between them; whereas points always have a line [or points] between them, and moments always have a time [or moments] between them. Were a length or a time made up of such points or moments, it would be divisible into [successive] indivisibles; but we have found it impossible for anything continuous to be divided into any parts without parts. Nor can such points or moments even have anything of some other kind [19] between them: it would be either indivisible or else divisible, whether into indivisible parts or into parts infinitely divisible; and on the last alternative, it would be continuous [and therefore a line or a time, respectively]. Evidently, anything continuous is divisible into parts infinitely divisible; if a continuum were divisible into indivisible parts, one indivisible part would touch another (since ends of things continuous with each other are one and touch each other).

By the same argument, magnitude, time, and movement would all be composed of indivisibles and would be divisible into them; or else none of them is. This will become clear in the course of the following analysis. If a magnitude consisted of indivisibles, then a motion along that magnitude would consist of an equal number of indivisible motions. Suppose [a line] *ABC* were composed of the indivisible parts *A, B,* and *C;* then [a moving point] *X* would move along *ABC* with a motion *DEF* having the corresponding parts *D, E, F,* each indivisible. If, then, a motion going on [23c] must have a definite subject and a moving subject requires an ongoing motion, a motion which is occurring would also consist of indivisible parts. Accordingly, *X* would have been moving over the distance *A* with motion *D;* over *B,* with motion *E;* and over *C* with motion *F.* But anything moving from somewhere to somewhere cannot, while in motion, *be moving* and at the same time *have completed its motion* to its destination. In walking to Thebes, for example, it is impossible to be walking to Thebes and at the same time to have concluded the walk to Thebes. So *X* would have been moving along the partless part *A* with a motion *D* then going on. Consequently, if *X* was not completing its passage through *A* until after it had been passing through *A,* part *A* must be divisible; for *X,* while passing through *A,* neither was at rest nor had completed its passage but was in a stage between these extremes. But if *X* would have been passing through *A* and would at the same time have completed its passage through *A,* then it would be possible for a walk, while proceeding to its destination, to have been completed; that is, it would be possible for anything to *have* moved whither it *is* moving! On the other hand, if *X* moves over the whole of *ABC* with a motion *DEF* but could not be in motion at all but only have completed a motion over a partless part *A,* then the motion would not consist of motions but of [discrete atomic] movements [109f]. That is, *X* would have completed a movement without being in motion; for *X* would have passed through *A,* through which it would never be passing. So it would be possible to have completed a walk without ever walking, for the walk would have bridged a distance without anything ever walking over it. Since, then, anything must be either at rest or in motion, *X* would be at rest at each of the parts *A, B,* and *C,* and therefore it would be possible for anything to be both continuously at rest and at the same time in motion; for *X* was supposedly moving over the whole of *ABC* and was supposedly resting at one or another of its parts and would consequently rest at the whole. Besides, if the indivisible parts of *DEF* were motions, it would be possible for anything, while its motion is going on, not to be in motion but to be at rest; and if they were not motions, it would be possible for movements to consist of parts which are not movements.

Thus, too, if a length and a motion were indivisible, time would likewise have to be indivisible; and so time would have to be composed of indivisible moments. For if all motion is divisible and anything moving at a uniform rate covers a shorter distance in a shorter time, then time will also be divisible. And if the time is divisible in which *X* is carried over the distance *A,* then *A* will also be divisible.†

2. Time and Spatial Magnitudes as Continuous

Since every magnitude, being continuous, is therefore divisible into magnitudes (for we have proved it impossible for anything continuous to be composed of indivisible parts), it follows necessarily that, of two moving bodies, the faster travels (1) a greater distance in an equal time, (2) an equal distance in a shorter time, and (3) a greater distance in a shorter time. Indeed, some define the "faster" in these very terms. Now, let *A* be faster than *B,* in the sense of changing sooner than the latter. Then (1) if *A* has changed from *C* to *D* during a time *fg,* the slower body *B* will in that time have failed to reach *D.* Thus, the faster body spans a greater stretch in an equal time. But (3) even in a shorter time the faster body crosses a greater expanse. (Fig. 1.) Let *B* as the slower body arrive at *E* when *A* has come to *D;*

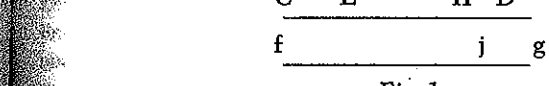

Fig. 1

† vii.7.207b21-25; iv.11.219a10-25, b15, 16, 12.220b24, 25; *Metaphysics* v.13.1020a 26-32.

232b then, since *A* has taken the whole of time *fg* to get to *D*, *A* has in a shorter time *fj* passed beyond *E* to *H*. Consequently, since the distance *CH* bridged by *A* is greater than *CE*, and the time *fj* is shorter than the whole time *fg*, the faster body passes over a greater stretch in a shorter time. It is also evident from these proofs that (2) the faster body covers an equal distance in a shorter time. (Fig. 2.) Relatively to a

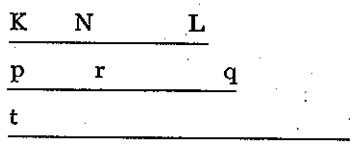

Fig. 2

slower body, a faster body goes a longer way in a shorter time. And taken by itself, a faster body travels a greater distance *KL* during a
10 time *pq* than it does a shorter distance *KN* during a shorter time *pr*. Hence, if the time *pq* is shorter than the time *t* which the slower body requires in passing over *KL*, the time *pr* is shorter still; since *pr* is less than *pq*, and anything less than what is less than a third thing is itself less than the same third thing. So the faster body moves across an equal distance in a shorter time. Again, if every moving body must move in an equal or shorter or longer time, and if a body requiring a longer time is slower whereas a body taking an equal time is equally fast and a faster body is neither equally fast nor slower, then the motion of the faster body occurs in a time neither equal nor longer but shorter. Hence, the faster body necessarily travels over an equal as well as a greater spatial magnitude in a shorter time.

20 [Now, time is continuous.] Not only does every movement take place during a time, and not only may there be movement in any period of time; but every moving thing can move relatively quickly or slowly,* and therefore there may be quicker or slower movement in any period of time. Moreover, by "continuous" I mean "divisible into parts that are infinitely divisible"; and in this sense [85] of the term, time must be "continuous." Let us follow up our demonstration that the faster body covers an equal distance in a shorter time. (Fig. 3.) Suppose that *B*

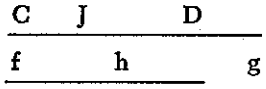

Fig. 3

* Thomas Aquinas: ". . . frequenter talibus propositionibus utitur in hoc sexto libro, quae sunt verae secundum considerationem communem motus, non autem secundum applicationem ad determinata mobilia."

(being slower than *A*) has finished moving across the stretch *CD* during time *fg*, with the consequence that *A* (being faster than *B*) will 30
have moved across the stretch *CD* during a shorter time *fh*; then since *A* has in the shorter time *fh* covered the whole of *CD*, the slower body *B* will in the same shorter time *fh* have covered a lesser distance *CJ*. But 233a
if *B* has covered *CJ* during time *fh*, then the faster body *A* will have covered the same lesser distance *CJ* in a still shorter time; so that the time *fh* will in turn be divided. In that part [75] of the time *fh*, then, the slower body *B* will in turn have travelled over a part of *CJ*; and this part of *CJ* will be to *CJ* as the part of time *fh* is to *fh*. As we continue this procedure of substituting [65f], at each step of the demonstration, the slower for the faster body or the faster for the slower, we continue to get the same result: the faster divides the time; the slower divides the distance. Since the alternating procedure always results in this alternating division, it is evident that every time will be 10
continuous; and it is clear at the same time that every spatial magnitude is continuous, for the time and the magnitude are subject to divisions which are in the same ratio and which are equal in number.

In the customary nonacademic arguments, too, it becomes evident that, since time is continuous, spatial magnitude must also be continuous. A moving body goes a half of a distance in a half of a time or, at any rate [105], a shorter distance in a shorter time. The reason for this is because a time and a spatial magnitude are subject to the same divisions. If either is infinite, so is the other. And each is infinite in the same way as the other: if time is infinite as to its extreme ends, so is spatial magnitude; if infinite in divisibility, so is spatial magnitude; 20
and similarly, if infinite in both ways.

This is the reason why the assumption is false on which Zeno bases his [opposing] argument.† He takes it to be impossible to span infinites or to come into contact with them severally during a finite time. Now, a length or a time or anything continuous is called "infinite" in two distinct senses, according as it is infinite in divisibility or is infinite as to its extreme ends. Although it is impossible during a finite time to touch things infinite in quantity [that is, infinite in the latter sense], this is quite possible in the case of things infinitely divisible; for the time itself is also infinite in this sense. So it is in the time which is infinite, not finite, that the infinite magnitude is spanned; and the in- 30
finite parts are touched in the parts of the time which are infinite, not finite. An infinite stretch cannot be traversed in a finite time; neither can a finite stretch, in an infinite time. But if the time is infinite, so is the spatial magnitude; and if the spatial magnitude, so is the time. Let

† vi.9.239b11-13.

233b BA‡ be a finite distance, and c, an infinite time; and let a finite part, cd, of the time be taken. Then a moving body X will in time cd cover a segment BE of the distance [BA]. The segment BE may indifferently "measure" BA as an exact multiple of it or another multiple less or greater [than BA]. If X always covers a distance equal to BE in an equal time and if the number of the distances covered portions out the whole, then the whole time in which X covers BA is finite; for the time will be divided into as many parts as is the distance. So if X does not cover the whole distance in an infinite time, but if X can even during a finite time cover the segment BE which "measures" the whole, then X will cover an equal distance in an equal time; and consequently the time [of the passage across BA] is finite. It is also evident that X does not cross BE in an infinite time if we take the time [of the passage across BA] as limited at one end [that is, at the beginning]; for if X covers a segment in a shorter time than it does the whole, then the shorter time, being limited at one end, must be [altogether] finite. We may in the same way disprove the supposition that the length may be infinite and the time finite. It is evident, then, that no line or surface or anything continuous can be indivisible [41].

This conclusion follows not only for the reasons stated but also because otherwise it would follow that the indivisible [41] would be divided. Since a body may move relatively quickly or slowly in any period of time and the faster moves across a greater stretch in an equal time, it is possible for the faster to span a stretch twice or one and a half times as large as that spanned by the slower body; for the rates of the motions may be so related, respectively. Suppose, then, that the faster body has travelled one and a half times as far as has the slower during the same time; and suppose that the greater distance has been divided into the three indivisible [41] parts AB, BC, CD, and the lesser distance into the two indivisible parts EF, FG. Then the time will also be divided into three indivisibles, since an equal distance is covered in an equal time. Hence, let the time be divided into the parts jk, kl, lm. But since the slower body has during the same time travelled over EFG, the same time will also be divided into two parts. Accordingly, the indivisible [middle part] will be divisible! Also, the slower body will cover a partless segment during a time greater than the indivisible time [in which the faster body covers a partless segment of its path]!

It is evident, then, that no continuum is without parts.

‡ The text has "*AB*," but designates a segment of it "*BE*."

3. Moments, Movement, and Rest in Time

The "now" also must be indivisible: that is, the "now" in the essential and primary sense in which the "now" is inherent [82b] in all time; not, indeed, the "now" in [39a] the derived sense [16] of a period of time. For the [momentary] "now" is somehow [4] an extreme end [18a] of the past [116a], since it has nothing of the future, and somehow an 234a extreme end of the future, since it has nothing of the past; it is [functionally], we maintain, a limit of both. Accordingly, if the [momentary] "now" can be shown to be essentially of the sort described and thus to be an identity, then it will also become evident that the "now" in this sense is indivisible.

The "now" which functions as the extreme end of both past and future must, indeed, be identical. If the "now" were *different* limits [of both past and future], the one limit could not succeed the other; for the continuous cannot be made up of partless components. If the "now" were *separate* limits [of both past and future], there would be a time between them, since every continuum must have something of the same kind between its limits; and the time between them would be divisible, 10 since we have proved that all time is divisible. Accordingly, the "now" would be divisible. But if so, a dividing-point within it would mark off within it a time extending to the dividing-point and a time still to come; so that the [whole moment as] future would contain some [4] past aspect, and the [whole moment as] past would contain some future aspect. Then, too, the "now" would not be such in its essential sense of a moment; it would be a "now" in the derived sense of a period of time, for the function of dividing [occurring within it] would not belong to it essentially. In addition, part of the "now" would be past and part future, and it would not be always the same part which would be the past or the same part which would be the future; and, since the time could be divided at numerous points, the "nows" would never be the same. Hence, all these consequences being impossible, it must be the same "now" which limits either [40] the past or the future; and, 20 therefore, the "now" must obviously also be indivisible, since it would otherwise be involved in the same consequences which we have traced. Thus, it is clear that time includes something indivisible which we call a [momentary] "now."

Obviously, too, nothing can be moving during a moment; if it could, its motion could also be quicker or slower. Let a faster body travel a distance AB in a momentary "now," n; then a slower body would in the same moment travel a lesser distance AC. But since the slower body would have travelled the distance AC in the whole of the moment, the faster body in travelling the same distance [AC] would require a shorter 30

time; so that the moment would be divided. But a moment has been proved to be indivisible. Accordingly, nothing can be moving within a moment. But neither can anything be at rest during a moment; for only that is properly said to be "at rest" which naturally can move but is not moving when or where or as it naturally can. Hence, since nothing can naturally move within a moment, neither can it within a moment be at rest. Again, if the same moment functions as the limit of a past
234b and of a future, and if a thing can be moving during the whole of one of the times and be at rest during the whole of the other time, and if the thing moving or at rest during the whole of a time would be moving or at rest during any part of the whole time within which it can naturally be moving or at rest, then (since the same moment is the limit of both past and future) it would follow that a body could be at once at rest and moving within the same moment. Again, we do not speak of a thing as being "at rest" unless both it and its parts are, in a present moment, in the same condition in which they were before; but in a present moment there is no "before" and, therefore, neither any "being-at-rest." Accordingly, anything moving is moving, as any thing at rest is at rest, in time [or in a continuous duration].

4. Subjects and Kinds of Divisibility

Every changing thing must be divisible. Not only does every change have a beginning and an end. But also, when the changing thing has arrived at the end, it is no longer undergoing the change; and when it and all its parts are at the starting-point under consideration, it is not yet undergoing the change, since the stability of a whole and of its parts is not an instability. Accordingly, anything undergoing a change must be partly at the terminal and partly at the initial stage of the change;* for a changing thing cannot, while changing, be either at both the beginning and the end of the change or at neither of them. The "terminal" stage here meant is the one that is proximate in the change under consideration, for example, in a change from white to gray, not to black; for, in order to be changing, a changing thing need not start or stop at either of two extreme opposites. It is evident, then, that every changing thing must be divisible.†

A movement is divisible both with respect to the time it takes and with respect to the movements of the parts of the moving thing. Thus, if *AC* as a whole is in motion, then its parts, *AB* and *BC*, will also be in motion. Let the motion of the part *AB* be *DE*, and that of the part

* Cp. vi.2.232a21.

† Thomas Aquinas: "Sed hoc diversimode invenitur in diversis mutationibus. Aristoteles in hoc sexto libro agit de motu secundum quod est continuus."

BC be *EF*; then the motion of the whole *AC* will be *DF* [the sum of the motion of the parts]. This must be the motion of the moving body as a whole, because each of that body's parts has one of the two motions which together make up the whole motion, neither part having the motion of the other part; so that the whole motion is the motion of the whole moving body. Again, in every motion there is something which moves. But the whole motion *DF* cannot be the motion of one of the parts; for *AB* has the motion *DE*, and *BC* has the motion *EF*. Neither can *DF* be the motion of anything else; for its parts (*DE* and *EF*) are motions of nothing other than *AB* and *BC*, respectively, which are parts of the whole body (*AC*) having the whole motion (*DF*), and for any single movement there never was more than a single subject. Hence, the whole motion *DEF* is the motion of *ABC*. Again, suppose that the whole body had another motion, *HI*, from which the
235a motion of each of the parts could be subtracted; then the latter motions would be equal to *DE* and to *DF*, respectively, for the reason that any movement of a single subject is single. Hence, if the whole motion *HI* were divided into the motions of the parts, *HI* would be equal to *DF*. Should *DF*, however, fall short of *HI*, the remainder *JI* would not be the motion of any subject: it could not be the motion of the whole or of the parts, since any movement of a single subject is single; and it could not be the motion of anything else, since continuous movement implies continuous subjects. The same result would follow if *DF* should exceed *HI*. Consequently, the whole motion *HI* would necessarily be equal to *DF*; and *HI* and *DF* would, accordingly, be identical. One way, then, in which a movement may be divided is into the movements of the parts of the moving thing; and everything that has parts must be subject to this kind of division. But a movement may also be divided on the basis of the time it takes. Not only does every movement take place during a time, but all time is divisible; and the shorter the time of the movement, the more curtailed the movement. Every movement must, therefore, be divisible in its temporal aspect.

Furthermore, since everything that is in movement "is moved" in some respect and during some time and with a movement proper to it, the divisions which relate to the time, to the movement [identified], to the process of undergoing the movement, to the thing moved, and to the respect in which the movement [constitutes a change], are the same divisions. There is this exception, however, that division does not relate to all the changing conditions in the same manner: place and quantity are divisible essentially; quality, only incidentally. Let *A* be the time during which a thing is being moved; *B*, the "movement." Then, if the whole movement was completed in the whole of the time,

it follows that in a half of the time less of the movement will have occurred; in a still shorter period, still less of the movement; and so on indefinitely. Conversely, if the movement is divisible, the time is likewise divisible: if the whole of the movement was completed in the whole of the time, then a half of the movement will have occurred in a half of the time; still less of the movement, in a still shorter period of time; and so on indefinitely. The process of undergoing the movement is divisible in the same way. Let *C* be "being moved." At the half-way point of the movement, there will have been less of *C* than the whole; at the half-way point of a half of the movement, there will have been less than a half of *C;* and so on indefinitely. We may also from the whole process abstract the two partial movements *DC* and *CE*, in order to show that the whole process matches [39a] the whole movement [identified], since there would otherwise have been more than one process matching the [completed] movement. This demonstration would parallel that by which we have shown that a movement is divisible into the movements of the parts of the moving thing. For when the partial processes [*DC* and *CE*] are taken in their correspondence with the respective halves of the movement, it will be seen that the whole process of "being moved" is continuous. So, too, we may go on to demonstrate that the distance is divisible, as is any respect in which a change occurs; except that the divisibility of some changing circumstances is incidental to that of the thing which changes [in those respects]. In short, if any one [of the five items we have distinguished] is divisible, so are all the rest. Similarly, they are all alike finite or infinite. The divisibility or infinity follows, for the most part, from the divisibility or infinity which inheres immediately in the [primary] subject of change. That the latter is divisible, we have proved;‡ and we shall later§ proceed to show that it is infinite.

