An Ontology for the In-Between of Motion: Aristotle's Reaction to Zeno's Arguments*

DOI: 10.14746/PEA.2021.1.7

MICHEL CRUBELLIER / *University of Lille* /

Aristotle says in his *Sophist* (...) that Zeno was the first person to have discovered dialectic.[1]

Dialectic puts opinions to the test on matters of which first philosophy gives real knowledge.[2]

1. Introduction

The present paper will perhaps appear misplaced in a collection of essays about Aristotle's reception of Eleatic ontology. In fact we do not know if, and to what extent, Zeno did

* An important part of what follows originates in contributions to the seminar on the *Physics* held by Pierre Pellegrin in Paris and Lille in the 1990s. I am pleased to remember the warm and stimulating atmosphere of those sessions, and I thank Pierre and all the other participants for so many fruitful discussions. I borrowed most of the translations of Greek texts to extant English translations, especially to Laks, Most (2016) for all the Zenonian material, and to the Revised Oxford Translation for Aristotle's treatises. In some cases, I had to make such changes as were required to fit in with my interpretations.

[1] D.L. VIII.57 (LM Zeno R 4 = DK 29 A 10)

[2] Arist. *Metaph.* IV.2, 1004b25–26.

care about ontology at all. Many historians of Greek philosophy even doubt that he ever expressed positive philosophical views of his own. If he did subscribe to an ontological creed, we have reason to believe that it was Parmenides' 'monist' ontology, which I do not intend to consider here (others contributors will).

My point is different. We know from Aristotle that Zeno devised some arguments about motion with paradoxical conclusions, "which cause so much trouble to those who try to answer them"[3] and are considered as rejecting the possibility of motion altogether.

Seen that way, these arguments would amount to a rejection of the whole of Aristotle's natural philosophy, since "nature is a principle of motion and change, and it is the subject of our inquiry. Therefore we must not ignore what motion is; for if it were unknown, nature too would be unknown"[4] – and, we may add, if it was shown to be impossible, nature too would be impossible. So the face-off with Zeno's paradoxes might remind us of the predicament created by Parmenides' claim that being must be one in the first book of the *Physics*.

However, Aristotle's reaction to these situations is not the same. In *Physics* I.2, he has described Parmenides' and Melissus' absolute monism as a major threat to natural philosophy; but he has immediately disposed of it by rejecting the burden of the proof and showing by means of appropriate *luseis* that the monists' arguments are not valid; nevertheless he also feels that he is bound to build an alternative picture of change. He does so in the second half of Book I, showing that in a sense change starts from not-being, although not from absolute not-being.[5] With Zeno, he does not take issue in such a dramatic manner. In fact, he does not say in so many words that his arguments lead to a rejection of motion altogether; but he takes them seriously. He obviously considers that it falls to the natural philosopher to solve such difficulties and that he has to address their structure and contents in detail, and not just their relevancy or irrelevancy.

The report and criticism of the four arguments is contained in one page of *Physics* Book VI (Chapter 9, 239b5–240a15). If you read just that chapter, you may feel that each argument is easily – perhaps too easily – rejected. But in fact Aristotle has prepared well ahead the arguments he uses for these refutations. He has done that explicitly a few pages before, in Chapter 2 (*Ph.* 233a21–b15), but in fact his objections implement a large part of the analyses of motion that he has carried out in Book VI and indeed from the beginning of Book V. These two books have a distinct character in that they develop technical and abstract analyses of the inner structure of motion and follow them up into their minutest details. Some of these analyses will be used later on in the demonstration of the existence of a First Mover of the heavens; but as they stand in the text of Books V and VI, they might be considered as a self-contained treatise about motion. The striking

---

[3] Arist. *Ph.* VI.9, 239b10–11.

[4] Arist. *Ph.* III.1, 200b12–15.

[5] Arist. *Ph.* I.8, 191a33–b27.

fact is that the specific philosophical style of these two books is quite different from what we read about motion in other parts of the *Physics* (on this see below § 8), while it looks much like what seems to have been Zeno's own style. I do not write that without fear and hesitation, since we know so little of Zeno's philosophical production – the more so since a large part of what we know comes from the *Physics,* so that the alleged resemblance could be caused and biased by the fact that Aristotle had perhaps rephrased and interpreted Zeno's arguments. However, I may draw some confidence from the fact that the arguments that we know by Simplicius' direct citations[6] show much the same style.

Another important similarity between Zeno's arguments and the general contents of Books V and VI is that they bear on what I will call 'the In-Between' of motion and change (on this see below § 9).

Thus, the aim of the present paper is to show that some important results of Books V and VI constitute a specific ontological description of motion, that Aristotle has elaborated, among other reasons, in response to the challenge of Zeno's paradoxical arguments. I do not intend to bring in historical arguments, in the narrower sense of that phrase, to establish that point. I am not sure that it could be done – due to the scarcity of our knowledge about Zeno – and at least I will not undertake to do that. The only historical argument of that kind that I can see is the interesting fact that Zeno is the only one philosopher whom Aristotle cites in Books V and VI, but I would not put too much weight on it. As I have just recalled, there is no formal 'declaration of war' against Zeno as there is against Parmenides in Book I. So I may readily concede that I mean that not as history but just as a mere story, convenient to put into light an intellectual landscape, and continuity in the history of a given problem over several generations (in fact, I will even give an argument to that effect in § 7).

In the pages that follow, I will first offer a description of Zeno's undertaking as it may have appeared to Aristotle (§ 2) and review the different arguments and the specific answers that Aristotle gives to each of them (§§ 3–7). This part of the paper collects the data for the discussion that follows: in §§ 8–9 I will try to characterize the distinctive method of inquiry of the last books of the *Physics* in the light of Zeno's own method (at least as far as we know it). In the last two sections, I will try to assign a specific 'ontological location' to Aristotle's analyses of the in-between of change (§ 10) and to interpret his claim that the structure of total order that he calls *before and after* is central to its ontology (§ 11).

2. On the character and contents of Zeno's writing

I do not intend to propose a reconstruction of Zeno's work and of his philosophy by itself, but to address his picture of motion through its reflection in Aristotle's *Physics.* But it

[6] Especially the fragments LM Zeno D5–6 (= DK 29 B 1) and LM Zeno D11 (= DK 29 B 3).

turns out that our information about Zeno has come to us mainly through Aristotle and Plato, or was set off on the occasion of comments on the relevant passages of Plato and Aristotle,[7] so that any historical interpretation of Zeno's arguments presupposes a correct assessment of Plato's and Aristotle's attitude towards his philosophy.

Plato's testimony is not exactly a real testimony, since it is placed in the mouth of the young Socrates and of Zeno himself on the occasion of a fictitious encounter between Socrates, Zeno and Parmenides. It does not give much information about the contents of Zeno's arguments,[8] but on the character and purpose of his writing. I am not claiming that we should accept at face value the story told by a fictitious character in a fictitious situation. However, Plato was writing for readers who had some acquaintance with Zeno's *sungramma* and the story told by 'Zeno' appears to be meant to explain some features of that unusual piece of writing.

Zeno wrote one book; maybe that was not even a book, but some kind of personal notes[9] – containing forty (or so) arguments.[10] It seems to have been just a collection of difficulties without any indication of a positive philosophical claim. This is probably the reason why young 'Socrates', in the *Parmenides,* suggests an interpretation which is praised by his elder interlocutors – and why ancient commentators still disagreed on his intention, as is shown by Simplicius' commentary on *Physics* I.2.[11] That interpretation of his arguments as moves in an indirect proof probably lead Aristotle, and others after him, to celebrate Zeno as the inventor of dialectic.[12]

Aristotle cites five of these arguments and two propositions that must have belonged in other similar arguments:

– He paraphrases and discusses the four aguments about motion that I will consider here. They are well-known and I will call them hereafter by the names that have become more or less canonical: the Dichotomy (or: the Division), the Achilles (or: Achilles and the Tortoise), the Arrow and the Stadium.

---

[7] The most serious candidate for being a source independent from Aristotle and Plato is Diogenes Laertius. However, a good deal of the stories he tells about Zeno's life and death (IX.26–27) might be just illustrations of his reputation as the founder of dialectic; the physical doctrines Diogenes reports under his name (IX 29 = LM Zeno R 39) look much like a wrong attribution, and the fragment that he reports (IX.72; LM Zeno D17 = DK 29 B 4) might result from a confusion with a similar opinion of Diodorus Cronos.

