ARISTOTLE'S PHYSICS

newly translated by
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with an
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CONTENTS

I. BOOK ALPHA

Natural Science and Its Principles

1. Order of Procedure in Natural Science

Getting scientific knowledge has conditions. Any science deals with 184a10
matters which can be systematically explored. Such affairs, moreover, call for interpretation in terms of their principles, basic factors, or elements. For only then may we claim to comprehend our subject matter when we have mastered its fundamental facts and principles and resolved it into its elements.

This is clearly true also of the science of nature.* In exploring nature, therefore, we must begin by trying to determine its first principles.†

There is a natural path [or order] for us to follow. It leads from what is familiar [181b] or evident [59c] *to us* to what is *by nature* clear or conclusive. The reason for this is that what is intelligible relatively to ourselves and what is inherently [105] intelligible are not the same. Hence it is also necessary for us to conduct our investigation in this manner. We must start with what is naturally obscure, though 20
apparent to us; and we must advance to what is naturally manifest and determinate.‡

*Thomas Aquinas: "Cujus subjectum est ens mobile simpliciter." Duns Scotus: "natural substance." Zabarella: "natural body" (cf. ii.1.192b14); other parts of "natural science," on "species of natural bodies."

†Simplicius ascribes to Aristotle a treatise *On Principles* (*Physics* i-iv, but later identified with i-v) and a treatise *On Movement* (v-viii, or vi-viii). Cf. *Meteorology* i.1.338a20.

‡Thomas Aquinas: "quae plus habent de entitate," "quae sunt magis in actu." Simplicius distinguishes the formal and material "contributing factors" (i) from the efficient and telic "factors" (ii) and attributes to Plato the recognition, in addition, of an instrumental "contributing factor" and of an exemplary "factor."

Now, what is at first plain and obvious to us *is* a confused situation to be analyzed [59e]. This is also the source from which the elements and principles in question later become known to us on analysis [75]. From generalities [43], then, we must proceed to their particular aspects [40].§ Thus, we are acquainted with the situation which we "sense" as a whole;‖ and a generality is [analagously] a kind of "whole" containing [65g] many [varieties] as parts.¶ Again, names are related in some such manner to definitions. The name "circle," for example, designates a certain "whole" without further determination [72g]; definition of the circle analyzes it into its various features or meanings [40]. So, too, children at first call men indiscriminately [150] as they do their fathers and women as they do their mothers; when they become older, they distinguish [72e] each individual explicitly.

2. Nature Not One Unchanging Being

There must be [in our scientific exploration of nature] either one or more than one principle or beginning [82]. If there is a single principle, it is either independent of movement as Parmenides and Melissus allege,* or subject to movement as the natural philosophers say; some of the latter identify the first principle with air, whereas others identify it with water.† If there is a plurality of principles, they are either limited or unlimited in number: if they are numerically limited but more than one, there are two, three, four, or some other definite [4] number of them; if they are numerically infinite, they are either, as Democritus describes them, homogeneous, though different in shape or in kind [20], or even contraries.‡ Just so, even those who want to find out how many *beings* there are undertake to inquire whether there is one or more than one principle or element of "beings" and whether, in the latter case, such principles or elements are limited or unlimited in number; what they, too, are therefore seeking to discover is whether there is one or more than one *principle or element.*

§ i.7.189b31,32; iii.1.200b24,25; *On Generation and Corruption* ii.9.335a24-28; *On the Parts of Animals* i.1.639a23,24; 4,644a23-28.

‖ Repeated perceptions and memories lead to unified experience and knowledge (*Posterior Analytics* ii.19).

¶ Universals become clarified by application to fresh instances.

* Eudemus (cited by Simplicius): Plato contrasted "supra-natural" considerations (like those presented by the Pythagoreans and the Eleatics) with the "elements" and other "principles" in things "natural and generated."

† Thales held "water" to be the generating element. Anaximander taught the "eternal movement" of the "infinite"; Anaximenes described it as "condensation and rarefaction" of "air."

‡ i.4.187a25, 5.188a22.

However, to consider whether being is a unity and is independent of movement, is to turn one's eyes away from nature! How, then, could we reason about principles—any more than we can in geometry with one who subverts *its* principles unless, to be sure, we appeal to a superordinate [16] or universal [92] science? Indeed, if there is nothing but unity (like that suggested), then there is no longer any principle, since a principle is a principle "of" some fact [4] or facts!§ To investigate whether there is a unity of the sort proposed would therefore be like launching out on an elaborate dialectic against any other arbitrary view [64] for the sake of having a "discussion": for example, against the Heraclitean position; or against a debater who would declare "being" to be "one *man.*" Or it would be like trying to resolve a contentious argument: for example, the arguments of both Melissus and Parmenides, which conclude wrongly from false premises; or rather especially the argument of Melissus, which from a single absurdity simply deduces the rest with no grace or effort. We, on the other hand, must regard it as basic [64h] that all or at least some natural beings are changeful, as is evident from induction. We need not, then, refute all arguments but only those which in a "demonstration" are erroneously derived from basic principles—not those not so derived. Thus, a geometer would properly refute the attempt [made by Hippocrates of Chios] to square the circle with the use of "segments," but not so Antiphon's attempt to square the circle [by "exhaustion," with a merely "approximate" result]. Nevertheless, since those of whom we are speaking do‖ not deal with nature, yet do happen to raise physical problems,¶ we may do well by briefly discussing them; for our inquiry has philosophic import.

To begin with the question which seems most appropriate: since "to be" [1]** has various meanings, let us try to make out what those who declare all things to "be" one are saying. Does "all things" mean "what *is*" [26] or quantities or qualities? And are all things "one" primary being [26] (for example, one man or one horse or one living being) or "one" quality (for example, whiteness or warmth), and so forth? All these alternatives differ considerably among themselves and are impossible to sustain. If all things are not only "what is" but also in any amount and of some sort, then, whether these are separable from one another or not, beings will be many. But if all things are either "such" or "so much," then, whether there is primary being or not, we are confronted with an absurdity if not an impossibility: for [qualities and quantities and] other considerations predicted of a primary being or

§ i.1.184a21-23.

‖ Or: "deal with nature, although they happen not to raise physical problems."

¶ i.2.185a33, 3.186a17, 187a2.

** "Being" is to be understood as a verb, in the sense of *esse* rather than of *ens.*

subject matter [85] cannot be detached from such primary being as if they were independent [74] of it. In particular, Melissus says that "being is infinite." Is "being," then, "so much of—"? Since "infinite" comes under the category of quantity, and a primary being or a quality or
185b attribute can be infinite only indirectly [3], namely, in a quantitative respect, we take recourse, in defining the "infinite," to quantitative operations, not to a primary being ["the infinite"] or to a quality or trait ["infinity"]. Accordingly, if "being" is both primary being and quantitative, then it is a duality, not a unity; but if it is primary being only, then "being" is not infinite and does not have magnitude (or else it would somehow have to be quantitative).

Next, since "unity" (like "being") has various meanings, we must also examine in what sense everything is declared to be "one." To be "one" means to be (1) continuous or (2) indivisible or (3) one and the same in a definition stating "what-it-meant-to-be-something" [88] (for example, vine-culture and wine-growing). But (1) if things are "one" in the
10 sense of being continuous, their "one" is "many" inasmuch as anything continuous is infinitely divisible. Also, part and whole would involve a difficulty (even if not for the argument, but on its own account): Do part and whole constitute a unity or a [duality or] plurality, and in what sense? If a [duality or] plurality, what kind? What if the parts are not continuous [as in a quantitative whole]? And if each of two unremovable parts is one with the whole [organism or situation], are they also one with each other? Then (2) if things are "one" in the sense of being indivisible, there will be no quantity or quality; and "being" will not be infinite, as Melissus describes it, or limited, as Parmenides describes it (since it is a *limit* rather than the *limited*†† that is indi-
20 visible). And (3) if all things are one in definition (like "clothes" and "garment"), the advocates of unity will have to become adherents of the Heraclitean view that to be good and to be bad or to be good and not to be good [88a] are the same; and then the same thing may be both good and not good or, for that matter, both a man and a horse. Their view will have to be, not that "beings are one," but that they are "no anything." Also, being a "this-such" [88a] will turn out to be the same as being "so much."

The "problem of the one and the many" continued to worry even the more recent of the older thinkers, who protested against letting the "same" thing become "one" and "many." Some, including Lycophron, wanted to eliminate "is" [from "*A* is *B*"]. Some even proposed recasting ordinary expressions like "the man is white" or "the man is walking" into such forms as "the man has received [the attribute] whiteness" or

†† A terminating point rather than the line.

"the man [in motion] walks"; they feared that, by putting in the word 30
"is," they would present one [primary being] as *being* many [circumstances]—as if "one" or "being" had but a single meaning! However, anything [1a] may be many things differently defined, as when the same thing is both white and musical despite the difference between "being white" and "being musical"; so that what is "one" is in this sense "many."‡‡ Or a thing may be many by division; namely, in the sense in which a whole is its parts. Confronted with such facts, the thinkers 186a
referred to became thoroughly perplexed and began to acknowledge that the one is many—as if [it had ever been credible that] the same thing cannot be "one" and "many," except (to be sure) when the "one" and the "many" are themselves mutually opposed;§§ at any rate, a thing‖‖ may be potentially [many] and actually [one].

3. Arguments against Being as One

Not only is it apparent on this approach [namely, from the meanings of the terms in the alleged principle of unitary being] that "beings" cannot be "one" [being]; but there is also no difficulty in refuting the arguments for the view under discussion. Both Melissus and Parmenides reason contentiously: their arguments conclude wrongly from false premises; or rather especially the argument of Melissus, which from a single absurdity simply deduces the rest with no grace or effort. 10

The fallacy of Melissus is obvious: he thinks that if "whatever has originated has a starting-point," then "anything which has *not* originated does not have a starting-point" [but is spatially infinite]! It is strange, too, that *everything* which *has* originated should have a starting-point (that is, a starting-point not of the time but of the *thing*, and not only of absolute generation but also of qualitative change), as though there were no change which comes about all at once!* Furthermore, why should the All, if it is one, be therefore exempt from movement? Why should it not move in the way a unitary part of it (such as a body of water) moves, namely, within itself? And why should there be no qualitative change? Besides, the All cannot by any means be one in kind 20
[20]; but the All can be one, if at all, only with respect to the material of which [86] it consists. Even some of the natural philosophers maintain the latter sort of unity, but not the former, since man differs from horse in kind, and so does one contrary from another.

‡‡ Against Menedemus of Eretria. Cf. also Plato *Philebus* 14, 15; *Sophist* 251.
§§ *Metaphysics* x.6.
‖‖ MSS. EIJ and Philoponus: "the one"; MS. F: "being"; Alexander: "being and one."
* vi.5.236a27; viii.3.253b23.