5. Ends and Beginnings of Changes

Since a changing thing changes from one definite condition [4] to another, anything which has undergone a change must, at the moment [17a] when it has completed the change, be in the condition to which it has changed. For a changing thing gives up or abandons its former condition, and changing either means or leads to giving up and abandoning a former condition; and if so, then analogously completion of the change puts the finishing touch to such abandonment. Thus, when something has changed from a state of nonbeing to its contradictory

‡ 234b10-20.

§ vi.7.

being, it has, at the time of the completion of the change, left the state of nonbeing behind; it is therefore at once in the state of being, since anything necessarily either is or is-not. Evidently, then, what has changed from one contradictory state to the other, is in the latter. Moreover, if such is the case in a change from one contradictory to the other, it will likewise be the case in the other kinds of change, what is true of the former in this regard being likewise true of the latter. Again, this must evidently be the case in each and every kind of change for the reason that whatever has completed a change must be somewhere or in some condition; and since it cannot be in the condition from which it has departed, it must be either in the condition to which it has changed or in some other. But if what has changed to *B* were then in some other state *C*, with which *B* is presumably not contiguous [136], then, since every change is continuous, the thing would be at the same time changing from *C* back to *B;* so that what has completed a change would, at the time when it has completed the change, still be changing to the condition to which it has already changed. Since this is impossible, what has changed must be in the condition to which it has changed. So, too, it is evident that if and when something has come into being, it "is"; and if and when it has perished, it "is-not." For what we are saying holds good for the various kinds of change generally, although it is especially clear in the case of a change from one contradictory to the other.

Not only is it clear that anything which has gone through a change is, at the time of the consummation of the change, in the condition to which it has changed; but the primary time in which it has completed its change must be indivisible [41]. I call that "primary" which is of a certain kind [5a] but which is not so because something else, being one of its parts, has this property.* Thus, let *AC* [as the primary time in which a change has been completed] be divisible, and let it be divided at *B;* then, if anything completes a change in time *AB* or in time *BC*, the inclusive time *AC* would not be the primary time of the completing of the change. If, on the other hand, anything was still changing in either *AB* or *BC* (in either of which it must have changed or have been changing), then it must also have still been changing in the whole of *AC;* but we took it as completing its change in *AC*. The same argument applies even if in one part of the time it is changing and in one part it has completed its change, for there would then be something [*BC*] prior to the first [time *AC*]. Consequently, the time at which a change has been completed cannot be divisible; and therefore it is

* vi.6.236b20-22.

also evident that the time at which anything has finally come into being or has perished is indivisible.†

However, "the primary time in which something has changed" has two meanings: one is the primary time in which the change has come to an end [100c], that is, when it is true to say that something has changed; the other is the primary time in which something began to change. The primary time which relates to the end of a change is a fact [82f] which we encounter [23]; for a change can be completed and thus have an end which we, moreover, have already shown to be indivisible because it is a *limit*.‡ On the other hand, a primary time which relates to the beginning does not exist at all: for there is no [continuous *part* of a whole change which would be an absolute] "beginning of a change"; and there is no primary part of the time in which a changing body *was first changing*. Let *AD* be such a primary time. Then *AD* would not be indivisible; for [if it were], moments would be contiguous.§ Again, let a body be at rest during the whole of [the immediately preceding time] *CA*. Then it would be at "rest" at *A* also. Therefore, if *AD* were without parts, the body would be at rest and would have changed in the same time [*A* and *D* being simultaneous]; for at *A* it would be at rest, whereas at *D* it would have changed. On the other hand, since *AD* could not be without parts, it would have to be divisible, and a body would have completed a change in any part whatever of *AD*. For if *AD* were divided and if a body would have changed in another part, then it would not have changed in the whole; but if a body‖ would have changed in one of the parts, then the whole [*AD*] would not be the primary time in which it has changed. So it must have changed in any part whatever [of *AD*]. It is evident, therefore, that there is no primary time in which the body has first changed, for the divisions are infinite!

Neither does anything which has changed have a part which has changed absolutely first. Since it has been proved¶ that every changing thing is divisible, let a changed body *DF* have such a primary part *DE*, and let *hi* be the time in which *DF* has changed. But if *DF* has changed in the whole of time *hi*, then only something less than *DF* could have changed in a half of the time and would therefore have changed before *DF;* and progressively something less in a progressively shorter time, and so on indefinitely. Consequently, a changing thing has no primary

† Against Sophistic arguments; for example, that Dion could not have died either when he was alive or when he was dead.

‡ viii.3.254b1, 8.264a4-6.

§ vi.1.231a27-29.

‖ Omitting: "had been changing in both and in the whole, but if it . . . ."

¶ vi.4.234b10-20.

part which has changed first. So there evidently is no such thing as an absolutely primary part either of a changing thing or of the time at which it has changed.

On the other hand, a different account must be given of a thing's changing conditions [15a], that is, of the respects [39] in which it has changed. For there is, besides a changing thing (for example, a man) and the time in which the thing changes, the condition to which it changes (for example, white). The former two are divisible; but the last is not, except incidentally. With this restriction, all three are divisible; since that is divisible to which a quality (such as white) belongs. However, among the respects in which a thing changes, those which are not incidentally but essentially divisible (namely, magnitudes) have no first part any more than does the changing thing or the time of the change. Suppose a magnitude *AB* would have moved from *B* to a primary place *C*. Then if *BC* were indivisible, two things without parts would be contiguous. And if *BC* were divisible, *AB* would have moved to a place prior to *C;* and to another, prior to that; and so on indefinitely (because the division has no final stopping-point). Consequently, there is no absolutely first point to which anything has moved. A similar procedure is applicable to quantitative change; for this, too, is in a continuum. Therefore, it is evident that only qualitative change has any essentially indivisible part.

6. Continuity as Not Divisible into First Parts

Since any changing thing changes in time—in one sense, in the primary time [or the time of that change only], but also, in another sense, in the time of the change because [39a] another time is such (as when a thing changes in a certain year because it changes on a certain day of that year)—therefore a changing thing completes its change in a primary time such that the thing must be changing in any part of that time. This is clear, accordingly, from our definition of "primary time."* Our point can also be established by the following considerations. Let *AB* be the primary time of a movement; and since all time is divisible, let *AB* be divided at *C*. Then the movable body is either moving or not moving in *AC;* and likewise, in *CB*. But if it moves in neither, it would be at rest in the whole; for nothing can move in a given time if it is not in movement in any part of that time. And if it moves in only one of the two parts of the time, then *AB* would not be the primary time of the movement; for the movement would relate to a different time. Therefore, the moving body must be moving in any part whatever of the primary time *AB*.

* vi.5.235b33, 34.

It follows from this proof that whatever is moving has moved before. For if in the primary time *AB* a certain body has moved a given distance, then a body beginning at the same time and moving at the same rate will in a half of the time have moved half that distance; 237a therefore, the former body moving at the same rate during the same time must have travelled the same distance as has the latter; and hence what is moving has been moving. Again, since a moment defines a time and a time falls between moments, and if the last moment is warrant therefore for saying that a thing has been moving in the whole or in any part of the time *AB*, then the thing could likewise be said to have moved in the other parts of the time. But the dividing-point *C* is the extreme limit of a half of the time. Therefore the moving body will have moved in a half or in any part whatever of the time, since every 10 division marks a time bounded by moments. If, then, all time is divisible, and what falls between moments is a time, every changing thing will have completed an infinite number of changes. Again, if a thing which changes continuously, which has not been destroyed, and which has not ceased changing, must at any time either be changing or have been changing, and if it cannot change in a moment, then it must at each moment of its change have been changing; and consequently, if the moments are infinite, every changing thing will have completed an infinite number of changes.

Not only must anything that is changing have changed; but what has changed must also have changed before. For whatever has changed 20 from one [place or state] to another, has done so during a time. Suppose *X* has completed a change from *A* to *B* in a moment. Then the moment in which *X* would have changed could not be identical with that in which it is in *A;* for it would then be in both *A* and *B* at the same time, and we have proved† that what has completed a change is not at the time of its completion of the change in the condition from which it has changed. And if *X* would have changed in a different moment, there would be a period of time between the two moments; for moments are not contiguous.‡ Accordingly, *X* has changed in a time. But all time is divisible; so that *X* has in a half of the time undergone another change, and still another in a half of that time in turn, and so on indefinitely. Consequently, it must at any time have changed before. Again, what we have been saying will become even more evident from 30 the continuity of the distance which a changing thing travels. Let *X* change in place from *C* to *D*. Then if *CD* were indivisible, two partless parts would be contiguous, which is impossible; so that there must be

† vi.5.235b6-13.

‡ vi.1.231b6-10.

a distance between them which, moreover, is infinitely divisible. Consequently, *X* was always previously changing in place from one to another of the infinitely numerous parts of the distance. So, then, *whatever* has changed must also have changed before. For, as to changes 237b between two things not continuous with each other, including [qualitative] changes between contraries and [the more radical] changes between contradictories [in generations and destructions], we can use the former proof, namely, from the infinite divisibility of time.

Thus, what has changed must have been changing, and what is changing must have changed; changing is preceded by having changed, and having changed is preceded by changing; and at no stage can we lay hold of an absolute "first." The reason [83] for this is because partless parts are not contiguous. We may rather continue the process of dividing indefinitely. For example, as we continue to bisect a line, the one series of segments continues to increase in length while the other continues to decrease.§ Hence, it is also evident that anything 10 divisible and continuous which has come into being must have been coming into being before and that anything divisible and continuous which is coming into being must have come into being; although sometimes what is coming into being is a part which is something other than the whole, for example, the foundation of a house. And as with what is coming into being and what has come into being, so it is with what is perishing and what has been perishing: a continuous being which is coming into being or which is perishing has a certain infiniteness immediately inherent [82h] within itself; so that nothing is being generated without having been generated or has been generated without being generated. Just so it is with perishing and having been perishing: perishing is always preceded by having been perishing; and having been perishing, by perishing. It is evident, then, that what has been produced must previously have been in the process of being 20 produced and that what is being produced must have been produced; for all distance and all time are infinitely divisible. Consequently, at whatever [stage of a change] a thing may be found to "be," that stage would not be an absolutely first [moment or point].

7. Finite and Infinite Time and Distance

Since movement takes time and, with increasing magnitude, a longer time, a finite movement does not require infinite time unless, indeed, the same movement or part of it is continually repeated, but the whole of a finite movement does not take the whole of infinite time. Clearly,

§ iii.6.206b3-6.

a body moving at a uniform rate must travel a finite distance during a finite time; for it completes its movement over a whole distance in equal periods of time which, moreover, number as many as do the equal parts taken of the distance. Therefore, since the parts of the distance are finite in size and number, so is the time; the latter equals the time of a part multiplied by the number of the parts. However, it makes no difference even if the body does not move at a uniform rate. Suppose 238a *X* has moved a finite distance *AB* during an infinite time *cd*. But then *X* must have travelled one part of the distance before another; for, clearly, *X* has in an earlier and in a later part of the time travelled different parts of the distance, because different parts of the motion are completed as the time grows longer (whether *X* changes at a uniform rate or not and whether the rate of motion is uniform or increases or decreases). Therefore, let *AE* be a part by which the distance *AB* is measured. Then this part of the motion would take a corresponding part of the infinite time; surely, it would not take the whole of the infinite time which was assumed to be taken by the whole motion. And if I select another part equal to *AE*, this part of the motion would also, for the same reason, take a finite period of time. Now, if I continue to take parts in this way, there is no part by which infinite time can be measured; for an infinite cannot be made up of [a finite number of] either equal or unequal finite elements, because things finite in plurality and size can be measured by a unit (whether they are equal or not, so long as they are finite in size). But the finite distance *AB* is measured by *AE* taken a certain number of times. Consequently, *X* will have travelled the distance *AB* during a finite time. Then, too, as with movement, so it is with coming to rest. And consequently, it is impossible for one and the same thing to be forever in process of becoming or of perishing.

For the same reason, there cannot be an infinite movement or coming-to-rest during a finite time, whether or not the movement is uniform. Let any part be taken by which the whole time is measured: a moving body would in that part of the time cover but a part of the distance, not the whole distance which is covered in the whole of the time; it would cover another part of the distance in another part of the time, and so on in each of the times. It would make no difference whether a part is equal or unequal to the first part taken, provided only that each is finite; for, clearly, while the time is thus being used up, the infinite is not, since only finite quantities are taken only a finite number of times. Consequently, an infinite extent cannot be covered during a

* a4-6.

finite time; and it makes no difference to the argument whether the distance is infinite in one direction or both.

It evidently also follows from this proof that a finite magnitude cannot traverse an infinite magnitude during a finite time. The reason [83] is the same: in any part of the time, a finite magnitude covers a finite magnitude; and so in each succeeding part of the time; and therefore, in the whole of the time, it covers a finite magnitude.

Since a finite magnitude does not traverse an infinite one in a finite 238b time, it is also clear that an infinite magnitude cannot traverse a finite one during a finite time. For if the infinite traversed the finite, the finite would also traverse the infinite. Which of the two is the body in motion, would make no difference; for, in either case, the finite would traverse the infinite. Thus, when an infinite magnitude *A* is in motion, a part of it *CD* would be at a finite *B;* and so would one part after another; and so on indefinitely. At one and the same time, then, the infinite would have traversed the finite, and the finite would have traversed the infinite; for the infinite cannot traverse the finite without the finite 10 traversing the infinite either by way of local passage through it or by way of measuring it. Hence, since the finite cannot traverse the infinite, neither can the infinite traverse the finite.

Moreover, the infinite cannot even traverse the infinite during a finite time. If it did, it would also traverse the finite, which is inherently comprehended [82h] in the infinite. In addition, the proof from the taking of the parts of time applies here also.

Accordingly, since the finite cannot during a finite time traverse the infinite, nor the infinite the finite, nor the infinite the infinite, it is evident that there can be no infinite movement at all within a finite 20 time.† For what difference would it make whether we presented the movement or the distance as infinite? If either is infinite, the other must likewise be infinite. For every local motion takes place in a place.

8. Coming to Rest, Rest, and Stages of Change

Since everything which is naturally either in motion or at rest moves or rests when and where and as it naturally does, therefore what is coming to a stop [111] must, when doing so, be in motion. For otherwise it would be at rest and therefore not in a status [12a] of "coming to rest" [110]. It follows likewise that coming to a stop takes time. For what is in motion takes time; but what is coming to a stop has been shown to be in motion and, hence, must come to a stop in a period of time. Again, the distinction of "quicker" and "slower" presupposes 30

† vi.2.233a21-b15.

time; and stopping may be quicker or slower. Moreover, what is coming to a stop must do so in any part whatever of the primary time in which it is coming to a stop. If it were not doing so in either half of the time, it would not do so in the whole of the time and would therefore never stop moving. And if it were doing so in but one half of the time, then the whole would not be the primary time of the process but would be the "time of the process" in a dependent sense only. (We have at a previous point in our discussion* applied this proof to moving bodies.)

239a Moreover, just as there is no first moment [17a] in which a moving body is moving, so there is none in which a body that is coming to a standstill comes to a standstill; for there is no [absolutely] first part [4] of either process. Let *AB* be such a primary time in which anything would begin to come to a standstill. Then *AB* could not be without parts: for there can be no movement in a partless time, because a moving thing must have *been moving* in a part [4] of the time, and what has been coming to a stop has been shown to be in motion. And if *AB* is divisible, the body is coming to a stop in any part whatever of *AB;* for we have just proved that what is coming to a stop must be doing so in any part whatever of the primary time in which it is coming to a stop. The primary time, then, in which anything comes to a standstill, is a [continuous] time, not a moment [41]; and since all
10 time can be divided into an infinite number of parts, there can be no first moment at which anything begins to stop moving.

Neither is there a first moment at which a body which continues to rest *began* to be at rest. It did not begin its rest in a partless moment, for no movement takes place within a moment [41], and only that can be at rest which can also be in motion. As we are accustomed to saying,† a body is, properly speaking, "at rest" when it can naturally be moved but is not being moved at a time when it naturally could. Again, we speak of a body as being "at rest" if in the present moment it is in the same condition in which it was before; so that a state of rest cannot be discriminated by reference to a single moment only, but only by reference to at least two moments. Consequently, the time in which a body continues at rest cannot be without parts. Having parts, then, it is a [continuous] time; and a body at rest will be at rest in any part whatever of the time of its rest, as we can show by means of
20 the proof used before [in similar contexts]. And consequently, there can be no first moment [at which a thing began to be at rest]. The reason [83] is because all resting or moving takes time; and since anything continuous is infinitely divisible, time can no more have an

* vi.6.236b25-32.

† v.2.226b12-15.

absolutely first part than can a magnitude or than can a continuum of any kind whatever.

Moreover, since every moving body moves during a time extending from the beginning to the end of the process [115], it cannot in that time (taken by itself rather than in some part) be at [39a] some primary part [of its path]. For if it (together with each of its parts) were to continue in the same [state or place] for any length of time, it would be at rest; and if it were at rest in the sense that it (together with its parts) can at one moment or another be truly said to be in the same [state or place], then a changing thing cannot in the primary 30 time of its change be completely [21] at any [identifiable part of its course]. All time being divisible, it would follow rather that the changing thing (together with its parts) would at different times be in the same [state or place]. If, on the other hand, it would at a single moment only be in the same state or place, it would not be at any [definite stage] during any time but only at a limit of the time. To be sure, it *is* at some stage at any one moment; but it could not be "at rest" 239b in a moment any more than it could be "in motion" in a moment. Surely, if a changing thing is "not moving in a moment" and if it "is at some stage," it is not therefore possible for it to be "at rest at a part" [of its passage] "during the time" [of its changing]; for it would then follow that anything in motion would be at rest.

9. Fallacies of Taking Divisibility as Prior to Movement

There is a fallacy in Zeno's way of arguing: "If anything is at rest or in motion when it is where [39a] it is [57g], and such is invariably the case with a moving body [121] at any moment, then a flying arrow cannot start moving [109e]." This is wrong because time is not made up of indivisible moments any more than any other magnitude is made up of indivisible parts.

