of the unity of change. However, in the very chapter on which I drew in that discussion, *Physica* 8.8, one can find a set of arguments in which Aristotle's concern with that issue is very clear. There he wants to argue, having established that there must be a perpetual motion, that only circular motion can constitute such a unified, perpetual motion, since every other type of motion necessarily fails to meet the combined criteria of unity and lack of interruption.

§ 1.1.   *Motion with and without structure*

It is Aristotle's purpose to prove this thesis that no kind of change except circular locomotion can last forever. In order to do so, he needs to show both that circular locomotion can continue indefinitely and that no other change or motion can. He hardly gives an argument for the former point,[4] but spends a great many words on the latter, starting already in *Physica* 8.7 and continuing for the largest part of *Physica* 8.8. The general point he wants to make is that every other kind of motion must sooner or later end and be interrupted by the absence of motion. I shall not consider all of these arguments, but confine the discussion to those which are of interest in the light of the previous chapters. At the same time I shall also try to give convincing interpretations of these rather difficult passages.

The first argument which should be discussed is the following:

> Everything moving continuously, when it is not hindered by anything, was also for a prior part in locomotion to that to which it moved according to the locomotion (ἅπαν γὰρ τὸ κινούμενον συνεχῶς, ἂν ὑπὸ μηδενὸς ἐκκρούηται, εἰς ὅπερ ἦλθεν κατὰ τὴν φοράν, εἰς τοῦτο καὶ ἐφέρετο πρότερον), e.g. if it moved to B, it was also in locomotion to B, and not when it was close, but straight away as soon as it started moving. For why rather now than before? Similarly also in the case of the other [motions].
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> Then [take] something in locomotion from A to C [which], when it goes to C (ὅταν ἐπὶ τὸ Γ ἔλθῃ), will again go to A, moving continuously. Therefore when it is moving from A to C, then it is also moving to A, making a motion from C, so that it makes at the same time contrary motions. For the motions along a straight line are contrary. And it is at the same time also in change from that in which it is not [*scil.* from C while still on its way to C]. If then that is impossible, it must be halting at C. Therefore the motion is not one. For a motion interspersed with halting is not one.[5]

This argument consists of two parts. In the first part Aristotle claims, on the basis of an indifference argument, that in the whole period of a motion as it is defined by its termini, that is, in every part of that period, the moving object is in motion to the end-terminus. This argument is based on two presuppositions. The first is the existential assumption that there is indeed a motion as determined by its termini which, taking some time for its process, results in the object being in the end-terminus. This is in line with Aristotle's idea that every motion is from somewhere to somewhere. Secondly, however, Aristotle conceives of the stretch of process between the given termini as homogeneous and internally

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4   *Physica* 8.8; 264b9-28
5   *Physica* 8.8; 264a9-21

undifferentiated, so that no answer can be given to the question of why it is from this moment onwards rather than that moment, that the object is moving to the end-terminus. Behind this idea lurks a radically different conception of motion. For if Aristotle is to avoid circularity, he should not base the homogeneity of the process on the idea that it is in its entirety a process to the end-terminus. Rather, it is because it is undifferentiated that it is in its entirety a process to the end-terminus. Therefore he must be using a different conception of motion than the from-to conception he employs in the first assumption, a conception of motion as a structureless stretch of making progress, without any form in the sense of being from something and to something.[6]

In the second part he uses this same structureless conception of motion to argue that something which goes from A to C but without interruption returns to A, because it is thus all the time in motion (in the structureless sense), is all the time in motion to A, even during the time of motion to C. What is more, since the motion to C is from A, the object is for the same reason all the time also in motion from A, even during the time of motion from C. Therefore the object is at the same time (ἅμα), during the whole time of continuous motion, in the business of performing two incompatible motions.

In this way Aristotle is playing off against each other two criteria for the unity of a motion, each corresponding to a different conception of motion. The first criterion is derived from this homogeneous conception, saying that a motion is one if it is not interrupted by absence of motion. The second criterion, on the other hand, is based on the from-to conception of motion, and distinguishes between forms of motion. Given the unity of the moving object and the uninterruptedness of the time, a motion is one if parts of it are not of a different form:

> What motion is a motion which is one and continuous, has been determined before: [a motion which is] of one thing and in one time and in something indistinguishable according to form (ἐν ἀδιαφόρῳ κατ᾽ εἶδος).[7]

Aristotle takes it for granted here that the motion from A to C differs in form from that from C to A. A motion which consists of these two different motions, then, cannot be one. By the first criterion, however, the mere fact that there is motion without interruption is enough to draw the conclusion that the whole stretch of motion constitutes one motion. Letting the first criterion prevail, Aristotle reduces to absurdity the position that it is possible that there are two consecutive, but different motions.

The same argument is in fact rephrased in a somewhat different vocabulary in the next passage:

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6 This conception of motion is less rich than the conception of motion as process ascribed to Aristotle by Graham, Physics *Book VIII* 191, for according to that notion a process is still aimed at some goal. Here we require a notion of motion as completely aimless. In this sense I am in agreement with Waterlow, *Nature, Change, and Agency* 149, when she says that in *Physica* 8.8 motion is almost indiscernible from rest in that both are 'solidly self-identical'. To this I might add that rest is also without any termini. However, a more appropriate comparison seems to be one with Aristotle's notion of activity (ἐνεργεία), which, as he explains in *EN* 10.4 and *Metaphysica* Θ.6, is all the time complete and not directed at some external goal. For not only does Aristotle consider rest as the absence of motion, but one also has at least the impression that something is happening in the case of an activity.

7 *Physica* 8.8; 261b36-262a2; the reference is to the discussion in *Physica* 5.4.

> At the same time the not-white has ceased to be and has come to be white (ἄμα ἔφθαρται τὸ οὐ λευκὸν καὶ γέγονε λευκόν). If then the alteration to white and from white is continuous and [the object] does not remain [white] for some time, the not-white has ceased to be at the same time as it has come to be white and as it has come to be not-white. For there will be the same time for all three [alterations].[8]

Since the change from not-white is the same as the change to white, one can only say that the change from not-white has been completed when it is also the case that the change to white has been completed. If then the object which changes to white immediately goes on, without any interruption, to change back to not-white, there will be one homogeneous stretch of motion. Because of this homogeneity, the object will have made, instead of two separate changes, one big change. Nevertheless, this change is by assumption both from not-white and therefore to white, and to not-white and therefore from white. Consequently the completion of the change from not-white occurs at the same time (ἄμα) as both the completion of the change to white and the completion of the change to not-white. According to the use of the perfect tense as set out in § 5 of the previous chapter, the object would therefore be white and not-white as well as other than not-white at the same time.

   With these two arguments at the back of our mind we can turn to the most difficult of the arguments in *Physica* 8.8, where he claims to prove that something moving up and then down must rest for some time in the point of return. In the first part of this argument Aristotle says:

> When [A] is continuously in locomotion, it is not possible that A has arrived or has left with regard to point B (οὔτε γεγονέναι οὔτε ἀπογεγονέναι οἷόν τε τὸ Α κατὰ τὸ Β σημεῖον), but only that it is [at B] in the now, and not in any period of time (except the period of time of which the now is a division),[9] that is, in the whole [time]. And if someone is to admit that it has arrived and has left, [it] will always [follow that] the [object] A in locomotion comes to a halt. For it is impossible that A has arrived at B at the same time as it has left [B]. Therefore [it must have done so] at different points in time. Therefore there will be a period of time which is in between. Hence A will rest at B. Similarly also in the case of the other points, for the same argument [applies] in the case of all. .. But [in fact] it [only] has, on the one hand, left from point A as a beginning[10] and, on the other hand, arrived at C, at the moment it finishes and comes to a halt.[11]

It is not surprising that Aristotle's argument has often been misunderstood. For it seems that he derives the conclusion that something which has arrived at a point and has left that point must rest in that point for some time, from the fact that, since the moment at which it has arrived cannot coincide with the moment at which it has left, there must be a period of time between these two moments, as they cannot be successive. If that were the case, however, Aristotle would also in his own eyes be guilty of a fallacy, since in *Physica* 6.5-6 he makes it quite clear that there is no first moment at which something has changed, and therefore no first moment at which something has left either.[12] This interpretation, however, is incorrect. As is indicated in the last sentence, the moment that something moving from A to C has left

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8   *Physica* 8.8; 264b2-6
9   The reference is to a period in which it is in B not for the period itself, but for something else.
10 Rather confusingly Aristotle uses the 'A' again when referring to the starting point.
11 *Physica* 8.8; 262a28-b8
12 Wagner, Physikvorlesung 693, White, *Continuous* 54-55, Charlton, 'Potential Infinites' 138-139, Bostock, 'Aristotle, Zeno' 42, and Sorabji, 'Instant of Change' 174 [85], all accuse him of such a mistake. Graham, Physics *Book VIII* 139, surprisingly does not comment at all.

A is the moment the change as a whole comes to its end and the object comes to a halt. In the case of an uninterrupted motion, the moment the moving object has left the starting point is the same as the moment of arrival at C. However, at the same time the motion from the starting point was posited to be to B and the motion to C to be from B. Therefore it would follow, just as in the two simpler arguments discussed above, that the object has left B (when it has arrived at C) and has arrived at B (when it has left A) at the same time. Since that is impossible, Aristotle reasons, the moment of having arrived at B differs from the moment of having left B. It is not the case, though, that the final conclusion follows (that there is a time which is in the middle), because moments cannot be successive. It follows rather through an intermediate proposition, namely that the moment of having left A (that is, the moment of having arrived at B) differs from the moment of having arrived at C (that is, the moment of having left B). On the basis of the structureless conception of motion, this can only be the case if the whole change is interrupted by a period of time in the middle.

   In the next argument Aristotle compares two objects, A and D, moving along equal lines E and F with equal speed from the ends of the lines in the direction of C and G. They differ, however, in that A is at some point B, while D is in motion when A is at B. Therefore, Aristotle concludes, D will arrive at G before A will arrive at C.[13] Aristotle explains this as follows:

> It is not at the same time that A has arrived at B and has left from it – that is why it is lagging behind. For if [it is going to be] at the same time, it will not lag behind, but it will be necessary that it comes to a halt. Therefore one should not admit that when A arrived (ἐγένετο) at B, D at the same time is in motion from the top of F. For if it is to be the case that A has arrived (γεγονὸς) at B, there will also be the fact that it left (ἀπογενέσθαι), and not at the same time. In reality, however, it was [in B] in a cut of time and not in a time.[14]

In the first sentence Aristotle presupposes the result of the previous argument, that whatever has arrived and has left an intermediate point on a journey must stay there for a while. In the second sentence he may in fact be saying that. It is also possible, however, that he there is providing a second reason why the having-arrived and having-left cannot occur at the same time: because the object will come to a halt in that case. For it may be that the idea is the same as in an earlier passage from *Physica* 8.8:

> An indication that the motion from A to B is contrary to the motion from B to A is that these motions stop and bring each other to a halt, when they occur at the same time (ὅτι ἱστᾶσιν καὶ παύουσιν ἀλλήλας, ἐὰν ἅμα γίγνωνται).[15]

The two contrary motions cancel each other out, when they occur at the same time. But if A has arrived at B at the same time as it has left B, the motions of going to B and leaving B must also occur at the same time, so that they as well cancel each other out.

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[13] *Physica* 8.8; 262b9-15. Aristotle's description is not very perspicuous, but this is the situation he seems to have in mind. What is most puzzling in the passage is that he declares that D will arrive earlier because 'what started and left earlier must also arrive earlier' (τὸ πρότερον ὁρμῆσαι καὶ ἀπελθὸν πρότερον ἐλθεῖν ἀνάγκη) (cf. Graham, Physics *Book VIII* 140-141). Let me try an explanation. Because A is at B while D is in motion, A will take more time to traverse the distance BC than D needs to traverse the distance from the corresponding point on F to G. This would then be explained by the fact that A has to rest in B – and that is what Aristotle actually goes on to explain.
[14] *Physica* 8.8; 262b15-21
[15] 262a6-8

Aristotle goes on to single out from the formulation of the situation the point which should be rejected, namely that at the moment of A's arrival at B, D is in motion. It is this point he rejects, I suppose, because it contains a reference to the arrival of A at B. However, there is no arrival[16] of A at B, because if there is an arrival, it will have arrived there, so that it must stay there for a while. Moreover, there must then also be a departure[17] which cannot take place at the same time, so that there must be a period of time between the two transitions. All this, however, is against the agreed point that A is only at the cut of a time, that is, in a now, in B.

From these arguments it follows that according to Aristotle an eternal unitary motion should meet two requirements. First, the termini of the motion should coincide. Only in that way is it possible that it is at the same time in motion to A as in motion from A.[18] Motion in a circle meets this requirement:

> Motion along a circumference will be one and continuous. For nothing impossible follows. For something moving from A will move at the same time to A, according to the same purpose, for it is also in motion to that at which it will arrive. ... Whereas circular motion is from the same to the same, motion along a straight line is from the same to something else.[19]

The second requirement is that it should not contain any complete motions within itself, for then we get into the paradoxical results of the arguments above. However, what determines the completeness of its parts? The answer must be found in the criteria Aristotle uses for the determining unity of form of motions, that is, for the individuation of motion. In the case of uniform locomotion the relevant criterion is the (ir)regularity of the track:

> It is impossible that the motion is regular [if] not in the case of a regular magnitude, for example, a motion along a broken [line] or a spiral or some other magnitude, any one part of which does not fit to any other part of it.[20]

Motion from A to A over C back and forth along the same track, for example, will not meet this criterion, since there is a discontinuity in the track at the turning point.[21] Because of this discontinuity there is a real goal for the motion along the way, which it will arrive at and depart from. It is clear, however, that circular motion passes the test.

§ 1.2.   *Is motion divisible?*

In all the arguments discussed above the conclusion is that it is impossible for a motion to go on immediately after it has reached some intermediate goal. It is a consequence of this impossibility that it is impossible to divide a motion into parts which are themselves motions bringing the moving object from the one terminus to the other. Is there then no

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[16]   In the sense of a transition from not being there to being there – note the aorist.

[17]   A transition from being there to not being there – again note the aorist.

[18]   There is a problem with this, though. For why is the motion from A to A, rather than from some other point B to B? And if it is both from A to A and from B to B, does then the circular motion consist of two motions, from A to B and from B to A? That would seem to threaten the unity of the whole motion. I shall not go into this matter.

