realism cannot fulfill. With such a thesis a physical investigation is not concerned; each particular science is bound to resolve those questions only which arise from the principles of that science. Induction from experience, Aristotle says, is sufficient evidence for the hypothesis of motion; to refuse the evidence of sensation in this case is to doubt the very existence of nature and of all sciences, since all make use of this hypothesis of physics. Even if true reality were infinite and immovable, as some say, still apparent motion must be admitted; and, though this be false opinion or imagination, motion of some kind there must be all the same, since imagination and opinion are themselves motion of a kind.

The four arguments of Zeno, however, Aristotle feels it incumbent upon him to answer, since they seem to be direct proofs of the impossibility of motion. These arguments in the order which Aristotle gives as original are 1) the dichotomy according to which a moving object must traverse half its course before reaching the goal and half of that before reaching the middle point and so on infinitely, 2) the Achilles which proves that, if of two objects in motion the slower has started to move first, it can never be overtaken by the swifter because the latter must first reach the point the former has left and the slower will always have moved on from that point, 3) the arrow in motion which cannot move because at

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16 Physical 184 B 25-185 A 5.
18 Physical 185 A 13-14.
19 Nature is the principle of motion and rest in those things which naturally exist (Physical 192 B 13-23).
21 Aristotle here chooses Melissus (cf. Physical 185 A 32) as the representative of those who deny the possibility of motion, although elsewhere he names Parmenides and Melissus together (Physical 184 B 16). The particular addition of Melissus, the infinitude of Reality, has no bearing on the question.
any time in its course it is in an indivisible instant in which there can be no movement, and 4) the stadium which illustrates the argument that a given time is equal to twice itself by showing that two equal series of points passing each other with equal velocities but in opposite directions and passing a third equal series which is at rest must traverse in the same time twice the number of points in each other as in the series at rest. These arguments Aristotle assumes to be directed against the possibility of motion as such, and his resolution of the paradoxes takes the assumptions as Zeno’s own and tries to show that motion is possible because these assumptions are unwarranted. In the Dichotomy Aristotle first answers that both time and space are equivalent in that both are infinitely divisible potentially so that the time in which a given space is traversed is infinite in the same sense in which that space contains an infinite number of points. This explanation is supposed to be a sufficient answer to the Achilles also. The Arrow he refutes by denying that time is composed of discrete instants, and in the Stadium he explains the paralogism as due to the false assumption that a body of a given size and speed will pass a body at rest and in motion in equal times, for Zeno assumes that the constituent elements of the moving bodies will be parallel for the same length of time as they are parallel to the points they pass in the body at rest. The Arrow as Aristotle presents the argument and answers it shows that Zeno was aware that the divisibility of time is parallel and equivalent to that of space, although Aristotle still insists that the first two arguments overlook this fact and that consequently his first solution is sufficient for these paradoxes as stated, he admits that it is not a final answer, since the diff-

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67 Although he does not directly say so in the Physics, his passing references to the arguments show that this was his interpretation. Cf. Ana. Pr. 65 B 18-19, Topics 160 B 8-9, Soph. Elech. 172 A 8-9, 179 B 20-21.  
68 Physics 233 A 21-B 15.  
69 Physics 239 B 11-29.  
70 Physics 239 B 30-33.  
72 See also V. Brochard, Études de Philosophie ancienne et de Philosophie moderne, pages 6 and 9.
cultures raised in connection with space also apply to time. The true solution, he says, is that a line contains an infinite number of points as a given time contains an infinite number of instants only potentially, that if a continuum is divided by the actualization of any of these points it ceases to be a continuum, and that a continuous motion traverses an infinite number of points or instants only accidentally, for it is only accidentally that a line contains an infinite number of sections, its essence being continuity. But this answers Zeno only by admitting his contention. The statement of Plato supports the interpretation which the paradoxes themselves suggest, namely that Zeno was not trying to prove that motion is impossible because continuity consists of multiple parts but that, if continuity consists of parts, if it can be analyzed into discrete quantities or synthesized from them, motion is impossible. These four arguments form a dilemma presented to the pluralists which corresponds to the mathematical dilemma quoted by Simplicius and has the same purpose as the argument concerning space. All the extant arguments of Zeno are directed to the same end, by demonstrating the inconsistencies of a materialistic pluralism to prove that continuity is uncomposite and so that Being is unique. In so far then as Aristotle believes that the continuous does not consist of separate moments he mistakes his opponent, for he is arguing against Zeno’s adversaries rather than against Zeno. There is still another argument of