Zeno formulated [90] four arguments about motion which worry 10 [200c] those who try to solve them. According to the first, "nothing can be in movement, since whatever is in local movement must arrive at the half-way stage before it arrives at the end."* We have commented on this contention in preceding discussions.† The second argument, known as "the Achilles,"‡ is to this effect: "The slowest runner will never be caught [65e] by the swiftest, since the pursuer must first reach the point from which the fleer has in the meantime escaped; so that the slower runner must always be some distance ahead." This

* Cp. vi.5.236a10-13; i.8.191b27-29.

† i.3.187a3; vi.2.233a13-34.

‡ "Achilles and the tortoise."

is the same argument as that from repeated bisection; but with this difference that ever-prolonged [65g] paths [142a] are to be analyzed into segments in different relations. It follows from the argument that a slower runner can never be overtaken, but only as it follows from "bisection" [in the first argument, that there is no motion]: the conclusion of both arguments, that the limit is not reached, turns on the way in which the distance is analyzed; the second argument only enlarges on the conclusion by saying that not even the swiftest runner of traditional story achieves his goal of catching up with the slowest. Consequently, the solution must be the same in both cases. The formula [46c] that "whatever is ahead cannot be overtaken" is false. What is ahead is not overtaken as long as it is ahead, to be sure; but it is overtaken.§ One need only admit that the distance traversed is finite. These, then, are the first two of Zeno's arguments. We have already reported the third: "The flying arrow continues at rest." This conclusion depends upon taking time as composed of moments; if this is not granted, the conclusion does not follow.‖

The fourth argument [known as the "Stadium"] deals with "equal bodies moving at the same rate in opposite directions in a race-course past bodies equal to themselves, one set moving in the direction away from the end [100] of the race-course and the other set moving in the direction away from the turning-point [138]." This argument is believed to lead to the conclusion that "one-half of the time is equal to the double." The mistake in this reasoning is rooted in the supposition [46c] that bodies moving at the same rate take the same time in moving past a moving body and past a stationary body of equal size. Let A's be stationary bodies of equal size; let B's be bodies equal to the A's in number and in size, but starting at the turning-point; and let C's be bodies equal to the A's in number and in size, but starting at the extreme end [18a] and moving at the same rate as the B's. (Fig. 4.)

A: – – – –
B: 4 3 2 1
C: 1 2 3 4

Fig. 4.

A: – – – –
B: 4 3 2 1
C: 1 2 3 4

Fig. 5.

Then, as the B's and the C's pass one another, B_1 and C_1 will be simultaneously at the [respective] end [of the A's]. (Fig. 5.) But C_1 will have passed all [the B's] while B_1 will have passed only one-half [of the A's]. Hence, since each moving body [supposedly] takes an

§ "Overtaking" is logically prior to a half of it.
‖ viii.8.263a11-b9.

equal time in passing each of the bodies it passes, the time [taken by B_1] will [supposedly] be only *one-half* [as much as the time taken by C_1]. But B_1 will at the same time have passed all the C's, for C_1 and B_1 will be at the opposite extremes at the same time.¶ The reason is because both B_1 and C_1 have taken an *equal* time in passing opposite the A's. This, then, is the argument. Its conclusion, however, rests on the false assumption which we have noted.

Similarly, we find no impossibility in change from one contradictory to the other. "If something, in changing from nonwhite to white, is at neither extreme, it is therefore neither nonwhite or white." But the fact that it is not wholly at either extreme does not prevent it from being described as white or nonwhite: for, to be so described, it need not be wholly such, but only in most or in the most important of its parts; and "not being thus or so" is not identical with "not being thus or so at all." Likewise, in the case of a change having as its extremes "being" and "nonbeing" or any other pair of contradictories: the changing thing must be in one of the opposite states, although it need not be wholly in either.

So, too, we are not confronted with an impossibility by the objection that the circle or the sphere or anything rotating on itself must be at rest. Since they, together with their parts, continue for some time to be in the same place, it is concluded that they are at once both at rest and in motion. However, the parts are not in the same place for any length of time; and, besides, even the whole is always changing from one position to another. For the orbits described as starting from A or B or C, and so forth, are not the same (except incidentally, like "musician" and "man"); and none of them is ever at rest, but each is forever changing to [the position of] a different one. (Fig. 6.) Likewise, in the case of the sphere or of anything else rotating on itself.

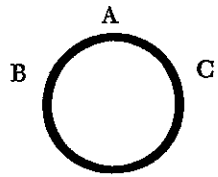

Fig. 6.

¶ The following statement appears to be a gloss: "As Zeno says, it takes as much time to pass each A as it does to pass each B."

10. The Indivisible as Motionless and Change as Definite

We may now take another step forward in our analysis by showing that what is without parts cannot be in motion, except incidentally, that is, only in so far as it is an inherent part [82h] of a moving body or line [142a]. What is without parts moves, so to speak, only as any thing in a boat is moving if and when the boat is in motion or as a part moves with the motion of the whole of which it is a part. By "things without parts," however, I mean such as are quantitatively indivisible. For parts of a body may have motions both essentially their own and dependent on the motion of the body as a whole. This distinction may be clearly observed in the case of a sphere and its innermost and other parts rotating with different velocities and thus having [potentially] many motions. However, to return to the point we are trying to make: what is without parts may have a motion like that of a man sitting in a moving boat, but cannot have a motion essentially its own. Let a thing without parts be changing from *AB* to *BC*, whether from one magnitude to another or from one quality [20] to another or from one contradictory to the other; and let *d* be the primary time in which it is changing. Then the partless thing would at the time of its changing have to be in stage *AB* or *BC* or partly in the former and partly in the latter, just as would anything else that is undergoing a change. But it could not be partly in each stage, since it would on that alternative have parts; nor could it be in stage *BC*, since it would in that case (contrary to our assumption) have completed its change. Accordingly, it would during the time of its changing be in stage *AB* and since being in the same state for any length of time is being at rest, it would therefore be at rest. Consequently, what is without parts cannot move or change at all. It could have a motion of its own only if time were made up of moments [which have no parts]; for it would then at any moment *have* moved or changed and would, therefore, never be moving, but would forever have finished moving. But we have proved before* that this is impossible. Time cannot be made up of moments any more than a line can be made up of points or than a motion can be made up of [atomic] movements [109f]. To attribute motion to what has no parts amounts to reducing motion to partless movements; and this would be like reducing time to moments or a line to points.

There is another way of showing that a point or anything else that is indivisible cannot move; namely, by means of the fact that no moving body can move a distance greater than itself before having moved a distance equal to or less than itself. If this is so, then it is evident

* vi.1.

that a point, too, would have had to move a distance less than or equal to itself. Being indivisible, however, a point could not have moved a distance less than itself. And if it would have had to move a distance equal to itself, then a line would have to be made up of points; for a whole line is measured by a point moving always an equal distance. But if a line cannot be made up of points, neither can anything indivisible move.

Still another proof is the consideration that, since all motion takes time and no motion happens in a moment and since all time is divisible, there must be for any moving thing whatever a period of time shorter than the time it takes in moving a distance equal to itself. Such a time is required for such a motion, since all motion takes time; and we have proved† that all time is divisible. Accordingly, if a point were to move, there would have to be a period of time shorter than the time in which a point would have moved a distance equal to itself. But this is impossible, for in a shorter time it would have to move a lesser distance; and then the indivisible would be divisible into smaller parts, just as the time is divisible into shorter times. In fine, what is without parts could move if and only if movement were possible in an atomic moment; for movement in a moment and movement of something indivisible are mutually [15a] convertible [90].

However, no single change is infinite. We have seen‡ that every change has a definite beginning and a definite end. Moreover, these limits are either contradictories or contraries. In changes from one contradictory to the other, each of the contradictories is a limit: in generation, for example, the final limit is being; in destruction, nonbeing. And in a change from one contrary to another, each of the contraries is a limit. Qualitative alteration, being a type of change, has such extremes; for qualitative alteration always proceeds from one contrary quality to another. Growth and decline, too, have such extremes: growth has a final limit in the complete magnitude consonant with the nature proper [55] to the growing thing; and decline has a final limit in the loss [111d] of that magnitude. As for local motion, it cannot be limited in precisely the same way, since its termini are not always contraries. However, "what cannot be done" has various meanings. If a thing could not have been cut in the strict sense that it would have been an impossibility for it to be cut, then it is impossible in the same strict sense for it to be in a process of being cut. So, in general, anything that cannot be definitely generated cannot be in a process of being generated; and anything that cannot undergo a complete change cannot be

† vi.2.232b23-233a10.

‡ v.1.225a1.

in a process of changing to anything to which it cannot change completely. Now, if anything in a process of local movement is to change its location from one place to another, it must be possible for it to complete such a change. Hence, its motion is not infinite and cannot be infinite, for it is impossible to traverse an infinite distance. We have shown, then, that no change can be "infinite" in the sense that it "cannot be defined by limits."

However, it remains for us to consider§ whether a movement that is single may be infinite in this sense with respect to the time of the movement. There is nothing to prevent eternal movement if the movement is not single but if, for example, local motion is followed by qualitative alteration, and the latter by growth, and this in turn by generation. In this way there can be movement through all time; but it will not be a single movement, since all these changes would not make up a unified movement. No movement which is a unitary movement can be temporally infinite, with but one exception; that exception is rotation.

§ viii.7.261a17-8.265a12.

VII. BOOK ETA

Series of Movements

1. Moved Movers and the First Mover

Anything* involved in a process [109a] is necessarily brought into operation [109a] by some agency [4]. Obviously, if a thing subject to change does not put [82] itself in motion, it owes its variation to something else; in such a case, the mover or agent must be something other than the thing acted upon. What, however, if a thing set in motion has the beginning of its movement within itself? Take *AB* as something moved, considering *AB* by itself without reference to the movement of any of its parts. Since *AB* is presumably not given a start by an external mover because it is itself a whole in movement, may we, then, take *AB* as self-moved?† This would be like supposing that, when *JK* both moves *KL* and is itself in movement, we would have to deny that *JL* is moved by anything [other than *JL* itself] because we do not see which of its parts is the mover and which is moved! Again, what is [supposedly] not given a start by anything would not necessarily stop moving because something else is in a state of rest; on the contrary, if anything is in a state of rest because something else has stopped moving, then the former is necessarily set going by something; and if this is admitted, then everything movable is responsive to some agent. Thus, since everything in movement is divisible, *AB* must be divisible. Let *AB*, accordingly, be divided at *C*. Then if *CB* is not in movement, neither would *AB* be in movement; if it were, then *AC* would be in

241b34 44 242a35

* Book Eta may be an independent work. The first three chapters exist in two versions, of which this translation follows *alpha* rather than *beta*.

† Plato *Phaedrus* 245D.

movement while *CB* would be in a state of rest, and *AB* would consequently not be in movement essentially and directly as we have assumed it to be. Hence, if *CB* is not in movement, *AB* must be in a state of rest. But what is in a state of rest because something else is not in movement is admittedly moved by something. Therefore, we conclude, anything involved in a process is necessarily brought into operation by some agency: for what is in movement is divisible; and if any of its parts is not in movement, then the whole must be in a state of rest.

Anything passing through any change, then, is necessarily acted upon by some agent, with the consequence that anything undergoing a local motion is moved by something else in motion, the mover being in turn moved by another thing in motion, and the latter by still another, and so on indefinitely; so that there must be a first mover, and there cannot be an infinite regress. For let us suppose that there is no first mover but that there is an infinite regress; and let *A* be moved by *B*, *B* by *C*, *C* by *D*, and so forth. Then, since the mover supposedly induces motion while being in motion, the motion of the thing moved and of the mover must be simultaneous; for it is at one and the same time that the mover induces motion and the thing moved is set in motion. It is evident, therefore, that the motions of *A*, *B*, *C*, or of any of the movers and of the things moved, are simultaneous. Let the motion of *A* be *E;* that of *B*, *F;* that of *C*, *G;* that of *D*, *H*. For although each thing in motion is moved by another, still, we may take each as having a numerically single motion, since every motion has a definite [*A*] starting-point and a definite stopping-point, and no motion is infinite as to its extremes. By a "numerically single motion," I mean one proceeding from a numerically single starting-point to a numerically single stopping-point in a numerically single period of time. For a movement 242b35 may be single generically or specifically or numerically: a movement is generically single when it falls under a single category, such as primary being or quality; a movement is specifically single when it proceeds between limits which do not differ but are the same in kind [20], for example, from white to black or from good to bad; and a movement is numerically single when it proceeds from a numerically single starting-point to a numerically single stopping-point in a numerically single period of time, for example, from "this" white appearance to "that" black appearance or from "this" place to "that" place and in "this" period of time (for a movement occurring in some other period of time would no longer be numerically single but only specifically single). We have discussed the unity of movement before.‡ Now, let the time in which *A* has completed its movement be *J*. Then, since

‡ v.4.

the movement of *A* is finite, so is the time. On the other hand, since the movers and the things moved are infinite, the movement *EFGH* (which is composed of all the particular movements) would also have to be infinite; for whether the movements of *A*, *B*, and so forth, are equal or whether they form a series of progressively greater movements, they would in either of these possible cases§ form a whole which is infinite. And since *A* and all the other things moved are moved simultaneously, the whole movement would occur in the same period of time in which that of *A* occurs and which is a finite period of time; so that there would be an infinite movement in a finite period of time. But this is impossible.‖

It might seem that this argument has proved the point we have promised [82a] to establish [namely, that there is a first mover]; but the argument does not provide the demonstration required, since it fails to show conclusively any impossible consequence [of the opposite view]. For although a single subject cannot undergo an infinite process in a finite time, yet many subjects may very well [in a finite time participate in processes which together form an infinite whole]. This is precisely what happens in the case under consideration: each thing acted upon holds its own course; yet it is quite possible for many things to be acted upon at the same time. However, if anything that moves anything else by way of a local and bodily motion must touch or be continuous with the thing it moves (as observation discloses in every case), then the things so interacting must at least touch or be continuous with one another so as to form a unity. It makes no difference to the present argument whether this unity is finite or infinite: if the subjects are infinite in number, then the motion which is the sum of all their motions must be infinite; and this would be so whether the particular motions are equal or progressively greater, since we may treat [65] the possible [12b] as actual [82e]. If, then, the whole made up of *ABCD*, whether finite or infinite, undergoes a movement *EFGH* in a finite time *J*, something finite or infinite would enact a finite movement in an infinite time. But neither is possible.¶ Consequently, the series must come to a stop, and there must be a definite first mover as well as something which is moved first. It makes no difference that we have derived this impossible consequence from an assumption [64h]; for we have taken the assumption as a possibility, and an 243a30 assumed possibility ought not to yield an impossible consequence.

§ iii.6.206b7-12.

‖ vi.7.238a32-b22.

¶ vi.7.238a32-b22.

2. Togetherness of Agents and Things Acted upon

A "proximate mover" (not the goal [96] of a movement, but its initiating [95b] factor) is correlative [137c] to what it moves, in the sense that there is nothing intermediate between them; and this "togetherness" is found in every case involving an agent and something acted upon [109a]. Moreover, since there are three kinds of "movement" (local, qualitative, and quantitative), there must also be three kinds of mover or agent: one, which transfers something from one place to another; a second, which brings about a qualitative alteration; and a third, which effects an increase or a decrease.

Let us take up local motion first, since this is the primary kind of movement. Everything undergoing a local motion is set in motion either by itself or by something else. Obviously, when things are moved by themselves, the mover and the thing moved are "together"; they have their proximate mover inherent [82h] within themselves, with the consequence that there is nothing interposed between them. But when things are set in motion by something else, their motion must be produced in one of the four ways [20] in which one thing can be put in motion by another; namely, by pulling, or by pushing, or by carrying, or by rotation. All local motion may be reduced to these four kinds. Pushing onward is the kind of pushing which occurs when a mover pushes something away from itself and follows its course so as to keep pushing it; pushing away, when a mover does not thus follow the course of the thing it has moved; throwing, when the mover impels [34] a thing to move away from it with a motion more violent than any which the thing thrown would naturally have, so that the thing thrown continues to move as long as the motion impelled predominates over the natural motion; and pushing apart is pushing away either from the mover or from something else, as pushing together is pulling either towards the mover or towards something else. There are many varieties of the last two; among them, parting the warp threads and beating the weft threads into place. So there are other processes of combining and separating, all of which are kinds of pushing together or apart—with the exception of the processes involved in generation and destruction. At the same time it is evident that combination and separation do not even constitute a [16b] distinct [4] kind [19] of movement, rather are all motions to be reduced to the four kinds already named. So, too, inhaling is a kind of pulling; and exhaling, a kind of pushing. We may similarly view spitting and other bodily actions [109], among which immissions are kinds of pulling and emissions are kinds of pushing away. Also all other kinds of local motion fall under one of the four varieties named and are accordingly to be reduced to one of them. Of

these varieties in turn, carrying and rotation are to be reduced to pulling and pushing. Since anything carried in or on something in motion is itself incidentally in motion and the thing which carries it is being pulled or pushed or rotated, carrying is dependent upon one of these three kinds of motion and therefore belongs to all of these three in common. And rotation is made up of pulling and pushing, since anything which produces a rotation must push part of a thing away and pull part of it back. Consequently, if anything which pushes or pulls is "together" with what it pushes or pulls, it is evident that there is also nothing interposed between anything undergoing a local motion and its mover. This is also apparent from the definition of "pushing" as "dislodging [109] a thing in a direction away from the mover or from something else to some other [place]" and from the definition of "pulling" as "dislodging a thing in a direction away from some other [place] to the mover or to something else," namely, as long as the motion of what does the pulling is quicker than the motion tending to disjoin the two continuous things from each other (for this is the way in which one thing is pulled onward with another). One might, indeed, suppose that there are other forms of pulling, as in the case of wood drawing a fire; but the only difference involved is that a stationary body draws things to where it is, whereas a moving body draws them to where it was. However, it is impossible in any case to move anything away from the mover to something else or vice versa without touching it; so that there evidently cannot be anything intermediate between anything in local motion and its mover.