[8] Nevertheless, Laks and Most retain (LM Zeno D4) a testimony left aside by Diels and Kranz: the argument that Socrates' summarizes in the first part of the *Parmenides* (*Prm.* 127e): 'if the things that are are many, then they must be like and unlike (δεῖ αὐτὰ ὅμοιά τε εἶναι καὶ ἀνόμοια); but this is impossible, for neither can the unlike be like, nor the like be unlike'. – This argument may seem rather weak, since it seems to be self-evident that what is like must also be unlike (insofar as *like* does not mean *identical*); but, for the reasons I am giving above, it would be strange for Plato to introduce deliberately a fake citation of a real book that he mentions just at that point in the dialogue.

[9] According to what 'Zeno' himself declares in Plato's Parmenides (*Prm.* 128d–e).

[10] Procl. in *Prm.* 694.17–19 (LM Zeno D2 = DK 29 A 15).

[11] Cf. testimonies R10–13 in Laks, Most (2016).

[12] See D.L. VIII.57, quoted above in the epigraph. There is also a possible hint at this specific style of argumentation of Zeno in the *Phdr.* 261d.

– He mentions another one about place: "if something is real, it must exist somewhere", *i.e.* 'in some place'. One should probably go on: "but if place itself is real it must be in some place too; and if that place is real it must be somewhere", and so on indefinitely.[13]

The two isolated propositions are:

– any part (ever so small) of a millet seed must produce a sound when falling on the ground;[14]

– that which, when added to something, does not increase its magnitude, is nothing.[15]

Information linked with Aristotle but not transmitted directly by him comprises the argument alluded to in the beginning of the *Parmenides* and literal citations provided by Simplicius in his commentary to *Physics* I.[16] Simplicius cites literally[17] two or three other arguments:

– One of them (LM Zeno D7 = DK 29 B 2) establishes that what "when added to something, does not make it any larger", is nothing or does not exist[18]; this is probably the same premiss as cited in *Met.* III.4 and perhaps the same as εἰ μὴ ἔχοι μέγεθος τὸ ὂν οὐδ' ἂν εἴη (Simp. *in Phys.* 141.1–2, LM Zeno D5), which might belong to the same argument as LM Zeno D6, as Diels assumed.

– Another one (LM Zeno D6 = DK 29 B 1) is about the division of continuous magnitudes; the paradoxical conclusion is that "if there are many things, it is necessary that they be both small and large, so small that they do not have any size and so large that they are unlimited."[19] The argument appears to rest on a dilemma: if we suppose that the process of division has come to an end, then how shall we conceive the ultimate elements? They must have either some size or no magnitude at all. If they have no magnitude, then the sum of them all will equal zero; if they have some size, however small, then the sum of an infinite number of such parts will excede any given finite magnitude.

---

[13] Arist. *Ph.* IV.1, 209a23–25; IV.3, 210b22–28 (LM Zeno D13 = DK 29 A 24); at 210b27, Aristotle objects that "it is not necessary to go on *ad infinitum*."

[14] Arist. *Ph.*, VII.5, 250a19–22 (LM Zeno D12 = DK 29 A 29). Although Aristotle calls it a λόγος, his answer does not attack it as being wrongly inferred or inferred from wrong premisses, but considers only the material falsity of that proposition in itself (on the ground that Zeno ignores threshold effects in causality).

[15] Arist. *Metaph.* III.4, 1001b7–13 (LM Zeno D8 = DK 29 A 21).

[16] These citations are brought about by an enigmatic mention, in Aristotle's text, of 'the argument from dichotomy', to which some thinkers deferred by assuming the existence of indivisible magnitudes (I.3, 187a1–3). In fact, there is nothing about the division of physical magnitudes in the immediately preceding context (the discussion of Parmenides' monism); at 186b35 we find the sentence: ἐξ ἀδιαιρέτων ἄρα τὸ πᾶν, but it seems to conclude a discussion about definition by division.

[17] Although he could cite literally these passages, it is clear from his commentary on chapter VI.9 (1012.21–29) that Simplicius did not have access to the full text of Zeno's writing, since he could not tell whether there were just four arguments about motion, or whether the mention of four arguments referred only to those which were hard to solve. Moreover, all along that section (1011.9–1020.6), he clearly appears to reconstruct the meaning and logical form of each argument as best he can from Aristotle's text.

[18] Simp. in *Phys.* 139.11-15. I am not sure that this is a distinct argument: its conclusion is not that paradoxical (it might be just a formulation of the so-called 'axiom of Archimedes') and at line 141.1 Simplicius says that it is a 'preliminary demonstration' (προδείξας).

[19] Simp. *in Phys.* 141.2–8.

– Another one (LM Zeno D11 = DK 29 B 3) is about the number of objects that must exist if there are many things; the paradoxical conclusion is that there are compelling reasons to say that their number is finite and that it is infinite.[20]

The four arguments reported in *Phys.* VI.9 are generally considered to be 'against motion', although each of them has (in Aristotle's report) a distinct specific conclusion. Only the Dichotomy is said to lead to the inexistence or the impossibility of motion (περὶ τοῦ μὴ κινεῖσθαι), and in fact even that could be qualified. A deflationary and perhaps more appropriate translation would be: "establishing that »a <given> motion *could not occur*« – because it just could not start, which is the point of the argument. The conclusion of the Achilles is that "the slowest will never be overtaken by the swiftest"; that of the Arrow is that "the flying arrow is at rest"; and that of the Stadium is that a certain lapse of time must be equal to the half of itself.

I will end this section by mentioning the question: if Zeno's writing contained forty arguments, of which only four especially addressed motion, what was the target of the other thirty-six? The *Parmenides* suggests that they were about multiplicity, but it also suggests that their connection with multiplicity was not immediately evident, otherwise there would be no reason to praise the young 'Socrates' for having seen it. On the basis of the limited sample that has come down to us, they seem to bear on different opinions, commonly held or perhaps also held by eminent philosophers – *endoxa*, in Aristotle's own idiom – about natural philosophy. This is another aspect of the affinity of Zeno's arguments with Aristotle's dialectic (more on that point in § 8).

3. The Dichotomy and the Achilles

> The first < argument > asserts that there is no motion (περὶ τοῦ μὴ κινεῖσθαι) on the ground that that which is in locomotion must arrive at the half-way stage before it arrives at the goal. This we have discussed above.
> The second is the so-called Achilles, and it amounts to this, that in a race the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead.[21]

Aristotle joins those two arguments together, for he says they have the same structure and must be solved in the same way (*Ph.* 239b25–26). "We have discussed this before" refers back to VI.2, 233a21–b15. In that context (Chapters 1–2), Aristotle establishes that whatever is continuous cannot be composed of indivisible parts. He has given first an *a priori* demonstration by showing (through elimination) that none of the conceivable modes of

---

[20] Simp. *in Phys.* 140.28–33.

[21] Arist. *Ph.* VI.9, 239b11–18.

composition could apply to indivisible parts (*Ph.* VI.1, 231a26–b18); then, leaning on an analogy between magnitude, motion and time,[22] he shows that either the three of them are composed of indivisibles, or none. In the course of that discussion, he remarks that Zeno's arguments appear to assume arbitrarily a different regime, if I may say so, or inner ontological structure, for spatial magnitudes and for time: while he allows to divide the finite course of a given motion in infinitely many parts, he claims that it would take an infinitely long time to pass successively through all these parts. But if one allows the infinite divisibility of a finite magnitude for time as well, then it will always be possible to have a one-to-one correspondence between the points of the course and the instants of time, without even having to decide the question whether both are composed of indivisibles or indefinitely divisibles. This objection applies equally to the first argument and to the Achilles.

In his comments about these arguments (*Ph.* 239b18–29), he calls the first one 'the argument by dichotomy' (τῷ διχοτομεῖν) and 'the dichotomy'. This way of referring to it may have led commentators to conflate it with Fragment D6 / B1, which, as we have seen (§4 above and fn. 24), is introduced by Simplicius in order to explain the sentence: "some thinkers gave way (...) to <the argument> from dichotomy by positing indivisible magnitudes" (*Ph.* I.3, 187a1–3). It is impossible to guess with certainty which 'argument from dichotomy' Aristotle may have meant at that place. Nevertheless, it is important to stress that the paradoxical conclusions of D6 / B1, on the one hand, and of the Achilles and the 'Dichotomy' of Book VI are quite different. D6 / B1 bears on the size or extension of things that 'are many' (εἰ πολλά ἐστιν, be they the whole of reality taken together or each extended object considered apart); that has nothing to do with motion.[23] On the contrary, the Dichotomy and the Achilles establish conclusions about motion, and in each of them the notion of succession in time (the notion of *before*) plays a crucial part. The mobile in the Dichotomy cannot reach the middle point *before* it has crossed the quarter of its course, and so on; Achilles will not come up to the Tortoise *before* he has run the small length the Tortoise has crossed while he was arriving at its previous position, and so on.