The same objections may be brought forward, together with others even more pertinent, against the view of Parmenides: his premises are false, and his conclusions do not follow. He not only falsely assumes that "to be" [1] has but one meaning, whereas it has several; but he also reasons wrongly. Even on the assumptions that "white" has but one meaning and that there is nothing but "white," there will none the less be many white things, not one only: the "white" will not be "one," either by being continuous† or in definition. Thus, in definition, "to be *what white is*" has one meaning; "to be *what is white*" [12a], quite another. Yet there will not [on this account] be something separate from and independent of the "white": whiteness differs from its possessor [82f] not by being *separate* from the latter but in its [distinctive way of] *being* [23]. However, Parmenides was unable to command a view of both [of these ways of being in their distinctness and in their togetherness]. His argument therefore requires more than that "to be" have but one meaning whenever it is *predicated;* but "to be" would also have to refer to an *identifiable* "being" [26a] with an identifiable "unity" [24e]. Otherwise, since an attribute is predicated of *something*, and since the subject is *different* from the "being" it happens to have, that subject would not "be"; there would thus [contrary to the thesis of Parmenides] "be" something that "is-not." For this reason, too, "what primarily is" [26a] cannot be an attribute of something else: if it were, its possessor could not itself be an existing *something* unless, indeed, "being" has many meanings such that each instance of it *is something*.‡

However, we are at present assuming [with Parmenides] that "to be" has but one meaning: if, then, "what primarily is" [26a] does not belong to something else, but other modes of being belong to it, why after all would "what primarily is" signify "what *is*" [1] rather than "what is-not" [1b]? Consider: if "what primarily is" not only "is" but also is white, and if "being what white is" is not "what primarily is" (since "being" cannot belong to it, on the assumption that there "is" nothing but "what primarily is"), then there "is" nothing white; indeed, not only is white not [an opposite] *something*, but white would not be at all. Then, too, since we declared our subject to be white, and white to mean what is-not, even *what primarily is* is-not! But if, in consequence, we take even "white" as denoting "what primarily is," then [contrary to the position of Parmenides] "being" has more than one meaning. Besides, if "being" is [immediately identical with] "what primarily is," then "being" will not even have magnitude [contrary to the views of Melissus

† i.2.185b10.

‡ Simply "to be," ontologically, characterizes anything whatever most generally; more significantly, "to be" is "to be something" and is therefore an affair of distinctions.

and Parmenides]. A reason for this is that if "being" has magnitude, then each of its parts will have a *different* "being" from that of the other [which, again, contradicts the original assumption].§

It is evident that "what primarily is" is even in definition [90] divided into "what primarily is" something [26b] else. Thus, if "man" exemplifies "whatever is something," so must also "animal" and "biped." Otherwise the latter would be accidents [3a] belonging either to "man" or else to some other referent [85]. But either of the latter alternatives is impossible. On the one hand, an "accident" may or may not belong [82f] to a subject, or else an accident is defined by means of the definition of its possessor: for example, "sitting" is a separable accident; but "snubness" cannot be defined without reference to the "nose" which we describe as "snub." Moreover, the parts or elements in a definition do not contain, as an inherent part [82h] of their own definitions in turn, the definition of the whole: thus, a definition of "biped" does not contain a definition of "man"; and in defining "white," we do not define "a white man." If all this is so and if a "man" only happened to be "twofooted" [as he may happen to be "sitting"], then "biped" would have to be a separable accident, so that "man" might not be a "biped";‖ or else the definition of "biped" would contain the definition of "man" [as "snub" is identical with "snub nose"], but this is of course impossible since it is rather the definition of "man" that contains "biped."¶ On the other hand, if "biped" and "animal" are accidents of something other than "man," and if neither of them exemplifies "whatever is something," then even "man" will also be an accident of something else.**

However, let it be so that "whatever is something" cannot be an accident of anything, and let the subject of "animal" and of "biped" be also the subject of both combined:†† is the All, then, composed of things that do not lend themselves to analysis [75a]? Some men did, indeed, at this point yield too much to two arguments:‡‡ to the argument that

§ i.2.185b11-19, 3.187a2.

‖ If "man" is different from "biped" or "animal," then "man" cannot be "biped" or "animal."

¶ If "man" is identical with "biped" or "animal," then "man is man," "biped" is "biped," "animal is animal."

** If "man" just "happens" to be "biped" or "animal" and either of these is "something else," then "man" and "biped" or "animal" happen to be in some respects alike and in other respects different. But "man" is said by definition to *be* a "twofooted animal," since "to be anything" is an affair of logic (186b14).

†† Yet it is not something else which is said to be a "man" as well as an "animal" and a "biped."

‡‡ Themistius: Plato, against Parmenides; Xenocrates, against Zeno of Elea. *On Generation and Corruption* i.8.324b25-325a32. Cf. also Plato *Sophist* 251-259; Aristotle *Metaphysics* xiv.2.1088b35-1089a19.

on a single meaning of "being" all things are "one,"§§ by replying that there "is" what-is-not [or the "void"]; and to the argument from bisection, by positing indivisible [41] magnitudes.‖‖ But even if "being" has only a single meaning and cannot at the same time mean its opposite [49], it is evidently not true that there can therefore be *nothing* which is-not: even if there cannot be anything which absolutely [105] is-not, what is there to prevent what-is-not from being what-is-not-[an-opposite-]*something*? Then, too, as for the statement that, if there is nothing besides "being itself," then all things will be "one," this is absurd: who would understand [184] "being itself" to be anything but *whatever-is-something;* and what is there in this understanding of the situation, as we have just shown, to prevent "being" from being "many"? Clearly, then, it is impossible for "being" to be "one" in the [undifferentiating] way in which it has been characterized.

4. Contraries and Other Principles in Natural Philosophies

The accounts which the natural philosophers give fall into two types [55b]. (1) Some assume a single body persisting in change [85], namely, either one of the well-known three* or something else which is both denser than fire and rarer than air; and they interpret all other things as many and as generated by the thickening and thinning of the one. The latter, moreover, are "contraries" consisting (to use general terms) of an "excess" and a "deficiency." Thus, Plato speaks of the "great-and-small" [or "quantity"]; but he presents these as material and the "one" as form, whereas the former men present the one persisting thing as material and the contraries as differentiae, that is, as forms. (2) Others, however, say that the contraries are present in [23b] the "one" and that they come to be separated [164d] out of it. This is what Anaximander says and is also the view of all those who declare the "one" to be "many," as in the case of the "mixture" from which, according to Empedocles and Anaxagoras, other things become separated. But there are also differences in the views of these men: Empedocles believes that the process is cyclical, whereas Anaxagoras thinks of it as nonrecurrent; and Anaxagoras supposes that his "things with similar parts" [22a] as well as the contraries are infinite in number, whereas Empedocles suggests his socalled "elements" only.

§§ Thomas Aquinas: "vel substantiam tantum vel accidens tantum." "Dicebat enim Plato quod accidens est non ens."

‖‖ Is "to be anything," then, exclusively an affair of atoms moving in the void? i.2.185b26, 186a23, 5.188a23.

* Water (Thales, Hippo), air (Anaximenes, Diogenes of Apollonia), fire (Heraclitus, Hippasus).

Anaxagoras seems to have conceived "infinities" as he did because he accepted as true the doctrine which the natural philosophers hold in common: "nothing can come from what is-not." Here is the reason why these men say that "all things were together" and that, when any kind of thing [5] comes into being, what happens is but a qualitative change or, according to some, an affair of combination and separation. Furthermore, each contrary comes "from" the other; hence, they reasoned, each was inherent [82h] in the other. Since everything that is originated must come from what is or from what is-not, and since what is cannot come from what is-not (as all natural philosophers agree), they hold the remaining alternative to be necessarily the true one, namely, that things come into being from inherent [82h] beings; but, they explain, we cannot perceive the latter because of their minuteness. Accordingly, they declare everything to be mixed up in everything, and for an understandable reason: they have been seeing everything as coming from everything.† The different appearances and names of things, corresponding to their preponderating parts, they explain by the infinitely numerous components in the mixture: no concrete whole, they think, is purely [and wholly] white or black or sweet, flesh or bone; but the most numerous of such components in anything determine the "nature" of that "thing."

However, what is infinite is unknowable in so far as it is infinite: thus, what is infinite in number and in magnitude is some unknowable quantity, and what is infinite in kind is some unknowable quality. But if the principles themselves are infinite both in number and in kind, then, since we get to know a composite thing by distinguishing its elements and their number, we cannot get knowledge of any concrete objects! Again, a whole may be indifferently of any size if its constituent parts may be so. But since a living being cannot be indifferently large or small, neither can any of its constituent parts: flesh and bones of animals or fruits of plants cannot grow or shrink indifferently to any extent we please; if they could, so could the organism as a whole! Again, let all such things be in one another, and let them not come into being but be constituents which become separated [out of the mixture]; let things get their names from the constituents predominant in them, and let anything come from anything (for example, water separated from flesh, and flesh from water); then, since every limited body is at last broken up [118] by a limited body, each thing obviously cannot be in each! As the flesh removed from the water increases in amount by continued separation out of what is left, even if the individual portions of flesh separated out become ever smaller, there is none the less some

† i.1.184a23-26.

minimal bit of flesh such that no smaller bit can be taken. Consequently, if the separation of the flesh comes to an end, there will be some water remaining in which there is no flesh, in which case everything is evidently not in everything; or if the separation of the flesh does not come to an end but the subtraction of flesh continues indefinitely, there will be in the limited piece of flesh an infinite number of equal limited pieces, which is impossible. Besides, since every body from which something is taken away necessarily becomes smaller, and since the maximum and minimum quantity of flesh is determinate, it is evi-
188a dent that no body can be separated out of the minimum quantity of flesh, for there would then be [a piece of flesh left which is] less than the least possible.

Again, the original infinite bodies would already have infinite flesh and blood and brain present in them, distinct [73] from one another, yet no less existing, and each infinite, which is unreasonable. But when it is said that there will never be a complete separation, this pronouncement is made inadvertently; still, the statement is true, since attributes do not have independent being. Suppose, then, colors and states of being to have been mixed together and subsequently separated: in consequence, "white" and "healthy" would be something by themselves, would be nothing but "white" and "healthy," and would not even be attributes of anything! The "mind" in this theory therefore foolishly undertakes
10 an impossibility if it wants to separate [completely] what cannot be separated either in quantity, where there is no least magnitude, or in quality, since attributes have no separate being. But the theory does not even grasp rightly the formation [116a] of things similar in form [57a]: mud can be divided into chunks of mud, but also in other ways; water and air have their existence and origination from each other, but not as do bricks from a house or as does a house from bricks; and it is better to assume fewer principles, as Empedocles assumes a limited number of them.

5. Arguments for Contraries as Principles

All men [with whom we are here concerned] set up contraries as
20 principles. Even in the company of those who say that the All is one and independent of movement, we find Parmenides treating hot and cold as principles, though he calls them "fire" and "earth." In another group, there are those who speak of the rare and the dense. Then, too, Democritus talks about the full and the empty, calling the former "being" and the latter "nonbeing," and about differences in position, shape, and arrangement, each of the latter being a genus which includes con-

traries: in position, we distinguish up and down, before and behind; in shape, we distinguish being with and without angles, straight and curved. Clearly, then, all these men treat contraries somehow as principles, and justifiably so: principles are not to be derived from one another or from anything else, but they are themselves the beginnings of everything; and these conditions are satisfied by primary contraries which, being primary, are not derived from anything else and, being 30
contraries, not from each other.

However, we must also consider the reason [90] underlying this fact [3b]. Let us assume at the outset a natural functioning [101c] of all beings such that not any chance thing acts upon, is acted upon by, or comes from any chance thing, except incidentally. The process whereby something becomes white does not arise from the circumstance that that thing is musical, unless the musical thing happens to be black or at least not white: only what is *not white* becomes white; that is to say, not *anything* which is "not white," but what is black or intermediate 188b
between black and white. In another example, only something nonmusical becomes musical; yet not *anything* which is other than musical, but the "unmusical" or something intermediate between the unmusical and the musical if there is any such intermediate state. By the same token, neither does anything pass [117] into any first chance thing: "white" does not pass into "musical," except perhaps incidentally, but into "nonwhite"; yet not into any chance thing that is nonwhite, but into "black" or into something intermediate between black and white. So, too, "musical" passes into "nonmusical"; yet not into any chance thing that is "nonmusical," but into "unmusical" or into something intermediate between the unmusical and the musical if there is any such intermediate state.