[19]   *Physica* 8.8; 264b9-12 and b18-19

[20]   *Physica* 5.4; 228b22-25

[21]   Strictly speaking it is not sufficient, though, that the track does not contain any discontinuity, for according to Aristotle's formal criterion an ellipse would not qualify, as not every part would fit on to every other part. One wonders, however, where according to Aristotle the boundaries between the really united motions should be.

progress or any intermediate result during one motion? Can we not say that now the Moon, moving in a circle around the Earth, is moving from a position between Sun and Earth to a position at the other side of the Earth, and that, continuing its motion, it later will be moving back again? Is there any way in which we can divide motion?

Aristotle was concerned to show in *Physica* 6.6 that during a continuing motion there are intermediate results brought about by motions which are parts of the whole motion, thus providing himself a foundation for the continuity of the proportionality between change, time and the path of change. He did so by arguing from the divisibility of a medium of motion to the divisibility of motion itself, punctuating it with completions of motions. This way of dividing the motion is no longer available to him. In other contexts, however, Aristotle is willing to talk about intermediate results and about motions being parts of other motions. This is very clear in *Ethica Nicomachea* 10.4:

> [The motions] in the parts of the time [of the whole motion] are all .. different in form from the whole and from each other. For the putting together of the stones is different from the fluting of a column, and they differ from the production of the whole temple... If locomotion is motion from somewhere to somewhere (πόθεν ποῖ), it is also different in form .. within the walk itself. For [the aspect of] from somewhere to somewhere is not the same in the stadium and in a part of the stadium, or [the same] in different parts [of the stadium], nor is traversing this line [the same as traversing] that line. For one does not merely go through a line, but through a line which is also in a place, and the one line is in a different place from the other. ... The many [partial] motions .. differ in form, since the [aspect of] from somewhere to somewhere determines the form (τὸ πόθεν ποῖ εἰδοποιόν).[22]

Even in *Physica* 8.8 Aristotle thinks that a motion can have parts, as appears when he remarks in passing that when he is talking about 'something which is not all the time making this particular motion' (τὸ μὴ αἰεὶ κινούμενον τήνδε κίνησιν), he is talking about motions 'which are different in form, and not if it is some part of the whole [motion]' (ὅσαι ἕτεραι τῷ εἴδει, καὶ μὴ εἴ τι μόριον ἐστιν τῆς ὅλης).[23]

There is, however, an obvious difference in formulation between these two texts. Whereas in the *Ethica Nicomachea* Aristotle says that all the partial motions have their own form, defined by the termini, in *Physica* 8.8 he reserves this term for the whole motion. As it is a common theme in Aristotle that things are individuated and are one according to their form, there thus seems to be a difference in the application of the criterion of unity beteen these passages. However, in the *Ethica Nicomachea* he has a different pair of terms to draw the same contrast between the whole motion and a part of it:

> Every motion (e.g. housebuilding) is in a time and [involves] some end, and [is] complete (τελεία) when it produces that to which it strives, either in that whole time or in [the end]. [The motions] in the parts of the time are all incomplete (ἀτελεῖς). … Whereas the [production] of the temple is complete (for it does not lack anything with regard to [the goal] laid down), the [production] of the foundation or of the triglyph are incomplete, because each [is the production] of a part. They differ then in form, and it is not possible to take a motion which is complete in form in any time, but if it is [to be possible, then this will be] in the whole time.[24]

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[22]   1074a21-b5, with some huge omissions, partly to be supplied later.
[23]   264a24-26
[24]   1074a19-29, with some omissions.

The partial motions may have a form, but in their form they are incomplete; only the whole motion is complete in form. The whole motion is complete in form, it appears, because it brings about the result as a whole; the partial motions are incomplete in form, because they produce merely parts of the whole.

This distinction opens up a possibility to talk about parts of motion while still respecting the stricture that they do not bring the moving object from one terminus to some intermediate terminus. Having a form, the partial motions do bring about something (in the sense that they are from somewhere to somewhere), but this something is merely a part of what is being brought about in the whole motion. As it is the whole result which provides the standard of completeness, the parts are not complete in themselves and can thus not be considered to be independent entities; their purpose is to contribute to the whole. Similarly the partial motions will not bring about anything complete in itself and independent; it is their purpose too to bring the object towards the final terminus, and not to some terminus of their own. Thus the motion is only divisible in so far as the result it brings about is divisible.

In *Physica* 8.8 Aristotle uses a different vocabulary, which allows him to develop this idea. He introduces it when comparing the situation in which something moving stops in an intermediate point, with the situation in which the object does not stop. These are his words:

> There being three things, beginning, middle and end, the middle is both [namely beginning and end] in relation to each of them, and it is one in number, but two in account (τῷ μὲν ἀριθμῷ ἕν, τῷ λόγῳ δὲ δύο). Further, what is potentially differs from what is actually, so that any point of [the points] within the extremities of the straight line is potentially the middle, but not actually, unless one divides it there and having stopped starts moving again. In this way the middle turns out to be a beginning and an end, the beginning of the later [line], and the end of the first [line]. I mean for example when something moving, A, halts at B and again moves to C.[25]

And:

> When then the moving thing A is to use the middle B both as an end and as a beginning, it is necessary that it halts because that makes it two, just as one might do in thought.[26]

Three pieces of philosophical vocabulary are introduced by Aristotle here: something being one in number while two in account; using something as something; and a point being actually or potentially a middle. They are clearly held together by the idea that a magnitude, as long as it has merely a beginning and an end and is undivided, forms a unity, while only when it is divided at a point between the original beginning and end it no longer forms a unity but a plurality. However, from a unity a plurality may come about, since the divided state might be, or might have been, the actual state, even though as it is the magnitude is not divided. Now on a magnitude there are points, indeed unlimitedly many points. As long as the magnitude is one, only two points are 'in use', namely the extremities, as beginning and as end. If one goes on to divide the magnitude, however, thus making actual the previously potential state, one does so at a single point on the magnitude, which thus becomes an actual point of division. Being a point of division, it is now used in two ways, as end of the

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[25]   *Physica* 8.8; 262a19-28
[26]   *Physica* 8.8; 262b5-7

first part and as beginning of the second part. Therefore one may describe it in two ways, thus making it two in account. Before the division, however, the point is merely one in number, and is not used at all, though of course it might be, or might have been, used.

The vocabulary of potentiality and actuality, of using one point as two, as well as the idea that to have two motions there has to be an absence of motion in between, all recur in Aristotle's second, improved, reply to Zeno's Runner paradox. In what respect he was dissatisfied with the old reply of *Physica* 6.2, and in what sense his new reply constitutes an improvement, I shall consider in the next section. Here I am merely using the passage to find out how Aristotle could have held on to the divisibility of motion. This is what he has to say:

> When someone divides the continuous [line] into two halves, this person uses one point as two, for he makes it into a beginning and an end. Both the person counting and the person dividing into halves do so. But dividing it thus, neither the line nor the motion will be continuous. For a continuous motion is [over something] continuous, and in something continuous there are unlimited halves present, though not actually, but [only] potentially. However, when one makes them actually [present], one will not make a continuous [motion], but one will halt – which is clearly what follows in the case of someone counting the halves. For it is necessary for him to count one point twice, for it will be the end of the one half and the beginning of the other, if one does not count the continuous [line] as one but as two halves. Hence one should say to someone asking whether it is possible to traverse unlimited things (either in time or in length), that it is possible in one sense, and not in another. For when the halves are actually, it is not possible, but it is possible when they are potentially. For someone moving continuously has traversed unlimited [halves] accidentally, but not without qualification (κατὰ συμβεβηκὸς ἄπειρα διελήλυθεν, ἅπλως δ᾿ οὔ). For it is an accident (συμβέβηκε) to the line that it is unlimited halves, but the substance and being (ἡ οὐσία .. τὸ εἶναι) is different.[27]

Here Aristotle extends the vocabulary of potentiality and actuality from the points at which a line can or is divided to the parts into which a line can or is divided. They can be potential parts, into which the line can be divided, but is not, and actual parts, into which the line is divided. Since the line is divisible at an unlimited number of points and since any two points between which there is an undivided stretch define a part, the number of potential parts is unlimited.[28] Not all potential parts can become actual at the same time, for a part which itself is divided further, does not exist as one part any more.

In a third passage, just before, Aristotle applies the terminology of actuality and potentiality to the end-point of a motion:

> [In the case of something going up to D and then immediately down again] it is not possible to assert that [the object] is at D at a cut [of time], but has not arrived or left. For it is necessary that it arrives at an end which is actually an end, not potentially (ἐπὶ τέλος τὸ ἐνεργείᾳ ὄν, μὴ δυνάμει). For the [points] in the middle are potentially [an end], but this one is actually so, both an end from below and a beginning from above, and therefore of the motions in the same way.[29]

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27 *Physica* 8.8; 263a23-b9

28 Sorabji, *TCC* 213, complains that Aristotle has disallowed himself to make this claim, by rejecting the actually unlimited. Surely this must be a misunderstanding of Aristotle's rejection, for he does accept the infinity of numbers (*Physica* 3.6; 206a11-12), which together also make up an actually unlimited collection. It is more likely, then, that Aristotle refuses to think of such collections of numbers or of potential parts as wholes. Cf. White, *Continuous* 111-112.

29 *Physica* 8.8; 262b29-263a1

In these three passages we recognize the idea that the whole magnitude moved over has parts into which it is divisible because it has everywhere potential dividing points. These points could be used by a motion as an end-point, but in fact are not. It merely passes through all of them, being there for the moment, but not completing or starting any motion there. Using them in the description of the motion, we might start talking about the motion to such a potential dividing point, but this has no ground in the reality of the motion, which is without any discontinuity.

Though it is thus possible to talk about the parts of motion, it is clear that this is a rather derivative sense. For it will be noticed that in these passages Aristotle only applies the distinction between potential and actual parts to the magnitude moved over, not to the motion itself. The continuity of the motion seems dependent on the magnitude moved over. If the magnitude moved over consists of actual parts, the motion over it must also consist of a plurality of separate motions, while if the magnitude has merely potential parts, the motion will also be one. But there is no indication that the motion itself is divisible. Rather it is what one might call the intentional object of the moving which is divisible.

Describing the relation between the moving and the magnitude moved over as one between an activity and its intentional object is also appropriate because of another feature of Aristotle's vocabulary. For not only is the continuity of the motion dependent on the continuity of the magnitude over, but the continuity of the magnitude may also depend on the mover. As appears from the analogy between the person counting the parts and the person moving over the magnitude, the mover, by stopping somewhere, in some way divides the magnitude. In the first passage quoted this is described in the vocabulary of 'using a point twice', which is equated with dividing the magnitude at that point.

From this it follows, however, that wondering whether a motion is divisible is like committing a category mistake. Just as the concept of a divisible thing is not divisible (unless in a different sense), so motion, the act by which the moving object uses two points (on a magnitude, but presumably also in time) as termini, is not the kind of thing to be divisible. It is rather a way of individuating magnitudes.

§ 1.3.   *An abstract summary*

Let me summarize the results of this section. The first result was that Aristotle uses two conceptions of motion, one of motion as structureless progress, without any inherent beginning or end, and one of motion as structured by having a starting point, an end point of completion and a process in between which is a process towards the end point (as well as a process away from the starting point). Related to these two conceptions are two ways of determining what constitutes one motion. According to the structureless conception, a motion is one if it constitutes an uninterrupted stretch of progress. How motion is individuated according to the second conception, on the other hand, depends completely on the termini picked out. In his argument that an object cannot continue moving immediately after it has completed a motion, Aristotle makes two assumptions. On the one hand, he assumes in line with the second conception that every occurrence of motion constitutes a structured motion. There are no unstructured occurrences. Thus every process is from somewhere to somewhere. On the other hand, in accordance with the first conception he also assumes that every uninterrupted occurrence of motion must all the time involve the same process,

because being uninterrupted, it is internally structureless. Thus despite the facts that every occurrence of motion must be structured and that there are no processes which are not from somewhere to somewhere, there is a level at which there is a process which is without structure and is not from somewhere to somewhere. If there were not such a level, Aristotle could not have had any problem with two different consecutive motions and processes, for the processes would have been just different too.

The second result of the section was that motion is in fact not the kind of thing to be divisible. Rather, because motion is an act in which an object uses two points on a magnitude (and in time) as termini, it is what brings about a division, not what is divided. If one wants to give sense to the idea that motion is divisible, one should say it is divisible in so far as the intentional object, that over which the motion takes place, is divisible. The wholeness and continuity of that object correspond to the wholeness and continuity of the motion.

These two results are very intimately related. One will recognize immediately that the structured from-to conception of motion is behind the idea that every individual motion is an act in which two points are used as termini. On the other hand, the idea that motion is divisible stems from the structureless conception of motion as just going on. If one conceives of motion as just an ongoing process of traversing so much ground over so much time, very much as in the arguments from proportionality in *Physica* 6, then there is no problem at all about talking about a stage of the ongoing motion. Motion functions here as a mass-concept, to which in itself individuation does not pertain, but it may be individuated in all kinds of ways, even by being interrupted. It is these ways we have in mind when we talk about the parts of motion. For itself, however, neither the whole unified motion nor the process in so far as it is a process from somewhere to somewhere can be divided, for it is the result of one way of individuating the underlying structureless process. Other ways of individuating this process yield other motions with their accompanying processes from somewhere to somewhere. Only one possible way can be realized.

The same model also explains why a discontinuity in the path of motion must be followed by an interruption of motion. For that discontinuity would set a limit to the underlying structureless process, because thus the spatial dimension of the process is limited in extent.

§ 2.　　　The metaphysics of continuity

In the arguments and passages quoted and discussed in the previous section, the reader will have recognized several of the ideas we encountered in the chapters on Zeno and Democritus. For example, the argument that during the whole change the process is a process towards the final terminus, resembles the argument from homogeneity as used by Zeno and rejected by Democritus. Also the introduction of the distinction between potentiality and actuality pertains to an important idea accepted by both Zeno and Democritus, namely a modalized version of the primacy of part over whole, also known as the Atomistic Principle that no unity may come from a plurality and *vice versa*. In this section I want to work out in somewhat more detail the way Aristotle's ideas are related to those of Zeno and Democritus and to what extent they can be seen as a response to the problems these predecessors raised. While doing so I shall have in mind bare objects and magnitudes, just as Aristotle has,

rather than the quite complicated phenomenon of motion. In the end I hope to have shown that the ideas I ascribed to Aristotle at the end of the previous section constitute a special version of a more general conceptual scheme which determines Aristotle's thoughts about issues of infinite divisibility.