Although Aristotle suggests to treat them on a par, as two variants of the same model ("for in both a division of the space in a certain way leads to the result that the goal is not reached" – *Ph.* 239b22–24), it is interesting to notice that they lead to somehow symmetrical impossibilities: in the Dichotomy, it is impossible to start; in the Achilles it is impossible to reach a certain result. Still more precisely, the symmetry is not perfect, for in the Achilles the aimed-at result is not given from the beginning, but depends on the relation between two distinct motions. It is difficult to guess whether Zeno introduced

---

[22] He has carefully expounded that analogy in Book IV (*Ph.* IV.11, 219a10–b33), and used it in order to define time; see below § 11.

[23] In fact, Simplicius expressly mentions dichotomy (140.33–34) about D11 / B3, *not* D6 / B1; but D11 / B 3 is an argument about the *number* of the multiple beings, not about their *magnitude*.

that difference on purpose[24] (and, if so, which purpose?), but I will return to that point later on (§ 10, under #4).

4. The Arrow

Unfortunately, and although it triggers Aristotle's excursus about Zeno's arguments in chapter VI.9, this one is particularly obscure and laconic in Aristotle's presentation, and the transmitted text has been questioned:

> Zeno's reasoning, however, is fallacious, when he says that if everything, whenever it is over against an equal <extent of space>, is at rest or in motion (εἰ γὰρ αἰεί, φησιν, ἠρεμεῖ πᾶν ἢ κινεῖται ὅταν ᾖ κατὰ τὸ ἴσον), and if that which is in locomotion is always in a *now*, the flying arrow is therefore motionless. This is false; for time is not composed of indivisible *nows* any more than any other magnitude <is composed of indivisibles>.
> (...) The third is that already given above, to the effect that the flying arrow is at rest, which result follows from the assumption that time is composed of *nows*: if this assumption is not granted, the conclusion will not follow.[25]

The difficulty of the first passage lies in the phrase ὅταν ᾖ κατὰ τὸ ἴσον, which raises two questions: (1) how are we to understand κατὰ + *Acc*.? (2) what is the unexpressed complement of τὸ ἴσον? Both questions will bear upon an important issue in the translation, namely, the choice of the noun or nominal phrase necessary to complete the meaning of τὸ ἴσον.

As to κατὰ + *Acc*., we may take some light from the immediately preceding context (*Ph*. VI.8, 239a23–b4), in which Aristotle states that a moving object can never be κατά τι, at least in a strict sense (κατά τι πρῶτον). The phrase refers clearly to the possibility of locating the moving object by reference to some external mark. Although I am not a native speaker of English, it seems to me that Hardie and Gaye's rendering 'over against' is a good solution. In Chapter 8, Aristotle seems to admit (but distinguish) two uses of that phrase, a stricter (as in κατά τι πρῶτον) and a looser one, in which the mobile need not coincide with the external marks.[26]

Now, in κατὰ τὸ ἴσον, does ἴσον refer implicitly (*a*) to the object itself ("(...) when it is in a space equal *to itself*" a body must be at rest") or (*b*) to different possible situations: if A is over against some space equal to those over against which B is and C is, etc., and A is at rest, then B and C must be at rest too; if A is in motion, then B and C must be in

---

[24] Aristotle suggests that it was perhaps just a matter of giving the argument a narrative, more dramatic form.

[25] Arist. *Ph.* VI.9, 239b5–9, 30–33.

[26] This looser use is to be assumed in Zeno's argument if one opts for interpretation (*b*) below; for the same reason I chose to render τὸ ἴσον by 'an equal <extent of space>'.

motion; etc? If you opt for interpretation (*a*), then ἢ κινεῖται at 239b6 does not make sense any more and you have to suppress it. This is what Ross and the great majority of modern interpreters do; many of them complete that suppression with different heavier emendations in order to get closer to this meaning.[27]

But this is not necessary, and we can make sense of the text as it stands, if we assume that being 'over against' some definite extent of space defines something like the state of motion of a physical object at a given time. Thus, if two objects are over against equal extents of space, they are both moving (possibly: at the same speed) or both at rest; this is interpretation (*b*) above. Then Zeno's argument would rest on the fact that if you consider objects at one instant, it is impossible to discern those that are moving from those that are at rest. — However, the gist of the argument must be something like that, even in interpretation (*a*),[28] since Aristotle's defence is that time is not composed of indivisible *nows*.[29]

5. The Stadium: Textual and exegetical questions

Aristotle's report of this fragment[30] is longer and more detailed; I give it below in full. Zeno appears to have followed the geometer's method of writing in three steps: [I] a general statement of the proposition; [II] the *exposition*, in which the proposition is rephrased in an arbitrarily chosen particular case; [III] the conclusion – here the two conclusions (*a*) and (*b*), since Zeno's point is that two incompatible propositions can be inferred from the situation he has described. In the text below, this procedure is inter-

---

[27] This line of interpretation dates back at least to Themistius; but there is no reason to suppose that he did not read ἢ κινεῖται, since he was writing a paraphrase. In the same vein, he completed κατὰ τὸ ἴσον with κατὰ τὸ ἴσον **αὑτοῦ διάστημα** to make his interpretation explicit. – Simplicius seems to have read the same text as we read in all the extant mss., but he comments on it by combining two different interpretations: (i) the arrow is not (cannot be) in motion in the *now* and (ii) everything must be either in motion or at rest. Thus the flying arrow must be at rest in the *now*, and therefore it must be at rest all along its flight, since its flight is made of a succession of *nows*. An orthodox Aristotelian answer would then be to grant (i) (Aristotle says that there is no motion in the *now*) but to deny (ii) (there cannot be any rest in the *now* either). This line of argument is relevant (this is more or less what Aristotle has just sketched in the last lines of Chaper VI 8), but it does not fit in well with the syntax of the text as it stands (notice also that Zeno's claim is that the arrow is 'motionless', not that it is 'at rest'). In ms. E the initial εἰ has been warped into an ἢ, probably in order to back up this interpretation.

[28] Any interpretation of lines 239b5–9 has to find a link between κατὰ τὸ ἴσον and ἐν τῷ νῦν. It seems to me that the supporters of interpretation (*a*) take that for granted too easily.

[29] Another puzzle with the same sort of conclusion (LM Zeno D17 / DK 29 B 4) is mentioned by Diogenes Laertius: "Zeno abolishes motion by saying that *what is moved does not move either in the place in which it is nor in the place in which it is not*." It may be authentic, but it cannot be easily connected with Aristotle's report of the Arrow. I will not consider it here, since my subject is Aristotle's reaction to Zeno's arguments, under the form that he knew.

[30] Arist. *Ph*. VI.9, 239b33–240^{a}18.

rupted twice, at [I'] and [III'], by Aristotle's own comments on the fallacy of the argument (in italics).[31]

The Greek text of section [III] is difficult and has given rise to various emendations, from ancient Greek commentators to modern editors and interpreters, and to some variance in the manuscripts. Modern scholars generally follow a text which, in my opinion, has been influenced by Simplicius' commentary (although some of Simplicius' most conspicuous misinterpretations have been rejected). In the interpretation that follows[32] I tried to keep as close as possible to the best transmitted text. I cannot discuss here all the interpretations that have been proposed, but I will indicate and explain the points on which I part from the received interpretation(s).

> [I] The fourth argument is the one about bodies of the same size that move at an equal speed in a stadium and pass alongside equal bodies in the opposite directions, the ones starting from the end of the stadium, the others from the middle,[33] in which case, he thinks, one half of a period of time time is equal to its double.
> [I'] *The fallacy consists in supposing that a body of equal size moving at an equal speed moves during the same time alongside a moving body as alongside a body at rest. But this is false.*
> [II] For example, let bodies of equal size at rest be AA; let BB be those that start from the middle <of the stadium>,[34] which are equal to the former in number and in magnitude; and let CC be those starting from the end <of the stadium>, which are equal to these in number and in magnitude, and equal in speed to the B's.
> [III] It follows that, (*a*) when they move alongside one another, the first B and the first C are at the end <of the A's> at the same time; and it also follows that the C has passed over (διεξεληλυθέναι) all the A's but, as to the B's, half of them; so that the time is one half, for each of them is in front of each <C> for an equal <time>. And at the same time it follows (*b*) that the <first> B has passed along (παρεληλυθέναι) all the C's (for the first C and the first B will be at opposite ends at the same time), being along <each of> the B's for exactly the same time as along <each of> the A's, as he says, because both pass an equal time along the A's.

---

[31] Incidentally, I disagree with Laks and Most, who put all of sections [I'], [II], [III] and [III'] together under the title 'Against the Fourth Argument'. In my opinion, only [I'] and [III'] are Aristotle's own interventions; the rest belongs to Zeno.