All processes, the simple and the complicated ones alike, follow the 10
same pattern [90]; but we readily overlook this fact when we fail to name the opposite [13] stages [64c] explicitly as such. Thus, it must be from a state of being out of tune that a state of being in tune arises, and vice versa; and what a state of being in tune must pass into is a state of being out of tune—not at all into any chance disharmony but into the corresponding opposite state. It makes no difference whether we speak of harmony or arrangement or composition: all these processes exhibit the same pattern. A house, a statue, and any other products arise in similar ways: a house, from materials not yet put together but relatively unordered, and a statue or anything shaped, from the respec- 20
tive unshaped state; the things of which a house consists constitute a certain arrangement, and the things of which a statue consists constitute a certain composition. This being so, everything that comes into being

or passes away comes from or passes into one of a pair of contrary states or a state intermediate between them; and since the intermediate states are composed of contraries (colors, for example, of light and dark shades), therefore all the things that are naturally produced are contraries or are composed of them.

As we have already indicated, most other philosophers would perhaps go along with us up to the point we have just reached: truth compels all of them, even if they fail to give any reason [90] for this position,* to describe their "elements" or "beginnings" (as they call them) in terms of contraries. They differ in the precise contraries to which they give priority in their accounts [83] of the origination [116a] of things: some select such as are more familiar in the order of sense perception, for example, hot and cold, wet and dry; others select such as are more intelligible in the order of reason [90], for example, odd and even, love and strife.† The contraries selected are thus somehow both the same and different. Although to most people they appear to be different, yet they are the same by analogy. Each of them is taken from the same list‡ of positive or corresponding negative terms, some of the pairs named being more inclusive than others. Not only are the contraries singled out [36] by the philosophers therefore at once somehow the same and different, but they are also by the respective criteria already stated superior or inferior. Some take the contraries which are more intelligible in the order of reason, namely, the universal (since reason grasps the universal), for example, the "great-and-small"; whereas others take the contraries more accessible in the order of sense perception, namely, the particular (since sense perception grasps the particular), for example, the dense and the rare. At any rate, it is evident that our principles must be contraries.

6. The Number of First Principles

We take up next the question: Are there two or three or more first principles? There cannot be one principle only, for contraries are not one [of their terms without the other]. But neither can there be an infinite number of first principles. In that case, "being" would be unknowable. Another reason is that there is in any one genus [19] but one

* Thomas Aquinas: "interdum intellectus hominis quadam naturali inclinatione tendit in veritatem, licet rationem veritatis non percipiat."

† Simplicius: Parmenides (fire and earth), Anaximenes or Xenophanes (earth and water), Plato (great and small), Empedocles (love and strife).

‡ *Metaphysics* i.5.986a23.

[fundamental] contrariety, and primary being is but one genus.* Besides, derivation from a limited number of principles not only suffices but, as is apparent from the principles used by Empedocles, excels derivation from an infinite number of principles; thus, Empedocles claims to derive from his principles all that Anaxagoras derives from his infinite principles. Finally, some contraries have priority over others; derived contraries (for example, sweet and bitter, white and black) differ [from the primary ones]; but first principles must always remain [first principles].† Clearly, then, there is not a single principle only, and the number of first principles is not infinite.

The number of first principles being limited, it would seem reasonable [90] not to present them as two only. For one may very well ask: How can density naturally function so as to convert rarity into anything, or vice versa? So with any other pair of contraries: friendship, for example, does not attract strife and produce something out of it; or vice versa. We must take a third something of quite a different sort along with a pair of contraries. Indeed, some‡ believe that a larger number of sources [86] is required to constitute the nature of beings. Again, if one does not suppose [64h] a different nature basic to contraries, there is the added difficulty that we do not observe contraries functioning as the primary being of any beings or take the first principle to be an attribute of any subject; if we did, there would be a principle of that principle, since the claim of what persists [85] in a change to being a first principle apparently takes precedence over the claim of what is predicated of that subject. Again, a primary being is not contrary to a primary being. How, then, can nonprimary beings [like contraries] constitute a primary being? Or how can nonprimary being have a status of priority to primary being?

Accordingly, if we accept as true both the previous argument [that contraries are principles] and the present argument [that the contraries do not constitute primary being], doing justice to both of these truths requires that we assume a third something. This is what those do who declare the All to be a single nature such as water or fire or something intermediate between them. Now, since fire, earth, air, and water involve contraries, an intermediate nature seems preferable to them. It is with good reason, therefore, that some characterize the persistent being as different from those [four] natures; second to them in order of preference would be those who identify the persistent being with air, since air is the element which has the fewest sensible differences; third would come those who identify the persistent being with water.

* Simplicius: one subject-in-process.

† "Form" and "privation."

‡ Democritus, Empedocles.

At any rate, all of these men elaborate the accounts they give of their "one" by drawing upon contraries such as "dense and rare" or "more and less" which, as has been said,§ are in each case an excess and a deficiency. Indeed, no less ancient than the treatment of contraries as principles seems to be the opinion that the "one," together with "excess" and "deficiency," are the first principles of beings. But this opinion has taken various forms: the earlier men deal with the latter two principles as active and the "one" as passive; some of the more recent thinkers prefer to employ the "one" as the active principle and the other two as the passive principles.

In the light of these and other considerations, the view seems reasonable that our principles are three in number, in contrast to the view that there are more than three. Not only does one passive element suffice; but if there are two pairs of contraries (as in the theory of four elements), there will be two distinct intermediate natures to go along with the two pairs of contraries, or the two pairs of contraries will be able to generate from each other,‖ and then one of the two pairs of contraries will be superfluous. Moreover, there cannot be more than one pair of primary contraries, since primary being is but one [and the same] genus of being: its principles will therefore differ from one another in priority and subsequence only; these will not differ in genus, since there is in any single genus a single pair of contraries to which all the pairs of contraries may be reduced.

It is evident, then, that there is not one element only and that there are not more than two or three; but whether there are two or whether there are three *is*, as we have suggested, very difficult to determine.

7. Subject and Contrary Terms of Change

Let us now formulate our own view, beginning with "becoming" in general and thus proceeding in a natural way from the features which all changes have in common to the features which are peculiar to the several kinds of change. We designate the "terms" of a change *from* "something" *to* "something else," or "something different," by means of expressions which are either "simple" or "complex." I mean that a "man" may become "educated" and that the "noneducated" may become "educated" or that a "noneducated man" may become an "educated man." I call "simple" the initial term "man" or "noneducated" and the final term "educated"; I call "complex" the initial and the final terms when

§ i.4.187a16.

‖ That is to say, the two pairs of contraries will have the same intermediate nature as their subject matter, so that a contrary in one pair can serve as a contrary in the other.

we say that "a noneducated man becomes an educated man." Also, we say either that "the noneducated becomes educated," or that "it is *from* the noneducated that the educated comes to be"; but we do not say that "it is from a man that the educated comes to be," but rather that "a man becomes educated." Of the subjects simply designated as such in these assertions of "becoming," the latter endures, whereas the former does not. For a "man" endures as such, that is, he is a "man" even when he has become "educated"; but the "noneducated" or "uneducated" does not endure as such, and neither does the "noneducated man" or the "uneducated man."

In the light of the distinctions uncovered in the various ways of describing any change, we find that change always presupposes [85a] something which changes [116a] and that this is numerically but not formally one. That is to say, it is not one in definition, since "to be a man" is not the same as "to be uneducated." The nonopposite, "man," endures; but the "noneducated" or "uneducated" does not, and neither does the "uneducated man." The term "from" which the change is said to start is chiefly what does not endure, as when we say that "it is from the uneducated" (not: "from the man") "that the educated comes to be"; although we sometimes use this description also for what does endure, as when we refer to the bronze "out of" which the statue comes (rather than to the bronze which "becomes" a statue). In the case of the nonenduring opposite, we say either that "it is from the uneducated that the educated comes to be," or that "the uneducated becomes educated." Hence, we also say either that "it is from an uneducated man that an educated man comes to be," or that "an uneducated man becomes an educated man."

However, "becoming" has more than one meaning. Some things do not "come to be" but "become this or that" [4b]. Only primary beings simply "come to be." In other categories there must evidently be some subject which becomes so much or such or related to something else or to some time or to some place: these ways of being are predicated of primary being; only primary being is not in turn predicated of some other subject. Still, reflective consideration shows that even primary or independent [105] beings come into being from some existing source [85]: such a source is always present whenever anything arises; for example, plants and animals come from seeds. In general, things come about in different ways: a statue, by shaping; growth, by addition; the Hermes, by extraction from a stone; a house, by being put together; and things whose material is converted into some other state, by qualitative alteration. Since all these changes evidently arise out of an existing source, it is clear from what has been said that anything involved

in "becoming" is always complex: there is what comes into being [for example, one "educated"]; and there is, in what undergoes such a change, a double aspect, namely, the persistent being (for example, a "man") and an opposite (for example, the "uneducated"). Other examples of an "opposite" are the unshaped, the unformed, the unordered; other examples of a "being persisting through a change" are bronze, stone, gold.

It is evident, therefore, in what sense every product is composed "of" a persistent being [85] and a form [91]. These are the fundamental principles or factors which explain what natural beings are or have come to be; not incidentally, however, but in what we call their "essential being" [26]. So an "educated man" may be analyzed into the components "man" and "educated." Thus it is clear in what sense the things which have come into being are composed "of" such elements. Moreover, the initial subject in process [85] is numerically one, although it has two formal aspects. What is to be counted is the "man" or the "gold" or, in general, the "material"; this is a positive "something" and is not an accidental feature of the source out of which the product arises. The "privation," on the other hand, which is "contrary" [to the form in which the change culminates], is incidental [to the subject]. Also, the [final] form is one: for example, the "order," "musical knowledge," or any other similar predicate. Accordingly, fundamental principles are in one sense two and in another sense three: in the former sense, they are the contrary terms of a change (for example, educated and uneducated, hot and cold, in tune and out of tune); in the latter sense, they are not the contraries, since one contrary cannot be acted upon by another. This difficulty, too, is readily resolved: what persists in change is other than the contraries; it is not itself contrary to anything. In one sense, therefore, the principles are not more numerically than are the contraries, that is to say, not more than two; but in another sense they are not two at all but three, because to be a subject in process (for example, to be a man, to be bronze) and to be a contrary (for example, to be uneducated, to be unshaped) are different [aspects of the starting-point of the change].

We have now stated how many principles there are in the case of natural beings which are implicated in "becoming": clearly, there must be a subject of contraries, and the contraries are two; yet in another sense this is not necessary, since one of the contraries suffices to account for [34] a change [115] by its absence or presence. The persistent nature* is known by analogy: as bronze is to the statue, wood to the bed, or relatively unformed material to something having a certain form, so is the persistent nature to the primary being which is an existent "this-something." The persistent nature, then, is one beginning or principle (though as a principle it is not "one" or a "being"† in the same sense in which a "this-something" is); another principle is [the object of] the definition; the third is the "privation" which is contrary to it. We have already explained in what sense these principles are two and in what sense more than two.