Neither is there anything intermediate between a thing which is being altered and that which is altering it. This is made plain by induction, since a last altering factor and a first altered factor always happen to be "together." We assume* that things undergoing qualitative alteration are being acted upon [35] with respect [39a] to their "passive" [35c] qualities [28]: for anything having a quality is altered inasmuch as it is sensible, and bodies differ in their sensible traits inasmuch as one body has more or fewer sensible traits than does another or has the same sensible traits in a greater or lesser degree; but, in any case, what is altered qualitatively is altered by [the action of another body having] the same sorts of [sensible] traits. For these are modifications [35a] of some persistent [85] quality [28]. Thus, we say that a thing is "altered" by being heated or sweetened or condensed or dried or whitened, whether the thing in question is a lifeless or a living being or whether the parts of the living being in question are nonsensitive or

*This sentence represents a reconstruction of the text along lines suggested by Simplicius. *See* W. D. Ross *Aristotle's Physics* (Oxford, 1936).

sensitive. For there is a sense in which even the senses undergo "alteration," since an actual perception is a bodily process in which a sense is acted upon in some way. A living being, then, undergoes qualitative alteration in as many ways as a lifeless being does, but not vice versa, for a lifeless being is not subject to alteration of sense organs and takes
245a no notice of action upon it as does a living being, although there is nothing to prevent even the latter from failing to take notice of a qualitative alteration which has nothing to do with the senses. Since it is by sensible objects, then, that anything is altered, it is evident that a last altering factor and a first altered factor are in every case "together": air is continuous with what alters it, and a body with air; a color is continuous with light, and the light with the eye; in hearing and smelling, the air is similarly related as proximate mover to the organ on which it acts [109a]; a flavor is likewise "together" with the
10 sense of taste; and there is an analogous "togetherness" in the case of lifeless or insensitive things. Consequently, there can be nothing intermediate between that which is being altered and that which alters it.

So, too, there is nothing intermediate between anything assuming and effecting an increase. That with which an increase starts is added to the subject in such a way that the whole forms a unity. Inversely, that with which a decrease starts becomes the occasion for the decrease when some part of it breaks loose. There must be a continuity, then, between that which starts [and that which assumes] the increase or decrease; and since there is nothing intermediate between things
245b that are continuous, it is evident that nothing intervenes between a proximate [17a] or immediate [18a] giver and a taker in a process.

3. Objects and the Senses in Qualitative Alterations

We must now proceed to show [187] that anything altered in quality is altered by sensible things and that only those things are subject [82f] to qualitative alteration which are directly [2] acted upon [35] by sensible things. One might suppose that qualitative alteration occurs in other ways also, especially by way of change in the forms [91a] or shapes [91] or in the positive states [33a] which a thing may receive or lose, but neither of these changes is a qualitative alteration.

10 When a thing has been fashioned into its final [100c] shape, we do not give it the name of its material. Thus, we do not call a statue "bronze," or a candle "wax," or a bed "wood"; rather do we describe these products, respectively, as being "of bronze," "of wax," or "wooden." On the other hand, when a thing has been acted upon so as to have been qualitatively altered, we continue to designate it by the name

of its material. Thus, we speak of "bronze" or of "wax" as being dry or liquid or hard or soft; indeed, we even speak of liquid or hot material as being bronze. In such instances, we denote a material and its property [35a] by the same term. Accordingly, if we do not distinguish 246a
a product of shaping by the name of the material which has the shape, whereas we do continue to identify a thing which has undergone qualitative alteration by its material, it is evident that productions of the former sort are not qualitative alterations. Moreover, it would seem absurd to say that a man or a house or anything else has, by coming into being, been altered in quality. To be sure, when anything is generated, *something* must undergo qualitative alteration; for example, a material must be condensed or rarefied or heated or cooled. Yet it is not the things being generated that are being altered in quality; and their generation is not a qualitative alteration.

So, too, bodily or nonbodily [154] states are not qualitative alterations. States or conditions differ in being better or worse, and neither 10
their superiority nor their inferiority is a qualitative alteration. Rather is any excellence a kind [4] of completion; for when anything has attained its proper excellence, we say that it is "complete" in the sense that it is then most especially in its "natural" condition. For example, a circle is a "complete" figure when it is as good a circle as can be formed. On the other hand, a fault is disruptive or destructive of an excellence. Accordingly, we do not call the completion of a house an "alteration"; indeed, it would be absurd to regard the coping and the tile as an alteration of the house or to regard a house as being altered in receiv- 20
ing its coping and being tiled over, which rather marks the completion of the house. Just so it is with excellences or faults and their possession 246b
or acquisition: excellences are completions, as faults are deviations from perfection; neither are qualitative alterations.*

Again, we ascribe to the being of all excellences a relational [29] status [33]. Thus, we view bodily excellences (like health and well-being) as dependent upon a proportionate mixing of hot and cold elements within the body or relatively to its surroundings; and beauty, strength, and other bodily excellences (as well as the lack of them) are contingent upon such relations. Positive or negative conditions like these dispose [64c] a body well or ill to those critical [55] changes [35a] by which it is naturally preserved or corrupted. Consequently, 10
since relations are not alterations and are not subject to alteration or generation or any transformation, it is evident that states or conditions and their loss or acquisition are not qualitative alterations. It may very well be so that the occurrence or nonoccurrence of a state or condition

*v.1.225a35, b1.

(like that of a form or shape) requires the alteration of *something*, for example, of hot or cold or of dry or wet or of other such elements on which the states or conditions in question may ultimately depend. For every excellence or fault relates to things by which its possessor is naturally altered in quality: a body in good condition is insusceptible [35d] to things to which a body in poor condition is susceptible [35c], and the former is also passive in ways in which the latter is, contrariwise, incapable of being acted upon.

247a Likewise, nonbodily states are all dependent upon certain relations; their excellences are completions, as their faults are deviations from perfection; and their excellences dispose their possessors well, as their faults dispose them ill, to critical changes. Consequently, nonbodily states and their acquisitions and losses are not qualitative alterations even though their occurrence requires the alteration of a sensitive organ by sensible things. For every moral virtue falls within the sphere of bodily pleasures and pains which depend, in turn, upon actions or memories or hopes. The pleasures and pains arising from actions belong [39a] to the senses and must, therefore, be occasioned [109a] by sensible objects; and the pleasures of memories and hopes arise from the memory of past pleasures or from the hope of future pleasures. Hence all such pleasure is produced by something sensible. And since virtue and vice arise in us together with the pleasure and the pain which they involve and which are qualitative alterations of something sensitive, it is evident that the acquisition and loss of moral virtues and faults requires the qualitative alteration of *something*. Accordingly, the occurrence of moral states is bound up with that of qualitative alteration but they are not therefore themselves qualitative alterations.

247b Like moral states, so mental [169d] states are not qualitative alterations; neither is there any generation of them. Knowing, above all, is to be understood in terms of its relation [to its objects]. And there can obviously be no generation of intellectual apprehensions as if capacity for knowledge were exercised [109a] of itself, instead of becoming an act of knowing in consequence of the occurrence [82f] of something else [to be known]; for knowledge, encountering [116] a particular [22] is somehow guided by it to universals [43].† Neither is there any generation of the use or actualization [of potential knowledge], unless one were to believe in a generation of sight and touch; for the act of knowing is analogous to these [intermittent acts of perception]. Not even an initial [82a] getting [65a] of knowledge [179] is a generation or a qualitative alteration: we do not claim an intelligent [172] understanding [179a] until our thinking has come to a stand;‡ but a process of coming to rest is not a generation, any more than any change whatever is a product of generation (as we have pointed out before).§ Besides, when one who has been intoxicated or asleep or ill has passed to the contrary condition, we do not say that he has been generated anew as a knower, even though he has been incapable of putting his knowledge to use; nor do we say this when he begins to acquire knowledge. For one cannot become intelligent or a knower unless one has passed from natural mental disturbances to tranquility of mind. This is the reason why children come short of their elders in capacity for learning or even for sense discriminations; they are at the mercy 248a of much excitement and unrest. Nature herself suffices to allay our agitation in some of our activities; in others, we must take recourse to supplementary measures; but in either case there must be some bodily alteration, as exemplified by the restoration of intellectual efficiency after one has become sober or awake.

It is evident, then, that qualitative alteration takes place in objects accessible to sense perception and in sense organs; not in anything else, except incidentally.

4. Comparability and Incomparability of Movements

The question may be raised whether every movement is or is not 10 comparable [58] with every other. If all movements are [taken to be] comparable and if things moving at equal rates [admittedly] cover equal distances in equal periods of time, [it may be objected that] curves would be equal to or longer or shorter than straight lines. Moreover, qualitative alterations and local motions completed in equal periods of time would be equal to each other; and consequently, events [35a] and lengths might be equal to each other. But this is impossible. Is it not rather the case that equal movements occurring in equal periods of time are equally fast, but that events and lengths cannot be equal to each other? It is impossible, therefore, for qualitative alterations to be equal to or less [or greater] than lengths. It follows, therefore, that not all "movements" are comparable.

How, then, shall we apply this conclusion [3b] to the example of the circle and the straight line? It would be absurd to deny that a 20 circular motion and a motion in a straight line can be co-equal [37c]—as if one were necessarily faster or slower than the other, just as if the one went downhill and the other uphill. However, it would

† Alternate version: "for it is from the experience of a particular that we derive knowledge of a universal" (247b20, 21).

‡ Plato *Timaeus* 44.

§ 2.225b15.

make no difference to the argument even if we were to say that the one is necessarily faster or slower than the other; for the fact that a curve would then be longer or shorter than a straight line would imply
248b that the two can be co-equal. Thus, if in a period of time *A* a faster body covers a [curved] path *B* while a slower body covers a [straight] path *C*, then *B* is greater than *C*. This accords with the definition we have given* of the "faster." But the faster also covers an equal distance in a shorter period of time. Hence, there will be a part of time *A* in which *B* will trace some part of the curve equal to the line which *C* traces in the whole of time *A*. However, in spite of this, if the motions are comparable, it would follow (as we have said) that there might be a straight line which would be equal to the circle; but a circle and a straight line are not comparable, so that the motions which correspond to them will not be comparable either.

Are we to understand, then, that things not designated by a single term having a single meaning are all incomparable? Why, for example, are a pen and a type of wine and the highest note in a scale incomparable as to their "sharpness"? Obviously, because it is in different senses that they are or are not "sharp." The reason why we can compare the
10 highest note and the note next to it is because we would call both of them "sharp" in the same sense. May not "fast," then, have different meanings as applied to motion along a curve and to motion in a straight line? And would not "fast" be much less applicable, in the same sense, to qualitative alteration and to local motion?

Or would it not be false to say, to begin with, that things unequivocally denoted by the same term are therefore comparable? Although we speak of "much" water or air in the same [quantitative] sense, we cannot compare water and air in this respect. If we do not agree to this statement, we at any rate use the term "double" to denote unequivocally a ratio of two to one; yet we cannot compare [water and air, and so forth, as respectively "double"]. Or shall we bring our previous argument to bear also upon these [relative] terms and say that "much," for example, is vague? The very definitions of some terms involve variables. Thus, even if "much" is defined as meaning "so much and more," still, "so much" varies [16b] from one case to another. The term "equal" is likewise equivocal; and so is the term "one," perhaps
20 most directly so; hence, also the term "two." For why would some things be comparable and others incomparable if all the things in question had a single nature?

Or shall we contend that the immediate subjects [12] of an attribute are incomparable when they themselves differ? A horse and a dog are

* vi.2.232a25-27.

comparable in the sense that one may be "whiter" than another because the attribute of whiteness belongs primarily to the bodily exterior which both have in the same sense; and a horse and a dog are, for the same reason, comparable in size. But a body of water and a voice are not comparable [in clearness or in volume] since the aspects [of the water and of the voice] to which such attributes primarily belong differ in these cases. Or would it not, on the other hand, seem clear on this interpretation that we could then represent [34] all equivocal terms designating attributes as having a single meaning and then ascribe differences to the possessors of each attribute in different cases? Thus, 249a
terms like "equal" and "sweet" and "white" would severally have the same meaning, but would become different in meaning when the respective attributes are become embodied in different subjects. Besides, not any subject is capable of receiving [12] any attribute at random; any one attribute [such as "white," and so forth] can have but a single immediate subject [such as bodily exterior, and so forth].

Shall we maintain, then, that things are comparable only on the twofold condition that they have a given attribute in the same sense and that, in addition, neither the attribute nor the thing which has the attribute can be divided into different kinds? I mean, for example, that colors can be divided into different kinds and that, consequently, things are not comparable in color, as if one of them were "more colored" than another; we compare one thing with another rather in respect of a particular color such as "whiteness."

To apply these considerations to movement: two things move at the same rate if their movements equal each other quantitatively in equal periods of time. But if one thing has been altered in quality over a 10
part of its length and another thing has been carried over a distance equal to that bodily part, would the qualitative alteration equal the local motion in speed? That would be absurd for the reason [83] that "movements" differ in kind [20]. And if we say, then, that things in *local* motion over equal distances in equal periods of time are equally fast, [we are still confronted with the difficulty that] a straight line and a curved line could equal each other. Why [83], then, [are the motions corresponding to these incomparable]? Because local motion is a genus [having different species]? Or because a line is a genus [having different species]? Now, although the time [of the motions] may be the same, still, if the paths differ [16b] in species, so do the motions differ [76] in species; for local motion is divided into kinds if its path is divided into kinds. On the other hand, although walking differs from flying as moving with the feet differs from moving with wings, yet local motion is divided into species only in accordance with the shape [91a]

of its path. Thus, we conclude that things are equally fast when their movements can cover the same path [142a] in equal periods of time, the same "path" being undifferentiated [76b] in species and therefore undifferentiated also in respect of the corresponding motions. In order to determine the [4] differentia [76a] of a motion, therefore, we must look [195] to its path.

Our argument shows [38] that a genus is not a unity [24] without differences [4]; but although the latter [differences] may be distinguished [74] from the genus, many of them escape notice. Thus some differences of meaning happen to be far apart; others have some sort of similarity among them; and still others come so close to forming a genus or an analogy that they hardly seem to be cases of different meanings. When, then, is there a distinct species [of quality]? When the same attribute is found in different subjects? Or when different attributes are found in different subjects? And what is the limit [72b] defining a distinct species? On what basis are we to judge [164] sweetness or whiteness to be [in each of its instances] the same or different? Would it be different because it appears different in different subjects? Or because it is not at all the same [in different subjects]?†

Turning now to qualitative alteration, let us ask: how can one qualitative alteration be as fast as another? If recovery of health is a qualitative alteration and one patient gets well rapidly and another slowly but some get well in the same period of time, then qualitative alterations can be equally fast; namely, when they take equal periods of time. But how shall we qualify [4] the alterations? We do not speak of "equal" qualitative alterations as we do of "equal" quantities; but qualitative alterations may be "similar." However, let things be "equally fast" [in their changes] when they undergo the *same* [kind of] change [115] in equal periods of time! Must we, then, compare with one another the subjects of the attributes [35a] or the attributes themselves? Since states of health are the same in kind, we may take cases of health recovered as accomplished [82f] changes which are without differences of degree but which are similar to one another. But when the qualities in question differ in kind, as when one subject is becoming white and another is becoming well, then the qualitative alterations are not identical or equal or similar; the differences exemplified divide the qualitative alterations into different species, which cannot form a unity any more than do the local motions [which are divided according to their paths]. Consequently, we must grasp the number of species into which qualitative alterations and into which local motions are divided. If the direct rather than the indirect subjects of a change [109a]

† 248b22, 24.

differ [76] in species, their changes will also differ in species; if the former differ in genus, the latter will also differ in genus; and if the former differ numerically, so will the latter. But in determining whether qualitative alterations are equally fast, must we look to the sameness or likeness of the attributes or to the subjects altered (for example, to the extent to which each has become white)? Or must we look to both, judging the alterations to be the "same" or "different" in terms of the attributes involved or to be "equal" or "unequal" in terms of the subjects involved?

Then, too, we must ask [195] in what sense generations or destructions may or may not be equally fast. Two processes of generation are equally fast when two things which are identical and indivisible in species are generated in equal periods of time; for example, two men (but not two animals). One process of generation is faster than another when the things generated in equal periods of time "differ" in species. We have no [more precise] term for two "different" [primary beings in generations and destructions] corresponding to "unlike" [attributes in qualitative alterations]. To be sure, on the [Pythagorean] theory that primary being is number, [one process of generation would be faster than another when a "greater" and a "smaller" number "of the same kind" are generated in equal periods of time; since on this theory] a "greater" and a "smaller" number may be "alike in kind" [57a].‡ But we have no general [92] term [like "unlike" or "unequal" to express the relation between "different" primary beings in generations and destructions] and no pair of terms [40] corresponding to "more" [and "less"] in the case of qualities [35a] differing intensively [6c] or extensively [148] or to "greater" [and "smaller"] in the case of different quantities [27].

5. Proportions of Forces, Objects, Distances, and Durations

Any mover (or agent) not only moves (or acts upon) something definite, but does so during a definite period of time and over a definite distance. The reason is that what is moving anything must at the same time also have been moving it; so that a certain distance must have been covered and a certain period of time must have been taken. Let *A*, accordingly, be the mover; *B*, the thing moved; *C*, the distance covered; and *D*, the time taken. Then (1) a force [11] equal to *A* will in a period of time equal to *D* move *B*/2 a distance 2*C*; or (2) it will move *B*/2 the given distance *C* in time *D*/2. In this manner, we establish the proportions existing between the terms

‡ "Triangular" numbers, "square" numbers, and so forth.

under consideration. Also, if (3) the given force *A* moves the give object *B* a distance *C*/2 in time *D*/2, then (4) *A*/2 (or *E*) will mov *B*/2 (or *F*) the given distance *C* in the given time *D*. Thus, th ratio between the force and the mass remains the same; so that eac force will move a given mass the same distance in the same perio of time. But (5) if *E* moves *F* a distance *C* in time *D*, it does no follow that *E* moves 2*B* a distance *C*/2 in time *D;* and hence, (6) if moves *B* a distance *C* in time *D*, *A*/2 (that is, *E*) need not therefor move *B* a distance *C*/2 in time *D* or in any part of time *D*. For may not move *B* at all. From the fact that a given force impels certain amount of motion, it does not follow that half of that force wi impel a motion either in any particular amount or in any particula period of time. If it did, one man might move a ship; for both th force of the ship-haulers and the distance they move the ship can b divided into as many [141] parts [as there are ship-haulers]. This the reason why we must reject as false the argument of Zeno that eve the smallest grain of millet must fall with a noise. Why should a grai in any period of time set sound-waves in motion as would the fallin of a whole bushel? It does not even make a fraction of a noise as it migh [by a stretch of the imagination be supposed to] make if it were b itself; for, as a part, a grain is nothing at all in a whole bushel, exce potentially. On the other hand, (7) if each of two forces moves eac of two weights a certain distance in a certain period of time, then th two forces taken together will move the two weights taken together a equal distance in an equal period of time; for, in these circumstance the proportion between the terms under consideration is preserved.