[32] I proposed this interpretation at Pellegrin's seminar in 1995. Pellegrin, although he did not retain my suggestion for his French translation, published it nevertheless as an appendix (Pellegrin 2000: 449–450), with a short footnote by way of comment. By that time I did not know that a similar interpretation had been developed long ago by Lachelier, although the journal *Corpus* had reprinted his 1910 paper in 1994. Lachelier resorts to a different set of editorial options, implying more conjectures and corrections than mine, but the gist of his interpretation is the same.

[33] It is generally acknowledged that 'the middle' means the turning-point in an antique stadium, so that, for the Greek reader, 'end' and 'middle' referred to extreme opposite positions.

[34] Some mss. (F, K and J *post correctionem*) read 'from the middle of the A's'.

[240a9] συμβαίνει δὴ τὸ πρῶτον **β** ἅμα ἐπὶ τῷ ἐσχάτῳ εἶναι καὶ [10] το πρῶτον **γ**, παρ' ἄλληλα κινουμένων. συμβαίνει δὲ τὸ [11] **γ** παρὰ πάντα τὰ **α** διεξεληλυθέναι, τὰ δὲ **β** παρὰ τὰ [12] ἡμίση· ὥστε ἥμισυν εἶναι τὸν χρόνον· ἴσον γὰρ ἑκάτερόν ἐστιν [13] παρ' ἕκαστον. ἅμα δὲ συμβαίνει τὰ **β** παρὰ πάντα τὰ **γ** [14] παρεληλυθέναι· ἅμα γαρ ἔσται τὸ πρῶτον **γ** καὶ τὸ πρῶ[15]τον **β** ἐπὶ τοῖς ἐναντίοις ἐσχάτοις, ἴσον χρόνον παρ' ἕκαστον [16] γιγνόμενον τῶν **β** ὅσον περ τῶν **α**, ὥς φησιν, διὰ τὸ ἀμ[17]φότερα ἴσον χρόνον παρὰ τὰ **α** γιγνεσθαι.[35]

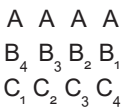
[III'] *This then is the argument, and it arises from the falsehood that I have indicated.*

The received version[36] implies two important corrections:

– at 240[a]11, to replace 'the A's' by 'the B's' – which can lean only on two late manuscripts (H and I) and possibly on the text of E *ante correctionem*;
– at [a]13, to replace 'the B's' by 'the <first> B'.[37]

In this version, the initial situation is:

and the final situation will be:



Thus "the <first> C has crossed all of the B's and the B's only half", by which we are supposed to understand that the B's have crossed only one half *of the A's* (as Simplicius supposes) or perhaps one half *of their own size*? If that is the meaning of Zeno's argument,

---

[35] Here is a simplified apparatus for these lines, adapted to the text that I retain:
[10-11] **γ**] ἐπὶ τῶ ἐσχάτω **β** [παρ' add. H – [11] τὰ **α** E[2]FJK *Alex. Philop. Simpl.* : τα **β** HI **β** E[1] – [11] τὰ δὲ **β** FHIJK *Philop.* : τὸ δὲ **β** E *Alex. Simpl.* – [11-12] παρὰ τὰ ἡμίση EFHIJK *Alex. Ishâq* : παρὰ τὰ ἡμίση **α** *Simpl.* – [13] ἕκαστον FHIJK : ἕκαστον αὐτῶν E – [13] τὰ **β** FHIJK *Simpl.* : τὸ ᾱ **β** vel τὰ **β** E (τὸ πρῶτον **β** coniecit Cornford) – [14] ἔσται EJ* : ἐστι FHIK – [17] παρὰ codd. omnes : κατὰ *Alex.*

[36] Here is Laks and Most's translation of the text they edit, which seems to me to be a good representative of the line of interpretation most commonly followed nowadays: "It follows that, when they move alongside one another, the first B and the first C are at the end at the same time; and it also follows that the C has crossed all of the B's and the B's only half, so that the time is one half, since each one passes beside the other for an equal time. And at the same time it follows that the <first> B has crossed all the C's; for the first C and the first B will arrive at the last <bodies> located at opposite extremities at the same time, as <the first C> is alongside each of the B's and each of the A's for an equal time, as he says, because both of them are beside the A's for an equal time."

[37] Corrections at that place can lean only on ms. E (fol. 49r, l. 9), which has been corrected – probably by the original copyist, since the ink is the same. It shows this:  . Cornford conjectured that it meant τὸ ᾱ [= πρῶτον] **β**; but that use of ᾱ might create a confusion with the use of letters for the data of the argument (and actually, at all other places in the context, E spells out πρῶτον in full). Otherwise, that might result from a correction of τὸ **α** or τὸ **β** into τὰ **β** (the copyist of E uses normally this form:  of the beta, although he sometimes uses as well).

then the proposed text is at least a strange way of expressing it: why speak of 'the <first> C' in one case and of 'the B's' in the other? and how are we to explain that τὰ ἡμίση is left without further determination (in a context in which every other element seems to be accurately determined)? Apart from these matters of expression, this version does not explain how Zeno meant to obtain the conclusion that "the time is one half." And of course the fallacy would be too obvious. Admittedly, Aristotle suggests that the argument is weak when he accuses Zeno of passing (willingly or by ignorance) over the well-known empirical fact of relative speed. But we may credit Zeno with a more subtle, albeit fallacious, move.

The interpretation I am advocating supposes that in the sequence τὰ[38] δὲ β παρὰ τὰ ἡμίση, τὰ δὲ β is an expressive prolepsis, thus giving to τὰ ἡμίση the determination that it would lack otherwise. So the argument will rest on the following decomposition of the crossing, which takes four moments:

[1]	A A A A $B_4\ B_3\ B_2\ B_1$ $C_1\ C_2\ C_3\ C_4$
[2]	A A A A $B_4\ B_3\ B_2\ B_1$ $C_1\ C_2\ C_3\ C_4$
[3]	A A A A $B_4\ B_3\ \mathbf{B_2}\ B_1$ $\mathbf{C_1}\ C_2\ C_3\ C_4$
[4]	A A A A $\mathbf{B_4}\ B_3\ B_2\ B_1$ $\mathbf{C_1}\ C_2\ C_3\ C_4$

Thus, τὰ δὲ **β** παρὰ τὰ ἡμίση means that C_1 has been in front of only one half of the B's, those that are marked in bold letters at times [3] and [4]. Although the process as a whole extends over four moments, the crossing of the B's by C_1 takes only two of them, that is, 'half the time'.

[38] Retaining the plural τὰ δὲ **β**, given by the mss. FHIJK, rather than τὸ δὲ **β**, although the latter has the (considerable) support of a good ms. (E) and of Alexander and Simplicius.

6. Further reflections on the meaning of the Stadium

Far from ignoring the fact of relative speed, the first part of the argument offers a smart account of that fact – indeed the best possible account of relatve speed in a discontinuous physical universe, in which a motion must be composed of a series of atomic elementary motions – *kinemata*,[39] just like the elementary motions that our eye (or brain) re-creates on the basis of the discontinuous still images on the film. Each of these events consists in the fact that an indivisible elementary magnitude leaps from one elementary indivisible position to the next one, in an elementary indivisible lapse of time.

In that picture of the physical universe, such elementary motions provide the unit of time, on the basis of the assumption that the duration of one such event is equal to the duration of any other one. Thus, crossing an object that moves at the same speed and in the opposite direction takes twice as less time than passing over an object at rest. *E.g.,* in the above figure, passing-over takes four elementary events (C_1 being successively in front of each one of the four A's) while crossing takes just two of them: C_1 in front of B_2 and C_1 in front of B_4. It is just as if C_1 had not been in front of B_1 and B_3 (as if these events had just fallen on the empty intervals between two images on the film).

The Stadium, just as Fragment D6 / B1, has a dilemmatic structure. Branch (*a*) of the conclusion states that C_1 takes twice as less time to cross the B's than to pass over the A's, while Branch (*b*) states that the crossing is composed of as many events as the passing-over, since if B_1 has moved from an extremity of the C's to the other, then it must have been successively in front of each of them during its movement. It is important to notice the use of perfect tense (διεξεληλυθέναι, παρεληλυθέναι) and the difference in the preverbs: δι-εξ- in Branch (*a*), παρα- in Branch (*b*): παρα- conveys the notion of moving *along* (implying a continuous movement), whereas δια- means that an interval has been crossed, possibly by a leap; it might be the case that the addition of εξ-, indicating that the action is considered as completely performed, enhance that difference of meaning. So διεξεληλυθέναι fits well the idea that a motion is made of elementary movements.