* Thomas Aquinas: ". . . materia prima . . . consideratur subjecta omni formae . . ." Zabarella: Out of "nude matter," nothing can be generated.

To recapitulate: we have shown, first, that contraries are principles; next, that there must also be something else [persisting through the change *from* one contrary *to* the other], so that there are three principles; finally, how the contraries differ, how the principles are interrelated, and what the subject in process is. It is not clear as yet whether the primary being [26] is the form [20] or the subject-in-process [85];‡ but it is clear that and how there are three principles and in what way each of them is a principle. So much, then, for the question: how many and what are the principles?

8. Coming from Being and from Nonbeing

The analysis of change affords the only way in which we can follow out the fundamental difficulty of the ancients to a solution. In their inexperience, those who first sought philosophic truth and the natural development [101] of beings were diverted into a wrong course of reasoning. "Nothing comes into being or passes out of being," they said, "because whatever comes into being would have to come from what is or from what is-not; and both of these alternatives are impossible." They went on to explain: "What is does not become anything, since it already is; and nothing comes from what is-not, since something must underlie." Thereupon they even went beyond this opinion as they progressively amplified its consequences until they came to the conclusion: "There cannot be many beings; only being itself is."*

We are now in a position to present a solution of the view they held for the reasons stated. What does it mean "for anything to come from what is or from what is-not"? Or what does it mean "for what is-not or for what *is* to act upon anything or to be acted upon by anything or to become anything"? Nothing essentially different from what it means "for a physician to act upon anything or to be acted upon by anything or to become anything"! What is said in the example of the physician

† Thomas Aquinas: ". . . dicitur ens et unum inquantum est in potentia ad formam."

‡ ii.1. *Metaphysics* vii.3.

* i.2.184b16, 4.187a21,22, 5.188a22.

has two meanings; so that we must distinguish two meanings also in such expressions as "coming from what is" and "what is, acts and is acted upon." On the one hand, the physician does not build a house in his capacity as a physician, but as a house-builder; and he does not turn white in so far as he is a physician, but in so far as he has been dark. On the other hand, he effects or fails to effect a cure in so far as he is a physician; and it is chiefly in this latter sense that we speak of a "physician" acting upon anything or being acted upon by anything or becoming anything, namely, *as a physician.* Clearly, then, [to deny] that anything "comes from what is-not" means, properly, [to deny] that anything "comes from what is-not *in so far as it is-not.*"† Because they failed to make this distinction, the early philosophers left their problem without a solution; and because of this perplexity [190] they even went so far as to deny the becoming and the being of anything else [that is, other than being itself], and thus to abolish all becoming. We for our own part agree with them that nothing comes from what "is-not" *absolutely,* but insist that a thing does come from what "is-not" *in an incidental sense*: it comes from its "privation," and this is, by itself, what "is-not";‡ hence, from something that does not remain in any product of a change. But the early men found this "mysterious" and therefore held it impossible for anything to come from what is-not.

Just so, we agree that nothing comes from what "is" or that what "is" does not become anything, except (to be sure) *incidentally;* but we insist that this, too, does occur in this latter sense. The point at issue is as if we argued about an animal coming from an animal, a particular animal from a particular animal, a dog from a horse: the dog would come not only from a particular animal but from "an animal," but would not therefore come into being *as an animal* since this [character] is already there; if a particular animal is to come *into* being not incidentally but *absolutely,* what it will come *from* is not an "animal." Similarly, if any being is to come into being [in an absolute sense], it will not come from what is any more than it will come from what is-not (namely, as we have said, in so far as the latter is-not). Moreover, we are not denying that "anything either is or is-not" [which is implicitly denied in the opinion we have been examining].

We have thus presented one solution of the difficulty raised by our predecessors; but there is another solution. The same terms may be analyzed with the aid of the distinction between the potential and the actual: [a product comes from what "is not" that product actually but

† Cf. Plato *Sophist* 258E.

‡ i.9.192a5. Zabarella: "privation," the contrary on whose removal a state of affairs comes into being; absence of a form in a material having proximate capacity for the form.

from what "is" that product *potentially*]. However, we have elaborated this distinction more accurately elsewhere.§

We have now resolved the difficulties which prompted our predecessors to deny some of the things we have been trying to explain, so that they were driven far away from the course which leads to an understanding of generation and destruction and of change generally. Had they but given attention to the "nature" [which persists in change],‖ they would have found in it the answer to their whole perplexity.¶

9. Matter, Form, and Privation

Unlike the men whose views we have just examined,* certain others acknowledge the nature which persists in change; yet they have not grasped it adequately.† In the dilemma of Parmenides, they accept the alternative that a product arises out of what absolutely is-not. Besides, they think that, since the nature in which a change starts is numerically single, it has but a single import [11]; but this is a very different consideration.‡ We ourselves distinguish a "material" and a "privative" aspect: the material factor *incidentally* is-not [what it becomes], whereas what we call the "privation" is *essentially* what is-not-[yet]; also, a material is in some sense almost even if not quite a primary being, whereas a "privation" is not a primary being in any way at all. In contrast, the other men declare their "great-and-small" (whether taken together or separately but in any case *both aspects alike*) to be "what is-not," with the consequence that their triad [the "one" and the "great-and-small"] differs considerably from ours [form, material, and privation]. They have progressed far enough to recognize that some nature must be present, but they still portray it as single. Although at least one of them characterizes it as a "dyad" of the "great-and-small," his account nevertheless comes to the same result. The reason is that he overlooks the other nature [the "privation"]. The material which persists is jointly responsible [83] with the form (like Plato's "mother") for the products of changes; yet that member of the pair of contraries which we call the "privative" aspect often seems to those who think only of its baneful character, not to be at all. Hence, whereas we, in

§ *Metaphysics* ix.

‖ Simplicius: the nature of privation and matter, or of the absolute and incidental, and the potential and actual, or the composite, nature.

¶ The subject-in-process endures while its initial form becomes replaced by the contrary form which it initially lacks; in other words, a material "is not" actually but "is" potentially what it becomes.

* i.8.191a24-33.

† Plato *Timaeus* 50.

‡ iii.1.201a34-b3.

acknowledging a divine and good goal of movement, distinguish between what is contrary to it and what in its natural activity has a natural impulse to tend in its direction, their view has the consequence that [matter as presumably] one of the contraries has an impulse to its own destruction! Surely, the form cannot tend towards itself, for it does not come short of itself; and a contrary cannot tend to it, for contraries are mutually destructive. But as the female or the ugly inclines to the male or to the beautiful (albeit not essentially but incidentally), so what [naturally] tends to a form is matter.§

We must also distinguish a sense in which "matter" is destroyed or is produced and a sense in which it is not. As that "in which" [there is a privation], a material really ceases to be; what ceases to be is the privative aspect in it; but as a potentiality matter itself [2] does not really pass away, but must be indestructible and unproducible. If matter were produced, some first constituent [82h] would have to be present [85a] out of which matter would arise; but to be such a constituent, is matter's own nature. Were matter produced, matter would therefore have been before it arose! But "matter" is by definition the "first" persistent being out of which anything arises and which inheres in the product in a way that is not incidental. So, too, if matter were destroyed, it would pass into matter in the end; hence, matter would have perished before it perished!‖

There is also the question whether the formal principle is one or more than one and what it is or what they are. However, the accurate determination of this issue falls within the province of first philosophy, to which we therefore leave this subject.¶ In the expositions [63] which follow here, we shall deal with natural and perishable forms.

What we have undertaken to show in our preceding analysis is that there are first principles, what they are, and how many there are. But let us resume our subject and, in so doing, start at another starting-point.

§ Thomas Aquinas (against Avicenna): "Nihil igitur est aliud materiam appetere formam, quam eam ordinari ad formam; ut potentia ad actum. Et . . . est ei semper appetitus formae; . . . quia est in potentia ad alias formas dum unam habet in actu. Nec etiam utitur hic figurata locutione, sed exemplari. . . ."

‖ Thomas Aquinas: "Sed ex hoc non excluditur quin per creationem in esse procedat."

¶ *Metaphysics* vii, xii.7-9.

II. BOOK BETA

Natural Science and Explanation

1. Nature and Art

Among beings, some are formed by nature, some by other causes.* Among those formed by nature, we may name animals† and their parts, plants, and the simple bodies (earth, fire, air, and water); all of these, together with beings like them, we call "formed by nature." Observation discloses [173b] how they differ from things not constituted [111i] by nature: each of them has *within itself* a beginning of movement and rest, whether the "movement" [or specific type of behavior] is a local motion, growth or decline, or a qualitative change. Such is not the case with things like beds and clothes: that is to say, to the extent that these come within the classification [25] of "products of art" [171], they do not have implanted within themselves any tendency [155] to change [115]; nevertheless, in so far as they happen to consist of stone or earth or a composite material, they do have such a beginning of movement and rest, but only in this respect. But even this circumstance gives evidence that the nature of a thing‡ is in some sense the factor [83] which initiates [82] movement and rest within that thing in which it is itself immediately, not incidentally, present [82f]. The reason for saying "not incidentally" may be illustrated by a physician who "incidentally" heals himself; but since even he cannot as a patient practice the medical art, physician and patient are usually two separate individuals, although

* ii.6.198a9,10. Cf. Plato *Timaeus* 30A,47E,52D,53B; *Philebus* 59; *Laws* x.886B-899D.

† *On the Parts of Animals* i. presents numerous parallels to *Physics* ii.

‡ *Metaphysics* v.4.

under certain conditions the same individual may happen to be his own physician and his own patient. What applies to the restoration of a patient's health, applies also to the products of any other art: not one of them has the source of its own production within itself; rather is this source in an agent external to the product (as in the case of a house or of any other product of manual labor) or, when the thing happens incidentally to act [83] upon itself, the source is in some distinct aspect of the product itself.

These remarks bring out what "nature" is. Accordingly, a thing may be said to "have a nature" if it has within itself the sort of "beginning" described: every such thing is a "primary being," since it is a "subject" [of change]; and a "nature" always involves a "subject" in which it inheres. Such things are also "according to nature." So, too, are their essential attributes; for example, the upward motion of fire neither *is* nor *has* a "nature" but happens "*by* nature" or, in other words, "*according to nature*." Thus we have explained what "nature" is and what it is to be "by nature" and to happen "according to nature." It would be ridiculous, however, to try to prove *that* nature is: it is obvious that there are many such natural beings; but to want to prove the obvious by what is not obvious shows inability to discriminate between what we can ascertain directly and what indirectly.§ Yet as a man born blind may resort to reasoning to convince himself about colors, so this failing, too, is a possible one; but those who have it must be unthinkingly talking about words.‖

Now, some hold that the nature or the primary being of natural beings is their proximate constituent by itself, apart from any arrangement of it: the nature of a bed,¶ they say, is wood and, of a statue, bronze. As Antiphon suggests, by way of giving a clue [38a] to this interpretation: bury a bed and let it rot until it gets enough power to send forth a shoot, this shoot would not be a bed but wood; hence, the bed's arrangement by convention and by art is only incidental to it, whereas its primary being is what remains continuously through its changing conditions! Moreover, suppose the relation between an object and its material to hold also between the material and something else (for example, between bronze or gold and water, between bronze or wood and earth, and so forth), then that element is the nature or primary being of the object! This is the reason why some declare earth, others fire or air or water, and still others some or all of these elements, to be the nature

§ "Knowing *that* our subject matter is, we inquire *what* it is." *Posterior Analytics* ii.1.89b34. With the approach of *Physics* ii.1, compare that of i.1.