May we apply these findings also to qualitative alteration and to in crease? In an increase, the effective agent, the subject acted upon the time, and the amount of the increase are all definite. So, too, in qualitative alteration, there is something definite which does the alte ing, something definite which is altered, a definite degree of altera tion which is completed, and a definite period of time in which th alteration has been effected. If a given period of time is doubled, th amount of the alteration will be doubled, and vice versa. Half of an object will be altered, or an object will be altered half as much, in half the time; or half of an object will be altered twice as much as the whole object in an equal period of time. But if an agent brings about a certain degree of a qualitative alteration or a certain amount of an increase in a given period of time, it does not follow that such an agent will in half the time alter or increase half of the object or a given object half as much; but as in the case of a force moving a weight so here, it may happen that the agent will not effect any alteration or increase at all.

VIII. BOOK THETA

Eternity of Movement

1. Movement as Ungenerated and Indestructible

Was there ever a time when movement* came into being and before which it had no being? And is movement doomed to pass away, with the consequence that a time will return when nothing will be stirred into activity? Or is movement ungenerated and indestructible and therefore something that always was and always will be? In other words, does process have a status [82f] of being [1a] to which considerations of "death" and even of pause are irrelevant and which may, accordingly, be described as a sort of continuing "life" encompassing all of nature's performances [111i]?† 11

Now, all of those‡ who have anything significant to say about nature acknowledge that there is movement; for they are interested in the cosmos [149b], and all their theories [187a] concern generation and destruction, which would not be possible if there were no process. But those who maintain§ that there is an infinite number of worlds, some springing up while others vanish, say that events are always occurring, since the generations and destructions of worlds involve them; whereas those who maintain that there is a single universe, be it eternal‖ or not eternal,¶ regard its moving system of energies as eternal or not 20

*Averroes: "de primo motu"; Thomas Aquinas: "universaliter de motu." Cp. viii.5.257a33.
†Plato *Laws* x.895.
‡Anaxagoras, Empedocles, Democritus.
§Anaximander, Leucippus, Democritus.
‖Plato, Aristotle.
¶Anaximenes, Heraclitus, Diogenes of Apollonia: Cycles.

eternal in keeping with their respective theory [90] of the universe.
As to the possibility of a time when nothing at all comes to pass, the
are only two ways in which this could be so. One way would be as s
forth by Anaxagoras; namely, that all things are together and at re
for an infinite time until mind imports movement and distinctio
[164d] into them. The other way would be in accordance with t
teaching of Empedocles; namely, that rest alternates with movemen
because there is movement when love unifies the manifold diversi
of things or when strife disrupts the unity again in all manner of way
and there is rest in the ensuing intervals [when love and strife are
equilibrium]. To quote Empedocles:

Since unity takes its rise from plurality,
And plurality, from a diffused unity,
Things come and go and are without stability;
But since their rotation continues forever,
They form a cycle with eternal steadiness.

The "rotation" of which Empedocles speaks must be understood as re
ferring to the alternating shifts from plurality to unity and from uni
to plurality. We shall find the consideration [195] of this suppose
state of affairs [33] profitable [9e] for our examination [166] of th
facts [7a] pertaining to a theory of nature as well as for our searc
[198] for the first principles.

Let us begin with distinctions which we have made before in ou
discussions of nature.†† We define "movement" as "the functioning
[9] of the movable as movable." Accordingly, each kind of "movement"
requires the presence [82f] of actualities [188c] capable of undergoing
that kind of movement.‡‡ Even apart from the definition given of
"movement," everyone would admit that, to be in process, a thing mus
be capable of that particular [40] process. Thus, to be altered, a thing
must be capable of being altered; and to be in local motion, a thing
must be capable of change in place. Thus, too, before anything
burned, it must be capable of being burned; and before anything start
a fire, it must be capable of starting a fire. Therefore, if there was a tim
when these things did not exist, they must have been generated; if not
they must be eternal. If, then, every movable thing was generated, it
supposed change or movement must have been preceded by another
in which the thing capable of giving rise or of submitting to a com
plete process was generated. But to hold that things existed [82g]
before there was any movement, would on first thought seem absurd

** Anaxagoras, Archelaus, Metrodorus of Chios: beginning of movement.
†† iii.1.
‡‡ Thomas Aquinas (against Averroes): ". . . sequitur, quod productio universalis
entis a Deo non sit motus nec mutatio, sed sit quaedam simplex emanatio. . . ."

and further reflection would show why it must be absurd. Suppose that, while there are things amenable to processes and things capable of producing them, there would be a period of time when a first mover would be [active] and a thing [acted upon] would react, but that there would be another period of time in which nothing of the sort would take place but only a continuing rest. It would follow that anything which was at rest but is in movement] must have previously undergone a change; for its quiescent state must have had conditions [83], since coming to rest is a privation of movement [as movement, in turn, is a privation of rest]. Consequently, such a thing must have been changed before its supposed first change! To be sure, some things initiate movement in one way only, as fire heats; whereas other things initiate contrary movements, as the same science may be used in contrary ways. Even so, the way in which the former things function is not altogether unlike the way in which the latter function: thus, a cold body may become the occasion for warmth by its mere removal from the scene, just as an expert may fail to fulfill his proper role by deliberately misapplying his knowledge. However, in any case, things are not capable of acting or of being acted upon or of moving or of being moved under any and all conditions [150] but only under determinate conditions [33] and in interaction with one another. It is only as they come into close relations, then, that one thing moves another and the latter is moved by the former, provided that the former was capable of originating the process and the latter was capable of submitting to it. Clearly, then, if movement had not been always in operation, the situation would not have been such that one thing was capable of inducing movement and the other was capable of being moved; but at least one of them must have undergone a change. This would necessarily happen in the case of correlatives [29]; for example, if one thing which was not "twice" its correlative now is "twice" the latter, at least one of them (if not both) must have passed through a change. Thus, [if movement had not been always in operation] there would be a change prior to the supposed first change.

We may here interject this question: how, when there is no time, can there be any "before" and "after"; or how, when there is nothing going on, can there be time? Since time is a number belonging to a process or else is itself a sort of process,§§ then, if there always is time, movement must be eternal also. Indeed, all who have reflected about time seem, with a single exception, to agree in describing time as ungenerated. Thus, Democritus avails himself of the argument that time is ungenerated, in order to show the impossibility of the view that all

§§ iv.11.219a8, 220a24, 10.218a33.

things have been generated. Plato alone presents time as generated; time, he maintains, is coeval with the heavens which, according to him, have had an origin.‖‖ But if time can neither be nor be conceived without a present, and the present is a sort of "mean" in the sense of being at once the starting-point of the future and the end-point of the past, ¶¶ then there must always be time. Surely, the extreme end of any supposed last period of time must be in some present, there being no period of time immediately accessible [65] to us other than the present, and therefore, since the present is at once a beginning and an end, there must always be time in both of its directions. Accordingly, if time as an aspect [35a] of movement [is eternal], it is evident that movement must be eternal also.

To resume the main argument. This argument gives evidence that movement is [not only ungenerated but] also indestructible. Just as the generation of movement would entail some change prior to a supposed first change, so the destruction of movement would have as a consequence a change subsequent to a supposed last change. A being which is no longer in movement does not therefore at the same time cease to be movable; for example, a thing which has stopped burning does not therefore cease to be combustible, for it is quite possible for things to be combustible when not actually on fire. Likewise, a thing which has terminated an action [109a] does not thereby lose its capacity for action [109c]. Now, destruction being a kind of change, a destructive power which has effected a [supposedly final] destruction would still be left to be itself destroyed; and thereafter what is capable of destroying it in turn would also have to be destroyed. But these consequences are impossible. Clearly, then, movement is eternal; and the view that there may be a time when there is something "going on" as well as a time when there is "nothing doing" looks for all the world like a figment of the imagination.°°°

No less fanciful is the view which sets up a situation of this kind as a principle of the natural course of events [101c]. Empedocles, for example, suggests that, as things go, love and strife must alternate in their control of phenomena and that in the intervals they refrain from all activity. No doubt, those who hold [34] with Anaxagoras to a single beginning [of movement] would go along with this opinion.

‖‖ Plato *Timaeus* 28B, 38B. Simplicius: Plato and Aristotle take "generated" and "ungenerated" in different senses.

¶¶ Thomas Aquinas (against Averroes): "Ex hoc enim quod tempus est fluens et non stans, sequitur quod unum nunc non possit bis sumi, sicut bis sumitur unum punctum. . . ."

°°° Thomas Aquinas: "Est autem ante tempus aliqua duratio, scilicet, aeternitas Dei, quae non habet extensionem, aut prius et posterius, sicut tempus, sed est tota simul. . . ." "Auctoritas autem divina praevalet etiam rationi humanae. . . .

But nothing natural is unordered; on the contrary, nature is uniformly [50] principled [83] by order [207a]. There is no ratio, however, between an infinite [time of change] and an infinite [time of rest]; but any order consists in a ratio [90]. An infinite period of rest, followed by a movement which starts indifferently at any time—with no order to account for the beginning of the movement at a given time rather than at some previous time, is far from nature's way of working [9c]; for the natural is either invariant [105] (and not now in one way and then in another), like fire being carried upward (and not only sometimes and sometimes not), or its variability has a pattern [90]. Empedocles and others may in a way be commended for recognizing some kind of order, at least to this extent that they speak of alternating rest and movement. But this speculative assumption, too, ought not to be illogically proclaimed as if it were an axiom; it ought to be supported by some reason [83] and be proved either by induction or by demonstration. Surely, the love and strife assumed do not explain [83] the alternation. Nor is their being [88a] an affair of alternation; rather is their being, respectively, an affair of combining and of separating. To secure the definiteness of the alternation, instances of it ought to be cited; instead, we are simply told that there is something in the universe [21] like the love uniting men and like the mutual avoidance among enemies. There ought also to be a definite [4] reason [90] for the equal periods of time allotted to movement and to rest. In general, it will not do to magnify an appeal to an invariant way of being or to an invariant occurrence into an all-sufficient principle; as when Democritus reduces his natural explanations to the consideration that things have happened before as they do now. He does not deign to search for a principle explaining this uniformity; but though there are cases in which this attitude is justified, there are others in which it lacks justification. Thus, the interior angles of a triangle are always equal to two right angles for definite reasons which account for this eternal truth; although there are, indeed, eternal principles which do not call for further explanation.

Let these comments suffice for the statement of our conviction that there never was a time when there was no moving state of affairs and that there never will be a time when there will be none.

2. Refutation of Objections to Eternal Movement

It is not difficult to resolve the leading counter-arguments [50] envisaging a possible time when the moving tendencies [109] of existence were absent from the whole realm of being. First, it may be thought that no change [115] is eternal, since every change naturally has a definite start and comes to a definite stop; so that every change must

be limited by the contraries within which its course [116] is confined and no process can continue indefinitely. Secondly, we observe even nonliving things which, though they are wholly or partially at rest and not only unmoved but without power of self-movement, are nevertheless capable of being moved and are at some time actually given a start. Hence, it is argued, if a movement which is not in being cannot be generated, then things must be either always or else never in movement. Thirdly, these considerations are said to be especially evident in the case of living beings. There are times when there is no transition within ourselves but only complete repose and when nothing external moves us; but presently we find ourselves in the midst of an activity which we have ourselves set on foot. To be sure, we do not see quite the same thing happen in the case of nonliving things, which always require an external mover; but an animal, we say, "moves itself." If there is any time, then, when an animal is in a completely quiescent state, it is possible for movement to be generated in a nonmoving being by its own power without the mediation of an external mover. And if this is possible in an animal, why not in the universe? Surely, what can happen in a "microcosm" can happen in the "megacosm"; and what can happen in the cosmos can happen in the "infinite" —if the "infinite" as a whole can be in movement or at rest.*

In the first of these arguments, the statement is warranted that there can be no eternal passage from one opposite [13] to the other as a numerically single process remaining identical with itself. This would necessarily follow, at any rate, if one and the same thing can have a motion which, however, is admittedly not itself forever one and the same. Yet even if a given single string of a musical instrument continues in the same state and is repeatedly struck in the same way, is the sound it produces always one and the same; or is each sound different? However this may be, there is nothing to prevent *some* movement which is continuous and eternal from being therefore also self-identical. This will become clearer at a later stage of our inquiry.†

The second argument, that what is unmoved comes to be moved, proposes nothing strange [61] if we consider that there are occasions when an external mover is present and occasions when an external mover is absent. Even so, we must still investigate how it is possible for the same thing to be sometimes put in motion and sometimes not by the same effective agent. This difficulty amounts to the question: why are not some beings always in a state of rest and others always in movement?‡

* iii.5.205a8-206a7.
† viii.8.
‡ viii.3.

The third argument appears to raise the most formidable problem of all. It suggests that movement can be generated in living things without being preceded by another movement in them because, it is alleged, an animal may abandon its rest by walking off, apparently without the aid of any external mover. Such, however, is not the case. Observation of an animal always discloses some part [101i] in movement such that the movement is not to be attributed [83] to the animal itself but perhaps to the operation of its surroundings. We do not credit an animal with originating every one of its own movements but only its local motions. Many processes are possibly, or perhaps even necessarily, set up in an organism by the environment; and some of them arouse thought or desire which, in turn, affect the organism as a whole. This is what happens, for example, in sleep in which there is no perceptivity, but in which some process occurs in consequence of which the animal awakes. However, we shall later§ clarify this issue also.

3. Rest, Movement, and Kinds of Beings

Let us begin our present line of investigation with the question which is fundamental to an examination of the second objection just noted:* Why is it that some beings are sometimes in movement and sometimes in a state of rest? We must, in this connection, consider three alternatives: either (1) all beings are always inert [110]; or (2) all beings are always transient [109a]; or (3) some beings are transient, whereas others are inert. On the third alternative, in turn, either (a) changeable beings are always in process, whereas stable beings are always in a state of repose; or (b) all beings are naturally sometimes [57] active and sometimes inactive; or (c) some beings are always independent of movement, whereas others are always subject to movement, and still others admit [65d] of both rest and movement. This last possibility remains after the other alternatives have been eliminated and is therefore the one we must maintain: it holds the solution of all the problems confronting us at this point; and to establish it is, accordingly, the aim of our present enterprise [197].

Now, to hold (1) that everything reposes in a state of inertness, and to hunt for reasons [90] for this view in disregard of the testimony of the senses, is a kind of intellectual incompetence which plays fast and loose [51] with things not simply in piecemeal [22] but in wholesale [21] fashion. This is to run counter [29] not only to the natural scientist but to virtually [36b] all the sciences and to all sober opinions,

§ viii.6.
* viii.2.252b12-16, 253a2-7.

which with one accord work with the fact of movement. Besides, ju
as a mathematician or anyone else regards assaults upon the fi
principles of his science [90] as beneath his notice, so a physicist ne
not trouble himself with an attitude which calls into question what
for him a matter of fact [64h]; namely, that nature is an originati
source of movement.

Next, the view [of the Heracliteans] (2) that everything is a tra
sient occurrence, though likewise false, is perhaps less destructive [7
of scientific exploration [198]. To be sure, we have in our writings
nature† taken nature to be a principle of movement and of rest alik
Still, nature is especially characterized [101a] by movement. Some ev
10 allege that, so far from some beings being subject to and others ind
pendent of movement, all beings are in constant movement, despite o
inability to perceive this because of the limitations of our senses. The
men do not tell us what distinctive kind of movement they mean
whether they are talking about all kinds of movement. Yet we sha
not find it difficult to reply to them. Thus, increase or decrease cann
proceed in an unbroken sequence [136a], but is interrupted by inte
vening states [138]. The argument in question is like that about ston
being worn away by the dripping of water or being split by the growi
of plants. If the dripping has moved or removed so much of the sto
it has not therefore moved or removed half as much in half the tim
but just as the hauling of a ship [results from the combined labo
of the haulers], so it takes a goodly number of drops to have an appr
ciable effect [109a] on a stone such as no portion of the number o
20 drops can have in any period of time. The amount removed is,
course, divisible into parts; but none of the parts was brought int
operation separately but only in conjunction with the others. Becaus
a decrease is infinitely divisible, then, it evidently does not follow tha
some part must therefore always be vanishing; on the contrary, a whol
may disappear all at once. So it is also with any qualitative alteration
If the subject undergoing a qualitative alteration is infinitely divisible
the qualitative alteration is not therefore itself also infinitely divisible
it often occurs precipitately (for example, in cases of freezing). Again
an interval of time is required for one who has fallen ill to return
to health; such a transformation does not occur suddenly [131] and
cannot, moreover, be a change in any direction whatever, but only to
health. We must conclude, therefore, that the representation of a quali
30 tative change as continuous flies in the face [51] of obvious facts
qualitative change is a change to a contrary state, and a stone is not
[continuously] becoming harder or softer. Then, as regards local mo

† ii.1.192b21.

tion, it would be very strange if the falling of a stone were beyond
our powers of observation or if we could not know whether it was
resting on the earth. Besides, the earth and all the other elements nec-
essarily remain in their respective resident [55] places, from which they
are removed only by violence; so that, if some of them are in their
resident places, it cannot be the case that all things are in motion. 254a
From these and other arguments like them, we may, accordingly, con-
clude with confidence that it is impossible for all things to be always
transient or for all things to be always inert.

Then, too, (3) it is beyond the bounds of possibility [12b] that (a)
some beings are always transient and others always inert, as if no
being were sometimes at rest and sometimes in movement. Considera-
tions like those which we have been bringing forward will also serve to
show the impossibility of this view. Thus, we observe identifiable beings
[15a] changing as already stated [from rest to movement and from
movement to rest]. Besides, our objector's position clashes with plain
matters of fact. There can be no increase [without intervening states];
and there can be no violent movement unless a being at rest can be 10
moved contrary [74] to its natural state [101]. Hence, the theory in
question would abolish generation and destruction. Virtually all thinkers
agree that for anything to be in process is a kind [4] of generation
and destruction: whatever is changing is becoming that in which the
change culminates or is coming to be in that condition; and the condi-
tion from which anything is changing is ceasing to be, or the changing
thing is ceasing to be in it. Consequently, there clearly are beings
sometimes in movement and sometimes at rest.