The paradox of the conclusion lies in the fact that one can count the duration in two different ways. This is expressed by the two syntactically parallel[40] clauses that mention 'an equal time' at the outset of each branch of the argument:

(*a*) ἴσον γὰρ ἑκάτερόν ἐστιν παρ' ἕκαστον
for each ot them[41] *is in front of each <C> for an equal <time>* (*Ph.* 240a12–13)

---

[39] The noun κίνημα occurs twice in *Ph.* VI, in both cases to deny that a motion could be composed of *kinemata.* Its meaning differs from that of κίνησις in that it refers to an achieved or finished movement (expressed by the perfect tense, see the typical occurrence in VI.2, 232a8–9).

[40] In my opinion this parallelism, which is not only syntactical and logical, but also semantical (since both clauses refer to equal times), forbids such conjectures as Alexander's, who suggested transposing 240a15–16 before 240a10–11, or Ross', who simply deletes it.

[41] I take ἑκάτερόν to refer to the B's and the A's respectively, so that ἕκαστον must mean 'each C'.

(*b*) ἴσον χρόνον παρ' ἕκαστον γιγνόμενον τῶν **β** ὅσον περ τῶν **α**
being along <each of> the B's for exactly the same time as along <each of> the A's (*Ph.* 240a15–16).

These sentences appear to be the premisses that explain each part of the paradox, and one can make sense of them only by assuming that time is measured by a number of elementary events.

Even so, the fallacy may seems gross and obvious; but, as Lachelier puts it:[42]

> You will probably say: – There is still some sophistry in that. It is not instantaneously and as a whole that B_1 arrives right in front of A_3, neither does C_2 take C_1's place right there in that same sudden and entire manner. B_1 moves gradually to the right and its anterior part coincides in succession with the different parts of A_3. Therefore, that same anterior part may coincide with all the parts of C_1 and C_2 which are moving towards it at the same speed. – Well, are you sure? Divide B_1 and A_3 on the one hand, C_1 and C_2 on the other, in slices as thin as you like, provided that they be all equal within each of these bodies: you will see the same facts happen with these fractions as before with the wholes. For the slices of C_1 and C_2, taken together, will be twice as many as the slices of A_3: so the anterior slice of B_1 will not be in a position to coincide during the same number of instants with all the slices of A_3 on the one hand, and of C_1 and C_2 on the other. Necessarily, thus, either it will have to skip one out of two of the latter, or it will take, to pass over C_1 and C_2, twice as much time as to pass before A_3 (...). This is what Zeno had undertaken to prove.[43]

Thus you would have to push the division further again and again, and in fact it would never be completed. As long as you try to analyze motions into constituent parts, be they ever so small, you are faced with that paradox. On the face of it, Aristotle's defence against the Stadium, as it stands in the text of *Physics* VI.9, appears to be crude and naive. The reason is that he could just oppose his firm belief in the empirical evidence of relative speeds, but he had not the necessary intellectual tools to account for it: relative speed is an effect of Galilean relativity that rests on the principle of inertia, which Aristotle notoriously ignored. Nevertheless, this is not his last word on that topic (see below § 10, #4).

---

[42] Lachelier is commenting on the transition between stages [2] and [3] of the model above.

[43] Lachelier (1910: 19) reprint.

7. A note on the two anonymous additional arguments: motion vs. change in general

Before leaving the text of Chapter VI.9, it is worth noticing that after the discussion of the famous four arguments, this chapter ends[44] with the mention and resolution of two other difficulties about change. Aristotle does not give any indication about their origin. Since he emphasizes that Zeno had produced *four* arguments about motion, we may suppose that these ones do not come from him, even though the first one has a kind of Eleatic flavour in its style (it is a dilemma and it rests on alternatives of the type "to be or not to be"). Nevertheless, we will meet again with the first one in the last discussion of Zeno's paradoxes in VIII.8; and they raise interesting questions as to Aristotle's scheme in that discussion, so I wish to introduce them shortly here and make a few comments about them.

The first one[45] bears on 'contradictory change', which means other types of change, as distinct from locomotion. Of course, Zeno did not know the broader use of *kinesis* (including qualitative change, growth and diminution, and generation and corruption), which was introduced long after him by Aristotle. His four 'arguments about *kínesis*', as reported by Aristotle, bear on locomotion only. In his answers, Aristotle follows in his footsteps; more generally, the discussions in Books V and VI (from V.3 on, in fact) seem to fit better with locomotion, although Aristotle has carefully expounded and explained his doctrine of the four types of change in chapters 1–2. It appears here and there that what he is saying holds for the three other types of change as well, but he never expresses that in so many words.

Motion (i.e., locomotion) has a particular position with respect to the other three types. *Inter alia*, the standard model of change of Book I, based on matter and form, does not apply so easily to motion: it is difficult to see how the fact of being here rather than there may be, for some objects, assimilated to the full possession of a form.[46] On the other hand, it is easier to apprehend the development of change and its intermediary steps in the case of motion than in the case of the other types, so that the analysis of motion provides a most convenient prop for the analysis of the in-between in general.[47]

Aristotle's focus on motion has another motive, which appears in reference to the second anonymous argument. There the difficulty is about the case of a rotating sphere,

---

[44] Admittedly, the division into 'chapters' is not by Aristotle himself; but in this case the transition between Chapters 9 and 10 clearly marks a step forward ("Having demonstrated these points..."), whereas the transition within Chapter 9 (at *Ph.* 240a18–19) is a smooth one.

[45] Arist. *Ph.* 240a19–29: "Nor in reference to contradictory change shall we find anything impossible – *e.g.* if it is argued that if a thing is changing from *not-white* to *white*, and is in neither condition, then it will be neither *white* nor *not-white*; for the fact that it is not wholly in either condition will not preclude us from calling it *white* or *not-white* (...). So, too, in the case of *being* and *not-being* and all other conditions which stand in a contradictory relation: while the changing thing must of necessity be in one of the two opposites, it is never wholly in either."

[46] This is not altogether impossible, however: for instance one might say that it is a better condition for a hungry animal to be in front of some substantial food; and so on.

[47] Aristotle expounds that point in Chapter IV.11 by means of a threefold analogy between magnitude, motion and time in the course of his inquiry about the definition of time (see § 9).

which moves although it does not change place (at least taken as a whole).[48] This model, as is well known, plays a crucial part in the last book of the *Physics*, since that kind of motion is the only one type of change compatible with the perpetual existence of motion and thus with the eternity of the physical world. And with this model, the notion of a change directed to the possession of a form does not make sense any more: in fact, the structure of the motion itself is the form. Therefore, strictly speaking the notion of 'in-between' will not make any sense either in that case; or rather, that kind of motion contains nothing else than what I propose to pick out as the in-between in the other cases (*i.e.* finite changes in the sublunar world).

These reflections result in an important restriction on my claim that the contents of Books V and VI consist in a reaction to Zeno's arguments. Aristotle has another goal, still remote at that moment but far more important for him: the demonstration of the existence and nature of the First Mover of the heavens.

8. Zeno's dialectic and Aristotle's ontology of motion

The premisses of Zeno's arguments combine reference to well-known experiences of motion with highly abstract requirements as to what it is to *move* and what must be the inner structure of motion; and Zeno assumes that every phenomenon of motion must be describable according to these requirements.

The basic situations of the arguments are simple and familiar: a movable object (a boat, a carriage) is set in motion. A runner tries to catch up with another one and overtake him. A launched arrow keeps going on. One cart passes another coming the other way. But the conclusions are counterintuitive: the boat or carriage will never be able to leave its place. Achilles will never overtake the Tortoise. The flying arrow is at rest as well. A certain lapse of time must be equal to the half of itself.

A distinctive feature of Zeno's way of arguing (in the context of 'Presocratic' philosophers of nature) is that he gives preference to *a priori* reasoning over empirical evidence. His paradoxes rest, first, on the use of formal properties that define the conditions of the possible existence of multiple or extended objects in space: *wholes and parts, continuity, differences, limits,* and the notion of a *total order* (the *between* and the *before-and-after*). This last notion, as we will see, is more specific to motion: a moving object cannot reach a given position if it has not first reached those that are *before* it. However, one must keep in mind that while Zeno *uses* these notions as tools, he does not define them or specify the rules for their use. It is *Aristotle* who undertakes (all through the major part of Books

---

[48] Arist. *Ph.* 240a29–b7: "Again, in the case of circles and spheres and everything that moves within its own dimensions, it is argued that they will be at rest, on the ground that such things, themselves and their parts, will occupy the same position for a period of time, and that therefore they will be at once at rest and in motion." Notice that this argument provides a nice counterpart to that of the Arrow, but it is impossible to guess whether Aristotle deliberately intended that contrast.