‖ Thomas Aquinas (against Avicenna): "ignorantia principiorum moventium non impedit quin naturam esse sit per se notum."

¶ 192b19, 20.

of beings. Whichever element or elements any of these men chooses, he puts it forward as the whole of a primary being, viewing all its other aspects as its modifications, states, or dispositions; any element, moreover, he contends, is eternal, since it cannot be transformed into anything else, and all other aspects of things he sets forth as coming and going an endless number of times. This, then, is one interpretation of "nature": the immediate persisting material of anything which has within itself a beginning of movement or change.

According to another interpretation, "nature" means "shape" or "form" as expressed in a definition. Analogously to the term "art," which relates to artistic skill and its products, the term "nature" relates to a natural process and its products. But since we do not ascribe the artistic character of an art object to a thing as long as it is only potentially, for example, a bed and has not yet received the actual form of a bed, a corresponding principle is to be maintained in the realm of things constituted by nature: what is potentially flesh or bone has not yet attained to its proper "nature" and is not properly a "natural" being as long as it has not assumed the definite [90] form by means of which we define what flesh or bone is. On this interpretation, therefore, "nature" would be the form of anything which has within itself a beginning of movement, the form being not separable except in thought [90]. To be sure, the being composed of both matter and form (for example, a man) is not *a* "nature," although it is [produced] "*by* nature";** yet, at any rate, form rather than material is "nature," since the term "nature" marks an actual being more appropriately than a potential one.

Again, man generates man. Because, on the other hand, a bed does not produce a bed, its "nature" is said to be not its pattern but wood: if the bed sprouted, we are told, what would come forth would not be another bed but wood. But even if this [pattern] is art, the shape [of man] is [his] nature, for man generates man.

Again, "nature" as genesis†† is a process *towards* [the product's] "nature." By way of contrast, the attempt to heal is a process directed not to the "art" of healing but to a healthy state; the task of healing must start *from* the art of healing,‡‡ instead of leading to it. But "nature" [as productive] is related to [the product's] "nature" in a different way: what grows [101b] out of something proceeds to something or "grows," not towards that from which it starts, but that towards which it tends. Hence, its final shape is its "nature." On the other hand, the

** 192b32-193a1.

†† Thomas Aquinas: "puta si natura dicatur nativitas."

‡‡ Thomas Aquinas: "actiones denominantur a principiis, passiones vero a terminis."

"shape" or "nature" of anything has two meanings, for there is a sense in which even a "privation" is a "form." But whether or not there is a "privation" or a contrary [of the final form] in simple generation, we must consider later.§§

2. Natural Science and Related Sciences

Having distinguished the different meanings of "nature,"* let us see wherein the mathematician differs from the natural philosopher, for the solids, planes, lines, and points with which the mathematician deals are, after all, aspects [33] of natural bodies; at the same time, let us consider more specifically whether or not astronomy is a part of natural science, for it would surely be unreasonable to expect the natural scientist to know what the sun and the moon are if he is not to know any of their essential attributes, especially when writers on nature patently do discuss what shape the sun and the moon have and whether or not the earth or the cosmos is spherical. Now, although the mathematician, too, occupies himself with these things, he does not concern himself with them as limits of natural bodies or with the properties they have in this status [23]; what he therefore does is to separate [73] them, particularly since they can be separated in thought [169c] from processes without any resulting incongruity [76] or falsity. But the advocates of the "ideas" do this confusedly [205] when in their theory they separate natural objects, which are much less separable than mathematical objects. This will become clear in any attempt to define these two kinds of entities and their respective attributes: odd and even, straight and curved, number, line, and figure can be independently of movement; not so things like flesh, bone, and man, which are defined like "snub *nose*," not like "curved." This difference is also clarified by reference to the more physical branches of mathematics (for example, optics, harmonics, and astronomy), which really proceed, in a sense, by a method the inverse of that of geometry: although geometry investigates physical lines, it ignores their physical aspects; optics, on the other hand, examines lines which are indeed mathematical, but deals with them not so much in their mathematical as in their physical aspects.

Accordingly, we must inquire [187] into "nature," since it has two meanings: form and matter, in the same way in which we would consider what "snubness" is: reflection shows that such things are neither purely immaterial nor considered in their purely material aspect. So one may here, too, ask: With which of the two aspects of nature does the natural philosopher properly deal? Or does he deal with that composed

§§ v.1; *On Generation and Corruption* i.3.
* ii.1.192a21, 193a28,b3,6,12.

of both of them together? If so, then he will also deal with each of them separately; but will he do this, then, in the same science or in separate sciences? If we look for light on this problem to the ancients, natural philosophy would appear to be exclusively interested in matter,† for even Empedocles and Democritus touched but lightly on questions of form and of what it means to be anything. If, on the other hand, art imitates nature, and every scientific technique [179] requires knowledge [182] of its distinctive form as well as of the material suited to it—if, for example, a physician understands health as well as the bile and phlegm on which health depends, and a builder understands the form of a house as well as its materials (such as bricks and timber), and so forth, then natural philosophy must take cognizance of both [the formal and the material] aspects of nature.

Again, any art or science takes cognizance both of the "where-for" or "end" and of all the means to this end. So, too, nature [as form] is an end which is correlative to [material nature as] means. In other words, when anything in a continuous passage [from its initial to its final form] comes to its appropriate terminus, this sort of stopping-point is also what the process is for. How absurd, therefore, the poet's line: "He has the consummation of his life!"‡ As if all endings [18a] were completions [100], instead of only the best ones! Then, too, the arts construct material objects, sometimes with intended useful results, but sometimes not. At any rate, we use everything as if it existed in our own interest, since we are ourselves in some sense an "end." In our work *On Philosophy*, we have distinguished two meanings of the expression "for the sake of": [namely, "for the sake of what" and "for the sake of whom"].§ But there are two sorts of arts which preside [82d] over a material by virtue of their knowledge: one sort uses the material, whereas the other is "architectonic" in directing its construction—although even the former sort is in a sense "architectonic"; but the two differ in that one of them knows the form (for example, the steersman knows and specifies the kind of form a helm is to have), whereas the other sort knows the material (for example, the maker of the helm knows out of what kinds of materials and by means of what kinds of processes the helm is to be made). Thus it is that in a process of art we ourselves make the material with a view to its uses [9c]; in natural processes, on the other hand, the materials are there to begin with [82f].

Again, "material" is one term of a relative distinction, since different forms require different materials. To what extent, then, must the natural philosopher know the form of a material, that is, *what* it is [87]? No

† *Metaphysics* i.3.
‡ Euripides.
§ Cf. *De Anima* ii.4.415b2,20.

doubt, to the extent that a physician knows sinews, and the smith bronze; namely, to the extent of knowing the function [96a] of the respective materials. The forms [or functions] with which the natural philosopher is concerned are such as may be distinguished from but are embodied in materials; for it is a man that generates a man, no less than the sun. But whether there are forms separate from materials and what they are, it is the task of first philosophy to determine.‖

3. Material, Formal, Efficient, and Final Explanation

On the basis of these distinctions, let us now examine what and how many sorts of explanatory factors [83] there are. All inquiry aims at knowledge; but we cannot claim to know a subject matter until we have grasped the "why" [203a] of it, that is, its fundamental explanation. It must clearly, therefore, be our aim in the present inquiry to get knowledge of the first principles to which we may refer any problem in our exploration of generation and destruction and of any natural transformation.

"An explanatory factor," then,* means (1) from one point of view, the material constituent from which [86] a thing comes; for example, the bronze of a statue, the silver of a cup, and their kinds. From another point of view, (2) the form [20] or pattern [89a] of a thing, that is, the reason [90] (and the kind of reason) which explains what it was to be [88] that thing; for example, the factors in an octave are based on the ratio of two to one and, in general, on number. This kind of factor is found in the parts of a definition [90]. Again, (3) the agent whereby [95] a change or a state of rest is first produced [82]; for example, an adviser is "responsible" [83a] for a plan, a father "causes" his child, and, in general, any maker "causes" what he makes, and any agent causes what it changes. Again, (4) the end [100] or the where-for [96]; so, when we take a walk for the sake of our health, and someone asks us why we are walking, we answer, "in order to be healthy," and thus we think we have explained our action. So any intermediate means to the end of a series of acts: for example, as means of health there are reducing, purging, drugs, instruments, and so forth; for all these are for an end, though they differ from one another in that some are instruments, and others are actions [9c].

Since what we call an "explanatory factor" may be any one of these different aspects of a process, it follows not only that anything actually has several such factors which are not merely accidental differences of

‖ *Metaphysics* xii.6-10.

* The text of 194b23-195b21 is nearly identical with the text of *Metaphysics* v.2.

meaning (as both the sculptor's art and the bronze are needed to explain a statue as a statue, the bronze being its material, and the sculpturing, its agent), but it follows also that these factors are reciprocal: for example, exercise explains good health, and good health explains exercise; though they explain each other differently (good health as end, and exercise as [82] means [109]). And the same thing may explain contraries: for the same thing which by its presence explains a given fact is "blamed" [83b] by its absence for the contrary fact; for example, a shipwreck is "caused" by the absence of the pilot, whose presence is responsible for the ship's safety.

All the factors here mentioned clearly fall under four varieties. From letters come syllables; from building materials come buildings; from fire, earth, and so forth, come bodies; from parts come wholes; and from assumptions come conclusions. The first factor in each of these pairs is the subject matter or the parts; the second is what it meant to be that particular whole, or synthesis, or form. A "cause" in the sense illustrated by a seed, a physician, an adviser, and any agent generally, is the factor whereby a change or state of being is initiated. Finally, there are the ends or the good of the others; for all the others tend toward what is best as toward their end. It makes no difference now whether we say "their good" or "their apparent good."†

These, then, are the kinds of explanatory factors. But they fall into many lesser varieties, which can also be summarized under a few heads. There are several ways in which explanatory factors explain, even when they are of the same general kind [57a]. Thus one factor is prior to another, which is posterior: for example, health is prior to both the physician and the technician; the octave is prior to the ratio of two to one and to number; and so always, the inclusive factor is prior to individual factors.

Then there are accidental factors of various kinds; for example, a statue is, we say, by Polyclitus, but it is also by a sculptor; the sculptor happens to be Polyclitus. And so the kind (sculptor) and the accidental (Polyclitus) it embraces are both factors in the statue; thus a man is responsible for the statue, and so is the more general species "animal"; for Polyclitus is a man, and man is an animal. These accidental factors are sometimes remote and sometimes proximate; for example, between Polyclitus in particular and man in general there would be such intermediate factors as "a white man" and "an artist."

Besides, any factor, whether essential [55] or accidental [3], may be actually in operation [9a] or merely capable of acting [11a]: a house being built is the work of "builders," but more actually of the builder

† Thomas Aquinas: "quia quod apparet bonum non movet, nisi sub ratione boni."

who is building it. The same is true of the things to which explanatory factors refer—they may be singled out or referred to more generally: for example, "this statue," or "a statue," or even more generally, "an image"; and "this bronze," or "of bronze," or, generally, "of matter"; and similarly with reference to the accidental factors.

Moreover, both accidental and essential factors may be combined: for example, instead of Polyclitus or the sculptor, we say "Polyclitus the sculptor." However, these varieties reduce to but six, each being taken either individually or collectively: the accidental factors (individual or collective); combined or separate factors; and actual or potential factors. There is another difference between them: the operating and individual causes exist and cease to exist simultaneously with their effects (for example, this man actually healing is correlative with this man who is now being healed, and this actual builder, with this thing-being-now-built); but potentially they do not exist together (for the house and the builder do not perish with the act of building).