The suggestion (b) that all beings are sometimes inactive and some-
times active must be rebutted by our former arguments. Let us again
take as our point of departure the alternatives we distinguished at the
beginning of this analysis. Either (1) all beings are inert; or (2) all
beings are transient; or (3) some beings are transient, whereas others
are inert. And if some beings are inert and others are transient, then 20
either (a) [some beings are always at rest, whereas others are always
in process]; or (b) all beings are sometimes inactive and sometimes
active; or (c) some beings are always independent of movement, where-
as others are always subject to movement, and still others are some-
times at rest and sometimes in movement. Although we have said so
before, we may now repeat that (1) it is impossible for all beings
to repose in a state of inertness. Even if being were in truth inert, as
those thinkers‡ hold who describe being as infinite and independent
of movement, this is at least not apparent to our senses; to our senses,

‡ i.2.185a32, 3.186a18.

many beings seem to be transient. Indeed, if there is any such thing as false opinion or even any opinion whatever, if there is any imagination, if anything seems different at different times, then there must also be such a thing as movement since imagination and opinion are in some sense [4] held to be "movements." But to institute a protracted search for arguments in a matter of this kind where we have the good fortune of not standing in need of any arguments, shows an inability to discriminate what *is* better and what is worse, what is credible and what is incredible, what *is* fundamental [82] and what is derivative. By the same token, it is impossible (2) for all beings to be transient and (3) it is likewise impossible (a) for some beings to be always in process, whereas others would be always in a state of repose. One certitude suffices to refute all these theories: we *see* some things now in movement, now at rest.§ It being impossible, therefore, for all beings to be always inert and for all beings to be continuously transient, it is evidently no less impossible for some beings to be always in process and for others to be always in a state of repose. Thus, it remains for us to consider whether (b) all beings admit of both movement and rest or whether (c) only some beings are to be so regarded, whereas others are always independent of movement, and still others are always subject to movement. It is the latter of these alternatives which we are trying to establish [63].

4. Movements as Due to Agents

Agents or things acted upon function as such incidentally or essentially. They induce or undergo movements only incidentally in so far as they happen to possess [82f] certain traits or in so far as the active or passive factor is one of their parts.* But they induce or undergo movements essentially in so far as their movements do not pertain to any of the traits or parts they happen to possess.

Now, of the things which are moved essentially, some are moved by themselves, whereas others are moved by something else; and some are moved naturally, whereas others are moved "contrary to nature" or violently. Anything moved by itself (such as any animal) is moved naturally; for when an animal is moved by itself *inasmuch as it has* within itself the beginning of its movement, we say that its movement is "natural." But although an animal as a whole thus moves itself naturally, its body may be moved naturally or violently; this depends [76] upon the kind of movement it happens to be undergoing or upon

§ All movements are identified as completed movements.

* v.1.224a24, 25.

the kind of element which may enter into its composition. Anything moved by something else is moved naturally or violently. Examples of violent movement include the upward motion of earthy things and the downward motion of fire as well as such motions of animal parts as are at variance [74] with their normal [101] position [64] or manner [55c]. Violent movements afford the clearest evidence that whatever is moved is moved by an agent. Next in order, this circumstance is manifest in those natural movements which are exemplified by animals moving themselves. What may be obscure in such movements is not that they are effected by an agent, but rather how we are to distinguish [65c] in them between the mover and the thing moved. It would seem that a mover and a thing moved are to be distinguished in movements of animals no less than in movements of ships or of any artifacts and that, moreover, it is only in this sense that an animal as a whole is a self-moving agent. But the distinction in question is made with the greatest difficulty in the class of things remaining according to our classification. We have noted, among things moved by something else, those which are moved violently. But there remains, among things moved by something else, a class of things opposed [64b] to those which are moved violently; namely, the class of things moved naturally.

Things whose movements are not only brought about by something else, but are also natural to them, confront us with the question: By what are they moved? Consider, for example, things light and heavy. Evidently, they are moved in directions respectively alien to themselves [13] by main force; but they are naturally moved to their respective resident [55] places, that is, light things upward and heavy things downward. In their natural movements, however, it is no longer equally evident by what agency their movement is effected. Surely, they cannot set themselves in motion, any more than they can bring themselves to a stop, as animals can. If fire, for example, could of itself move up as an animal can of itself start walking, then fire could presumably also of itself move downward as an animal can of itself stop walking. It would, moreover, be unreasonable to suppose that, if [elements] moved of their own accord, they would be capable of only a single kind of self-initiated "movement." Besides, how would it be possible for anything continuous and naturally unitary [101i] to bestir itself? In so far as anything is one and continuous (rather than merely contiguous), in so far it is incapable of being acted upon [35d]. Things must admit of division [73] if they are to function [101c] both actively [34] and passively [35]. Hence, nothing naturally unitary [like fire, and so forth] can be self-moving, any more than can anything else that is continuous;

but within such things, the active [109a] and the passive factors must be just as distinguishable [75] as we observe them to be in the action of living things upon nonliving things.

Now, nonliving things are [even in their natural movements] moved by something. This becomes evident if we distinguish different factors [83] accounting for their movements; that is, if we divide movers, as we have divided things moved, into those whose movements are violent and those whose movements are natural to them. Thus, a lever moves [109c] a weight by main force, whereas a body which is actually [9] hot can act [109c] in accordance with this very nature upon a body which is potentially [11] hot; and so forth. Just so, a body can be acted upon [109b] in accordance with its nature if it is potentially of a certain sort or so much or somewhere; provided that the process in question can arise [82] in it, and provided that the process would not be incidental to it. (Although the same thing may be [potentially] of some character as well as of some dimension, still, the one aspect would not belong to the other essentially but would be incidental to it.) Fire and earth, then, are forcibly moved by some agent in ways at variance with their nature; they are moved naturally when they are impelled to pass from their respective potential states to their corresponding activities [9].

The "potential," however, has more than one [6] meaning [36]. This is the reason [83] why the agent may escape observation [59d] in the upward motion of fire and the downward motion of earth. Consider an analogy: a learner is a potential knower at one stage; he becomes a potential knower at another stage when he has acquired knowledge which, at a given time, he is not putting to actual use [9a]. In any case, however, the interaction of something capable of acting with something capable of being acted upon is the occasion for a passage [116] from a potentiality to an actuality. Thus, a learner passes from his [first] potential knowing to a second [16] potential knowing: from the knowing which is potential in the sense that the learning process has not been completed, to the differently potential knowing of one who does not turn the knowledge he possesses to actual account [187]. But one who has arrived at the latter stage puts into practice [9a] his intelligence [187], unless his activity is impeded; if he did not do so, he would really be in the opposite state of ignorance. So it is with natural bodies [or elements]: a cold body is potentially hot; when turned into fire, it burns—unless it is prevented from doing so. So, too, with heavy and light bodies: when water (the first heavy body which is potentially light) is transformed into air, it becomes a light body and at once acts as such (unless hindered); for light bodies tend [9]

to rise and, when held "down," are prevented from doing so. A similar analysis may be made of quantitative and qualitative changes, with similar results.

We may, however, persist in asking: why, after all, do heavy and light bodies tend [109a] to their own respective places? The reason [83] is that they naturally [101c] tend in distinct directions. This is precisely what it means for them to be [88a] light or heavy; namely, that they tend upward or downward, respectively. But, as we have said, there is more than one way of being potentially light or potentially heavy. When a thing is water, it is at least in some sense potentially light; and when it is air, it is still only potentially light in the sense that its upward tendency may be counteracted; whereas, on the removal of the obstacle, it becomes actually light [9a] and proceeds to rise. Analogously, what is [potentially] of a certain quality becomes [115a] actually so, as when an expert [179a] is at liberty to think [187]. Likewise, what is of a certain quantity expands when unchecked. As for anyone who removes an obstruction such as a pillar from under a roof or a weight from a wine-skin in a body of water, he in a way moves the object he has freed; that is, he moves it incidentally only, somewhat as a wall intervenes to cause a ball to rebound which a thrower has hurled against it. Clearly, then, none of the things we are talking about move themselves; yet they have a "source [82] of movement." Not that they produce any movement or keep it going; but they are amenable [35] to movement.

In fine, the movements of things in their courses are natural or violent; and the latter are due to external agents, whereas the former may be enacted by self-moving agents or be due to external agents. Thus, light and heavy things have two sorts of "movers": those which have produced them and made them light and heavy; and those which have freed them from the hindrances to their movements. Hence, all things in movement are acted upon by some agent.

5. The First Mover Taken as Self-Moved or Unmoved

An object is acted upon by an agent in one of two ways: its mover may itself be acted upon by another; or its mover may act of itself. A mover acting of itself may, moreover, affect an object [18a] directly [17a]; or it may do so by means of intermediate agents [6c], as when a pry which moves a stone is wielded by a hand in the control of a man who does not have another mover. We recognize as "movers" both the first and the last in the series; especially the first, which is not moved by the last but moves it and which can act without the last, whereas the last cannot act without the first (a pry, for example, can-

not be a "mover" without being itself "moved" by a man). Everything that is in process, then, must be acted upon by an agent, the agent being in turn acted upon by another or not being so acted upon. And a moved mover requires a first unmoved mover, whereas the latter does not require the former; for there can be no infinite series of moved movers, since an infinite series has no first term. If, then, everything that is in movement is acted upon by an agent, and the first mover, though acted upon, is not acted upon by something else, then the first mover must be self-moved.

The same argument may be put in another way. Every agent acts upon an object by some means, whether by its own agency or by some other means. Thus, a man moves a stone without or with the aid of a pry; and something may be knocked down by a gust of wind or by a stone driven by a wind. But movement by any means is impossible without a mover acting by its own agency. Anything which is an agent in its own right does not require the backing of another; whereas a dependent agent requires an independent one, or else there would be an infinite regress of instrumental agents. A series of moved movers must have a limit, then, if it is not to extend into infinity: if a pry which moves a stone is moved by a hand, it is the hand that moves the pry; if something else does the moving with the hand, the hand is moved by something other than itself. Accordingly, a series of instrumental agents presupposes one that is self-directing. If the latter, then, is acted upon, and there is nothing else to act upon it, such a mover must be self-moved. So we have another argument which shows that, if an object is not directly acted upon by a self-mover, the series of its movers can be traced to a self-mover.

The same result may be reached in still another way. Suppose that every movement is due to a moved mover. On one alternative, being moved would be an accidental trait of the movers [188c]; so that what is being acted upon would act—but not *because* it is being acted upon. On the opposite alternative, it would be essential to agents that they be acted upon.

According to the former alternative, then, being acted upon would be accidental to agents; and an agent would not be acted upon necessarily. If this were so, it would be possible for a time to come when no being whatever would be acted upon; for what is accidental is not necessary but has the possibility of not-being. However, an assumed possibility can have no impossible consequence (although it may have a false one). But it is impossible that there should be no movement; we have proved* it necessary that there should always be movement.

* viii.1.

Then, too, it is a reasonable conclusion [that there must be an agent not acted upon by another]. For there must be a thing acted upon, an agent, and that whereby the latter acts upon the former; there must be all three of these. The thing moved must be moved, though it need not move anything. The means by which the movement is effected must be both an agent and acted upon, since it changes together with the object moved and has contact and continuity with it; as is plain from a thing which puts another in motion, where the two must have at least some contact. And the mover which is not a means of this sort must be unmoved. Moreover, we see things which can be moved but cannot initiate [82] movement; and we see beings which are not moved by anything else, but only by themselves; and so it would seem probable, if not necessary, that there is also a third kind of being, namely, an unmoved mover. Hence, when Anaxagoras presented "mind" as the source of movement, he was right in describing this "mind" as impassive and unmixed. How could it be a mover unless it were itself unmoved? And if it were not aloof from the mixture of things, how could it dominate?

According to the second alternative, agents would not be acted upon accidentally but necessarily; and if an agent were not acted upon, it would not act upon anything. Hence, an agent would either have to undergo the same kind [20] of process which it initiates; or else it would have to undergo a process of a different kind. I mean, for example, that either nothing could heat or heal or carry anything unless it were itself being heated or healed or carried; or else nothing could heal anything without being carried or carry anything without increasing in size. This is evidently impossible. We would have to identify [36] the processes down to their smallest [41] parts [75]; so that a teacher of geometry would have to be learning precisely what he is teaching, and one who is throwing anything would have to be thrown in exactly the same manner! Or we would have to derive each kind of process from one of a different kind [19]; so that a carrier would be expanded, what expands it would be qualitatively altered, and what alters this would be subjected to some further sort of process! But such a series would soon come to a stop, since the kinds of process are limited in number. If it be suggested that the series reverts to its starting-point as if what does the altering would be carried from one place to another, this would amount to saying directly that a carrier is being carried or that a teacher is being taught; for, clearly, a thing is acted upon not only by a direct agent but more especially by a prior one. But the suggestion made is impossible; it would have the consequence that a teacher would still be learning and would be ignorant of what he knows.

Then, too, there is an absurdity greater than any pointed out in the previous arguments. If everything that is moved has only a moved mover, then everything capable of moving anything would be capable of being moved. This would be like saying that every remedy is remediable and that every builder is buildable! Such an agent would be acted upon either directly or indirectly. Thus, if an agent, in directly acting upon something, is acted upon by something else in a different way (as when one capable of effecting a cure would therefore be capable of being taught), still, as we have said before, the series would soon revert to the same kind of process. But the first alternative is impossible [as in the case of a teacher still having to learn what he is teaching]; and the second alternative is fanciful, for it would be absurd to suppose that what can alter anything must therefore necessarily increase in size. What is acted upon, then, is not necessarily acted upon by something else which would, moreover, be a moved mover; the series has a limit. Consequently, what is acted upon will in the first instance be acted upon by something that is at rest, or by itself.

Besides, if we had to raise the question whether the primary [82] moving [109] factor [83] is self-moved or is moved by something else, anyone would reply by proposing the former. For a factor [15a] which is independent [2] ontologically [1] is always prior [17] in the order of explanation [83] to a factor having a dependent [39a] status [16].

At this point, our inquiry must make a fresh [16b] start [82]. We must ask: If anything moves itself, how in plain terms does it do so?

Everything in movement is necessarily infinitely divisible, for our general reflections on nature† have shown that everything essentially in movement is continuous; so that it would be impossible for anything moving itself to move itself with all its parts. For in such an event, a self-mover, though specifically [20] one and indivisible [41], would totally and in an identical transaction place and be placed or alter and be altered and therefore teach and be taught or heal and be healed. Moreover, we have shown‡ that what is acted upon is something movable. But what is movable is not actually but only potentially in movement; what is potential is, moreover, only on the road [112] to actuality; and movement is an uncompleted actualization of what is movable. An agent, however, functions as a fully active being [9]: it is a hot body which heats another body; and, in general, a formative act [116d] presupposes possession of the form [20]. Thus, [on the view we are examining], the same thing would as such be at once hot and not hot; and a similar consequence would result wherever an agent

† vi.4.234b10-20.

‡ viii.1.251a9-16.

would have the quality it imparts [37b].§ Accordingly, a self-mover must have one aspect according to which it initiates a process and another aspect according to which it undergoes a process.

It would evidently be impossible for anything to move itself by each of two parts moving the other. For one thing, there would then be no first mover; rather would each part, after all, be moving itself. But a process is better accounted for [83a] by a prior agent than by a dependent [136] one, by a self-mover than by a mover moved by something else, and by an agent farther from the thing acted upon but closer to the beginning of the process than by an agent relatively intermediate. For another thing, the part moving the other part would not necessarily be moved by anything other than itself; only incidentally would it be moved by the other part in return. In the possible failure of the latter case to occur, there would be only a part that is moved and another active as the moved mover. Then, too, the eternity of process does not require that an agent be acted upon in return but only that there be some unmoved or self-moved mover. And besides, an agent [necessarily acted upon in return] would have to be acted upon in a corresponding way; for example, what gives heat would have to be receiving heat.

It would also be impossible for anything to act primarily as a self-mover by one or some of its parts moving themselves. For a self-moved whole would be moved either by one of its parts or as a whole by itself as a whole. If, on the one hand, a self-mover were to operate as such only by way of some self-moved part, this part would be the primary self-mover; and this part would, accordingly, move itself independently, whereas the whole would not be moving itself in independence of the part. If, on the other hand, the whole were self-moved as such, any of its parts would be only incidentally self-moved. Let us therefore suppose that they are not moving themselves. Then a part of the whole would be an unmoved mover, and another part would be acted upon; for this is the only way in which any whole could operate as a self-mover. For any whole to move itself, there would have to be a part initiating and a part undergoing the process; thus, the agent by which *AB* would be moved would be both *AB* itself and a part *A*.

We can show that, since a mover may be moved by something else or may be unmoved, and since a thing that is moved may or may not move something else, therefore a self-mover must have as one part an unmoved mover and as another part something that is moved but that does not necessarily move something else (but at best only by chance). Let a self-moving whole *ABC* have a part *A*, which is an unmoved

§ viii.4.255a21-23.

mover; a part *B*, which is moved by *A* and moves a part *C*; and a part *C*, which is a moved nonmover. (There could be more intermediate terms before *C*, but one suffices.) By removing *C*, we get a self-moving whole *AB*, in which *A* acts upon something and *B* is acted upon, whereas *C* would not move itself or be moved at all. Also, *BC* would not move itself without *A*; for *B* would be a mover of the kind which is moved, not by any of its own parts, but by something else. Hence only *AB* moves itself. So a self-moving whole need have but two parts: one, an unmoved mover; and the other, something moved which does not necessarily move anything else. And the two parts must be in mutual contact; or, at any rate, one part must be in contact with the other. If the mover is a continuum, as the thing moved must be,‖ then the mover and the thing moved are in mutual contact. Clearly, then, it is not because some part is able to move itself that a whole moves itself, but it moves itself as a whole; and it both communicates and receives movement because it has a part which communicates and a part which receives the process. It is not the whole, but it is the part *A*, which communicates the process; as it is not the whole, but it is only the part *B*, which receives it. (For *C* to be moved by *A*, would be impossible.¶)

However, there is this question to be considered: if we remove a part from *A* (if the unmoved mover is a continuum) or from *B* (which is acted upon), would what is left of *A* communicate any process or what is left of *B* receive any? If so, the whole *AB* would not be self-moved in a primary way; but, part of *AB* having been removed, the remaining part would form a new whole *AB* which would presumably be moving itself. Perhaps there is nothing to prevent each of the two parts or at least the part acted upon from being potentially divisible, yet not actually divided; whereas, after its actual division, it would no longer be in possession of the same nature [or power]. Hence there is nothing in things potentially divisible to prevent the whole from being a self-mover, even in a primary sense.

It is evident, then, that a prime mover is unmoved. What is acted upon by something may be referred directly to the first unmoved mover or to something which is itself also acted upon but which moves and stops itself. In either case, what primarily acts upon anything that is in process is an unmoved mover.**

‖ *On Generation and Corruption* i.6.323a21.

¶ vi.4.234b10-20; viii.5.257a34.