§ 2.1.   *Parts, wholes and homogeneity*

For both Zeno and Democritus the most important principle was the primacy of parts over the whole. Zeno expressed and applied a modal version of this principle in his arguments, namely that whatever has parts and is divisible, cannot be or become a unity (and *vice versa*). Democritus accepted this version of the principle, but limited its application to physical wholes, which, he argued, cannot be divided in such a way that their parts are separated by a gap. He did allow for mathematical divisions, by which something physically unified could be *considered* as a plurality of parts. Thus in the case of mathematics he accepted for each possible way of considering an object as divided the principle of the primacy of parts over the whole, but, rejecting its modalization, not across possible ways.

  Aristotle takes a different course. It is clear from the example of the line which is actually one, but potentially two and even unlimited, that, like Democritus, he denies the modalized version of the principle for mathematical divisions. In addition, however, he rejects this version of the principle for physical divisions. This appears from his rejection of atomism in general, for which we have seen evidence in Chapter Three, and shall see more evidence in the present chapter. Also in his examples of wholes being actually one and potentially two he does not distinguish between mathematical division and physical division in this respect:

> Actuality is the fact that a thing exists, not in the way [though] in which we use 'potentially' (ἔστι δὴ ἐνέργεια τὸ ὑπάρχειν τὸ πρᾶγμα μὴ οὕτως ὥσπερ λέγομεν δυνάμει). We say, for example, that Hermes is potentially in the wood and the half[-line potentially] in the whole, because it can be taken away from it.[30]

The wholesale rejection of the modalized version is something he makes explicit in his comments on the atomistic principle in *Metaphysica* Z.13:

> It is impossible that a substance consists of substances which are actually present [in it] (ἐνυπαρχουσῶν ἐντελεχείᾳ). For things which are thus actually two [will] never be actually one, but if they are potentially two they will be one. For example the double [line consists] of two halves [which only exist] potentially (ἡ διπλασία ἐκ δύο ἡμίσεων δυνάμει γε). For the actuality separates [them]. Hence if a substance is one, it will never consist of substances which are present [in it], that is, in this way, which Democritus states correctly.[31] For he claims that it is impossible that one [thing] comes to be from two or two from one. For he posits the atomic magnitudes as substances.[32]

Initially it may seem that Aristotle here actually endorses Democritus' Atomistic Principle (or at least half of it) when he says that Democritus states it correctly. However, on a closer

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[30] *Metaphysica* Θ.6; 1048a30-33
[31] For the translation, cf. M. Frede and G. Patzig, *Aristoteles 'Metaphysik Z'. Text, Übersetzung und Kommentar* I (Munich, 1988) ad locum.
[32] 1039a3-11

look it is clear that Aristotle limits this endorsement to the case of substances which are actual. In so far as objects are actual substances – to use a pleonastic phrase –, it is impossible that they merge into one or that they consists of actual substances. Nevertheless they are divisible, when the parts, in being separated, are turned into actual substances: 'Actuality separates them.' As a consequence, the old unified substance disappears and is replaced with two new substances.

Democritus used his Atomistic Principle to rein in the effects of Zeno's argument from homogeneity, according to which an object is either everywhere divisible or nowhere divisible, because it is everywhere the same. In reply Democritus insisted that an object composed of a plurality of atoms, was not everywhere the same, because it contained discontinuities. However, since the divisibility everywhere of an object is only problematic to those who, like Democritus but unlike Aristotle, accept the Atomistic Principle, Aristotle himself is free to use the argument from homogeneity. This is what we see him doing when stating objections against atomism:

> Further, is there one nature of all these [indivisible] solids or do they differ from each other, as in the case where some are fiery and others earthy in mass (τὸν ὄγκον)? For, on the one hand, if there is one nature of them all, what is it that keeps them apart? Or because of what reason do they not become one when they touch, as when water comes into contact with water? For the latter does not differ in anything from the former. If, on the other hand, they are different, of what kind are they? And it is clear that that one should posit these [kinds] as principles and grounds of what results from them, rather than the shapes.[33]

Also after his report of the argument from homogeneity as used by the Eleatics in *DGC* 1.8, Aristotle comments favourably on the logic – not the outcome – of the argument.[34] More in general one may suspect considerations of homogeneity to be behind Aristotle's idea that continuity in the sense of uninterruptedness is sometimes a sufficient condition for unity.[35]

The fact that Aristotle appeals to considerations of homogeneity to deny the plurality of two touching entities shows that he must have a conception of unindividuated stuff of which physical objects are made up.

It must be added, though, that Aristotle only uses this argument from homogeneity in the case of physical objects. He does not have any problems with two magnitudes which touch, but remain two. The contexts in which these examples occur, however, are of a much more abstract kind, as they involve either some object moving over the magnitude or mind dividing a magnitude, for example in mathematics. In the previous section we saw how Aristotle used the vocabulary of 'using' a point as two, and thus dividing a magnitude, by stopping there. Similarly he allows for the division of a period of time by stopping at a certain moment, thus distinguishing between a period of motion and a period of rest.[36] But surely the same period of time might not be divided with respect to some other actor. By mentioning a person counting the parts into which a magnitude may in a Zenonian way be divided, Aristotle's reply to Zeno's Runner paradox also provides an example of a division for which not even a stop is necessary. Just thinking of a

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[33] *DGC* 1.8; 326a29-b1. 'Shapes' as used here refers to the atoms themselves.
[34] The report is at 325a2-12, quoted in Chapter Two, p. 65; the comment occurs at 325a17-18.
[35] See e.g. *Metaphysica* Δ.6; 1015b36-1016b3 and I.1; 1052a19-21.
[36] *Physica* 4.11; 220a12-13

point as dividing the magnitude will do.[37] Most explicit is Aristotle's description of geometrical proof in *Metaphysica* Θ.9:

> Also geometrical proof-constructions (τὰ διαγράμματα) are found through actuality, for people find them by dividing. If things had been divided, they would have been obvious; at the moment they are present potentially. Why [are the angles of] the triangle [equal to] two right [angles]? Because the angles around one point are equal to two right [angles]. If then the [line] parallel to the side had been drawn, it would have been immediately clear to someone looking. … So it is clear that the [constructions] existing potentially are found when they are brought to actuality. The reason is that thought is actuality, so that potentiality [is discovered] from actuality and because of that [people] acquire knowledge by constructing.[38]

In such contexts, where the divided magnitude is the intentional object which is 'used' in a certain way, but does not seem to change itself, an argument from homogeneity would not have any point.

Aristotle presents the distinction between the one unified actual magnitude and the unlimited plurality of its potential parts in answer to Zeno's Runner paradox. In Chapter One § 4.2.1, I argued that in *Physica* 8.8 Aristotle has in mind two different versions of this paradox as well as two different arguments. In addition to the original Runner-version, he describes a counting version of the same paradox, according to which it is impossible to count an unlimited number of parts. Whereas Zeno's original argument, as alluded to in passing,[39] concluded that it is impossible to traverse unlimited things over a limited time, Aristotle is here more concerned with the argument concluding that it is impossible to traverse or to count unlimited things. The reason is that he has come to realize that his solution as presented in *Physica* 6.2 (see Chapter Three, pp. 121-122) is philosophically inadequate. According to that solution, there is no problem with traversing in the Zenonian way an unlimited series of parts taken out of a limited whole, because the time of traversal will be divided in the same way, and therefore not be unlimited in extent either. The problem Aristotle has with this solution, in the present passage, is that it requires the time and the magnitude both to consist of an unlimited series of parts, which the runner or counter has to traverse or count separately. It is, however, Aristotle's firm belief that it is impossible to traverse an unlimited series. Nowhere does Aristotle argue specifically for that belief,[40] which is incorporated into his description of the most relevant sense of 'unlimited': 'that which is of such a nature as to have, but does not have, a traverse or limit.'[41] The most plausible explanation, it seems to me, is that Aristotle, just like Zeno, failed to see how such an unlimited series could form a whole and thus involve a limit, in the way, for example, a motion is conceived as a whole, being from somewhere to somewhere, or in the way a body, which Aristotle defines as limited, is a whole.[42] Another reason Aristotle may have had for rejecting the completion of an unlimited series of divisions, is that in this way it would also be possible to separate in a Zenonian way the final point of a line from the rest of

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[37] Cf. also the reference to making one point two in thought at *Physica* 8.8; 262b6-7
[38] 1051a21-32
[39] 263a16-17
[40] Cf. Bostock, 'Aristotle, Zeno' 38.
[41] *Physica* 3.4; 204a5-6
[42] *Physica* 3.5; 204b5-6

that line. It would then follow that the line has at least one indivisible as a separate part. That possibility, however, Aristotle reduced to absurdity in *Physica* 6.1.

It seems clear that by refusing Zeno the point that the magnitude moved over is divided, Aristotle has made himself invulnerable to the Zenonian attack mounted in the Runner paradox and the paradox of plurality. Where there is one unified whole, there is no unlimited series of ever-decreasing parts without a limit to the whole composed of them.

§ 2.2. *Limits, matter and form*

Despite the fact that Aristotle, by asserting the primacy of the whole over the parts, has protected himself against Zeno's attack, one may not be satisfied yet with his response. In order to avoid the absurd situation that a magnitude is divided in a Zenonian way, without a last part to serve as a limit, it is not enough to insist that parts only exist potentially and to hold thus that a whole is more than a sum of the parts into which it is divisible. For not only should a magnitude not consist of independent parts, it should also not be divisible into them in such a way that it is possible that all the unlimited parts have been brought into actual existence. So a magnitude ought not to be potentially unlimited in exactly the same sense as it is potentially two halves, for it is potentially two halves because it can be divided into two.

Aristotle is aware of the point, as appears from what he says in *Physica* 3.6:

> One should not understand 'being potentially' in such a way that – just as in the case that it is possible that this is a statue, because it *will be* a statue – there is also something unlimited which will be actually.[43]

It is not exactly clear, however, how Aristotle draws the distinction between the sense in which something is potentially two and the one in which it is potentially unlimited. For he adds the following remarks:

> Since *being* has many senses, the unlimited is in the way the day and the contest are, by [there] always [being] something else [which is] occurring (τῷ ἀεὶ ἄλλο καὶ ἄλλο γίγνεσθαι). For also in those cases [things] are both potentially and actually, for the Olympic games are both because of the contest being able to occur and by its occurring. ... In general the unlimited is in this way: because always something else is being taken; and what is being taken is always limited, but always different.[44]

I believe Aristotle's point here to be the following.[45] In the case of ordinary things which are potentially *F* this potentiality to be *F* consists in the fact that in some situation[46] the

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[43]   206a18-21; the same point is made in *Metaphysica* Θ.6; 1048b9-15.

[44]   *Physica* 3.6; 206a21-28

[45]   My interpretation differs considerably from those offered by Hussey, Physics *Books III and IV* 82-83 and 84, and Charlton, 'Potential Infinites' 142-143; it resembles the interpretation of Bostock, 'Aristotle, Zeno' 38-39, and in some respects those of J. Hintikka, 'Aristotelian Infinity', in: *Time and Necessity. Studies in Aristotle's Theory of Modality* (Oxford, 1973) 114-134, at 115-117, and Lear, 'Aristotelian Infinity', *Proceedings of the Aristotelian Society* 80 (1979/80) 187-210, at 191 (despite the hammering Lear gives Hintikka, on some points they at least seem to be in agreement).

thing is actually *F*. Obviously magnitudes cannot be potentially unlimited in this way. For Aristotle, however, the relation between potentiality and actuality is of a conceptual nature in that every potentiality is to be understood through its corresponding actuality.[47] In order to keep this conceptual correlation between potentiality and actuality intact, therefore, he introduces another way in which something can *be* potentially and actually. This way is the way in which processes exist. Their being actual consists in going through successive stages, so that their being potentially consists in having the potentiality to be going through successive stages. Similarly the being actually or potentially of the unlimited consists in the actuality or potentiality of there always being something else which is being taken.[48]

The process of 'always something else being taken' which Aristotle has most of all in mind is the process of dividing a magnitude in a Zenonian way or the converse process of adding in a Zenonian way.[49] The actuality on which being potentially unlimited depends, then, is the occurrence of the process of being divided in a Zenonian way, when the divisions are being made one by one. Thus we do not need to posit a situation in which something has been divided into an unlimited number of parts to explain its being potentially unlimited; it is already explained by the possibility of this process. This is also what Aristotle says in *Metaphysica* Θ.6:

> The unlimited is not in such a way potentially that it will actually be separate, but by knowledge (γνώσει).[50] For it is the fact that the division does not run out which warrants (ἀποδίδωσι) that this actuality is potentially, not the fact that there is a separate [actuality] (τὸ δὲ χωρίζεσθαι).[51]

It is the never-ending process of division which is the actuality to which the potentiality (for this actuality) corresponds conceptually, not some separate actuality. [52]

Understood in this way, that it is merely because it is possible for a magnitude to be undergoing the unlimited process of division that this magnitude is potentially unlimited, Aristotle's claim that a magnitude is potentially unlimited does not commit him to paradoxical consequences. However, staying clear from one danger appears to bring Aristotle closer to another. For if it is impossible to complete a Zenonian division, it seems also impossible to explain our grasp of limit entities, as we shall never be able to say: 'Now, look, *this* is a limit entity.' Nevertheless Aristotle talks a lot about them, so he ought to be able to provide at least some account of our grasp of them.

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[46] The phrase 'in some situation' is meant to be neutral between situations which will be the case and situations which might be the case, but not necessarily will be the case. Despite Aristotle's use of the plain future ἔσται at 206a20, I think that Aristotle would have the latter, broader type in mind.

[47] E.g. *Metaphysica* Θ.8; 1049b12-17.

[48] It is important to understand 'process' here not, as Lear, 'Infinity' 190 and 193, seems to do, in the sense of a complete motion, which according to Aristotle is always limited, but in the sense of an ongoing process. Aristotle points this out explicitly in a passage at 206a29-33 (which already in antiquity did not appear in all the manuscripts, and which is excised by Ross, Physics 555-556):
> One should not understand the unlimited as a this, as for example a human being or a house, but in the way the day and the contest are said [to be], to which being [belongs] not because some kind of substance has come to be (ὡς οὐσία τις γέγονεν), but always in the case of coming to be or passing away (ἀεὶ ἐν γενέσει ἢ φθορᾷ), limited, but ever different.