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63 *Physica* 26 A 4-B 9.
64 *Parmenides* 126 D 2-6.
65 Simplicius, *Phys.* 141, 2-8; cf. *ibid.* 139, 7-8. See also *Metaphysics* 1001 B 6-10, where Aristotle misunderstands Zeno’s argument (cf. page 40, note 156 supra) against the construction of continuous lines, etc., from indivisible, that is infinitely small, units (cf. Simplicius, *Phys.* 139, 9-19).
66 *Physica* 209 A 23-26; see page 145 supra.
68 In *Metaphysics* 1069 A 12-14 Aristotle says that from his explanation of the successive and the continuous it follows that a point and a unit are not the same thing. Ross thinks this is an attack on Zeno because Zeno is said to have called the point τό ἀτομον (Simplicius, *Phys.* 99, 11); this, however, he did only to deny the identification (Eudemus *apud* Simplicius, *Phys.* 97, 12-16).
Zeno's relating to continuity which Aristotle opposes; Zeno, he says, falsely concludes that any part of a measure of millet must make a sound in falling if the whole measure makes a sound.\(^8\) For Aristotle force is not continuous,\(^7\) and the air set in motion by the bushel of grain, since it is moved by the bushel as a whole, may not be affected in any degree by a part of the bushel, for the force of the whole cannot be divided and attributed to all the parts since in the whole the parts exist only potentially. The conclusion of Zeno, as represented in this passage, is that any part of a grain of millet however small must make a sound in falling. In the quotation given by Simplicius Zeno forces this conclusion on Protagoras by getting him to admit that the sound must vary directly with the size of the body making the sound and that any part of a grain bears some proportion to the size of the whole heap. It is unlikely that Zeno himself believed that any part of a grain would make a sound; and it is certain that he did not accept the premise, for that a body can be constructed of least parts whether finite or infinitely small is precisely the thesis against which all his arguments were directed. This paradox, then, was a dilemma of the same nature as the paradoxes concerning motion; his adversaries had either to admit the apparent absurdity of forces and sounds corresponding to infinitely minute bodies or abandon their theory of the composition of con-

\(^*\) Philosophy 250 A 19-25. Simplicius (Phys., 1108, 19-28) quotes the argument as a dialogue between Zeno and Protagoras, and for that reason Burnet (E.G. P., p. 312, n. 4) thinks it unsafe to attribute the argument to Zeno himself. Even if the quotation of Simplicius is from a later writing, however, it is possible that the argument itself was original with Zeno.

\(^*\) Physics 250 A 16-19; cf. Carteen, _La Notion de Force dans le Système d'Aristote_, pp. 21-22.
continuity. Although Zeno would certainly have opposed Aristotle's own solution of the difficulty, Aristotle is clearly wrong in supposing that the assumption of all these arguments, the composite nature of the continuous, was subscribed to by Zeno himself, whose objection to Aristotle's solution must have been precisely that, while it excludes a synthesis of continuity, it admits an analysis into "potential parts" which in fact destroys the unity of the Real.

The investigation of the nature of continuity and the relationship of Zeno's arguments thereto lies outside of this study; but there are certain special criticisms made by Aristotle which must be examined. The first objection to the Dichotomy and the Achilles, that the two senses of infinity are confused and that, if the time as well as the distance be thought of as equally infinite in potency of division, Zeno's difficulty is resolved, not only is no final answer (as Aristotle later admits) but is not even a valid dialectical argument. The course of the two arguments depends upon the axiom that any two continua, whether spatial or temporal, if they consist of an infinite number of points or moments, are equally inexhaustible; to say that the spatial points and temporal moments are simultaneously exhausted does not meet the difficulty at all. It is just the assumption that any finite space and any finite time contain an infinite number of elements that necessitates the conclusion. The Stadium wins only Aristotle's disdain for assuming that a body with a given velocity takes as long to pass an object at rest as it does to pass one moving with equal velocity in an opposite direction. But here again the argument is misinterpreted because the assumption against which Zeno was arguing

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11 A heap of grain is not a continuum, and Zeno would not have confused it with one; but that lends sharpness to his argument, for to his way of thinking his adversaries represented continua as being in fact discontinuous aggregations. If they had admitted the existence of an infinite range of sound below the level of audibility as Archytas later did (Archytas, fragment 1, page 332, 3-5, Diels), this argument could not have served Zeno's purpose. Protagoras, however, could not admit the existence of "inaudible sounds."