We must, however, always seek the "highest" [or "principal"] explanatory factor of each case, as in any other investigations [of "reasons why"]; for example, a man builds only because he is a builder, and a builder, only because he has mastered the builder's art, which is therefore the more primary factor; and so in all such cases. Again, generic effects go with generic explanatory factors (for example, a statue with a sculptor), particular effects go with particular explanatory factors (for example, this statue, with this sculptor); so, too, potential effects correspond precisely to potential factors, and things actualized, to factors actually operating.

Let this suffice, then, concerning types of explanatory factors and the ways in which they operate.

4. Opinions Concerning Luck and Chance

In explaining events, we often speak of "luck" and "chance," since many beings and happenings occur "by luck" or "by chance." Accordingly, we must ask: in what sense do luck and chance explain anything? Are they the same or different? In general, what is luck, and what is chance?*

196a Some question whether there is any such thing. Nothing happens by luck, they say, but everything called "by luck" or "by chance" has some determinate explanation; for example, if someone goes "by luck" to the market-place where he unexpectedly meets someone he has been wishing to meet, this is, after all, a consequence of his decision to go to

* These questions are answered in reverse order in ii.5, 6.

market. So for any other event ascribed to luck, they say, it is always possible to find some explanation other than luck; indeed, it would seem very strange, they argue, if luck were really [7] a definite [4] factor. Moreover, they ask, why did none of the ancient sages in explaining generation and destruction develop a theory [72e] of luck? May it not have been because they, too, believed that nothing happens by luck? However, we may reply, is not this, too, very "strange"? Consider: men generally are not unaware of the possibility of tracing many matters of luck and of chance to some definite factor which accounts for what happens (as the old argument [of Democritus] has it which eliminates luck), yet they continue to ascribe some events to luck and others not. Ought not the ancient sages for this reason alone to have given some attention to this subject? Yet they did not even recognize luck along with friendship, strife, mind, fire, or any other factor which they named. Their failure to develop a theory of luck and of chance is unjustifiable, whether they set them aside altogether or simply passed them by; especially since they did not disdain on occasion to take recourse to them. Thus, Empedocles remarks that air is not uniformly drawn upward but, as it were, by luck; as he puts it in his cosmogony, "it happened at that time [when friendship prevailed] to move in that way, but at other times in other ways." Empedocles also asserts that most parts of animals originated by luck.

Again, some attribute [83b] the heavens and all worlds to chance happenings, on the theory that the "vortex" arose "of itself," that is, the motion which separated and arranged the entire universe in its present order. This, too, is very "strange"! It is not by luck, they say, that animals and plants are and come to be, but these are to be explained by nature or mind or something of the sort, since a seed does not develop into any random thing but one kind into an olive and another kind into a man, and so forth; yet the heavens, the most divine of all things visible, have no such determinate explanation as animals and plants have but arise spontaneously. Even if this were the case, it would be a situation that might well give us pause and prompt us to say something 196b of importance about it. Apart from the strangeness of the theory in other respects, it is especially "strange" to assert chance in the case of the heavens where we do not observe it and to deny luck to a region in which many events occur by luck; what happens is the very opposite of what their theory would lead us to expect.

Some, again, hold luck to be an explanatory factor but to be something divine and rather daemonic and therefore obscure to human intelligence.

Hence, we must examine what chance and luck are, whether they are the same or different, and how they are to be classified in relation to the explanatory factors which we have distinguished.

5. Facts and Traits of Luck and Chance

We observe that some events always occur in the same way and some usually so. Evidently, we do not ascribe either of these two classes of events to luck; nor do random events happen in the same way either necessarily and always or even for the most part. But everyone distinguishes, besides uniform and typical events, exceptional or nonnormal events. Evidently, then, there is such a thing as luck or chance; and by nonnormal events we mean random events, as by random events we mean nonnormal events.*

Then, too, we distinguish events which happen to some end [96b] and those which do not; and among ends, we distinguish those which are intended [178] and those which are unintended. Clearly, then, things may not only have necessary uses and probable [125] uses, but they may also have at least some other possible [12a] uses. Now, things happen† to some end either by nature or by design [170]. They happen by luck when they come about by accident. Thus, just as anything may be either essentially or accidentally, so explanatory events or factors may also be of either kind. In the building of a house, for example, the builder is an essential factor, but the fact that he may be white or a musician is incidental; the essential factor is determinate, whereas incidental ones are indeterminate, since any individual may have an infinite number of attributes. As we have said, then, when events which happen to some purpose or end come about by accident, we ascribe them to luck or to chance. (How these two differ, we shall explain later; but for the present it is evident that both of them refer to things that happen to some purpose or end.) Suppose, for example,‡ that a creditor would have gone to a market to recover his loan had he known that his debtor was there, but he happened to go there for another purpose with the result that he got his money, although it was not his usual or invariable practice [as it might have been for someone else] to go to the place where the two men met; the result (getting the money) is, like any object of deliberate choice, a factor external to the agent; and we say that the event happened by luck [relatively to the normal case], for we would not say this if he had gone there regularly or normally for the purpose of soliciting funds. Clearly, then, luck is an accidental factor which may intervene in events otherwise directed to an end in accordance with some intelligent choice

* *On Generation and Corruption* ii.6.334b4-19; *Rhetoric* i.10.1369a32-b5; *Posterior Analytics* i.30.87b20,21. Thomas Aquinas (against Avicenna): "nihil quod est ad utrumlibet, exit in actum, nisi per potentiam appetivam determinetur ad unum."

† 196b21-25, 197a5-14, 25-27 are duplicated in *Metaphysics* xi.8.

‡ ii.4.196a1-5.

[178]. Hence luck and thought [170] pertain to the same event, for choice takes thought.

However, the explanatory factors of events that occur by luck are necessarily indeterminate; therefore, luck, too, is held to be indeterminate and obscure to men, so that in a way nothing might be held to happen by luck. All of these opinions have some reasonable justification. In one way there are things which happen by luck, namely, accidentally, so that luck is in some sense an accidental factor; but in another way nothing happens by luck, namely, absolutely. For example, a builder is responsible for a house; that he may be a flute-player, is incidental. Again, there may be innumerable reasons for a man's coming and getting his money when he did not come for that purpose: he may have wanted to see someone or have been following or avoiding someone or have gone to see some spectacle. So, too, luck is rightly said to be unpredictable. Prediction [90] applies to what is [1a] always or for the most part; but luck characterizes a third class of events. Consequently, since factors of this kind are indeterminate, luck is also indeterminate. Still, there are cases in view of which we may ask: may we, then, explain a random occurrence by *any* random factors? We may explain a given case of health, for example, by the blowing of the wind or by the rays of the sun, but hardly by a haircut; for some incidental factors are less remote than others.

Moreover, it is good or bad luck when the result is good or evil; and prosperity or misfortune, when the results are on a grand scale. Even when we fail by but a little to come to some great good or evil, we are fortunate or unfortunate in that we can all the more readily think of the good or evil as present and the slight miss as absent. Again, fortune is rightly held to be unstable, since luck is unstable inasmuch as none of the things due to luck are either invariable or typical.

Both luck and chance, then, are incidental factors (as has been said) in the class of events which may happen, but which do not happen absolutely or usually, yet which happen to some end.

6. Luck, Chance, and Explanation

Chance and luck differ in that the former has a wider extent. Everything that occurs by luck, occurs by chance; but not everything that occurs by chance, occurs by luck.

Luck and the consequences of luck happen only to beings with capacity [82f] for good fortune and for the conduct of life [188b] generally.*

* Thomas Aquinas: ". . . vita practica sive activa est eorum quae habent dominium sui actus. . . ."

Hence luck must pertain to practical affairs; as is evidenced by the belief that good fortune is almost though not quite identical with happiness and that happiness is in turn a kind of activity, namely, "doing well." But beings lacking capacity for conduct of affairs cannot achieve anything even by luck; for example, inanimate beings, brutes, or children. They are incapable of shaping their course by intelligent choice [178] or of experiencing good or bad fortune—except by analogy [57], as Protarchus pronounced altar-stones fortunate because they are valued above others which serve as stepping-stones. Yet beings unable to act by luck may indeed in some sense be acted upon by luck, namely, when an agent brings something about by luck in dealing with them.

Chance, on the other hand, is found both among living beings other than man and in many inanimate beings. We say, for example, that a certain horse came by chance to a safe spot because in consequence of his coming he found safety there, though we do not say that he came "with a view to his safety." Similarly, we say that a certain three-legged chair [tossed into the air] fell onto its feet "of itself" because it did so not "in order that" but "with the result that" someone could sit on it.

Evidently, then, we attribute to "chance" events which happen to some end or result, but which do not happen with the end-result in view, and which have an external explanatory factor; and, of the events which happen by "chance," we attribute to "luck" those only which are possible objects of choice [178] for beings who can choose. The meaning of "chance" or "automatism" is reflected [38a] in the phrase "in vain," as applied to an action which does not result in the outcome intended: for example, a walk taken to stimulate bowel-movement is said to have been taken "in vain" if the desired result does not occur; so that any action which naturally functions [101c] as a means to an end other than itself is "in vain" when it does not issue in the end to which it is naturally instrumental—for it would be ridiculous for anyone to say that he had bathed "in vain" because he did not thereby bring about an eclipse of the sun, since no one bathes to such an end. Etymologically, then, the "auto-matic" [or "self-active"] characterizes an event which by "itself" happens "in vain": a stone, for example, does not fall for the purpose of hitting anyone; hence, it falls "automatically" because [contrariwise] it might fall by the action of an agent and for that purpose. However, luck and chance are most clearly differentiated in events which happen by nature but contrary to nature: we attribute such events to chance rather than to luck; yet even such events differ [from chance in the strict sense] inasmuch as the latter is due to an external factor, whereas these are due to an internal factor.

We have explained what chance and luck are and wherein they differ from each other. Both belong to the type of "explanatory factors" whence comes the beginning of movement. They are always a sort of factor operating either by nature or by design, although the number of these is indeterminate. But in spite of the fact that the results of chance and of luck are results for which mind or nature might be responsible, those chance results have come about because of some accidental factor. It is clear that,† since nothing accidental is prior to the essential, neither are accidental factors prior to essential factors. Accordingly, chance and luck are posterior to mind and nature; and hence, even if chance is a factor responsible for the heavens, mind and nature must be prior factors not only for many other things but also for this universe itself.

7. Relations of Explanatory Factors

Clearly, there are explanatory factors, and they fall into four types corresponding, as we have analyzed them, to the four meanings of the question "why." The "why" of anything may ultimately mean: (1) "what it is," for example, a straight line or the commensurable or anything else as defined in mathematics or in the realm of unchanging considerations generally; or (2) "what started a process," for example, a war, as in revenge for a raid; or (3) "to what end," for example, in order to win rulership; or (4) in the case of products, their "material."* Since these are the four types of explanation, the natural philosopher must try to understand them all if he is to deal adequately [101a] with the "why" of anything in terms of each type of explanatory factor: the material, the form, the agent, the "where-for."