** *De Anima* i.3; Plato *Laws* x.894.

6. The First Mover as Eternal, One, and Immovable

Since movement necessarily goes on eternally and without interruption,* there must be one or more primary movers; and the prime mover must be unmoved. Whether each individual "unmoved mover" is eternal, has nothing to do with our present argument. We are trying to show that there must be something which is unmoved in the sense that it transcends all change (inherent or accidental), but which has the function of moving [109c] other things. Suppose it possible, if anyone insists [177], for some things to be for a period of time and then not to be without ever passing through any gradual process of generation and destruction; for if anything having no parts is at one time to be and at another not to be, it would have to "be" and then "not be" without gradually changing to either of these conditions. Suppose it possible also for some "principal [82] unmoved movers" to be at one time and then not to be. Still, this cannot be true of all of them. Clearly, there must be something [eternal] to account [83] for self-movers which would for a while be and then be no longer; for every *self-mover* must have magnitude, since nothing which is without parts can be moved, even though it is not necessary for every *mover* to have magnitude. The continuous going on of generation and destruction, then, cannot be explained [83] by any single unmoved being which is transitory; nor can it be explained by a succession of transitory beings bringing different things to pass. Neither any one of them taken singly nor all of them taken together can provide foundations [83] for anything eternal and continuous: the movers must be in eternal and necessary relation [33] to the world's eventfulness; whereas they are [supposedly] indefinite [130] in number [150] and are not totally simultaneous beings. Clearly, then, even if some unmoved movers and many self-movers perish and are replaced by others a thousand times and even if one unmoved being moves another being and the latter moves still another, there is something nevertheless which encompasses all of them, which is distinct [74] from any of them, and to which some things owe [83] their being and others their nonbeing and on which change depends for its continuity; and whereas these movers induce [83] movement in other beings, their own movements are evoked by it.

Since movement is eternal, the first mover must also be eternal if there is but one such mover; and if there is more than one prime mover, there must be a plurality of eternal movers. However, one is preferable to many† and a finite number is preferable to an infinite

* viii.1, 2.252b17-28, 253a7-21.

† *Metaphysics* xii.10.1076a4.

number of them.‡ For a simpler [131a] assumption [65] throws more light upon the same facts [3b], since it is more fitting for the determinate [131a] and the better to prevail [82f] in the natural course of things whenever possible [12b]. Then, too, if one being is the first of things unmoved and is eternal, that one suffices to be related to other beings as the beginning of their movement.

We have further [4a] evidence [59d] for the unity and eternity of a first mover. We have shown that movement must be eternal; and it must therefore be continuous, for the eternal is continuous whereas the successive is not. But if movement is to be continuous, it must have unity; and to have unity, it must have a unitary mover and a unitary subject. For a movement having one mover after another would not, taken as a whole, be continuous but would be successive.

The conviction concerning a first mover may be confirmed by a reexamination of the principles pertaining to movers. Some beings are evidently sometimes in movement and sometimes in a state of rest. From this, it has become clear to us that neither are all things transient, nor are they all inert, nor are some always transient and the others always inert. The test [63] of these alternatives is at hand in the things which have the twofold power of being in movement and being at rest. But this kind of beings is obvious to all. Hence, we want to show that each of two other kinds has a distinct nature: some things are always independent of movement; and some things are always subject to movement. In proceeding to this point, we have found [64] that everything that is in movement is acted upon by an agent, that this agent is either unmoved or moved, and that every moved mover in a series is acted upon either by itself or by something else; and thus we arrived at the conclusion [65] that movements are started by self-movers among the things moved but, taken in their universality, by an unmoved mover. Now, we see beings which are evidently of the kind that move themselves; namely, living beings, especially animals. These have given occasion for the opinion that movement may arise in things where, before, there was no movement at all; because we seem to see such beings pass from an unmoved state of being to a state of being in movement. But what we need to grasp is that they move themselves in one way only and, strictly speaking, not even in that. The crucial factor is not in themselves. On the contrary, there are natural movements in animals, such as growth and decline and respiration, which they do not produce of themselves but which they undergo even in a state of rest when they are not moving themselves. The crucial factor is their environment. They draw upon the environment for many things,

‡ i.6.189a15.

such as food; and the nourishment they take in accounts for some of their movements. Thus, they sleep while their food is being digested; when it is being distributed, they awake and move themselves. What primarily starts their movements, therefore, is external to them. For this reason, too, they do not move themselves continuously. It is something else that moves them; and this itself undergoes movement and change as it comes into relation with any being that moves itself. The [so-called] "prime mover or factor" in all these self-moving beings is also "self-moved," but only incidentally; for it is the body which changes its place, with the consequence that the being [supposedly] acting on the body like a lever also moves itself [incidentally].

Hence we may be sure that anything unmoved which incidentally moves itself cannot give rise to continuous movement; so that, since there must be movement continuously, the first mover must be immovable even incidentally. This must be so if in the world of beings there is to be, as we have said, unceasing and undying movement; and also if being itself is to continue in the same status of being. For if the first principle persists, the "All" will also persist, since the "All" is continuous with its first principle. As for anything that is incidentally moved by something else, this is different from any being incidentally moved by itself: only perishable things are incidentally moved by themselves; whereas being incidentally moved by something else belongs even to some principles of celestial bodies, namely, of such as have complex orbits.

If there is an eternal mover which is eternally unmoved, then what is directly moved by it must also be eternal. This clearly follows also from the fact that, without a moved mover, there would be no generation or destruction or transformation of other things. For an unmoved mover acts forever in a uniform way so as to evoke a single type of movement; its relation to its object is not subject to change. Not so with a [celestial] body which is moved by a moved mover [namely, the sphere of fixed stars], the latter being moved directly by the unmoved mover. Such a body [for example, the sun] varies in its relations to the things [188c] it influences. It therefore does not institute [83] a process which is ever the same. Being in opposite [50] positions [132] and states [20] at different times, it will affect any of the things which it controls in opposite ways; so that they will sometimes be at rest and sometimes be in movement.

What we have said also answers our previous question: why is it that all things are not transient or all inert or some always transient and the others always inert, but some things are sometimes in movement and sometimes in a state of rest? The reason [83] for this is now clear.

Whereas some things are always subject to movement because they are moved by an eternal unmoved mover, other things are necessarily subject to change [or alternating movement and rest] because they are moved by a mover subject to movement and change. But, as has been said, the unmoved mover, abiding in a simple, unvarying, and identical condition, induces a single simple movement.

7. Local Motion as Primary and Continuous

Let us now make a fresh start, in order to shed further light on these considerations. Can any movement be continuous; and if so, which? And which kind of movement is primary [or most inclusive]? Clearly, if there must always be movement and a certain kind must be primary and continuous, this is the kind which the first mover induces; and this kind of movement is necessarily single, continuous, and primary.

Now, of the three kinds of movement, quantitative [142a], qualitative [35a], and local [132], the primary one must be local motion [121]. To begin with, increase presupposes [82g] qualitative alteration. A subject is increased, in one way, by its like; in another way, by its unlike. We say that a contrary is food to a contrary; but it is assimilated by becoming like to like, and this transformation to a contrary state must be a qualitative alteration. And if anything is altered, there must be something which alters it; for example, something which brings about the passage from its potential to its actual hot condition. So it is clear that the mover does not have a constant relation to the thing altered but is sometimes closer to it and sometimes farther away from it. And these interrelations cannot occur [82f] without local motion. Hence, if there must always be movement, then there must always be, first among movements, local motion; and if there is a primary and a non-primary [18] kind of local motion, then the primary kind of local motion must be always.

Then, too, all modifications [35b] are rooted [82] in condensation and rarefaction: heavy and light, soft and hard, hot and cold,* seem to be like [4] density and rarity. These, in turn, are a combination and a separation, respectively; and it is said that the generation and destruction of primary beings [26] are based [39a] on combination and separation.† But in being combined and separated, things must change from one place to another.‡ Moreover, also in their increase or diminution extended things must undergo change in place.

* *On Generation and Corruption* ii.2.329b24-30.

† Anaximander, Anaxagoras, Empedocles, Democritus.

‡ viii.4.255a34; *Metaphysics* ix.5.

Further reflection discloses still another indication of the primacy of local motion. In movement as in other affairs, "first" has more than one meaning.§ That is "prior" on whose being that of other things depends but whose being does not depend on theirs; or which is prior in time; or which is prior in full being [26].

First, there must be movement continuously, and continuous movement would have greater continuity of being than would successive movement; the former, too, would be better than the latter, and we invariably assume the better to be present [82f] in nature if possible; motion, moreover, can be continuous (as we shall prove later‖ and now take for granted), but only local motion can be such. Consequently, local motion must be primary. For what is subject to local motion is not necessarily subject to quantitative or to qualitative change or to generation or destruction; but none of these changes is possible without that continuous motion which the first mover induces.

Again, local motion is primary in time, since it is the only movement to which eternal bodies can be subject.¶ To be sure, local motion is the last movement any living individual comes by; for after birth, living individuals first change in quality and grow before they achieve the competence [100d] requisite to moving locally. But prior to them there must be something else, having power of local motion, to bring them into being; there must be a parent which, in producing its offspring, is not itself being generated. Although generation may therefore be held to come first of any movements because the thing [subject to movement] must be first generated, this is true only of something generated taken individually. Generated things must be preceded by something else which is subject to movement and which, instead of having to be generated, is a being; as this being must in turn have something prior to it.** Generation, then, cannot be primary, since all things subject to movement would in that case be perishable; and clearly, therefore, none of the subsequent movements (increase, alteration, diminution, destruction) can be prior to local motion. All of these come after generation; so that, even if generation is not prior to local motion, neither can any of the other changes be prior to local motion.

In general, what is being generated is still undeveloped [100f] and only on its way [114g] to its prime [82]; so that what is later in the order of genesis is prior in the order of nature. Thus, in the order of generated beings, the movement which appears [82f] at the final stage of their development is local motion. That is why some living beings,

§ *Metaphysics* v.11.

‖ viii.8.

¶ ii.4.196a24-b5, 6.198a5-13.

** ii.2.194b13.

such as plants and many kinds of animals not provided with the requisite organs, are motionless; whereas motion is in the power [82f] of animals free from such imperfection. If local motion, then, characterizes [82f] animals in the degree in which they have attained to their most fully developed nature, local motion must be prior to all other forms of movement in the order of complete being [26]. Another reason is that any being deviates less from its normal state [26] in local motion than in any other kind of movement; in this movement alone its being does not become transformed in the sense in which a trait it possesses becomes transformed in qualitative alteration or its size in an increase or diminution.

Above all, local motion is clearly the chief [55b] kind of movement belonging to anything that moves itself. And among all the things that initiate and undergo movement, we single out [46] the self-mover as the foremost [17a] agent [82] acting upon the things that are in movement.

Having shown that local motion is the primary kind of movement, we must now proceed to determine which is the primary form of local motion. This analysis [198] will also bear out [59d] our present and previous†† assumption that it is possible for some motion to be continuous and eternal.

It is apparent, in the light of certain facts, that no movement other than local motion can be continuous. Every other movement or change proceeds from an opposite to an opposite: in generation and destruction, the termini [72b] are being and nonbeing; in qualitative alteration, contrary qualities [35a]; in increase and diminution, a large and a small or a complete and a deficient size. Moreover, contrary changes have contrary termini. But a being which is not always in motion must for some time previous to that motion be at rest. Obviously, then, what is changing [from one motion to a contrary motion] must [for some time] be at one of the contraries as at a resting-place. So, too, with opposite kinds of change: destruction and generation are mutually opposed as such [105]; and a particular [40] destruction and a particular generation are mutually opposed. Therefore, if it is impossible for anything to be transformed in opposite ways at the same time, the change will not be continuous, but a period of time must intervene between the opposite changes. Whether these opposite changes (generation and destruction) are contraries or not, makes no difference; all that matters to the argument is that it be impossible for the same thing to be possessed of both at the same time. Neither is it important [163] for the argument if a thing need not be in a state of rest in one of the

†† viii.7.260b23, 3.253a29.

opposite states; nor if a change does not have as its contrary a state of rest. Undoubtedly, what is-not at all is not in a state of rest; and destruction has its terminus in nonbeing. What is important is the time-interval; for if a period of time intervenes [between opposite changes], the change cannot be continuous. So the significant [163] point in the case of the motions was not their contrariety but the impossibility of both occurring at the same time. We need not be disturbed by the consequence that one thing, motion, has more than one contrary: rest as well as motion in the contrary direction. All we need to grasp is that a motion is in some sense opposed to both (just as the equal or a measure is opposed both to the greater and to the less) and that opposite motions or changes cannot belong to the same thing at the same time. Moreover, it would be a strange view of generation and destruction, or of things in general, if what has been generated must at once be in process of being destroyed without enduring for any length of time at all. We may apply this conviction to other kinds of change as well, since it would be natural for all of them to follow the same [57c] pattern [33].

8. Circular Motion as Continuous and Infinite

Let us now explain [36] which kind of motion, single and continuous, can be infinite; namely, circular motion.* Every mobile being moves in a circle or in a straight line or in a composite figure; and therefore, if either of the simple motions is not continuous, the composite motion cannot be continuous either. Clearly, anything which moves in a finite straight line cannot move continuously: it must turn back; and the motions of what turns back in a straight line are contrary, whether up and down or forward and backward or left and right (for these are the pairs of contraries pertaining to place). We have already† defined a single and continuous movement as the movement of a single subject in a single period of time and in a specifically single respect. We had to take into account all three: the subject, such as a man or a god; the time, such as the duration of the movement; and also the respect, that is, the place or quality or form or magnitude. But contraries, so far from being single, differ specifically; in particular, those which we have named differ locally. Thus, a motion from *A* to *B* is contrary to a motion from *B* to *A*, as is shown [38a] by the fact that, if they were to occur simultaneously, they would check and stop each other. It would be the same with motion on a circle: a motion from *A* to *B* is contrary to a motion from *A* to *C*; they would

* viii.2.252b7-12, 28-253a2.
† v.4.

check each other even if they were to go on continuously without having to turn back, since contraries are mutually destructive or at least obstructive. (Fig. 7.) A lateral motion, on the other hand, is not contrary to an upward motion.

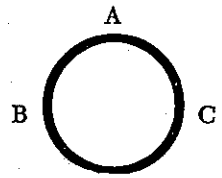

Fig. 7.

That motion in a straight line cannot be continuous, is especially apparent [59d] from the fact that turning back requires a pause. This is true regardless of whether the motion is along a straight line or a circle; for rotation is not the same as circular motion which includes, besides the continuous sort, that which turns back when it comes to its starting-point. The need of a pause in turning back may be verified [183] by sense perception as well as by argument. We may begin the argument with the distinction between three points: the beginning, the middle, and the end; where the middle is a beginning relatively to the end and an end relatively to the beginning and thus, though numerically one, by definition two. We may also make use of the distinction between being potentially and being actually. In the straight line, then, any point between the extremes is a middle potentially; but it is not a middle actually unless a thing in motion divides the line at that point by stopping there and resuming its motion, and then the middle becomes the beginning of the later motion and the end of the earlier motion (as when *A* in its motion stops at *B* and resumes its motion toward *C*). As long as the motion is continuous, however, *A* cannot have come to be or ceased to be at *B;* it is there only at a moment, not for any time—except that it is there within the period of time in which the moment constitutes a division. If someone were to insist [64] that *A* had come to be and ceased to be at *B*, then the moving thing *A* would always be coming to a stop: for it is impossible for *A* to have at the same time come to be and ceased to be at *B*, so that it must have done so at different moments; and there would therefore be an interval of time, so that *A* would be in a state of rest at *B* and likewise at all the other points (since the same reasoning would apply to all). Thus, when *A* uses the middle *B* as both an end and a beginning, it must pause there because it treats *B* as two (just as

anyone might do in thinking about it). But a body which has finished its motion and come to rest has ceased to be at the starting-point *A* and come to be at *C*.

We are thus in a position to reply to a difficulty which may be raised in this connection. Take [a distance] *E* to be equal to [a distance] *F;* take *A* to be in continuous motion from the starting-point of *E* to *C;* and at the same time when *A* is at point *B*, take *D* to be in uniform motion from the starting-point of *F* to *G* with the same velocity as *A*. Then *D* would arrive at *G* before *A* arrives at *C*, for the reason that "the first to start must be the first to arrive." (Fig. 8.) *A* would

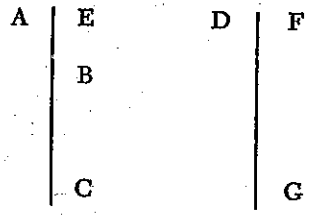

Fig. 8.

lag behind because *A* would not have simultaneously come and gone at point *B;* had *A* come and gone simultaneously, *A* would not have been overtaken; to be overtaken, *A* would have to linger. But then we ought not to make the assumption that, when *A* was at *B*, *D* was moving from the starting-point of *F!* For if *A* has "come to" *B*, *A* will also have "gone from" *B;* and the process of going is not simultaneous with that of coming. But *A* was at *B*, not during a period of time, but at a [momentary] "section" of time! It is impossible, then, for us to use the terms cited in a description of continuous motion. On the other hand, it is necessary for us to take recourse to those terms in a description of the kind of motion which involves turning back. Take *G* moving up to *D* and then moving back down. *G* thus uses the single extreme point *D* in two ways, both as an end and as a beginning; and *G* must therefore pause at *D*. But *G* cannot have simultaneously come and gone at *D*, since it would then both be and not be at *D* at the same moment. We cannot apply to this case the solution of the former problem: we cannot say that *G* is at *D* "at a moment" and has not been "coming to" *D* or "going from" *D;* for *D* must in this case be an actual goal, not a merely potential one. Although the intermediate points in the motion have potential being, the being of the terminus is actual: it is an end from below and a beginning from above; and so it is the end of the upward motion and the beginning of the down-

ward motion. What turns back in a straight line, then, must pause; so that there cannot be any continuous eternal motion [to and fro] in a straight line.

This analysis [55c] also provides us with an answer to the objection drawn from Zeno's [first] argument.‡ Shall we suppose [46c] that half [of a distance] must be traversed [before the whole]; that the series of half-distances is infinite; and that it is impossible to traverse an infinite number of distances? Or stating the question in another form, shall we suppose that one ought to be able to count the halfway points as a body in motion comes to them; so that, when the body has traversed the whole distance, one would have counted an infinite number—which is admittedly impossible?