[49] *Physica* 3.6; 206b3-12; cf. also *Metaphysica* Θ.6; 1048b15-17.

[50] For the interpretation of this clause, see notes 53 and 59.

[51] 1048b14-17. In my translation I have been guided by remarks in M. Burnyeat et al. (eds.), *Notes on Books Eta and Theta of Aristotle's* Metaphysics (Oxford, 1984) 127-128.

[52] Interpreting the passage in this way, we do not have to posit an actuality whose mode of being is mysteriously potential, as Wieland, *Die aristotelische Physik* 298, and Ross, Metaphysics II 253, do.

The account I propose to ascribe to Aristotle is based on his conception of the unlimited as (the potentiality for) being in the process of being divided without end. It consists of the following steps. (1) There is a limited magnitude M which can undergo a Zenonian process of division without end. We will not be able to continue this process of division indefinitely, but such limitations are not due to the magnitude itself, as no magnitude consists of indivisibles. Thus we grasp the idea of such an unlimited process.[53] (2) In this process we are taking ever different parts of that whole magnitude M. All these parts separately are limited, but the series of these parts is without a last part, so what is being taken throughout the process is, just as the process itself, without end, incomplete and unlimited. This is something which Aristotle stresses himself:

> Unlimited is that of which there is always something outside to take, for those taking according to quantity. That of which there is nothing outside, on the other hand, is complete and whole. For thus we define the whole, as that of which nothing is absent, such as a whole man or box.[54]

(3) There is no part of M which is not taken by this process, since '[what is being taken] in the direction of division (ἐπὶ τὴν διαίρεσιν) exceeds every definite [magnitude] and will always be smaller.'[55] (4) Yet M as a whole is limited and complete. (5) Therefore there is something unlimited within the limited magnitude M as a whole. On the other hand, M must include something which, being apart from the unlimited within it, serves as the limit of the whole M, in order to make it complete. This latter element must be indivisible, since every divisible part is taken up in the unlimited process of division and converse addition. These two aspects of the whole magnitude, Aristotle calls the 'matter' and the 'form' of the magnitude as a whole:

> The unlimited is the matter of the completeness of the magnitude and that which is potentially whole, but not in actuality (τὸ δυνάμει ὅλον, ἐντελεχείᾳ δ' οὔ); [it is] divisible in the direction of division and the converse addition, but not whole and limited for itself, but for something else (οὐ καθ' αὑτὸ ἀλλὰ κατ' ἄλλο). And in so far as it is unlimited, it does not surround, but is surrounded (οὐ περιέχει ἀλλὰ περιέχεται, ᾗ ἄπειρον). That is also why it is unknowable in so far as it is unlimited. For the matter does not have a form. … The matter within and the unlimited is surrounded, while the form surrounds.[56]

The relation between the unlimited and the whole magnitude Aristotle describes in several ways. The unlimited aspect of the whole is, taken 'for itself', not a whole, but 'for something else' it is a whole. This 'something else' is the form, which, by being together with the unlimited, yields the whole magnitude. The other way round, the whole magnitude is 'accidentally' unlimited, but not 'without qualification', in 'substance' or 'being', as we read in Aristotle's reply to Zeno's Runner paradox in *Physica* 8.8.[57] The unlimited aspect of the whole, taken for itself, is potentially whole, but not actually so, because it can be partioned in other ways too, with different forms, to form a plurality of wholes, as happens

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[53] This is one possible meaning of the clause γνώσει appearing at *Metaphysica* Θ.6; 1048b15: the unlimited is potentially 'because of [our] knowledge' that there is always a further division to make. This is the interpretation put forward in Burnyeat, *Notes on Eta and Theta* 127, and Wieland, Die aristotelische Physik 298; cf. Lear, 'Infinity' 192.

[54] *Physica* 3.6; 207a7-10

[55] *Physica* 3.6; 206b19-20

[56] *Physica* 3.6; 207a21-26 and 3.7; 207a35-b1

[57] 263b6-9

in fact during the unlimited division. The whole is therefore actually whole because of the form it has. Again the other way round, the whole is potentially unlimited because of the matter it has.

Finally, the relation between the unlimited and the element responsible for the wholeness of the magnitude, the form, is that between something surrounded and something surrounding. This smacks of separation into two parts – which would be impossible, because it is impossible to go through all the unlimited divisions. However, because the whole argument as presented above is based on the *idea* we have of such an unlimited process which is in turn based precisely on our knowledge that such a separation into points is impossible, it would merely concern an abstract separation[58] into two different aspects of the whole magnitude, the formal aspect which provides limits and makes it a whole, and the material aspect which makes the whole divisible.[59]

It is quite possible that in the following passage from *Metaphysica* α.2 the point that we can grasp the material aspect of a line is referred to:

> [Knowing an unlimited series of terms is not possible.] For it is not the same as in the case of a line, which does not halt according to the divisions, but which on the other hand one cannot grasp without coming to a halt. (That is precisely why someone traversing the unlimited [line] will not count the cuts.) But further it is necessary that grasping the matter [occurs] in someone moving (ἀλλὰ καὶ τὴν ὕλην ἐν κινουμένῳ νοεῖν ἀνάγκη).[60]

Unlike in other cases, one can, by grasping the matter, grasp the unlimited in the case of a line moved over, because that matter is the basis for the possibility of moving endlessly according to the divisions, without coming to a halt.

With the abstract distinction between the matter and the form of an object, between the unlimited and the limit, Aristotle has provided us with an account of how to grasp limit entities. They are those things which remain after the unlimited aspect of the whole, which we grasp as that which is being removed in the endless Zenonian process, has been distinguished within the whole limited magnitude.[61]

Though, as an account of how to grasp limit entities, the above will do, two further points have to be made about Aristotle's conception of limit entities. For he distinguishes in practice between three different kinds. The first kind is the limit as form. This

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[58] Cf. *Physica* 4.2; 209b9-11: 'When the limit is abstracted (ἀφαιρεθῇ).. nothing remains except the matter.'

[59] This is the second possible meaning of the clause γνώσει appearing at *Metaphysica* Θ.6; 1048b15: the unlimited is potentially because '[it can be separated] in knowledge' or thought. This interpretation is adopted by Hussey, Physics *Books III and IV* 87, and *CAW* 1666. Remarkably enough, it is also assumed in Burnyeat, *Notes on Eta and Theta* 128, even though the alternative interpretation (see note 53) is adopted on the previous page. I would suggest that in material terms there is nothing wrong with holding both views at the same time, because the separation in thought of the material, unlimited aspect of a magnitude would be based on our knowledge of the interminability of the division, not on the occurrence of the whole process of division. However, in grammatical terms the two interpretations are incompatible, as they presuppose different grammatical constructions. I think the grammatical construction of the first interpretation is more natural. Moreover, the point of the clause would then be of more immediate relevance in the context.

[60] 994b23-26. I follow Jaeger's text, rather than Ross', who proposes to emend the best attested reading into τὴν ὕλην οὐ κινουμένῳ (Metaphysics I 219-220).

[61] Cf. perhaps *De Anima* 3.6; 430b20-23:
> The point and every division and what is in this way [*scil*. according to quantity] indivisible, is signified in the way of a privation. ... One knows [it] in some way through the contrary.

The point is known as that entity in the realm of things which have quantity and are thus divisible, which does not have quantity and is therefore not divisible.

idea, that the form or shape of an object is its limit is fairly common in Aristotle. It appears, for example, in Aristotle's book of definitions, *Metaphysica* Δ, where 'limit' is defined as 'that which is the form of a magnitude or of something having magnitude.'[62] Also in Aristotle's discussion of place in *Physica* 4.1-5, form is often equated with limit.[63] In this way, limits may even have size, according to Aristotle:

> [Something is in a place as] in the primary extremity of what surrounds, which [extremity] is neither a part of that in it nor larger than the extension, but equal [to it]. For the extremities of the touching things are in the same [spot].[64]

The size of the form consists of course in the distance between the limits of the magnitude, just as the size of a circle consists in the magnitude enclosed by it. These limits, in their turn, are limits in a different, but related sense, as the extremities at the beginning and the end of the whole magnitude, that is, as its boundaries. This is probably Aristotle's primary notion of limit. Derived from it is the third sense in which Aristotle talks about limit entities, namely as points and nows, which do not necesssarily serve as boundaries between wholes. Still they are conceptually dependent on the second sense, as they are to be conceived of as *possible* boundaries. The difference between the second and third sense is invoked, for example, in passages from *Physica* 8.8.

This threefold division between senses of 'limit', however, does not correspond to a threefold division between senses of 'form'. Forms only exist at the actual level, for it is because of them that the whole magnitude is one, and not two. Since it is impossible that what is one is also two, there is only space for one form, and not forms defined by any two points on the magnitude. Even in the first sense, then, as a form with size, the form is indivisible. As I said earlier, in connection with Aristotle's restricted acceptance of the Atomistic Principle (pp. 235-236), the divisibility of a whole is due to its matter, which may receive different forms; when an entity is being divided, the one form disappears, and two forms return in its place.

Finally, we should take note of a distinction in Aristotle's use of the term 'matter'. In the discussions of the unlimited and of place, in books 3 and 4 of the *Physics*, 'matter' signifies for itself the undifferentiated aspect of a whole which may be individuated in different ways. As it is, it is limited and informed by one particular form; thus it is limited 'for something else'. However, Aristotle also uses the term 'matter' to refer to something between the matter-as-limited by this form and the completely unlimited matter. This use appears for example in *Metaphysica* Z.10:

> It is not the case that, even though a line ceases to be when divided into the halves, or a human being [ceases to be when divided] into bones, sinews and flesh, because of that they consist of these things as if these were parts of the substance [*scil.* the substantial form], but in the way they consist of matter; they are parts of the combined whole, but not any more of the form or of that which has a formula.[65]

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62   *Metaphysica* Δ.17; 1022a5-6
63   E.g. *Physica* 4.2; 209b3-5, b9-11, and 4.4; 211b12-14; cf. 4.4; 211a31-34.
64   *Physica* 4.4; 211a31-34
65   1035a17-21

Thus the matter is not conceived of in a completely indeterminate way, but in a quasi-individuated manner, namely by reference to possible individuations, rather than by reference to the actual individuation as the matter as limited by the present form.

§ 2.3.   *A somewhat formal model for talking about matters of continuity*

If one compares the results of § 2.1 and § 2.2, one will notice many similarities. The relation between process and completion within a whole motion strongly resembles the relation between matter and form within a whole object. According to the account of our way of grasping the difference between matter and form which I ascribed to Aristotle, he derives the idea of a distinction between matter and form from the distinction between process and completion.[66] Also the indivisibility of the form and the whole taken as whole are mirrored by the indivisibility of the motion itself. Both are divisible because they comprise something structureless and homogeneous, which we may identify with the matter for itself and with the aimless process. In both cases this structureless aspect is taken up by the unifying aspect, also in the case of motion called its form, and individuated by it. Also in both cases Aristotle, limiting these individuating powers of the form somewhat, argues from the homogeneity of 'two' consecutive stretches of matter or process to the unity of the whole stretch.

The only difference between the case of motion and the case of objects is that while an object in a way may undergo a transition from being unified and whole to being divided and two, such a transition is impossible for a motion. This is of course due to the temporal character of motion. Thus the vocabulary of being potentially two while being actually one cannot be applied to motion. Motion, however, is still divisible in the sense that the same unindividuated stretch of process might have been, in a different situation, interrupted by periods of rest.

Taking that difference into account, however, the following model, formulated in terms of bare objects, may serve as a summary of the results of these two sections:

1. All objects are wholes, having a certain structure, namely a beginning and an end, with something in between.
2. This structure is called the form of the whole.
3. The form is defined by the limits.
4. That which is in between the limits of the object is the matter.
5. This matter is homogeneous and has points everywhere.
6. This matter can be described in two ways: (a) the-matter-of-the-whole, that is, the matter as limited or informed in a certain way, namely by the form of the whole; (b) completely limitless and structureless matter. The form informs the matter in sense (b), thus yielding a whole having a structure and matter in sense (a).
7. The matter can also be informed by other forms, thus yielding a different whole, having a different structure and different matter in sense (a).
8. Transitions from a whole W_1 consisting of form F_1, defined by limits l_1 and l_2, and matter M_1 (in sense (a)) as limited thus, to two wholes W_2 and W_3, consisting of forms F_2 and F_3, defined by limits l_1 and l_3 and l_3 and l_2 respectively, and of stretches of matter M_2 and M_3 (in sense (a)) as limited thus, is called a division of the object. This division

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[66]   It is therefore no surprise that in some of its features this account resembles the argument Aristotle employs in *Physica* 6.5; 235b32-236a7 to prove that the primary time in which something has changed is indivisible.

therefore consists in the disappearance of F_1 and of M_1 and the appearance of F_2 and F_3 as well as of stretches of matter M_2 and M_3. The converse transition is called a merging of two objects, and consists in the disappearance of F_2 and F_3 as well as of stretches of matter M_2 and M_3 and the appearance of F_1 and matter M_1.

9. The forms themselves are indivisible. Wholes are divisible because of their matter in sense (b).

10. From the perspective of the situation in which whole W_1 exists, the points which function as l_1 and l_2, defining form F_1 and informing the matter, are called actual; the whole W_1 having form F_1 and the informed matter M_1 (in sense (a)), exists actually.

11. From the same perspective all other points between l_1 and l_2 can function as limit l_3 – these points are potential limits; all the wholes W_2 and W_3 having form F_2 and F_3 defined by l_1 and l_3 and l_3 and l_1 respectively, and each having correspondingly informed matter (in sense (a)), exist potentially.

12. Two wholes W_2 and W_3 merge into one whole W_1 if their matter (in sense (b)) is not interrupted. (Though they can still be treated as two separate wholes, by moving over them in two stages or by thinking them as two separate wholes.)

§ 3.   Three difficult arguments

With the account offered in the previous section, most aspects of Aristotle's metaphysics of continuity are now in place. What I want to do at the end of this chapter, is to discuss three arguments in which Aristotle obviously deals with issues involving continuity and infinite divisibility, but which are so difficult that his exact postion is far from clear. My aim is to show how we can make sense of them in conformity with the ideas formulated in the previous sections, which they therefore corroborate. In addition, they will fill in some further details.