Often the [first] three factors coincide. "What" something is and "to what end" it is, may be the same; and a prime mover may be identical with these factors in form or species, since man generates man, and so with moved movers generally. As for unmoved movers, they do not belong to the domain of natural science, since they evoke movement without having within themselves either movement or a beginning of movement. In this regard, therefore, we must distinguish three sciences [197]: one, concerning unmoved beings; another, concerning moved beings which are imperishable; and a third, concerning moved beings which are perishable.

In giving an account of the "why" of anything, then, we must take into consideration at once its material, what it is, and its mover. But

† Lines 7-13 are duplicated in part at the end of *Metaphysics* xi.8.

* Thomas Aquinas: "Sed quia forma est causa essendi absolute, aliae vero tres sunt causae essendi secundum quod aliquid accipit esse, inde est quod in immobilibus non considerantur aliae tres causae, sed solum causa formalis."

investigators seeking explanations of events [116a] employ the method of asking, chiefly: "What comes after what?" "What started the process? And on what did it act?" Thus they give their chief attention to the sequence of events [136c]. However, the beginnings in control of
198b natural movements are of two sorts. One of them is nonphysical, since it has no tendency to change within itself. This is an unmoved mover: it is (1) the completely immovable or first of all beings; and it is (2) what anything is or its form, which is also at the same time its completion or the end to which it functions. Hence, since nature [in its processes] has uses [96b], we must in our attempts to get knowledge admit the "final" factor along with others.

In short, the question "why?" calls for a comprehensive answer. Thus; [we must explore (1) the efficient factor:] "this must result from *that*," and "from that" either without qualification or in most cases; [(2) the material factor:] "if this is to be, then *that* must be," just as syllogistic conclusions are conditioned by their premises; [(3) the formal factor:] "*that* was what it meant for this to be"; and [(4) the final factor:] "*that* is why it is best for this to be thus and so," not of course absolutely but relatively to its [40] distinctive being [26].

8. Natural Processes and Their Ends

10 Let us now state how end-results [96b] are grounded [83] in nature and then how there is necessity in natural processes [101a]. Writers on nature generally reduce their explanations to "necessity." Since hot and cold (and so forth) naturally function in certain ways [5], they say, it is by necessity that states of affairs [4a] are as they are and arise as they do. If these men speak of any other factor such as friendship and strife or mind,* they touch on it briefly and abruptly bid farewell to it. So, they ask, why should not nature act, not to some preferred end—but as it rains, not in order that crops may grow, but by necessity?
20 Rising vapor must cool and, having become cool, must turn into water and descend, whereupon crops happen to grow; so, too, if crops on the threshing-floor are spoiled, the rain did not fall in order to spoil them, but this is simply the way things come about. Hence, why should not even bodily parts like teeth have developed in the necessary course of nature—sharp front teeth suited for the tearing of food and flat back teeth suited for the crushing of food? May they not have been produced, not to some end, but by coincidence? And may it not be so with all bodily parts supposedly having some inherent end or purpose? Those organic structures, then, which came into the world as if they had been

* Cp. Plato *Phaedo* 97-99.

produced to some end, survived because they had been automatically 30
organized in a fitting way; all others, like the man-faced offspring of oxen in the theory of Empedocles, have perished and continue to perish.

However, this or any similar line of reasoning in objection [to natural ends] cannot be sustained in the sense in which it is usually pursued. All natural products like those mentioned are either always or for the most part generated in definite ways, which is not the case with any products of luck or of chance! Thus, we do not ascribe frequent rain 199a
in winter or heat in summer to chance or to coincidence, as we do frequent rain in summer or heat in winter. If events, then, presumably either result from coincidence or else happen to some end, and the events mentioned cannot be ascribed to coincidence or to chance, then such events must happen to some end. Even the men who argue as we have reported agree that events like those in our illustration happen naturally. Hence, there must be among natural beings and products such as exist or come into existence to some end. Again, in any procedure [188a] which has an end, what comes first and what comes next are performed for that end. But as in human operations, so in natural proc- 10
esses; and as in processes, so in human operations (unless something interferes). Human operations are for an end, hence natural processes are so too. If a house, for example, came into being by nature, it would come into being [in stages] just as it now does by art; and if natural objects not only came into being by nature but also by art, they would come into being [in successive stages] just as they do in the course of nature; [in either case] each stage is [continuous with and] for the sake of the next.

In general, moreover, art completes what nature is unable to carry to a finish; or art imitates nature. If, then, processes by art are to some end, it is clear that natural processes are too. The earlier [in a series] are related to the later ones in processes by nature as they are in processes by art.

This is strikingly evident in those other animals who do not act by 20
[conscious] art [171] or experimentation [194] or deliberation [177a], which is the reason why some people debate whether or not spiders, ants, and the like work by intellect [169] or something else. Moreover, as we pass gradually down the scale, it becomes apparent that there is adaptation to ends also in the growth of plants which, for example, put forth leaves to shelter their fruit. Hence, if it is *both* by nature *and* to an end that the swallow builds its nest and the spider spins its web and that plants put forth leaves for the benefit of the fruit and send their roots down rather than up for nourishment, it is evident that there is such a factor [as an "end"] in natural processes and beings. Further, since "na- 30

ture" is double, meaning either "material" or "form," and the latter is the end, everything else being for the sake of the end, the "form" will be the For What aimed at.

Now, mistakes occur even in processes by art, as when a scribe writes incorrectly or a physician gives a wrong dose; so that, clearly, 199b mistakes are possible in processes by nature also. If there are certain processes by art in which right procedures serve their respective ends, and failures occur when the end sought is not achieved, so it is with natural products; among the latter, monstrosities or freaks exemplify a falling short of natural ends.

If, then, among original formations [in the theory of Empedocles], the offspring of [man-faced] oxen were unable to attain to a certain [72b] completion or end, they must have been generated by a principle in which was some corruption, just as now [monsters are generated by some corruption] of the seed. Again, seeds must have come into being first, and not animals all at once; the "undifferentiated" which came "first" [before extant animal forms] must have been seed [not animal]. 10 Again, since plants function to some end, only with less organization than animals, were there or were there not among them olive-headed offspring of vines? Absurd! But no more absurd than man-faced offspring of oxen among animals!

Again, any chance products ought [on his theory] to arise from seeds. Such an assertion would completely abolish everything "natural" and "nature"; for that is "natural" which in a continuous "movement" from some "beginning" within itself arrives at a definite end—not indeed the same end for all from any beginning whatsoever, nor indeed any chance end, but always the same end for each [kind] unless something inter- 20 feres. To be sure, ends and means may come about by luck, as in the story of the stranger who came by luck and before departing ransomed a prisoner† as if he had come for that purpose (although he really did not); here the result is incidental [to the purpose of his coming], for luck is according to our previous analysis an incidental factor. But when a certain result occurs always or for the most part, it is not an incidental or a lucky occurrence; and "natural" results are such as always or usually occur in definite ways unless something interferes.

As for those who think that nothing comes into being for any end if they do not see the moving factor deliberating, their argument is absurd; even art does not deliberate. Indeed, if the art of shipbuilding were *in the wood* [instead of being in a visible artist], it would act like *nature;* 30 hence, if art proceeds to some end, so does nature. This becomes especially clear when someone [without deliberation] heals *himself;* nature

† Preferable to the reading "bathed."

is like this. In sum, nature is evidently a [genuine] factor [83] which, moreover, operates to some ends [96b].

9. Necessity as Related to Ends

In what sense, then, does anything happen [82f] "necessarily"? "Conditionally" [64h] [in subjection always to ends]? Or also [without any reference to ends, and thus] unconditionally [105]?

Currently, the belief prevails that "necessity" is to be found in gen- 200a eration [by nature], as though it were supposed that a wall had come into being because of the necessity by which what is heavy is naturally borne downward, and what is light, upward; in particular, because the foundation-stones had fallen to the base, the bricks (being lighter) had risen to a higher place, and the wood (being lighter still) had shot up to the top. Yet a wall, although unproducible *without* these things, does not come into being *because* of them, except as its material conditions; but a wall is brought into being to serve as a shelter and as a protection. So with all other cases in which ends are relevant: they do not come into being without means having a necessary nature, yet they do not therefore arise because of them, except as material condi- 10 tions; but are produced to some end. Why, for example, is a saw such as it is? In order to perform a certain function [4a] to a certain end. This end cannot be brought about unless the saw is made of iron; then, *if* the saw is to function [9c] as a saw, it *must* be made of iron. Necessity, then, is hypothetical [64h], but not as an end. In other words, necessity is in the *material;* the end is in the "logos."

Necessity is almost [55b] the same kind [57d] in natural processes as necessity in mathematics. Thus, *since* a straight line is such [that it forms, together with another on which it stands, adjacent angles equal to two right angles], therefore it is *necessary* for a triangle to have its internal angles equal to two right angles. But the converse does not follow; although, indeed, if the "conclusion" concerning the triangle were *not* so, then the straight line would not be as stated in the "premises." On the other hand, in the case of what happens to some end, the relation is inverse: if an "end" will be or is, its "antecedents" must be 20 future or present also; and if they are not, the end will not be achieved —as in geometry, if the "conclusion" does not hold, neither does the "first principle." The end is itself a "beginning," not, to be sure, of the action, but of the reasoning [176]—whereas in mathematics, where there is no action, first principles are the beginning of reasoning only. Thus, we reason: *if* there is to be a house, *then* certain materials *must* be available [82f] or be produced; or, in general, there must be materials for

some end, and among such materials are bricks and stones if the end is a house. But the end is not present or future because of them, except that they are its material conditions. Yet if there are no materials at all, if there are no stones and if there is no iron, then there will be no house and no saw either; just as in geometry, if the internal angles of a triangle were not equal to two right angles, then the first principles of geometry would not be true either.

It is evident [from this analogy] that necessity in natural productions refers to what we speak of as their material and its changes. But the natural philosopher must speak of both factors, more especially of the final factor: for it is this which accounts for a material [and its processes], not the material which accounts for the end; and the end is that for which [the material is necessary]. [That is to say,] the beginning is from a definition or a meaning! In the processes by art, for example, if the house [we want] is such and such [5], then certain materials must be produced or be available; and if the health [we desire] is such and such [4a], then certain conditions must be brought about or be present. Just so [in natural processes], if a man is such and such [4a], then certain things [are necessary]; and if so, then certain others. Necessity is also in the definition of a thing: if we define the function of sawing as a certain way of dividing, the dividing cannot take place unless the saw has teeth of such and such a kind, and these cannot be such unless they are made of iron. There are also in a definition certain parts which function, so to speak, as the [necessary] material for the definition.

III. BOOK GAMMA

Movement and the Infinite

1. Definition of Movement

Since we are exploring nature as a beginning of movement and change, we must not neglect to define what movement is, lest unclearness [190] about movement lead us into inevitable unclearness about nature; and then, having defined movement, we must in the same manner take up the terms which follow [136b] from it. Thus, movement being continuous, what is infinite becomes evident primarily in what is continuous, with the consequence that the continuous is often defined in terms of the infinite: "that is continuous which is infinitely divisible." In addition, movement is held to be impossible without place, the void, and time. Clearly, then, we must investigate and find out what we can about each of these topics, not only for the reasons stated but also because the features mentioned are general and common to all the things with which our science deals; and a theory of special [42] traits must come after a theory of common [92] traits.