V and VI) a systematical review and analysis of all these terms, with the view that a more precise and correct account of these concepts will solve Zeno's arguments, which he discusses at the end of Book VI.

Zeno's arguments imply, second, some important epistemological assumptions:

(1) He assumes that *to account for a physical reality is to analyze it into, and to reconstruct it on the basis of, its elementary parts*; he does not state this rule in so many words, but it plays an important role in his arguments (and Aristotle does not fail to mention it in the discussion). Perhaps he thought that this principle was a natural epistemological consequence of the thesis that physical beings are multiple.[49]

(2) There are some operations that can be iterated indefinitely on certain objects; he had a keen eye to detect them, and he found a striking formula to express that fact: "it is the same thing to say this one time and to repeat it every time" (ὁμοῖον δὴ τοῦτο ἅπαξ τε εἰπεῖν καὶ ἀεὶ λέγειν, Fragment LM Zeno D6 / DK 29 B 1);

(3) He also allows himself to consider what would be the case at the end of such processes, although they cannot in fact be carried on to an end.[50]

In the case of motion, propositions (2) and (3) can be specified as:

(2') Whatever has an extension can be indefinitely divided.

(3') Nonetheless, one may treat the products of such divisions as if they were definite objects.

For him, the problem of motion is to understand how an object can pass from the situation D to the situation F through a series of changes E_1, E_2, E_3, ..., E_n which are in a total order relation.

According to these premisses, proposition (1) may be specified as follows:

(1') 'Motion' may be recognized as a real (and intelligible) fact if and only if one can account in a clear and consistent manner for what happens as the moving object travels along an indefinitely divisible interval.

According to propositions (2') and (3'), he gives a special attention to what happens in the cases in which E_i differs from $E_{(i+1)}$ by the smallest possible difference and when one approaches the limits of a given fact or process. Zeno thinks that that happens (has to happen) in the smallest possible unit of time (an atomic moment or instant).

Thus his arguments assume that the existence of motion implies that of elementary motions, which correspond to the ultimate stage of steadily iterated division. And his arguments claim that although there *must* be such elementary components, one *cannot*

---

[49] A variant of this conjecture (which I do not need to assume) is the widely held historical supposition that Zeno's arguments were levelled at some 'Atomist' natural philosophers, whoever these might have been.

[50] That this style of reasoning was known by Aristotle and that it had been used by some geometers before him to establish that the diagonal of the square is incommensurable, is attested by *Metaph.* IX.4, 1047b6–12 (cfr. also *APr.* I.23, 41a26–28, *GC* I.2 , 316a14–23).

account for them (*i.e.* describe them, define them and more generally think of them) in a consistent way.

The first two arguments work by showing that the assumption of infinitely many infinitely small motions leads to conclusions that would ruin basic commonsensical assumptions about motion; the Arrow focuses on one particular atomic moment and claims that one could not distinguish motion from rest; the Stadium seems to show that there cannot be such elementary atomic changes.

This is so – Zeno says – because these familiar facts conflict with some of the constraints without which motion would be altogether unintelligible. I will call the set of these constraints 'Zeno's ontological picture of motion'. It is ontological insofar as it rests on *a priori* determinations that define what it is, for a motion, to be a motion. But this is not really an ontology, *i.e.* a sufficiently complete and consistent system of claims about the essence and structure of a domain of reality. This is rather a picture, and a sketchy one; and it is a fiction. Zeno did not adhere to it: from the beginning, it was intended to be refuted. As such, it does not need to be complete and stable, provided that it squares sufficiently with the facts and notions that most people ordinarily associate with motion.

Books V and VI – and, in fact, a large part of the *Physics* from Book III to Book VIII – have the same *a priori* character as Zeno's arguments. Aristotle takes up the task of assessing and criticizing that fictitious ontology of motion, a task which amounts in the end to proposing another one that could avoid Zeno's paradoxical conclusions while satisfying any sound and necessary requirement that may be contained in his premisses.

These books ask such questions as: "is motion indefinitely divisible?", "are its parts continuous or contiguous?", "what makes a motion (or a change) *one*?", "is there a first moment in a change?" – which they answer by means of a small number of elementary notions, which he obviously considers as indispensable and sufficiently clear by themselves, such as *same* and *distinct*, *whole, part* and *limit, prior* and *posterior*, and so on. That list resembles that of the objects and questions that "dialecticians try to inquire, starting their investigation from reputable premisses only."[51] Thus the identification of Zeno as the discoverer of dialectic might reflect not only his effective use – highlighted by the story in the *Parmenides* – of refutation as a method of indirect proof, but also his manner of arguing *a priori* on physical questions.

The discussions in the *Physics* – especially in Books V and VI[52] – have that same 'dialectical' character, as if Aristotle had taken over Zeno's specific method for setting and discussing physical questions.

François De Gandt has proposed[53] to describe the specific philosophical style and contents of Books V to VII as 'une topique des mouvements'; by 'topique' he meant

---

[51] Arist. *Metaph.* III.1, 995b19–25.

[52] In fact, that philosophical style is also present in Book IV (in the definition of time) and it is used in Books VII and VIII in the long demonstration of the existence of the First Mover.

[53] De Gandt (1991: 95–97).

'an exploratory mode of inquiry' in the style of the *Topics*. I subscribe to that diagnosis, although I would like to add that these books go further than mere exploration; they establish some important points about the nature of motion.

9. The In-Between

I have already mentioned another aspect of the kinship of these two books with Zeno's arguments: they focus on what happens, or may happen, *in the course* of a motion or of a process of change. One should look more closely at that specific interest, since this is not Aristotle's usual way of considering motion and change. He gives other, more famous and much different accounts of the ontology of *kinesis* in the *Physics*.

In Book I, as an answer to Parmenides' contention that nothing can come to be out of nothing, he expounds his famous model of change involving matter, form and an active mover. According to this model, change is the effective bestowal of a form on a material substratum which is in some way able or prepared to receive it.

That concept of change is central to Aristotle's metaphysics. On the one hand, it is an essential tool for his specialized inquiries in natural philosophy: to account for a natural process is to identify its substratum, the form that it aims at realizing and its first mover. On the other hand it is closely related to the metaphysical doctrines of the four causes and of substances as compounds of matter and form.

In this view, a change (*one* change) is a well-determined unity, from a given starting-point to a definite end[54] (or better the other way around: to a definite end from a given starting-point). The particular processes that are contained within this unity are only conditions for its possibility or 'material' causes. For instance: the specific reactions produced in the patient's organism by the tools or drugs used by the doctor.

Change, thus described, must be understood in one piece; what happens between the starting-point and the endpoint does not matter much.[55] However, these intermediary steps are something real and as such one must be able to account for the specific sort of reality that their existence represents. Aristotle's answer is the definition of *kinesis* given in the opening chapters of Book III: change, seen that way, is 'the actualization of a potentiality *qua* potentiality'. That definition gives an ontological status to the in-between, but it does so only in an abstract, general way; whereas the discussions of Books V and VI, as well as Zeno's arguments, go deeper into the inner structure of the in-be-

---

[54] If – as it often happens in real life – the process is incomplete in some way or other, for instance when it is interrupted before reaching to its end, some intermediate state which should have remained only potential, will become effective and permanent; but this is only accidental.

[55] The doctrine of the two entelechies, sketched in the *De Anima* in order to account for sense-perception and intellection (*de An.* II.5) represents the most radical version of that point and might help understanding Aristotle's fundamental insight: once the substratum is ready, and provided that some specific agent exerts the appropriate action, the actualization of the form can be immediate – even though the preparation of the substratum is a complex process that requires some time.

tween, that is: of which sort of parts is it composed?, and what sort of relations are there between its parts?[56]

Now one may ask: why did Aristotle feel the need to inquire so extensively about these questions? With his general ontological account of change, he seems to have a quick and effective answer to Zeno's paradoxes: considered as a natural event, a motion is one fact, not a series of elementary facts; the divisions or subdivisions of the overall process are only virtual or potential. He has another strong answer to the Division and Achilles:

> Hence Zeno's argument makes a false assumption in asserting that it is impossible for a thing to pass over or severally to come in contact with infinite things in a finite time. For there are two ways in which length and time and generally anything continuous are called infinite: they are called so either in respect of divisibility or in respect of their extremities (Arist. *Ph.* VI.2, 233a21–26).

> The claim that that which holds a lead is never overtaken is false: it is not overtaken while it holds a lead; but it is overtaken nevertheless if it is granted that it traverses the finite distance' (Arist. *Ph.* VI.9, 239b26–29).