§ 3.1.   *Two, one, nothing*

The first argument I want to discuss deals with the issue how one should describe what happens with points or limits when two entities come into contact with each other or are divided from each other. It is one of a set of arguments Aristotle employs in *Metaphysica* B.5 against the idea that mathematical entities like bodies, planes and points are substances and ontologically prior to perceptible bodies. The main idea of this argument is that that cannot be the case, because these mathematical entities do not meet the requirement for being a substance that they should be able to come into being through a process of coming into being. To show this, Aristotle takes up the case of what happens when two bodies come into contact or undergo a division. This is how Aristotle formulates the argument:

> It appears that a substance, when it, while not being before, now is, or, while being before, later is not, undergoes these things after [a process of] coming into being and ceasing to be (μετὰ τοῦ γίγνεσθαι καὶ φθείρεσθαι). Points, on the other hand, and lines and surfaces cannot be coming into being or be ceasing to be [even though] at the one time they are, while at the other time they are not. For at the very moment bodies touch or are divided, there turn out to be, in the one case when they touch, one point, and, in the other case, when they are divided, two points (ἢ διαιρῆται τὰ σώματα, ἅμα ὀτὲ μὲν μία ἁπτομένων ὀτὲ δὲ δύο διαιρουμένων γίγνονται ὅταν γὰρ

ἅπτηται).[67] Hence, in the case the bodies have been put together, [the point] is not, but has ceased to be, and in the case the bodies have been divided, the [points] which previously are not, are (ὥστ᾽ οὔτε συγκειμένων ἔστιν ἀλλ᾽ ἔφθαρται, διῃρημένων τε εἰσὶν αἱ πρότερον οὐκ οὖσαι). For surely the indivisible point is not divided into two.[68]

What exactly happens at the moment that two bodies come into contact with each other? According to the dominant interpretation, the two boundaries of the two bodies merge into one, so that one of the points, having perished, no longer is.[69] This account is never argued for, but one may see it as a proposal for a solution to an interpretational difficulty. This difficulty is how to combine three statement Aristotle makes into one coherent picture. The first statement is that when the bodies are divided, there turn out to be two boundaries. This implies that before the coming into contact, there are two boundaries. The second statement is that at the moment of contact, there turns out to be one point. The third statement is that when the bodies have been put together, the point has ceased to be and is not any more. Things seem to go very quickly, first two, then one, and in the end nothing! To avoid this rapid disappearance of all points, the idea is to let the third statement about the point not being any more refer to one of the two original boundary-points, and to take the one point of the second statement as the remaining boundary-point.

This interpretation, however, is inconsistent with Aristotle's statement that when two bodies have been divided there is a plurality of points which earlier did not exist, but now do. That means that *both* of the boundaries which turn out to be there when the bodies are divided, do not exist before. Conversely, then, it must be both of them which do not exist any more when the two bodies have been put together, and not merely one. Therefore we must try to come up with a different solution to the interpretational problem posed.

A solution can be provided if we distinguish between three situations. The first situation is that in which there are two bodies separated by a gap:

(1)

        A   B
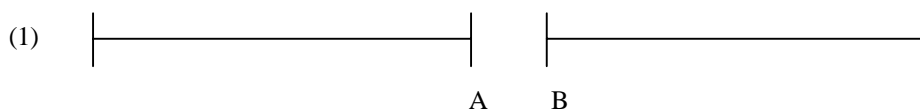
In this case there are two boundaries, A and B. The second situation occurs when these two bodies get into touch with each other:

(2)

       A/B

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[67] The present tense γίγνονται cannot here denote a process of coming to be, since it is Aristotle's claim that there is no such thing as a process involved. Therefore I would interpret it as belonging to the metalanguage, rather than being descriptive of the situation: *if we look* at the one case there *turns out to be* one point, and *if we look* at the other two.

[68] *Metaphysica* B.5; 1002a30-b4

[69] White, *Continuous* 12 and 123, Sorabji, *TCC* 11, and J.J. Cleary, *Aristotle and Mathematics. Aporetic Method in Cosmology and Metaphysics* (Leiden, 1995) 240.

Now the originally separated boundaries A and B coincide and thus turn out to be one. This is not a stable situation, however, for two bare bodies touching each other immediately become one because of their homogeneity. Thus there is no boundary at all, but merely a potential point of division:

(3)
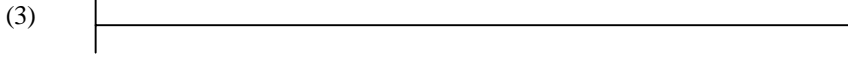
The idea behind my interpretation is that when Aristotle says that when the bodies have been put together, the one point has ceased to be and is not any more, he is thinking of the transition between (2) and (3). On the other hand, when he says that when the bodies have been divided, there are two points which previously did not exist, he is thinking of the transition between (3) and (1). I do not think that there is anything strange with this asymmetry. It can be explained from the natural tendency to describe any new situation by comparing it to the old situation. Thus going from (1) to (3) one focuses on the two boundaries, which then first coincide and become one, and subsequently disappear as one. Going from (3) to (1), by contrast, it is only really possible to have such an intermediate stage in an artificial way, because as long as the two bodies have not been divided, they remain one and unified, and do not have a boundary between them.[70]

There are several reasons for assuming that this is the sequence Aristotle has in mind. First, there is a notable difference in the use of tense. First he talks in the present tense about bodies which come into contact and divide (ἅπτηται and ἁπτομένων as well as διαιρῆται and διαιρουμένων), but in the next sentence he switches to the perfect tense (συγκειμένων, ἔφθαρται and διῃρημένων). This difference would correspond to the difference between situations (2) and (3), in the case of bodies getting into touch and then having been put together, and in an artificial way to the difference between situations (2) and (1), in the case of bodies being divided and then having been divided.

The second reason is that, interpreted in this way, we can make good sense of the justification Aristotle gives for the proposition that when the bodies have been divided there are *two* boundaries which were not there before. For itself this justifying statement, that the indivisible point is not divided into two, could be made to fit with the commonly adopted interpretation, as this interpretation posits the creation of one *extra* point; and with this statement Aristotle would then argue that this extra point is completely new and not the result of some division. However, on such an interpretation, the statement would not fare well as a justification for the new existence of *two* boundaries.[71] It can only serve successfully as a justification if Aristotle has the three situations (1), (2) and (3) in mind and rejects (2) in favour of (3) as the correct representation of the situation that two bodies have been put together. Apparently Aristotle thinks that if one assumes that when two bodies have been put together there is still one boundary between them,

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[70] As J. Annas (transl. & comm.), *Aristotle's* Metaphysics *Books M and N* (Oxford, 1976) 139, seems to suggest, one could create such an intermediate situation by treating a point as the end of one half and as the beginning of another half. Thus there would be a point which, in the words of *Physica* 8.8; 262a21, would be 'one in number, but two in account' (see p. 230). This conception, however, belongs to a completely different way of dividing magnitudes, namely by the actuality of thought. In the present argument, by contrast, the division is physical, by way of separation by a gap.

[71] Moreover, also considerations of indifference would have to be ignored. For if in the situation of (1) there is one new and one old point, which of the two is going to be the new point, A or B?

that is, if one assumes that the situation of two bodies having been put together is to be represented by (2), then one is committed to the division of that point in case of separation of the two bodies. If, by contrast, one rejects that representation and envisages the situation to be that of (3), there is no point to be divided at all.

The third reason for adopting this interpretation is that, construed in this way, the situation Aristotle envisages does not differ very much from the picture he has in mind in the preceding argument against the view that mathematical entities like surfaces and points are substances prior to perceptible objects. For there Aristotle argues:

> In addition, any shape whatsoever is similarly present in the solid [body] or none [is]. Hence, if not even Hermes [is present] in the stone, neither [will] half the cube [be present] in the cube as something determinate (οὕτως ὡς ἀφωρισμένον). Therefore the surface [will] not [be present] either, for if any [surface] whatsoever were present, also the one which determines the half (ἡ ἀφορίζουσα τὸ ἥμισυ) would have existed. The same account also applies in the case of a line, a point and a unit.[72]

Also in this argument, which is meant to deny the status of substance prior to perceptible objects to the very same entities as the next argument, there is a situation that two parts of a whole are together, for example as two halves in a cube. It is clear that here Aristotle's position is that there is no surface between such parts.

The second and third reasons I give in support of my interpretation may not seem fully convincing. Firstly, it may not be clear how Aristotle can hold that if one assumes (2) to be the correct representation of two bodies having been put together, this commits one to the divisibility of a point in order to reach situation (1). Secondly, it will probably be objected that not all the arguments advanced against a certain idea, even though they all have the same ultimate purpose, need to attack from the same ground. It is also a matter of dialectic, is it not, based on the presuppositions of the adversary. In reply to these two points, however, I want to show that the issue addressed in the preceding argument is closely related to that of our argument, and especially to the question of how Aristotle can hold that the divisibility of the indivisible point follows from taking (2) to be the situation of two bodies together.

To see how these two points are connected, we have to turn first to the details of the preceding argument. This is based on three ultimate premisses: (i) all shapes within a solid are equally real or unreal; (ii) every shape or surface determines an object; (iii) parts in a whole solid, like Hermes in the stone, do not exist in a determined way. Aristotle argues that premisses (ii) and (iii) are inconsistent with premiss (i), from which it would follow that mathematical entities like points and lines cannot be substances. It is indeed the case that those who defend the substantial status of shapes as prior to perceptible objects, but still present in those objects, are committed to (i). For how else could one differentiate between shapes than by arguing that some are the shapes of unified perceptible objects and others are the shapes of perceptible objects which do not exist in a determined way? Such a way of differentiation is unavailable to these people.[73] Since they obviously do not want to say that none of the shapes exists, they must hold that all shapes exist as substances and, in Aristotle's vocabulary, as determined shapes.

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[72] *Metaphysica* B.5; 1002a20-25
[73] This point is missed by A. Madigan SJ (transl. & comm.), *Aristotle* Metaphysics *Books B and K.1-2* (Oxford, 1999) 126, where he argues that those who posit mathematical entities as substances should attack (i).

Aristotle attacks this position by importing into the argument considerations about perceptible objects being determined or not. He assumes in (iii) that Hermes is not in the stone in a determined way, and therefore that half the cube is not in determined way in the whole cube either. Because of (ii) the shapes in these parts are not determined either, which contradicts the position that all shapes exist as determined shapes. It seems diffi-cult to imagine an escape for the defenders of the prior substantial status of mathema-tical entities present in perceptible objects. Either they must hold that Hermes, just as every one of the unlimited number of parts, is after all present in the stone as a deter-mined object, or they must reject the idea that shapes play a part in the individuation of perceptible objects. The latter alternative is not attractive, because then the realms of mathematical entities and of perceptible objects will have nothing do with each other. That would be problematic, since in the Academy these mathematical entities were usually posited in order to offer a philosophical explanation of phenomena involving the perceptible world (like our knowledge of the perceptible and unstable world). The former alternative, on the other hand, leads to problems with the unity of any perceptible object with size, so that one ends up with a kind of composition from indivisibles.

Now the very same idea that all shapes present in an object are equally real and determined also plays a crucial part in the only other argument in Aristotle's works in which the indivisibility of the point is invoked in such a context. It concerns an argu-ment in *Metaphysica* M.2 where, once again, Aristotle raises an objection against a con-ception of mathematical forms being present in perceptible objects:

> It is clear that [assuming this conception to be correct] it is impossible to divide any body. For it will be divided at a plane, and that at a line, and that at a point, so that if it is impossible to divide a point, [it is] also [impossible to divide] a line, and if [it is impossible to divide] that, it is also [impossible to divide] the other things. What difference does it make then whether [the perceptible bodies] are such natures, or whether, while they are not, there are such natures in them? For the same will follow: when the perceptible bodies are divided they will be divided, or the perceptible [bodies will] not [be divided] either.[74]

Recent commentators have had great difficulties with this argument.[75] As Ross already understood, however, the picture Aristotle has in mind in this argument is that of all the mathematical forms present in the perceptible objects being determined: on a line there is a determined point everywhere. This leads to problems if one imagines that the perceptible object, in which the mathematical forms are present, is separated into two parts. The separa-tion occurs at a point, but after the division there are two boundaries rather than one com-mon boundary. Thus the indivisible point is divided. (The line cannot be divided between two points, because points are not successive.)[76]

Thus Aristotle in this passage from *Metaphysica* M.2 assumes the divisibility of the point to follow precisely if an undivided line is represented as in situation (2), two parts having been put together with one determined or actual boundary in between. Since it is impossible to divide the point, which is by definition indivisible, there cannot be an

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[74]   1076b4-11
[75]   Annas, Metaphysics *Books M and N* 139, accuses Aristotle of 'foisting implausibly crude conceptions on to his opponent', namely that a point at which a line is divided, is a minimal extension, which therefore has to be divided together with the division of the line. Cleary, *Aristotle and Mathematics* 283, follows her on the main point.
[76]   See Ross, Metaphysics II 412.

actual boundary anywhere. As I said earlier, it follows then that both of the two boundaries of the separated bodies are new.

Interpreted in this way, we recognize in Aristotle's argument about the creation and annihilation of boundaries his own ideas about what happens when bodies divide or merge. The original forms vanish and new forms appear. Moreover, the instant disappearance of the one boundary resulting from the coincidence of the previously two boundaries can only be justified if one believes, with Aristotle, that two bodies, upon coming into contact, become one unified whole. As we saw, Aristotle justifies on other occasions this unification through the argument from homogeneity.