is overlooked. The Arrow had proved that a continuum cannot consist of points because there can be no motion in the indivisible point and moment in which the moving object finds itself at any time. If, however, motion from point to point be assumed, the Stadium argues that, although there is a one to one correspondence between the elements of any section of time and any extent of space, in one indivisible moment a single point must occupy two positions, that is must pass two points. But, since point corresponds directly to moment, two such moments are required for such a motion. Consequently, one moment is equal to two.\(^4\) This argument develops that of the Arrow just as the Achilles develops the Dichotomy; and, as the answer to the two latter is one and the same, so Aristotle’s remark concerning the Arrow is the only one valid for the Stadium, namely that the assumption that time consists of instants is false. There remains only the question whether Aristotle’s conception of the continuous solves the difficulties.

\(^4\) The paradox can be stated in various ways. Brochard says (op. cit., pp. 8-9) "in the indivisible instant two positions were occupied by the moving bodies. But in that case the instant is no longer indivisible. In other words it is impossible to conceive of an indivisible instant such that one cannot . . . find . . . a movement which divides it . . . . To say that the instant is divided into two equal parts is to say, by hypothesis, that it is double itself." The argument may be so stated as to draw the same conclusion with regard to spatial points. The purpose of the paradox may be brought out perhaps more clearly by stating it in a different fashion but with the conventional diagram:

\[ \begin{array}{cccc}
A^1 & A^2 & A^3 & A^4 \\
B^1 & B^2 & B^3 & B^4 \\
C^1 & C^2 & C^3 & C^4 \\
\end{array} \]

If the two bodies B and C move with equal speed in opposite directions, when B\(^1\) and C\(^1\) are in line they will have moved one point in one instant (for movement is from point to point and moment to moment); but they will then occupy a point intermediate between A\(^3\) and A\(^4\). The points of A, as well as of B and C, are contiguous, as are the moments of motion from A\(^3\) to A\(^4\). Then between any two contiguous points and moments, if space and time consist of indivisible elements, motion requires that there be another point and moment. If now in a single moment B\(^1\) and C\(^1\) be brought into a line with A\(^3\), the point intermediate between A\(^3\) and A\(^4\) must have been passed by both B\(^1\) and C\(^1\), so that the movement from A\(^3\) to A\(^4\), if A\(^3\) and A\(^4\) represent contiguous points, requires two moments for passage from point to point; and, if A\(^3\) and A\(^4\) represent contiguous moments, two points were passed in one moment.
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raised by Zeno’s arguments. Unwittingly, as has been shown, he is at one with the Eleatic philosopher in denying that continuity can be constructed of elements whether finite or infinite; but he still insists that the continuous line contains potentially an infinite number of sections and that the moving object traverses an infinite number of elements in time and space, although it does so not absolutely but per accidens. Such a distinction was unknown to Zeno; but, had he heard of it, he would probably have rejected the explanation on the ground that Reality loses its uniqueness and ceases to be a whole if divisible even in thought. Aristotle’s own doctrine of the priority of actuality might have been turned against him to show that if he asserted the potential existence of an infinite number of points in the line he must concede the actual existence of an infinite number of elements in continuity. Whether or not the Aristotelian explanation of continuity is sound and sufficient, the analysis of Zeno’s arguments mistakes their purpose, and the specific criticism of them lacks depth and appropriateness.

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*Physics* 263 A 27-B 9.


* Cf. *Metaphysics* 1049 B 4-1051 A 2. In 1051 A 22-53 the potentially existing mathematical relations are said to be discovered only by their actualization. If this actualization be the result of the prior activity of thought, the contradiction is still not resolved; the continuous as consisting of an infinite number of elements is as impossible in intellectu as extra intellectum.

* So Koyré (*op. cit.*, pp. 618-619) argues for the actual prior existence of the infinite.

* Following the examination of Zeno’s paradoxes, Aristotle refutes an argument which on the basis of the law of contradiction denies the possibility of change (*Physic* 240 A 19-29). That argument was probably Megarian (see page 89, note 578 *supra*). Immediately thereafter (*Physic* 240 A 29-B ?) Aristotle mentions an argument according to which circles and spheres are in motion and rest at the same time since the parts and the whole of such bodies when in motion are for a time in the same place. Against this Aristotle contends that the parts are continuously changing their positions and that the circumference of the whole is likewise constantly changing, the circumferences drawn from any two points being only accidentally the same. The thesis here combated is given among the arguments on motion by Sextus Empiricus; twice he says that it was used to overthrow the paradox of Diodorus Cronus, for those who advanced it thought thereby to prove against him that an object can be in motion...