> (...) there is no absurdity (...), in supposing the traversing of infinite distances in infinite time, and the element of infinity is present in the time no less than in the distance' (Arist. *Ph.* VIII.8, 263a13–15).

That is: if we admit the analogy between magnitude, motion/change, and time, then the problem disappears. Zeno's fallacy consists in allowing himself to treat time in a different way from magnitude.

These are appropriate answers to Zeno's interrogations, *i.e.* to his premisses. But Aristotle thinks he has to account for the in-between not only in order to silence Zeno, but also in order to achieve substantial knowledge of change. A passage in Book VIII stresses emphatically this point:

> But, although this solution[57] is adequate as a reply to the questioner (πρὸς τὸν ἐρωτῶντα ἱκανῶς ἔχει) (...), nevertheless *as an account of the fact and the truth* it is inadequate (πρὸς δὲ τὸ πρᾶγμα καὶ τὴν ἀληθείαν οὐχ ἱκανῶς).[58]

---

[56] Notice that this is not the end of the story of Aristotle's concern for the in-between. Since the actualization of the potential requires a certain amount of preparation of the subject or substratum, he has to account for the conditions of that preparation, which involves material conditions. He will do that in the first book of *Generation and Corruption* I, taking issue with the upholders of discontinuist theories of matter, mainly Empedocles, but also the Atomists and Plato

[57] The solution expounded in Chapter VI.2.

[58] Arist. *Ph.* VIII.8, 263a15–18.

10. Aristotle's answers: Preliminary moves

Aristotle's full answer to Zeno's arguments rests on some preliminary moves.

(1) As I have had occasion to mention (§ 8), he revisits the notions implemented in Zeno's paradoxes and submits them to a careful scrutiny. Thus, in Chapter V. 3, he defines *to be together* and *apart*, *in contact*, *between*, *in succession*, *contiguous*, and *continuous* by means of the notions of *part and whole, limit* (and also *same / other, contrary*). The crucial outcome of that inquiry, with regard to Zeno's arguments, is that what is continuous cannot be composed of indivisible elements.

(2) Although, according to his holistic model of change, the change as a whole is more real than, and prior to, its parts, he takes some pains (in Chapter V. 4) to define accurately what makes a change *one* change on the basis of local criteria. A given process is one change:

– if it affects the same object or substratum,

– if it occurs within one and the same *pragma* (the range of states or properties determined by one pair of contraries)

– and lasts during one uninterrupted homogeneous stretch of time.

(3) He draws on the analogy that he has developed in Book IV between magnitude, motion and time. Thus he shows that "either all of these are composed of indivisibles and are divisible into indivisibles, or none" (Arist. *Ph.* VI.1, 231b18–20).

(4) Like Zeno, he uses the differences in speed as an argument, but in an opposite manner. In the Stadium, the differences in speed create a paradox because Zeno assumes that there must be elementary components. The Stadium assumes as a premiss that the basic constituents of every motion are minimal events in which a mobile crosses the smallest possible length in the smallest possible interval of time. Then, Zeno shows that it is impossible to conceive the basic constituents of the motion of a given body once it is assumed that this motion has different relative speeds with regard to different external objects. He concludes, or at least he suggests, that our concept of motion must be inconsistent and empty.

Aristotle, on the contrary, assumes that motions really exist and that they have differences in speed. He concludes that no part of a motion, however small, can be said to be indivisible. For the quicker of two motions will cross the same magnitude in less time and the slower will cross less magnitude in the same time. Thus, if one motion takes time T_0 to cross magnitude M_0, a quicker one will take time T_1, shorter than T_0; and during T_1 the slower motion will cross magnitude M_1, lesser than M_0; and in turn the quicker will take a still shorter time T_2 to cross M_1, and so on :

> We can carry on this process for ever, taking the slower after the quicker and the quicker after the slower, and using what has been demonstrated; for the quicker will divide the time and the slower will divide the length. If, then, this alternation always holds good, and at every turn involves a division, it is evident that all time must be continuous. (Arist. *Ph.* VI.2, 233a5–9)

11. The before and after

Seen from an ontological point of view, the analogy between magnitude, motion and time is not merely a formal isomorphism. It has a genetic aspect, so to say; it develops from the most accessible to the most abstract, from magnitude to time, through the mediation of motion.

Notice that Aristotle does not introduce a direct correspondence between magnitude and space, as most modern philosophers would readily do;[59] for him, there is a crucial difference between time and magnitude: the latter can be as given all at once – which is impossible in the case of time. As he says in the *Categories*,[60] the parts of a magnitude have a position while the parts of time have only an order, because they do not 'remain' (οὐχ ὑπομένει, οὔκ ἐστιν ὑπομένον).

Magnitude, time and motion share the essential feature that Aristotle names 'the before-and after' (τὸ πρότερον καὶ ὕστερον), *i.e.* they have a structure of total order: of any two of their elements, one must be *before* and the other *after*, otherwise they would be one and the same. But in the case of magnitude, that relation exists only θέσει – a phrase that one might translate either as 'by position' or 'by convention'; both would be correct in a sense. If a magnitude is taken in itself, its parts are only 'just there'; it is only when you assume a position within or in relation to that magnitude, that one point might be said to be closer or farther than another, before or behind. This is not so with motion. In motion, the before and after is a necessary and strictly determined condition of its existence and of its being just that motion. As Aristotle puts it, "the before and after in motion is what, by being that, it is motion."[61] "What, by being that, it is <such and such>" is an attempt to imitate as closely as possible the Greek phrase ὅ ποτε ὂν κίνησίς ἐστι. This enigmatic phrase[62] occurs only ten times in the Aristotelian corpus, seven of which belong to the context of the definition of time in *Physics* IV. It is more or less parallel to the phrases ἕτερόν τι ὄν / οὐχ ἕτερόν τι ὄν ('by being something else' / 'without being something else'), by which Aristotle characterizes the ontological status of accidents and substances respectively, so that ancient commentators came to consider it as merely equivalent to τὸ ὑποκείμενον, 'the substratum'. But that does not explain why, in a few distinct contexts, Aristotle carefully uses this difficult expression instead of τὸ ὑποκείμενον. The difference is that ὅ ποτε ὂν conveys a notion of indeterminacy, the notion of a *je-ne-sais-quoi* expressed by the adverb ποτε. The idea is that the *hó pote on* (here, the *before and after*) is a condition for the existence of motion that can

---

[59] For instance Kant (1787: 50).

[60] Arist. *Cat.* 6, 5a15–37

[61] Arist. *Ph.* IV.11, 219a19–21.

[62] I am following here the interpretation of this phrase by Brague (1982) and Hussey (1983).

be conceived of without the concrete determinations that make it this or that motion, although it cannot exist independently of motion.

The ontological status of time, defined as 'the number of a motion according to the before-and after', is a consequence of that specific ontological position. This is another story, but we have to keep in mind that the formal structure of the 'in-between' of motion has the same status or, if I may say so, the same ontological location. In Chapter IV.11, Aristotle develops in more detail the correspondance, within the analogy, between the point, the moving thing and the *now*:

> The *now* in one sense is the same, in another it is not the same. In so far as it is in succession, it is different (which is just what its being *now* was supposed to mean), but what, by being it, it is a *now* is the same; for motion, as was said, goes with magnitude, and time, as we maintain, with motion. Similarly, then, there corresponds to the point the body which is carried along, and by which we are aware of the motion and of the before and after involved in it. This – whatever it may be[63] – is the same (whether a point or a stone or something else of the kind), but it is different in its description – as the sophists assume that *Coriscus in the Lyceum* is a different thing from *Coriscus in the market-place*. This, then, is different in so far as it is at one time here and at another there (...). This is what is most knowable; for motion is known because of that which is moved, local motion because of that which is transported. For what is transported is a *this*, whereas the movement is not. Thus the *now* in one sense is always the same, in another it is not the same; for this is true also of what is transported.[64]

See how Aristotle assumes boldly, for the sake of his demonstration, what he considers generally as the matrix of sophisms, *i.e.* the identification of an object with one of its accidents. In his concrete deambulation, Coriscus goes from the Lyceum to the marketplace for his own business and all along he is the very same Coriscus; but try to lessen his substantial identity down to the point at which it is exactly balanced by the difference between his two different positions, and that ambiguous mode of existence is exactly the ontological position of the *now*. We are not concerned with the ontology of time here; but since time is defined as the number of motion, my claim is that Aristotle's propositions about the inner structure of motion refer to exactly the same ontological location, that is, they describe an *hó pote ón*: a layer of reality which is known just insofar as it expresses the conditions for the existence of real natural motions.[65]

That ontological location could and should perhaps be simply called potential, since it corresponds to an incompletely determined mode of being; and in fact it squares with

---

[63] This is ὅ ποτε ὂν again; a fuller translation would be: "whatever it may be that makes it a moving object."