§ 3.2. *Grasping indivisibles*

In *De Anima* 3.6 Aristotle discusses the issue of the thinking or rather grasping (νοεῖν) of indivisibles. After having made some remarks about grasping indivisibles in the realm of concepts and building-blocks of propositions, he shifts to the topic of grasping indivisible magnitudes:

> Since 'indivisible' is used in two ways, either potentially or actually, there is nothing against grasping something indivisible in the case where one grasps a length (for it is actually indivisible) and [doing so] in an indivisible time. For the time is similarly divisible and indivisible as the length. It is therefore impossible to say what one thinks of (ἐννοεῖ) in each half [time]. For [the halves] are not (unless [the magnitude] is divided), except potentially. Grasping each of the halves separately, one also divides the time at the same time – in that case by way of the length, as it were (τότε δ' οἰονεὶ μήκει). And if one grasps [the length] as consisting of both [halves], one also [does so] in a time covering both [times] (Εἰ δ' ὡς ἐξ ἀμφοῖν, καὶ ἐν τῷ χρόνῳ τῷ ἐπ' ἀμφοῖν.)
>
> In an indivisible time and by way of an indivisible [act] of the soul one graps what is indivisible, not according to quantity, but by form (Τὸ δὲ μὴ κατὰ ποσὸν ἀδιαίρετον ἀλλὰ τῷ εἴδει νοεῖ ἐν ἀδιαιρέτῳ χρόνῳ καὶ ἀδιαιρέτῳ τῆς ψυχῆς). The [act] by way of which one grasps and the time in which one grasps are accidentally divisible, and not *qua* those, but *qua* indivisible (Κατὰ συμβεβηκὸς δέ, καὶ οὐχ ᾗ ἐκεῖνα, διαιρετὰ ᾧ νοεῖ καὶ ἐν ᾧ χρόνῳ, ἀλλ' ᾗ ἀδιαίρετα.) For also in these there is something indivisible, though perhaps not separable, which makes the time and the length one. And that is likewise so in everything continuous, both time and magnitude.[77]

Though one will recognize several ideas from the discussion in the previous sections, this passage is far from perspicuous and some clarification is in order. A first point concerns the distinction between two uses of ἀδιαίρετον, one of ἀδιαίρετον potentially, and another of ἀδιαίρετον actually. This distinction has almost universally been taken to be a lexical distinction between 'indivisible', that is, 'capable of being divided', and 'undivided'.[78] As a

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[77] 430b6-20; I follow the text as established by Jannone in A. Jannone (ed.) and E. Barbotin (transl.), *Aristote. De l'âme* (2nd ed.; Paris, 1995), rather than the edition of W.D. Ross (ed. & comm.), *Aristotle De Anima* (Oxford, 1961). Ross not only makes a few other choices, preferring other transmitted readings, but he also emends heavily, by changing a few letters to get different cases, by adding words to the text for interpre-tational reasons, and even by transposing the first sentence of the second paragraph to a position after that second paragraph. Jannone, by contrast, always makes the most conservative choices. For a justification of some parts of the translation, see the discussion.

[78] Ross, De Anima 300, D.W. Hamlyn (transl. & comm.), *Aristotle: De Anima Books II and III (with passages from book I)* (2nd ed.; Oxford, 1993) ad locum and 143, *CWA* 684, and E. Berti, 'The Intellection of "Indivisibles" According to Aristotle, *De Anima* III,6', in: G.E.R. Lloyd & G.E.L. Owen (eds.), *Aristotle on Mind and the Senses. Proceedings of the Seventh Symposium Aristotelicum* (Cambridge, 1978) 141-163, at 144-145; cf. E.

matter of Greek usage, it is possible to draw such a distinction, since the suffix -ετος, though most often signifying a capacity, may also refer to an actual situation. Moreover, understanding the distinction in this way does seem to make sense in the context, where the point being made is that a length as well as a period of time are actually ἀδιαίρετα as long as they are not divided and their parts are not grasped separately.

As far as the material point of drawing such a lexical distinction is concerned, I do not have any problem with it. I would agree that a magnitude is ἀδιαίρετον in actuality, because it is not divided into separate parts, and that it is διαιρετόν in potentiality, because it can be divided into separate parts. However, I do not think that we should interpret Aristotle as distinguishing *lexically* between 'indivisible' and 'undivided'. First, it is not necessary to do so. Above we saw that Aristotle limits his endorsement of Democritus' Atomistic Principle, which says that 'it is *impossible* that one thing comes to be from two or two from one'[79], to the actual situation. Thus in the actual situation it is impossible that something which is one turns into something which is two; hence in the actual situation it is indivisible. Of course, if one takes other situations than the actual one into account, this same thing may be divisible. Similarly, we may interpret the additions δυνάμει and ἐνεργείᾳ not as ways of distinguishing between two senses of the *word* ἀδιαίρετον, but as distinguishing between two criteria according to which something is indivisible, between indivisibility across all possible situations and indivisibility within the actual situation alone. Secondly, if available, one should prefer an interpretation according to which Aristotle is here drawing a metaphysical distinction, rather than explaining a merely lexical ambiguity in the term ἀδιαίρετον. One consideration is that if he had wanted to make a lexical point, he could have done so far more effectively by explaining ἀδιαίρετον in one sense as the contradictory of διῃρημένον. More important, however, is the observation that Aristotle often uses ἀδιαίρετον as a near-synonym of 'one' or 'unified' (ἕν) and 'whole' (ὅλον), and even 'atomic' (ἄτομον),[80] which are meant to convey something stronger than just 'being undivided'; they indicate that there is something holding these undivided parts together as a whole which is more than those parts. In our passage we encounter this idea as well, in the sentence that 'also in them there is something ἀδιαίρετον, but perhaps not separable, which makes the time and the length one.' Here something stronger than just something 'undivided' seems to be required. (Taking ἀδιαίρετον here suddenly as 'potentially ἀδιαίρετον' is impossible after the preceding two sentences, in which the time which is διαίρετος is obviously only actually ἀδιαίρετος.) Further, 'one' in the same sentence is used as a synonym for ἀδιαίρετον, so that that word should also have a stronger meaning than just undivided. Similarly, for example, in *Metaphysica* Δ.13, Aristotle calles a countable multitude, that is, a number, 'that which is divisible *potentially* into non-continuous [parts].'[81] He does so not in order to point out that a number can be divided into parts, but in order to indicate that the units into which the number is divisible, are present in it in a potential way, being held together by something which brings unity to the number.[82]

Berti, 'Reconsidérations sur l'intellection des "indivisibles" selon Aristote, *De anima*, III, 6', in: G. Romeyer Dherbev & C. Viano (eds.), *Corps et âme. Sur le* De anima *d'Aristote* (Paris, 1996) 391-404, at 394.

[79]   *Metaphysica* Z.13; 1039a10-11

[80]   See for example throughout *Metaphysica* I.1.

[81]   1020a10-11

[82]   See for example *Metaphysica* H.3; 1043b32-1044a5 and Z.13; 1039a11-14.

Once the distinction is understood in this way, the first paragraph of the passage seems clear enough. It applies the idea of potential and actual divisions to divisions brought about by the intellect. As we saw in § 2, in addition to a physical division by way of a gap, it is also possible to divide a magnitude by thinking of it as divided. What does need further clarification is the second paragraph of the quoted passage. It is difficult to understand its overall point, but especially the first two sentences cause problems. I shall try to clarify the whole paragraph by focusing on these two sentences.

There has already been a long history of disagreement about the line of thought in this paragraph. There are those who say that after having dealt with the grasping of indivisibles in the realm of quantity, Aristotle in the first sentence makes a remark in passing about the grasping of indivisibles in species (εἴδει), that is, the most basic kinds, like *man*, which cannot be differentiated further into separate species, as for example *man* and *woman*; after this remark he continues the discussion of the grasping of indivisibles in the realm of quantity. Often this alleged discontinuity in Aristotle's discussion has been taken to justify a transposition of the first sentence of the second paragraph until after the final sentence.[83] Others agree that the first sentence is about indivisibles in species, but do not think that it constitutes a remark in passing, because, they claim, in the rest of the second paragraph a comparison is made between these indivisibles in species and the indivisibles in the realm of quantity. Just as the indivisible magnitudes are potentially divisible, so the indivisible species are accidentally divisible, because the εἶδος in the sense of the species-definition comprises its genus and specific differentiae.[84]

As for the former interpretation, it is of course objectionable to posit such a discontinuity; the proposal for transposition only serves to brings this out more clearly. However, the attempt made in the latter interpretation to find some continuity in the second paragraph, by positing a comparison between two kinds of indivisibles, is not very successful either. For the point that 'also in these there is something indivisible, though perhaps not separable, which makes the time and the length one' is not put forward in order to compare two kinds of indivisibles, but in order to justify or explain the previous sentence, which on this interpretation would be about indivisibles in species. Though there is here a tacitly comparative point being made as well, as appears from 'also', this comparison cannot be with the indivisibles which are subject of the first two sentences of the paragraph, since then the point of the justification gets lost.

What both interpretations have in common, though, is that they understand the first sentence to be about a kind of indivisible different from those in the realm of magnitude, or, as it is sometimes phrased, the 'indivisibles according to quantity'.[85] Elsewhere in Aristotle, however, the things which are indivisible according to quantity are not magnitudes and periods in so far as these are indivisible, but rather points and units, which are completely indivisible.[86] Thus in *Metaphysica* Δ.6 Aristotle says:

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[83]   E.g. Ross, De Anima 296-297, and Hamlyn, De Anima 144.

[84]   Berti, 'Reconsidérations' 396-398, Jannone and Barbotin, De l'âme 108, and T. de Koninck, 'La *noêsis* et l'indivisible selon Aristote', in: J.-F. Mattéi (ed.), *La naissance de la raison en Grèce* (Paris, 1990) 215-228, at 219-220.

[85]   E.g. Berti, 'Reconsidérations' 394.

[86]   This would also be the case in *Metaphysica* B.3; 999a2-3, where 'indivisible according to quantity' refers to the units in a class.

> In every case that which is one is indivisible either by quantity or by form (τὸ ἓν ἢ τῷ ποσῷ ἢ τῷ εἴδει ἀδιαίρετον). What is indivisible according to quantity (τὸ κατὰ τὸ ποσὸν ἀδιαίρετον), in one sense, as indivisible in every respect and without position, is called a unit, while in another sense, as indivisible in every respect and having a position, it is called a point. What is divisible according to quantity in one respect is a line, in two respects a plane and in all, that is, three respects a body.[87]

What is more, in this passage Aristotle also mentions something 'indivisible by form', contrasting it to what is indivisible by quantity. Now this distinction is meant to apply to the examples given before of things which are one in that they provide a first measure by which we become acquainted with a class of things. This first measure is different for every class: 'it may be here a quarter-tone, there a vowel or mute, another thing in the case of weight and again something else in the case of motion.'[88] Now weight and motion are not indivisible according to quantity, so that the first measure in their cases must be indivisible by form. We know from § 1 that one respect in which a motion is called one, and thus also indivisible, by form, is that it has the form of being from somewhere to somewhere.

More generally, we saw in the previous section that whole magnitudes have forms which, by informing their matter, are responsible for their being wholes. In this sense also magnitudes are one and indivisible, even though they are divisible according to quantity. It must be those forms Aristotle is referring to when he says that 'also in these there is something indivisible, though perhaps not separable, which makes [these magnitudes] one.'[89]

All this is enough for us to conclude that the first sentence of the second paragraph of our passage does not introduce a new kind of indivisible, but identifies the indivisibility in actuality, mentioned in the first paragraph, as indivisibility by form. This identification is brought out much more clearly if one translates as I do: 'In an indivisible time and by way of an indivisible [act] of the soul one graps what is indivisible, not according to quantity, but by form.' Thus the indivisibility of the act by which one grasps, and in its wake the indivisibility of the time in which one grasps, are taken as given; and the indivisibility by form of the length then follows from the indivisibility of this act of grasping.[90] This is in full accordance with Aristotle's statement in the first paragraph that 'by grasping each of the halves separately, one divides them'.

Next, it has to be explained what exactly Aristotle is saying in the second sentence of the second paragraph: 'The [act] by way of which one grasps and the time in which one grasps are accidentally divisible, and not *qua* those, but *qua* indivisible.' (Κατὰ

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[87]   1016b23-28

[88]   1016b21-24

[89]   There is supporting evidence from Xenocrates, who employs the contrast between 'indivisible according to quantity' and 'indivisible by form' in the same way as I think Aristotle does. Testimony to that effect can be found in Simplicius, *In Physica* 140.6-12, where he quotes Porphyry:

> Those around Xenocrates said that what is,] is not divisible *ad infinitum*, but that its divsibility stops at some atomic things. These, however, are not atomic in the sense of being partless and smallest, but, though being cuttable and having parts according to quantity and matter, they are atomic and primary in form. (R. Heinze, *Xenocrates. Darstellung der Lehre und Sammlung der Fragmente* (Leipzig, 1892) fr. 45, and M. Isnardi Parente (ed., transl. & comm.), *Senocrate – Ermodoro: Frammenti* (Napels, 1981) fr. 139.)

[90]   Literally it says 'that with which one grasps' (ᾧ νοεῖ), but this must be the act of grasping. There are even two manuscripts, Hᵃ and V, which make this explicit, by reading καὶ ἀδιαιρέτῳ τῆς ψυχῆς νοήσει at 430b15. Of the first manuscript Jannone says in his introduction that it seems more closely related to the original text than any other manuscript (De l'âme xliii). Cf. also *Metaphysica* Δ.6; 1016b1-2.

συμβεβηκὸς δέ, καὶ οὐχ ᾗ ἐκεῖνα, διαιρετὰ ᾧ νοεῖ καὶ ἐν ᾧ χρόνῳ, ἀλλ᾽ ᾗ ἀδιαίρετα.) What is at least clear is that the act by which the mind grasps something indivisible by form, and the time in which this is done, are now said to be divisible, even though in the previous sentence they were called indivisible. The apparent conflict, however, is removed by the addition of the word 'accidentally'. As we know from Aristotle's solution to Zeno's Runner paradox, presented in *Physica* 8.8, the track over which the runner runs or whose parts the counter counts, is 'accidentally unlimited' because 'it is an accident to it that it is unlimited halves'.[91] We should understand 'accidentally' here in exactly the same way: to the indivisible act and the indivisible time it is accidental that they are divisible, because this divisibility belongs to their potential aspect, not their actuality.