In our former accounts of motion, we solved this problem in terms of time being infinitely divisible: there is nothing strange in traversing an infinitely divisible distance in an infinitely divisible time, the infinity inhering [82f] in the distance accords [57c] with that inhering in the time. This solution was a sufficient answer to the questioner who asked: Can an infinite number of things be traversed or counted in a finite time? But this solution does not state adequately the true [7a] state of affairs [188c]. Suppose one were to leave out the reference to distance in the question whether an infinite distance can be covered in a finite period of time and one were, instead, to ask the question about the time itself, which is infinitely divisible. The solution given would then no longer be adequate; instead, the true one would have to be presented, which we have set forth in the foregoing arguments. One who divides a continuum into two halves treats a single point as two by taking it as both a beginning and an end. This is done no less by one who counts the halves than by one who bisects a line. Neither a line nor a motion, when thus divided, is continuous: a continuous motion is a motion over a continuum; and although the latter contains an infinite number of halves, it contains them potentially only, not actually. Taking the halves as actual would lead to getting a motion which is not continuous, but which is arrested. This would also be the obvious result of counting the halves: a single point would have to be counted as two, as the end of one half and the beginning of another; that is, if what is being counted is not a single continuous whole but is two halves. Hence, the question whether an infinite number of things can be traversed either in time or in distance must be answered by saying: in one sense, yes; in another sense, no. If there is an actually infinite number [of moments or points], it is not possible [to pass through them]; if they are potentially only, it is possible [to pass through them]. Anything which is in continuous motion has crossed an infinite number of points incidentally, but not directly [105]; for a line can incidentally be bisected without limit, but its primary way [26] of being [23] is altogether different [16].

‡ vi.2.233a21-31; 9.239b11-14.

As for a moment or temporal "point" which keeps "before" and "after" apart, any state of affairs [188c] has in any "moment" only such traits as it has afterwards; for, clearly, if we were not to regard a moment in this way, then a given state of affairs would at once both be and not be as it is and would not be so at the very time when it has come into being. True, a moment common to both the earlier and the later time is numerically single; but it is not one and the same in its definition as the end of the earlier and the beginning of the later time. And in its relation to a state of affairs, a moment always belongs to a situation in its later phase [35a]. Take a time *ACB* and an object *D* which is white at time *A* and not white at time *B;* at time *C*, then, *D* is both white and not white. For if *D* was white during the whole of time *A*, it is white in any part of *A; D* is not white in any part of *B;* and *C* is in both *A* and *B*. But in that case we ought not to agree to *D* being white during the whole of *A;* we ought rather to exclude its last moment *C*, which already belongs to the later stage. If in the whole of time *A* the "nonwhite" state was coming into being and the "white" state was passing out of being, then at time *C* the "nonwhite" state has completely come into being and the "white" state has completely passed out of being. Consequently, *C* is the first moment at which *D* may truly be said to be ("white" or) "not white" [as the case may be]. If not, then when *D* has become white, it is not white, and when it has ceased to be white, it is white; or else *D* would have to be both white and not white at the same time and would indeed both have to be and not to be at all. But if anything, after not being [1b], has come [116] to be [1] and, while it is still becoming, still is-not, the time cannot be divided into atomic times! For if *D* was becoming white in time *A* and if *D* both has become and is white in another "atomic" but "contiguous" time *B*, that is, if *D* was becoming white but was not white in time *A* but is white in time *B*, then there must have been between *A* and *B* a productive process [116a] and therefore also a time in which it happened [116]. This argument is not addressed to those who deny atomic times. For them, a state of affairs both has come into being and is at the last moment of the very time in which it was coming into being; and this moment has no other "contiguous" or "successive" to it, whereas "atomic times" are [presumably] "successive." Evidently, too, if *D* was becoming white in the whole of time *A*, the [supposed] "time" in which it both has become and was becoming such is no greater than the whole of the time in which it was becoming such.

Now, we have presented various concrete [55] arguments to co
vince anyone [that circular motion only can be continuous]; but t
same conclusion follows also from a number of arguments based
dialectical [36] considerations [195a]. Anything which is in continuo
motion must, before arriving at point *B*, have been moving towards th
point, provided that nothing deflects the moving body from its pat
and it must have been moving towards *B* not only when approachi
B but from the very beginning of its motion, for why should it have be
doing so at one moment rather than at another? Such is the case al
in types of movement other than local motion. But if anything we
in continuous motion from *A* to *C* and back to *A*, it would [on th
principle stated], while still moving from *A* to *C*, be moving also fro
C to *A;* in other words, it would simultaneously have contrary motio
(since motions to and fro in a straight line are contraries). At th
same time, the thing would be moving from *C*, where it is not; b
since this is impossible, it must come to a halt at *C*. Accordingly, it
motion is not a single one; for no motion is single which is broken b
a pause.

That this finding applies to every kind of movement, can be show
from more general considerations. We have enumerated§ all th
kinds of movement to which things can be subject; and these kind
of movement have for their opposites corresponding kinds of rest. No
what is not always subject to a given distinct kind of movement
do not mean a given "particular" movement) must be subject to
prior opposing rest (which is the "privation" of the movement). Mor
over, since motions to and fro in a straight line are contraries, an
nothing can simultaneously have two such contrary motions as on
from *A* to *C* and one from *C* to *A*, these motions are not simultaneou
but relatively to the former, the latter motion is future. All this being
so, the latter motion must be preceded by a rest at *C*, which we hav
found‖ to be the state of rest opposed to the motion from *C*. Clearly
then, the motion [from *A* to *C* and from *C* to *A*] is not continuous
There is another argument which is even more intimately related [55
to the problem in hand. Take something as having simultaneously
ceased to be nonwhite and become white. If the thing is then being
altered to and fro continuously without remaining white for some time
it would have been subject to no less than three changes at the same
time: having ceased to be nonwhite, having become white, and having
become nonwhite. Besides, although the time [of movement to and
fro] is continuous, it does not follow that the movement is therefore

§ v.2.

‖ v.6.229b28-230a7.

continuous; rather does it form a sequence [136b].¶ How can two such
contraries as white and black have the same limit [18a]? [The last
stage in which anything is white cannot be identical with the first
stage in which it is black.]

Circular motion, however, can have unity and continuity without any
impossible consequence. In circular motion away from *A*, a body is
forthwith in position for motion towards *A*, since it is then in motion
towards the point at which it will arrive. It does not simultaneously
execute contrary or opposite motions, for not every motion to a point
is contrary or opposite to a motion from that point. Such motions are
contrary if they are motions along a straight line, because the latter
has points that are contrary in place (for example, the points at the
ends of a diameter are at the greatest possible distance from each
other); and such motions are opposites if they are motions along the
same line. Nothing, therefore, prevents circular motion from being
continuous and from going on incessantly: circular motion proceeds
from a point back to the point itself, whereas motion along a straight
line proceeds from the original point to a different one; and circular
motion does not, like motion along a straight line, proceed repeatedly
between the same termini. A motion can have continuity, then, al-
though it is ever taking place in different positions; but motions within
the same limits cannot have continuity, since a moving thing would
then be moving in opposite directions at once. Neither, therefore, can
there be continuous motion in a semicircle or in any other arc, where a
moving body has to pass over the same ground and through the same
contrary changes again and again. Such motions do not join their end
and beginning, as circular motion does; and the latter is therefore
exclusively "finished" [100].

This distinction also shows that the other kinds of movement cannot
be continuous. In all of them, the same passage has to be made over
and over: in qualitative alteration, through the intermediate quali-
ties; in quantitative change, through the intermediate sizes; and simi-
larly in generation and destruction. Whether we take the intermediate
stages of a change to be few or many or whether we add any to them
or subtract any from them, repeated changes in any case pass through
the same stages. Those physicists** are clearly in error, then, who
declare all sensible things to be in constant motion: the kind of process
through which these things pass must be one of those we have dis-
tinguished, particularly (according to their descriptions) qualitative
alteration; for they say that things are in constant flux and decay and

¶ v.3.226a34, 227a10.

** Heracliteans.

even that generation and destruction is a qualitative alteration. But our argument has been general, extending to all movement and showing that no movement can be continuous except circular motion; neither, then, can qualitative or quantitative change.

Let this suffice to prove that no change can be infinite or continuous, with the exception of circular motion.

9. Circular Motion as Primary; Recapitulation

Clearly, circular motion is the primary form of local motion. We have divided* local motion into the circular, rectilinear, and composite. But the simple kinds must have priority over the composite, which is made up of them; and the circular must have priority over the rectilinear, than which it is the simpler and more complete. Motion along an infinite straight line is impossible, since nothing is infinite in this way; and if there were an infinite of this sort, nothing could span it (since the impossible does not happen, and it is impossible for the infinite to be spanned). And motion to and fro along a finite line is a compound of two motions, whereas a single motion along a finite line is incomplete and soon at an end. But the complete is prior to the incomplete, and the imperishable is prior to the perishable, in the order of nature and of definition and of time. Then, too, a motion which can be eternal has priority over one which cannot. And circular motion can be eternal, as no other motion or change can; in the latter, pauses must occur at which movement ceases.

There are good reasons [60c] for the fact [3b] that circular motion presents a contrast to the rectilinear in having unity and continuity. A straight line contains a definite beginning, middle, and end; it thus has points at which a moving body starts and stops and at both of which that body is therefore in a state of rest. A circle, however, does not have such definite points: why should one point on a circle be a limit rather than another? Any point on a circle may serve as beginning or middle or end; with the consequence that a body in circular motion is in some sense always and never at a beginning and at an end. Hence a [revolving] sphere is in a sense both in motion and at rest, since it remains at the same place. The reason [83] for this is that the center is at once the primary, intermediate, and ultimate principle [of the circle or the sphere]; so that, since the center is not on the circumference, the body which is always moving round the middle, instead of to an end, has no end-point at which it can come to rest and, since the center is

* viii.8.261b28.
† iii.5, 8.

stationary, the whole is always somehow both at rest as well as in continuous motion. Moreover, because the measure of all other movements is rotation,‡ this must be the primary movement, for all things are measured by what *is* primary; and conversely, because rotation is primary, it is the measure of all other movements. Then, again, circular motion alone can be uniform [in velocity]. In rectilinear motion, things do not move with uniform speed from their starting-point and towards their finishing-point; the greater the distance they put between themselves and their place of rest, the faster they move. Circular motion alone is such [101c] as to have neither its beginning nor its end within itself; but [the center which functions in both of these ways is] outside [the circumference].

All the thinkers who have given [34] attention [167] to movement uphold [199] the primacy of local motion inasmuch as they credit [46d] the things producing local motion with being the originating principles of movement. Thus, "love" and "strife" are said to "move" things by combining and separating them, respectively; and combination and separation are forms of local motion. Thus, too, Anaxagoras attributes to "mind" as the "first mover" the function of separating things. Likewise, those who do not explicitly recognize [36] a moving factor [83], but have provided for motion by having recourse to "the void," ascribe local motion to nature, since this is the kind of movement which goes on in the "void" as in a place; other kinds of movement, they say, belong not to first beings but to beings which are made up of them and which increase, decline, and are altered in accordance with the combinations and separations of their constituent atoms. In much the same way, those who base [149c] generation and destruction on density and rarity reduce [149a] them to combination and separation. In addition, those who regard [34] the soul as the moving factor [83] designate [46] "what moves itself" as the source of movement; but the self-induced movement of living things is local motion. Above all, in speaking of things "in motion," we refer principally to things leaving one place for another; if they grow or decline or are altered while they remain in their place, we do not say that they are "in motion" but specify the kind of process through which they are passing.

To sum up, we have stated that there always was and always will be movement, what is the first principle of eternal movement, what sort of movement is primary, which kind of movement can alone be eternal, and that the first mover is immovable.

‡ iv.14.223b18.

10. The First Mover without Parts or Magnitude

Let us now proceed to show that the first mover must be without parts and without magnitude. To this end, let us first put forward [72e] certain premises [17]. One premise is that nothing finite can produce movement for an infinite time. For, besides the mover and the thing moved, we must here take into account the time of the movement; and these are either all infinite or all finite, or else one or two of them are infinite and the remaining two or one finite. Now, if a [finite] mover A moves a [finite] body B in an infinite time C, then the time F in which a part D moves a part E cannot be equal to C; for a longer time is required to move the larger body B. Consequently, time F is not infinite. But whereas, by adding to D [parts equal to D] and to E [parts equal to E], we would exhaust A and B, the infinite time C cannot be exhausted by subtraction of [finite] times equal to F. Consequently, the time C in which A [presumably] moves B is finite. It is impossible, then, for a finite mover to move anything for an infinite time.*

Having proved [59d] that a finite body cannot move anything for an infinite time, we may prove [59a] the more general [44] proposition that a finite body [142a] cannot have infinite power. Let a greater power be one which produces an equal effect in less time than does another; for example, in heating or sweetening or throwing or, to put it generally, acting upon anything. Then a finite agent having infinite power would have to act upon its object [35] to a greater extent than would another agent, since infinite power is greater than any other; but there could be no time in which it would so act. Take A as the time in which an agent having infinite power heated or pushed anything, and AB as the time required by [an agent having] finite power; then, by continually adding to the latter a greater finite power, we would sooner or later come to something which has completed the act [109a] in time A. For constant addition to a finite magnitude would result in a magnitude exceeding a determinate limit [72], just as constant subtraction would result in one falling short of a determinate limit. Hence an agent with finite power would act in the same time as the agent with infinite power. But this is impossible. Consequently, a finite agent cannot have infinite power.

* Thomas Aquinas (against Avicenna): ". . . non semper per ablationem intelligenda est solutio continuitatis, quam impossibile est esse in corpore caelesti; sed ablatio intelligi potest secundum quamcumque designationem. . . . Apparet autem ex processu Aristotelis, quod hic loquitur de tempore motus, secundum quod tempus motus accipitur secundum partes mobilis, et non secundum quod accipitur secundum partes magnitudinis. . . ."

So, too, an infinite body cannot have a finite power. To be sure, a smaller body may have a greater power; but then a larger body may have a still greater power. Let AB be a finite body; and let [a part] BC move a body D in time EF. Then a part twice as great as BC would move D in a time FG which, on the assumption of an inverse proportion, would be one half of the time EF. In this procedure, we would never exhaust AB; but we would be always getting a smaller period of time. Hence, the power must be infinite, since it exceeds any finite power. Every finite power, however, must operate in a finite period of time; for if it moves anything in a certain period of time, a greater power will do so in a shorter period of time (according to an inverse proportion) but in a period of time which is still determinate. But a power (no less than a number or a magnitude) which exceeds any that is determinate must be infinite. We may also make use of another proof [63]. Take an infinite body having a [finite] power: this power would be of the same kind [19] as the power of a finite body; and the latter power would be a measure [that is, a proper fraction] of the power of an infinite body!

We have thus shown that a finite body cannot have an infinite power and that an infinite body cannot have a finite power. However, we would do well by taking up at this point a problem connected with local motion. If everything that is in motion (other than things that move themselves) is moved by an [external] agent, how is it that some things (such as projectiles) can be in continuous motion after they have ceased to have contact with their mover? Suppose that what moves them also moves a medium such as air, which would then be a moved mover: it would be equally impossible for the air to continue in motion when the first mover no longer has contact with it; all the things moved would have to be in motion simultaneously, and they would have to cease to be in motion when the first mover ceases to move them even if it, like a magnet, gives to what it has moved the power of moving something else. We must admit that the first mover brings into operation [34] this power [5b] of air or of water or of some other medium which is capable [101c] of being moved as well as of moving something else. But the medium does not, when it ceases to be moved, at the same time stop moving something else. Although it ceases to "be moved" as soon as its mover stops moving it, still, it continues to function as a mover: it moves something else that is consecutive to it; and the latter may be said to do likewise. The power to move something else wears away gradually to the extent that it decreases at each successive stage. It comes to an end when a mover no longer conveys the power of moving something else but only that

of being moved. Moreover, the last of the movers and of the things moved must come to a stop together; and when this happens, the whole motion has run its course. This motion, accordingly, belongs inherently to things capable of both motion and rest. Also, although this motion seems continuous, it is not really so; it is rather a motion of things that are either successive or contiguous, and it has not one mover but a number of consecutive movers.† That is why motion of this kind occurs in such media as air and water. Some call this process a mutual replacement.‡ However, our own account alone can solve the difficulty in question. In mutual replacement, all the movers and things moved must function simultaneously and must cease to function simultaneously; whereas
20 what concerns us here is the apparent continuous motion of a single projectile. Since the same mover cannot continue moving the projectile, the question is: by what agency, then, is it kept in motion?

[To return to the main argument.] There must be, in the world of beings, a movement which is continuous and therefore has unity; so that it must not only be the movement of some single magnitude (without which there would be no movement at all), but it must also have, besides a single subject, a single agent (since the movement would otherwise not be continuous, but would be a succession of separate movements). Therefore, if the mover is single, it must be either a moved or an unmoved mover. As a moved being, it would have to go hand in hand with what it moves so as to be itself subject to change;
267b it would therefore itself have to be moved by an agent. Consequently, the series, to have stability, must be anchored in an unmoved mover. Such a mover need not be changed with what it changes; it can always and without effort induce movement. And the movement it induces is the only or the most uniform movement for the reason that the unmoved mover is not subject to any change. So, too, if the movement induced is to be uniform, the object in motion must not be subject to any change in its relation to its mover. The mover must therefore be either at the center§ or at the circumference of the sphere [of the fixed stars], since the center and the circumference are the originative principles of the sphere. However, since the fastest motion occurs nearest the mover and is the motion of the circumference, therefore the mover is at the circumference.

10 On the other hand, it is questionable whether something that is in motion can induce motion continuously, instead of inducing motion only successively as in successive pushing. Such a mover would have to be continually pushing or continually pulling or continually pushing and

† viii.6.259a18.
‡ Plato *Timaeus* 79B-80C.
§ Pythagoreans.

pulling; or else the power of moving would have to be transferred from one mover to another as in our illustration of the projectile, where motion is transmitted from one part to another of a divisible medium like air. In either case, however, the motion cannot be one; it can be successive only. It would follow, then, that only an unmoved mover, which is invariable and in an invariable and continuous relation to its correlative, can induce a motion that is continuous.

This analysis [72e] shows that the unmoved first mover cannot have any magnitude. If it had, its magnitude would have to be either finite 20
or infinite. We have proved in an earlier passage of our *Physics*‖ that there can be no infinite magnitude and have now proved that nothing finite can have an infinite power and that nothing can be moved by a finite agent for an infinite time. Since the first mover, however, induces eternal movement and therefore does so for an infinite time, it evidently follows that the first mover is indivisible and therefore without parts or magnitude.

‖ iii.5.