[64] Arist. *Ph.* IV.11, 219b12–22, 29–33.

[65] Apart from the study of time and motion in the *Physics*, the notion of *hó pote ón* is used by Aristotle in two other contexts, in order to analyze fundamental facts about basic structures of nature: the constitution of blood in the *Parts of Animals* (*PA* II.2, 647a15, b24) and the reciprocal transformations of the simple elementary bodies in *Generation and Corruption* (*GA* I.3, 319b3).

the canonical definition 'the entelechy of the potential *qua* potential'; however, it must be stressed that this is not the same sort of potentiality as the potentialities of natural beings.

The discussion of that point of general ontology would lead us too far; in the last lines of this paper I will limit myself to exploring the notion that the *before and after* is an essential ontological feature of motion (and change) *qua* motion or change.

In Chapter VI.5, Aristotle claims that there is no first moment of change, although there may be a last one:

> The primary time that has reference to the end of the change is something really existent; for a change may be completed, and there is such a thing as an end of change, which we have in fact shown to be indivisible because it is a limit. But in reference to the beginning there is simply no such thing; for there is no such thing as a beginning of change, nor any primary time at which it was changing.[66]

Many commentators have expressed perplexity about that claim, starting with Theophrastus: "How did <Aristotle> take the limit to be indivisible, but the beginning divisible to infinity?"[67] Theophrastus seems to have thought that since this analysis of the structure of change rests on mathematical arguments it must be reversible, and thus one might as well claim that the first moment is indivisible and the last one indefinitely divisible. Here is Aristotle's argument, which looks much like the Dichotomy:

> For suppose that AD is such a primary time. Then it cannot be indivisible; for, if it were, the nows would be consecutive. Again, if the changing thing is at rest in the whole time CA (for we may suppose that it is at rest), it is at rest in A also; so if AC is without parts, it will simultaneously be at rest and have changed; for it is at rest in A and has changed in D. Since then AD is not without parts, it must be divisible, and the changing thing must have changed in every part of it (for if it has changed in neither of the two parts into which AD is divided, it has not changed in the whole either; if, on the other hand, it is changing in both parts, it is likewise changing in the whole; and if, again, it has changed in one of the two parts, the whole is not the primary time in which it has changed: it must therefore have changed in every part). It is evident, then, that there is no primary time in which it has changed; for the divisions are infinite.[68]

How are we to understand that strange pronouncement? What distinguishes motion, as a physical fact, from the abstract, geometrical structure of magnitude, is its inscription in the *before and after.* That creates an asymmetry between the starting-point and the end. Change has a direction, and it is directed towards its end rather than set off by some

---

[66] Arist. *Ph.* VI.5, 236a10–15.

[67] After Simp. *in Ph.* 986.7–10.

[68] Arist. *Ph.* VI.5, 236a15–27.

event at its beginning; this is an implication of Aristotle's teleology. In a sense, he agrees with Zeno on the fact that the motion does not 'start'; but that does not mean that motion cannot exist, but only that the beginning of the motion *qua* motion is inassignable and that the first instants of the process are not significant in themselves. Every moment of the process develops under the influence of the ultimate term; that goes along with the fact that a change is named after its endpoint or goal.

And why does Aristotle claim that there is a last instant of change? In fact, it is not so much a last instant of change as a first instant at which the object *has changed*. In the last book of the *Physics*, in the course of the demonstration of the existence of the First Mover, Aristotle refers back to the Dichotomy and the Achilles and to his own answers in Book VI:

> Now in our first discussions of motion we put forward a solution to this difficulty turning on the fact that the period of time contains within itself an infinite number of units: there is no absurdity, we said, in supposing the traversing of infinite distances in infinite time, and the element of infinity is present in the time no less than in the distance. But, although this solution is adequate as a reply to the questioner (the question asked being whether it is impossible in a finite time to traverse or count an infinite number of units), nevertheless as an account of the fact and the truth (πρὸς τὸ πρᾶγμα) it is inadequate. For suppose the distance to be left out of account and the question asked to be no longer whether it is possible in a finite time to traverse an infinite number of distances, and suppose that the inquiry is made to refer to the time itself (for the time contains an infinite number of divisions): then this solution will no longer be adequate, and we must apply the truth that we enunciated in our recent discussion. In the act of dividing the continuous distance into two halves one point is treated as two, since we make it a beginning and an end (...). In the case of counting the halves, it is clear that this result follows; for then one point must be reckoned as two: it will be the end of the one half and the beginning of the other, if he counts not the one continuous whole but the two halves.[69]

That former answer was only a *lusis*, Aristotle says, *i.e.* a defence by detecting the fallacy in the opponent's premisses. Now, he says, we need an answer with a positive content. The reader will perhaps be slightly disappointed by what Aristotle brings here as a positive counterpart, for that seems to be nothing more than the distinction between potentiality and actuality that he has established at the beginning of Book VI in the case of spatial magnitudes. But the refutation goes on:

> It is also plain that unless we hold that the point of time that divides earlier from later always belongs only to the later so far as the thing is concerned, we shall be involved in the consequence that the same thing at the same moment is and is not, and that a thing is not at the moment when it has become. It is true that the point is common to both times, the earlier as

[69] Arist. *Ph.* VIII.8, 263a11–25, 263a30–b3.

> well as the later, and that, while numerically one and the same, it is not so in definition, being the end of the one and the beginning of the other; but so far as the real thing is concerned it always belongs to the later affection.[70]

Let A, C, B, be successive instants in a change, and D the object that changes. Let D be *not-white* at A and *white* at B, and let C be the point at which it has changed from *not-white* to *white*. If we reckon C as two, then we would have to say that at C, the thing D is both *white* and *not-white*, which would violate the law of non-contradiction. This is the first anonymous argument of Chapter VI.9 (cf. § 7 and fn. 46). There, Aristotle had a rather hazy answer: although the thing that changes must be (at each moment) in one of the two opposites, "it is never wholly in either." Here, a decision is made: at C the object is definitely *white*. By this decision, Aristotle declares and defines the ontological reality of motion.[71]

---

[70] *Ibidem*, 263b9–15.

[71] Kant too, facing a similar challenge (*i.e.* Hume's arguments against the idea of a necessary connection in what we consider as causal sequences), resorted to the existence of a real order between the stages of natural processes. See *Critique of Pure Reason*, Transcendantal Analytic III, proof of the second Analogy (p. 236–238 of the second edition).

BIBLIOGRAPHY

De Gandt, F., 1991, "Sur la détermination du mouvement selon Aristote et les conditions d'une mathématisation", in: F. De Gandt, P. Souffrin (eds.), *La Physique d'Aristote et les conditions d'une science de la nature,* Paris, pp. 85–105.

Diels, H., Kranz, W., 1934–1937 *Die Fragmente der Vorsokratiker*, 3 volumes, Berlin.

Kant, E., 1787, *Kritik der reinen Vernunft*, 2nd edition, Riga.

Lachelier, J., 1910, "Note sur les deux derniers arguments de Zénon d'Élée contre l'existence du mouvement", *Revue de Métaphysique et de Morale* 5–6 (reprinted in: *Corpus* 24–25 (1994), pp. 11–21.

Laks, A., Most, G. W., 2016, *Early Greek Philosophy*, vol. V: *Western Greek Thinkers*, Cambridge.

Sorabji, R., 1976, "Aristotle On the Instant of Change", *Proceedings of the Aristotelian Society*, suppl. vol. 50, pp. 69–89 (reprinted in: J. Barnes, M. Schofield, R. Sorabji, *Articles On Aristotle*, vol. III: *Metaphysics*, London 1979).

MICHEL CRUBELLIER
/ University of Lille, France /
michel.crubellier@univ-lille.fr

An Ontology for the In-Between of Motion: Aristotle's Reaction to Zeno's Arguments

This paper proposes an interpretation of Books V and VI of Aristotle's *Physics* as being (at least partly) a reaction to Zeno's four "arguments against motion" that Aristotle expounds and discusses in *Phys*. VI 9. On the basis of a detailed textual analysis of that chapter, I show that Zeno's arguments rest on a frame of *a priori* notions such as part and whole, in contact, between, limit, etc., which Aristotle takes over in order to account for the inner structure (here called "the In-Between") common to all facts of motion and change. That frame allows him to develop a specific ontology for that inner structure – although it exists only potentially according to the Aristotelian orthodoxy – because he needs such an ontology in order to vindicate the reality of motion and change.

KEYWORDS

Aristotle, Aristotle's *Physics*, change. continuous, dialectic, infinite, motion, ontology, time, Zeno of Elea