This leaves unexplained what the point is of Aristotle's addition 'and not *qua* those, but *qua* indivisible.' Asking the question in these terms, however, may already invite objections, on the ground that my translation would prejudge matters. For the fact is that several proposals for translation and even emendation have been made. Some scholars strike 'but *qua* indivisble' (ᾗ ἀδιαίρετα) altogether and translate: '[They] are in this case divisible only incidentally and not as such.'[92] Others read ἀλλ᾽ ᾗ <ἐκεῖνα> ἀδιαίρετα and translate: '[They] are divisible incidentally and not as those things were, although they are indivisible as they were.'[93] Still others do not formally strike or emend anything, but achieve a similar effect by supplying a few words in the translation: 'Et c'est par accident, et non pas en tant que … ceux-là [c'est-à-dire les indivisibles selon la forme], que sont divisibles ce par lequel il les pense et le temps dans lequel il les pense, mais ~~il les pense~~ en tant qu'indivisibles.'[94] The purpose of all these alternative construals is to get rid of the contrast between '*qua* those' and '*qua* indivisible' which is suggested if one translates, as I do: 'The [act] by way of which one grasps and the time in which one grasps are accidentally divisible, and not *qua* those, but *qua* indivisible.' For if there is a contrast, then '*qua* those' cannot in effect mean '*qua* indivisible'. That sense, however, is to be required by the apparently implied contrast between 'accidentally' and '*qua* those'.

One of these contrasts has to go. Against the three alternative construals set out above, I propose to dispose of the contrast between 'accidentally' and '*qua* those'. This is possible if one interprets the clause 'and not *qua* those' as a qualification of 'accidentally' rather than as equivalent to it. Thus it would specify from what perspective it is accidental to the act and the time that they are divisible. One can interpret the clause in this way by taking the reference of 'those' (ἐκεῖνα) to be the things into which the act of grasping and the time of grasping are divisible, rather than these in so far as they are indivisible. Thus I would say that 'those' refers to the halves mentioned at 430b11-12.[95] Interpreted in this way, one could paraphrase the second sentence as follows: The act by

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[91]   263b6-8

[92]   The emendation has been proposed by Torstrik. The translation is taken from *CWA* 685; cf. W. Theiler (transl.), *Aristoteles:* Über die Seele (2nd ed.; Berlin, 1966) 145, and Ross, De Anima ad locum, who wonders whether Torstrik may be right.

[93]   The translation is taken from Hamlyn, De Anima 61, though with the substitution of '(in)divisible' for '(un)divided'; the emendation is proposed by Ross, De Anima ad locum.

[94]   Translation taken from Berti, 'Reconsidérations' 396; as far as the underlined words are concerned, a similar translation is adopted by Barbotin in Jannone and Barbotin, De l'âme ad locum.

[95]   Cf. Hamlyn, De Anima 144.

which one grasps a length which is indivisible by form, and the time in which one does so, are only accidentally divisible in so far as this act and this time are indivisible, and not in so far as they are those parts into which they are divisible. For as far as they are those parts, it is not an accident any more that they are divisible. The clear advantage of such an interpretation is that one does not need to emend or to supply a clause in a rather contrived way.[96]

So the context in which also this second paragraph must be understood is that of the capacity of thought to divide a length. It does so by performing one act of grasping, which occurs in one period of time, and which uses a part of a length as one.[97] In this act and in this time there is something indivisible, namely the form which in the act is impressed upon the time and the length, and thus makes them one. These actualizing powers of thought ensure that in an indivisible act of grasping something indivisible by form is grasped, as Aristotle states in the first sentence. It is only accidentally that this act of grasping is divisible, namely because its intentional object is divisible. Also in this respect the act of grasping a length is like a motion over a length.

§ 3.3.   *Aristotle's 'refutation' of atomism*

In § 1 of Chapter Two, we analysed Democritus' argument for the existence of atomism, as presented in Aristotle's *De Generatione et Corruptione* 1.2. It had two parts, the first consisting of only one observation, that the object of discussion, *M*, is divisible:

(D)   *M* is divisible somewhere.

The other part started with a supposition to be reduced to absurdity:

(1)   *M* is divisible everywhere.

That is:

(2)   It is possible that *M* is divided everywhere.

However, in the situation that *M* is divided everywhere, there are no parts with size left. But that means that an object with size consists of parts without size – which is absurd. So (1) is not true:

(3)   *M* is not divisible everywhere.

This second part of the argument left open the possibility that *M* is indivisible. However, because of (D) that possibility was sealed off. Therefore:

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[96]   In case one would find my proposal for the reference of the clause ἢ ἐκεῖνα not acceptable, one should consider emending by inserting διαιρετά after ἐκεῖνα, and retain the overall interpretation. This emendation seems more plausible than any of the other emendations or translations proposed.

[97]   For the vocabulary of 'using', see *Physica* 8.8; 262b5-7, where Aristotle also refers to thinking or grasping, and *Metaphysica* 1.1; 1052b32-33, where Aristotle explains that in the measurement of lines we 'use the foot as atomic', in order to have a unit of measurement.

(C)   *M* consists of atoms.

It was also shown in Chapter Two that formally this argument is invalid, since it trades on an ambiguity of the term 'divisible everywhere'. If this means 'everywhere possibly divided', the step from (3) to (C) is legitimate, as only something which consists of atoms is not everywhere possibly divided. However, the step from (1) to (2) is then not allowed, as the statement that something is everywhere possibly divided does not imply that it is possible that it is divided everywhere. On the other hand, if 'divisible everywhere' means 'possibly divided everywhere', there is no problem with the step from (1) to (2), but then step from (3) to (C) becomes unacceptable, as the statement that something is not possibly divided everywhere does not rule out that it may be everywhere possibly divided.

However, I argued that this gap in the argument for the existence of atoms was closed by Democritus by invoking his Atomistic Principle, that no unity may come about from a plurality, and *vice versa*. In support of this idea, I suggested, in Chapter Two § 1.2.2, that Aristotle acknowledges the part played by the Atomistic Principle, when he says that 'it is necessary, therefore, that there are indivisible magnitudes in [something], especially if, that is, coming to be and passing away is going to be by segregation and aggregation.'[98] Elsewhere Aristotle derives this identification of generation and aggregation from the Atomistic Principle. Moreover, only if interpreted in accordance with the Atomistic Principle can this identification be used as a premiss in the argument for the existence of atoms.

Though all this made for a very neat account of the foundations of Presocratic Atomism, my point that Aristotle acknowledges the part played by the Atomistic Principle, is not immediately clear. For Aristotle does not present this argument for the existence of atoms without a purpose. Rejecting atomism, he wants to show what is wrong with it. Moreover, he thinks that revealing the fallacy in the argument provides sufficient ground for rejecting the identification of generation and aggregation, and to replace it with a different account of generation. The way, however, in which Aristotle tries to achieve these two goals is not neat at all; it is far from clear what exactly his refutation of atomism consists in and how it entails the larger conclusion Aristotle wants to draw. Nevertheless, in this final sub-section I want to show again that Aristotle is arguing in line with the metaphysical ideas about matters of continuity I ascribed to him in § 2, and that his argument thus amounts to a rejection of a version of the Atomistic Principle.

§ 3.3.1.   Unclarities

There are two interpretational issues which need to be addressed. The first concerns Aristotle's overall strategy in this second chapter of *De Generatione et Corruptione* 1. Early in the chapter, Aristotle introduces the issue with which he is most of all concerned:

> Since almost all think that .. [things] come to be and pass away by being aggregated and segregated (καὶ γίνεσθαι καὶ φθείρεσθαι συγκρινόμενα καὶ διακρινόμενα), ... we must hold an inquiry by concentrating on these points. For they involve many well-argued puzzles. For if generation is aggregation (ἐστι σύγκρισις ἡ γένεσις), many impossibilities follow. On the other

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[98]   *DGC* 1.2; 316b32-34

hand, there are other arguments, compelling and difficult to dissolve, that it cannot be otherwise. And if generation is not aggregation, either there is no generation or alteration at all, or we must also try to solve this point, difficult though it is. Basic to all this is whether the things which are come to be, alter and grow, and suffer the contrary [changes] in this way: with there existing primary, indivisible magnitudes, or whether there is no indivisible magnitude. For that makes a huge difference (διαφέρει γὰρ τοῦτο πλεῖστον).[99]

This suggests that Aristotle thinks that he can investigate the issue whether there are atoms or not independently, and can then base his verdict on the question of whether generation is aggregation on the results of that investigation. However, as I repeated above, Aristotle also invokes the very same identification of generation and aggregation as a kind of premiss for the argument for the existence of atoms. It thus seems as if, on the one hand, he thinks that atomism implies the identification of generation and aggregation, while on the other he treats this identification as a premiss for atomism. [100]

Moreover, it is not clear in what way exactly Aristotle thinks the question of atomism is relevant for the issue whether generation is aggregation. In the course of *De Generatione et Corruptione* 1.2, Aristotle restates the argument for the existence of atoms in the form of a puzzle, in order to expose the fallacy in the argument. This allows him to conclude that 'there is segregation and aggregation, but neither into atoms nor from atoms.'[101] But apparently he assumes that he has at the same stroke also decided the issue whether generation is aggregation:

> But unqualified and complete generation is not defined by aggregation and segregation, as some claim, [who also claim that] change in what holds together (ἐν τῷ συνεχεῖ) is alteration. That is just where everything goes wrong. For there is generation without qualification, as well as destruction, not by aggregation and segregation, but when something changes from *this* to *this* as a whole. They, however, think that every such change is an alteration; but it is different. For in what underlies there is something corresponding to the account (κατὰ τὸν λόγον) and something corresponding to the matter (κατὰ τὴν ὕλην) . When, then, there is a change in these, there will be generation or destruction. On the other hand, when there is a change in the affections, that is, accidentally, there will be an alteration.
> ... Now this much has been settled, that it is impossible that generation is aggregation, as some claim it to be.[102]

Aristotle is very confident. One wonders, however, how he thinks to be entitled to this conclusion.

The other interpretational problem concerns Aristotle's restatement of the atomistic argument and its subsequent refutation. There he says:

> (1)   [I] it is impossible that magnitudes consist of contacts or points, it is necessary that there are indivisible bodies and magnitudes. However, also for those who posit them no lesser impossibilities follow. There has been an inquiry into them elsewhere. But we must try to solve them – that is why we must state the puzzle again from the beginning.
> (2)   There is nothing absurd about every perceptible body being divisible at any point as well as being indivisible. For the one will belong to it potentially, while the other will belong to it in actuality.

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[99]   315b15-28, with some omissions.
[100]   Already Philoponus, *In DGC* 38.20-39.4, noticed this problem; see also note 44 in Chapter Two.
[101]   317a12-14
[102]   *DGC* 1.2; 317a17-27; 30-31

(3)   But it would seem to be impossible to be potentially divisible everywhere at the same time. For if it were possible, it could also happen (not so that at the same time it is both, indivisible and divided, in actuality, but [that it is] divided at any point). There will then be nothing left, and the body will have passed away into something incorporeal, and would come to be again either from points or from nothing at all. And how is that possible?

(4)   However, it is clear that it divides into separable and into ever smaller magnitudes and into magnitudes coming apart and separated.

(5)   Neither, then, may one dividing in successive stages bring about an infinite process of breaking, nor is it possible for the magnitudes to be divided at every point at the same time (for it is not possible), but [only] up to a limit. It is necessary, therefore, that there are invisible atomic magnitudes in it, especially if, that is, coming to be and passing away are to occur by segregation and aggregation.

(6)   This, then, is the argument which appears to necessitate that there are atomic magnitudes. Let us state, however, that it commits a hidden fallacy, and [say] in what way this is hidden. For since there is no point contiguous with a point, there is a sense in which being divisible everywhere belongs to magnitudes, but also a sense in which it does not. However, 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 there is a point everywhere, so that it either consists of contacts or of points. There is, though, a sense in which [being divisible] belongs everywhere, because there is one [point] anywhere, and all [points] are like each; but there is no more than one [anywhere] (for they are not successive), so that [it is] not [divisible] everywhere. For if it is divisible in between, it will also be divisible at a contiguous point. But that is not possible, for a position is not contiguous with a position or a point with a point, but that is division or composition.[103]

In the restatement of the atomistic argument we recognize in (3), and also in (5), a concern with a problem which is related to the one Aristotle addresses in *Physica* 3.6. There Aristotle wonders how one can make sense of the idea that a magnitude is potentially unlimited if it is impossible that it is actually divided into an unlimited number of parts. Here the problem is how one can say that a magnitude is everywhere divisible, at an unlimited number of points, if it is impossible that it is actually divided at all those points. The atomist thinks that for that reason one cannot say that a magnitude is everywhere divisible, but Aristotle disagrees. Aristotle's escape in the refutation in (6) is to distinguish between two ways in which something can be everywhere divisible. One would expect this distinction to be equivalent to the distinction between possibly divided everywhere and everywhere possibly divided (see Chapter Two § 1.1), but it is difficult to understand the refutation in this way. Instead we have a complicated argument showing that it is indeed impossible to be divided everywhere, on the ground that this would involve there being two points everywhere. How does that show that there is a sense in which it is possible to be divisible everywhere?

It is now commonly thought that Aristotle does not show that there is a sense in which a magnitude is everywhere divisible, but rather presupposes this sense.[104] In the refutation, he would then be merely pointing out a logical gap in the atomistic argument, by drawing the distinction here mentioned.[105] This distinction would then be based on Aristotle's conception, set out in § 2, of an actual whole being really one and only hav-

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[103]   *DGC* 1.2; 316b14-317a12
[104]   The only one to dissent is White, *Continuous* 18.
[105]   Miller, 'Aristotle against the Atomists' 98, Williams, DGC 75, Charlton, 'Potential Infinites' 136, Joachim, On Coming-to-be 84, White, *Continuous* 201-202, and W.J. Verdenius and J.H. Waszink, *Aristotle on Coming-to-be and Passing-away. Some Comments* (2nd ed.; Leiden, 1968) 11-14.

ing potential parts divisible from each other at potential points.[106] In support, one often refers to the distinction which Aristotle draws in (2) between potential and actual divisibility. It is the same distinction we encountered, in § 3.2, in *De Anima* 3.6, and which I explained as the distinction between indivisibility within the actual situation and divisibility with reference to other possible situations.[107] In the actual situation only the whole really exists; the parts into which this whole is potentially divisible, exist in other possible situations. Thus this distinction seems to express the very same idea which is supposed to be behind Aristotle's refutation.[108]

It is problematic, however, to interpret the distinction drawn in (2) between potential and actual divisibility as pointing forward to the later refutation. First of all, this is not at all how Aristotle presents it. According to him, the restatement is merely a restatement, and the refutation only takes place in what is explicitly presented as the refutation.[109] Secondly, the core of the puzzle is stated by Aristotle in terms derived from that very distinction: it seems impossible that something is potentially divisible everywhere. That makes it unlikely that this distinction is behind the later refutation.

In addition, the fact that Aristotle mentions in (5) the identification of generation and aggregation as a premiss of the atomistic argument, seems incompatible with the idea that he just wants to expose a logical gap in that argument. For as we saw in Chapter Two § 1.2.2, the only way to make sense of the identification as a premiss is to interpret it as a version of the Atomistic Principle, saying that all possibilities of division are already present in the actual situation. So merely insisting that there is a way of being divisible everywhere which does not involve the actual presence of all possibilities of division would not go to the core of the atomist's argument..

All this shows that we are in need of an explanation of Aristotle's reasoning in both the restatement and the refutation, and that this explanation should give every step a significant role in the overall argument. Moreover, the last point, that Aristotle must somehow give grounds for rejecting the identification of generation and aggregation, shows that there is a close connection between the two interpretational issues which have to be dealt with regarding Aristotle's discussion of atomism in *De Generatione et Corruptione* 1.2: the overall strategy of the chapter and the details of the argument in the restatement and refutation. If we are able to offer an account of Aristotle's refutation which does give him such a ground for rejecting the identification of generation and aggregation, we have at least the beginnings of a solution to both issues.

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[106] Some version of this account is thought to be behind Aristotle's refutation by Williams, DGC 72, Miller, 'Aristotle against the Atomists' 92-98, and Verdenius and Waszink, *Coming-to-be* 13, even though they disagree on many points of detail.

[107] Just as in *De Anima* 3.6, this distinction is commonly interpreted as being of a lexical nature, for example by Williams, DGC ad locum and 67; cf. Miller, 'Aristotle against the Atomists' 92. That does not change the point, however.

[108] Williams, DGC 72, and H.J. Krämer, *Platonismus und hellenistische Philosophie* (Berlin, 1971) 261; cf. Miller, 'Aristotle against the Atomists' 92.

[109] Some scholars, like Williams, DGC 75-79, especially 75, are prepared to bite the bullet in this respect and argue that Aristotle is not doing what he tells us he is doing. Others even go as far as discarding all references to actuality and potentiality as interpolations; see Verdenius and Waszink, *Coming-to-be* 12-14.

§ 3.3.2.   An account in outline

I shall start my proposal for a solution with what may seem a small point. As I explained above, many commentators think that the distinction between potential and actual divisibility which Aristotle draws in (2) contains the seeds of his refutation. That seemed problematic, however, because the puzzle of how a magnitude could be said to be divisible everywhere is stated in (3) in terms of this distinction. Thus the distinction must be understood in such a way that it does not immediately rule out that divisibility everywhere is taken to involve the possibility of being divided everywhere. Such a way becomes available if we recall an observation I made at the end of § 2.2. There I pointed out that Aristotle has two ways of conceiving of the matter of an actual whole: as completely indeterminate, homogeneous, matter, and in a quasi-individuated manner, by reference to possible individuations. According to the second conception, the matter of an actual whole is thought of in a structured way, as if somehow the parts are lying ready to be separated out. The same way of understanding something to be potentially divisible is suggested by Aristotle's application of this terminology to numbers, calling a countable multitude 'that which is divisible potentially into non-continuous [parts].'[110] In the case of a number, the parts are clearly present in the actual whole in a determined way, rather than forming one homogeneous, undifferentiated stretch.

Now such an understanding of potential divisibility, in terms of the possibly separated parts which only need to be brought to actuality by an act of division, does not lead to problems as long as one considers each possibility of division distributively. To each separate possibility of division just two potential parts correspond. A whole which is divisible can therefore be represented as follows:

where the two boxes inside the larger box represent the two potential parts. However, if one applies the same conception of potential divisibility to all possibilities of division collectively, absurdities follow. For according to that conception, one needs to posit, corresponding to all these potential divisions together, potential parts which are there to be actualized by these divisions. The only parts which can fulfill this function are sizeless, since any other part is not a part which can be actualized by a division everywhere.

Thus with this conception of potential divisibility we have not only identified a way of understanding the distinction between potential and actual divisibility which does not preclude the puzzle of (3) being stated, but also the very idea which is the source of that puzzle. Moreover, it is also an idea which can be expressed in terms of defining generation and passing-away as aggregation and segregation respectively. The whole which consists of two potential parts put together is destroyed by the segregation of its parts; it comes into being again by the converse aggregation of the parts. Each separate division and unification thus amounts to nothing more than moving the given parts around in a certain way. Already before a division, the whole has an internal structure consisting in

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[110]   *Metaphysica* Δ.13; 1020a10-11;

the parts being aggregated; with the division merely the relation of forming an aggregated whole disappears, but the parts do not change for themselves. It is this relation which, just as in the case of a number, is the actual aspect of the whole, and in respect of which the whole is indivisible.

Interpreted in this way, the restatement of the atomistic argument (2)-(5) does not contain any element which immediately points forward to its refutation. The distinction between potential and actual divisibility does not need to entail Aristotle's own conception of a whole consisting of a form and structureless matter. The only sense in which it may be said to prepare the ground for the subsequent refutation is that, by adding the identification of generation and aggregation as a premiss of the atomistic argument, it explicates the conception of division on which the argument is based.

So it should be this conception of potential divisibility as involving an internal structure which Aristotle needs to refute. Now from the interpretation I offered in Chapter Three § 4.2.2 of the argument in (6), it appears that this is exactly what Aristotle is doing. By comparing the argument of (6) with a passage in *De lineis insecabilibus*, I explained that the two points which are everywhere, if a magnitude is possibly divided everywhere, are different in kind, one of them being an intercontact at which the magnitude is divisible, and the other being a constitutive point into which the magnitude is divisible. The picture Aristotle has in mind of a magnitude which is possibly divided everywhere is as follows:

C I C I C I C I C I C

where each intercontact I is both coinciding and contiguous with a constitutive point C.[111] One can see how Aristotle derives this picture from the conception of a potentially divisible magnitude as a magnitude which has an internal structure, with places at which it is divisible, and parts into which it is divisible: he retains the places of division as intercontacts and lets the parts shrink to constitutive points.

Since we know from *Physica* 6.1 that this consecutive ordering of indivisibles is impossible, Aristotle thus reduces to absurdity the conception of a division as a mere actualization of already present parts. One might object to this conclusion, by pointing out that it only reduces to absurdity this conception in combination with the hypothesis that a magnitude is everywhere divisible; logically speaking Aristotle could have rejected this hypothesis, just as the atomist does. However, we do not need to assume that it is Aristotle's purpose in *De Generatione et Corruptione* 1.2 to refute atomism as such. As he makes clear a number of times throughout the chapter, there are independent grounds for denying the existence of atoms. The clearest statement to that effect he makes in (1), referring to other works – and we may assume that they include *Physica* 6.1. Another statement occurs even *after* the so-called refutation in (6), thus indicating that it is not Aristotle's aim in (6) to refute atomism, for then he would have referred to that argument. Rather, assuming that magnitudes are everywhere divisible, he wants to show how one can understand that they are everywhere divisible without falling into the absurdities to which the atomist reduces the assumption of magnitudes being everywhere

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[111]   And each constitutive point or intercontact is contiguous, through different intercontacts or constitutive points respectively, with two other constitutive points or intercontacts respectively – but that is not relevant in the present context.

divisible. As he says in (1), it is this puzzle he wants to solve. He does so by rejecting on the basis of an argument the underlying premiss that a divisible whole has an internal structure of already present parts being aggregated. Since this idea can also be expressed by defining generation and passing-away in terms of aggregation and segregation respectively, he consequently also rejects this way of defining generation and passing-away.

At this point, we have come to the first interpretational issue to be dealt with regarding this chapter of *De Generatione et Corruptione*. For now that it has been shown that Aristotle rejects the identification of generation and aggregation by reducing it to the absurdity of there being at every place two consecutive points, an intercontact and a constitutive point, we can appreciate his confident conclusion that it is impossible to define generation in terms of aggregation.

What is more, from this refutation of the underlying premiss, it is perhaps also possible to understand the alternative definition of generation which Aristotle offers a little later on. By refuting the conception of a divisible whole as something with an internal structure made up of its parts and their relation of being aggregated, Aristotle replaces it with a conception of a whole which is divisible everywhere because it has just one point anywhere. Since there is no internal structure of already present parts, the whole must have a merely homogeneous stretch of matter which is divisible at any point and can thus be individuated in an unlimited number of ways. This would be fully in line with the account I ascribed to Aristotle in § 2. According to that account, a division of an object consists in the replacement of the form and matter-as-informed by the form of the original whole with two new forms informing two new stretches of matter-as-informed by these forms (point 8 in § 2.3). Now it may be that this corresponds to the alternative definition of generation he offers after the refutation:

> There is generation without qualification, as well as destruction, not by aggregation and segregation, but when something changes from *this* to *this* as a whole. ... In what underlies there is something corresponding to the account and something corresponding to the matter. When, then, there is a change in these, there will be generation or destruction.[112]

Though, in the context, Aristotle's foremost concern seems to be with saving transmutations of elements as cases of generation,[113] this defintion should not undermine such examples as the generation of a statue of Hermes out of a block of wood or the destruction of a whole by dividing it into two halves. They can be accommodated if we understand the change in the aspect corresponding to the account to be the replacement of the one form with the two new forms, and the change in the aspect corresponding to the matter to be the disappearance of the one homogeneous stretch of matter-as-informed and the arrival of two other stretches of matter-as-informed. Similarly, but in a more forced way, we might view the division of a whole into two parts as the change in the whole as identified by its matter from the *this* of being one to the *this* of being two.

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[112] 317a20-26, with an omission (quoted as a whole above, p. 255).
[113] As also appears from his remark at 317a27-30 that when segregated things become more susceptible of destruction. His example is the change from water into air.

The outcome of this account of Aristotle's reasoning in the restatement and refutation of the argument for the existence of atoms, and of his grounds for rejecting the identification of generation and aggregation, is that the issue whether or not there are atoms, or rather, whether or not the argument for their existence is sound, is indeed 'basic' and does indeed 'make a huge difference' with regard to the question whether to define generation in terms of aggregation. It is, however, not basic in the sense that, in order to settle this question, the atomistic argument can be investigated independently from it. In that sense, the suggestion of the passage quoted at the beginning of § 3.3.1 has not been borne out. But perhaps we were reading too much into this passage, for only a few lines earlier Aristotle talks about the 'many impossibilities' which follow from the identification of generation and aggregation.[114] As I have already pointed out, we encounter similar references to 'many impossibilities' throughout the chapter, but then following from atomism itself.[115] It seems likely that they are all the same. Also according to Aristotle, the argument for the existence of atoms stands or falls with the identification of generation and aggregation, and thus with a version of the Atomistic Principle.

§ 4.   Conclusion

In this chapter I offered an exposition of Aristotle's fully worked out conceptual scheme for talking about continuity and infinite divisibility, as well as interpretations of a series of difficult arguments dealing with issues of continuity. For a summary of Aristotle's scheme, I refer to the model presented in § 2.3. Here I want to draw attention to the conceptually most important features of this scheme.

Just as in the chapters about Zeno and Democritus, two issues were seen to play the leading roles in Aristotle's thinking about continuity. With regard to the question of priority between parts and whole, he rejects explicitly the modalized version of the priority of parts over the whole, so that a divisible whole of parts remains a unity as long as it is not divided. He does not distinguish between physical divisions and mathematical divisions in this respect, as Democritus did. The reason why he does not draw such a distinction, is that he holds on to a version of the argument from homogeneity, namely that two touching bare objects or two consecutive motions without interruption must form one whole.

The framework within which Aristotle takes a position on these two issues, however, is very different. Where Democritus just talked about limits as those things with which objects touch, or as the goal of a unlimited series of approximations, but nothing more, Aristotle gives them, as we already saw in the previous chapter, a much more important role. He conceives of them as the bearers of the structure which they provide to each unified magnitude or motion by limiting the stretch of magnitude or process between them. In *Physica* 6, Aristotle is very liberal about the structuring capacities of limits, in that he treats all the parts defined by any pair of limits on an equal footing. As we saw in this chapter, however, he is elsewhere much stricter, in two respects. First, he is confronted with the question of priority, as well as with the problem that if an object is

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[114]   315b20-21
[115]   315b33, 316b16-18 and 317a14.

infinitely divisible, it seems to follow that it can be divided in such a way that it actually consists of an unlimited series of parts without any limit. In response, he gives priority to one pair of limits determining one unified whole; all the other limits do not do any work, though they may, in different situations, take over the function of giving structure to wholes from the present pair, bringing about other wholes. The second respect in which Aristotle is stricter with regard to the structuring capacities of limits is that as far as physical objects and motions are concerned, he does not think that any pair of limits can determine a whole. An uninterrupted stretch of the same stuff or an uninterrupted stretch of motion must form one unified whole, with limits at the outside.

Since this so-called argument from homogeneity only works if the process or stretch of magnitude of one structured motion or object is the same as that of the consecutive motion or object, Aristotle's acceptance of it amounts to giving some independent metaphysical status to the stretch of magnitude or process in so far as it is not structured by limits. Thus Aristotle rejects his own idea, put into practice in *Physica* 6, of ascribing an infinite structure to this homogeneous aspect, with all the parts in a sense already present in it. We saw in the last section of this chapter that in two difficult arguments he is insisting on precisely this point, that we should not think of an divisible object as already containing its parts and their limits. He replaces this conception with something which is for itself structureless, though it can be structured in all kinds of ways. That is precisely why he needs such an unstructured principle – in order to provide something persisting in changes of structure, as in unifications and divisions.

Wholes for Aristotle may consists of a stretch of in itself structureless mass structured by limits, but that does not mean that these two aspects can exist separately. With respect to limits, Zeno and Democritus had already struggled with this problem, but Aristotle seems to be the first to give an account of our ability to grasp limits as dependent parts of a whole. He does so by showing how we can grasp the structureless aspect and the limits apart from each other. His account is ultimately based on the notion of a process as just going on, without end. Because we know by argument that a Zenonian division cannot be completed, we have a grasp of an unlimited process in which each part of the divisible whole will be taken away at some stage. Through our grasp of this endless process, we also grasp the unlimited series of parts, together forming something without a limiting part. At the same stroke, we have also grasped the limit, since the limit is the difference between the unlimited series of parts and the limited whole out of which they are being taken in the process. Understanding limits seems to imagine oneself as having been able to complete an unlimited process. It is no wonder that Aristotle's predecessors were puzzled about them.