First, then, as we have proposed, let us consider movement. Now, being,[a] whether primary or quantitative or qualitative, and so forth, may be only actual, or [only] potential, or both actual and potential. Moreover, the relative may be "more or less"; or the relative may be active or passive, that is, a possible mover or something that can be moved, since what can impart movement is relative to what can receive movement, and vice versa. Then, too, there is no movement apart from things: for when they change, they always change in primary being

[a] Much of iii.1-3 is duplicated in *Metaphysics* xi.9.

or quantity or quality or place; and there is nothing which, because it
201a is common to all, falls into no one category, so that there is no movement or change any more than there is any being apart from the categories. But the categories apply [82f] to anything in one of two ways: by form or by privation. This is true of any specific primary being [4a] and also of any quality (white or black), any quantity (complete or incomplete), any spatial change (up or down, light or heavy). Consequently, there are as many kinds [20] of movement and change as there are of being.

10 Since any kind [19] of being may be distinguished as either potential or completely realized, the functioning [10] of what is potential [11c] as potential, that is "being in movement": thus, the functioning of the alterable as alterable is "qualitative alteration"; the functioning of that which *can* increase or decrease the contrary (there is no name common to both) is "increase" or "decrease"; the functioning of that which *can* be generated or destroyed is "generation" or "destruction"; the functioning of what *can* change its place is "local motion."

That this is what motion is, can be shown as follows. When building materials, insofar as we say them to be such, are actually functioning as building materials, there is something being built; and this is [the process of] building. Similarly, learning, healing, rolling, leaping, aging, ripening [are movements whenever something is being completed or
20 fulfilled, neither earlier nor later].† Since some things, then, are both potential and actual, though not at the same time and in the same respect—but (for example) what is potentially hot is actually cold, therefore such things will act upon or be acted upon by one another in many ways (for everything is capable both of acting and of being acted upon). Hence, too, every mover which is a physical agent is moved; indeed, every mover of this sort moves by being itself in movement. It seems to some that every mover is a moved mover; no—what is so will become clear from other considerations‡; there is also an unmoved mover.

The functioning,§ therefore, of what is potential, when there is actually something being realized, not as itself, but as movable, is motion. By
30 "as," I mean this: bronze is potentially a statue; nevertheless, the complete functioning [10] of bronze "as" bronze is not [exhausted in] its being changed [109]. For what it is to be [88a] bronze and what it is to be a certain potentiality for being changed are not the same; since if they were strictly the same in definition, the complete functioning of

† *Metaphysics* xi.9.1065b19-22.
‡ viii.5.
§ "Fulfillment" and related terms are to be understood in the sense of verbs.

bronze as bronze would be a movement. But they are not the same, as has been said. This is clear in the case of contraries; for to be capable of being healthy is different from being capable of being dis- 201b
eased (if they were not, being healthy and being diseased would be the same). But it is the same subject [85] that may be either healthy or diseased, such as blood or some other bodily fluid. Since, therefore, [to be bronze and to be potentiality] are not the same, as color and the visible are not the same, the complete functioning of the potential as potential, it is evident, is movement.

Clearly, this is movement; and it takes place whenever complete functioning itself does, and not earlier or later. For any power may sometimes function and sometimes not, for example, building materials; their functioning as building materials is the process of building. For the 10
functioning [9] of building materials is either this process of building, or it is the house. But when it has become the house, it is no longer buildable; hence the buildable exists in the process of building. Its functioning [9], accordingly, must be the process of building; and the process of building is a movement. And the same account applies to other movements.

2. Movement and Moved Movers

The truth of this argument is clear also from what others say about movement and from the fact that it is not easy to define it in any other way. For one cannot include movement or change in any other kind [19] of being. And this is clear from what those say who call it 20
"otherness" or "inequality"* or "nonbeing." None of these, however, is necessarily moved; and things do not change toward these or from these more readily than from their opposites. The reason movement is referred to such kinds of being is that it is held to be something indefinite; and the principles governing the privative type of contraries are indefinite, since no privation is a "this" or a "such" or fits into any of the other categories. And another reason why movement is held to be indefinite is that it cannot be classified either as a potentiality or an actuality of things [1a]; for movement does not apply necessarily to, 30
let us say, a quantity, either in its potential or in its actual state. Movement is supposed to be a sort of imperfect actuality, for the reason that the potentiality, whose actuality it is, is incomplete. And therefore it is hard to grasp what movement is; for it must be classified either under "privation" or under "pure actuality," and none of these appears to be possible. Consequently, what has been said remains plausible: 202a

* Plato *Timaeus* 52E, 57E, 58A.

movement is the kind of actuality which has been described, which is hard to discern, but which is capable of being.

Then, too, every mover which is capable of being moved is moved, as we have pointed out, and its unmoved state is "rest," which is an absence of movement in anything subject to movement: for to act upon anything movable as such, is precisely to "move" it; and since such a mover does this by contact, it is at the same time acted upon. Hence, movement is the functioning of the movable as movable when the mover touches the movable so that the mover is at the same time acted upon. Moreover, a mover always conveys a definite [4] form, such as a primary being or a quality or a quantity, and it is in terms of this fundamental factor, the form, that the movement which the mover imparts is to be construed; for example, it is an actual man who begets a man from what is potentially a man.

3. Actualization of Mover and Moved

The difficulty is clear also: movement is in the movable; for movement is the perfecting [10] of the movable by some mover [109c], and the functioning of this agent is not different [from the perfecting of the movable].* For movement must be the perfecting of both; since a thing is an agent or mover because it has the power of moving, and is actually moving when that power is functioning. But it is [also] the power to make the movable function. Hence there is a single functioning of both [powers] alike, just as the intervals from one to two and from two to one are the same, and the ascent and descent; these are one, although their definition is not one. Similarly, with the mover and the moved.

There is a dialectical objection: perhaps it is necessary that the complete functioning of the agent and of what it acts upon be different: of the one, acting; of the other, being acted upon. The function and end of the former is something done; but of the latter, something undergone. Since both are "movements," then, in what do they take place if they are different? Are both of them in what is being acted upon and moved; or is the activity in the agent, and the being acted upon in what is acted upon? (If the latter must be called an "activity," it is in another sense.) On the latter alternative [that the activity is in the "mover," and the undergoing, in "what is moved"], the movement will be in the mover; the same reasoning will hold of mover and moved; so that every mover would either be a moved mover, or would have movement in it without being moved. On the former alternative if both are in what

* *Metaphysics* ix.1.1046a19.

is being moved and acted upon, both the acting and the being acted upon, if, for example, both teaching and learning take place in the learner), one consequence would be that the functioning of each thing would not be inherent in that thing. Another consequence would be the absurdity that what is moved would undergo two movements at once; and which two qualitative alterations would one thing undergo which is moving toward a single form? This would be impossible. But suppose the functioning [of the mover and the moved] to be one [functioning]; still, it would seem unreasonable to suppose that two things differing in form should have one and the same function. Hence, the consequence would be that if teaching and learning, or acting and being acted upon, were the same, then to teach would be the same as to learn, and to act would be to be acted upon, so that a teacher would have to be learning everything he is teaching, and an agent would have to be undergoing everything he is producing. 202b

However, it is not at all absurd that the functioning of one thing should be in something else: teaching is the functioning of someone able to teach; it is certainly in someone, and is not disconnected; but [the teaching] of the one [teaching] is in the one [taught]. Again, there is nothing to prevent the functioning of two things from being the same: not the same as to being; but as what is potential is related to what is actually functioning. Then, too, it is not necessary for one to be learning while teaching; and even if to act and to be acted upon are the same, it is not in the sense in which they have the same definition expressing what-it-meant-for-them-to-be [88], like "clothes" and "garments," but (as we have said before) in the sense in which the road from Thebes to Athens and the road from Athens to Thebes are the "same." The illustrations given show what things have all their attributes the same: namely, not things which are in any way whatever the same; but only things which have the same definition [23]. To be sure, even if teaching is the same as learning, to learn need not therefore be the same as to teach; just so, even if two places are separated by the same distance, the spanning of the distance from here to there would not therefore be the same as the spanning of the distance from there to here. In general, teaching and learning or acting and being acted upon are not the "same" in the strict sense of the term, but what is the same is the movement to which each of such correlatives belongs; for the operation of "this" upon "that" and that's being acted upon by this differ in definition. 10 20

We have thus stated in both general and particular terms what movement is, for it is not hard to see how each of its kinds is to be defined. Thus, qualitative alteration is the functioning of the alterable in so far

as it is alterable; or in plainer language, the functioning of what can act and of what can be acted upon, as such. So, too, both in general and in particular terms, with building, healing, and so forth; and a similar definition may be given of any of the other kinds of movement.

4. The Being of the Infinite

The science of nature deals with magnitudes, movement, and time, each of which is necessarily either infinite or finite, even though not everything is "either infinite or finite"; for example, considerations like qualities and points probably need not be considered in either of these ways; hence, it behooves one who explores [197] nature to develop a theory of the infinite. Is there such a thing or not; and if so, what is it? That the theory of the infinite belongs [55] to natural science, is indicated by the fact that all the recognized philosophers aiming at a theory of nature have worked out reasoned views [90] of the infinite; indeed, all of them treat [64] the infinite as in some sense a *principle* of beings.

Some, like the Pythagoreans and Plato, regard "the infinite" as something independent [2], that is, not as an attribute [3a] of something else, but as being itself a *primary being* [26]. The Pythagoreans, who do not treat numbers as anything separate [or abstract], locate the infinite in sensible things; they also declare what is beyond the boundary of the universe to be infinite.* Plato, however, denies that there is anything beyond the boundary of the universe, either anything bodily or any "ideas" (since "ideas" are "no-*where*"); and he locates the infinite both in sensible things and in the "ideas."* Moreover, the Pythagoreans identify the infinite with even number: inasmuch as even numbers can be divided [65d] and are also limited by the odd,† they give [33d] to beings [1a] an infinity [of forms]. By way of evidence, the Pythagoreans appeal to what happens to numbers [in geometrical patterns] when gnomons are placed successively round the unit and [analogous constructions are formed] apart from the unit: in the former series,‡ the resulting [square] figures [20] preserve a unity [of shape]; in the latter series,§ the resulting [rectilinear] figures are always diverse [in the proportion of their adjacent sides]. Plato, however, maintains two infinites, the great and the small [in discontinuous number series].

* Plato *Timaeus* 32E; *Philebus*.

† The Pythagoreans seem to have taken the point as indivisible and patterns of even numbers as capable of division through the middle of the gaps between the points.

‡ $1+3+5 \ldots +(2n-1)=n^2$.

§ $2+4+6 \ldots +2n=n(n+1)$.

On the other hand, all those philosophers who give their attention to nature take [64h] infinity as a *character* of something different from infinity, namely, as a character *of some concrete nature* among the so-called "elements" (such as water or air or something intermediate between them); but whereas no one who regards the elements as finite in number describes them as infinite [in extent], those who treat the *number* of elements as infinite, like Anaxagoras with his homogeneous parts and Democritus with his differently shaped atoms, declare the infinite [whole] to be continuous by contact [of the elements or atoms].‖ Moreover, Anaxagoras believes that any part is a mixture like that of the whole [150] because he sees anything as coming from anything. This is apparently also the reason why he says that at one time all things were together: this flesh, this bone, anything whatever, therefore all things, and all at the same time; for the separation not only of each particular thing but also of all things has, according to him, a beginning. Since whatever arises, then, arises from a body similar to it, and all things have a genesis (though not all at the same time), the genesis must also have a beginning: this beginning, which is one, he calls "mind"; and "mind" in turn must begin its thinking and activity from some starting-point. Hence, all things must at some time have been together and must at some time have begun to be in movement. Democritus, however, maintains that none of the primary natures comes out of another. Still, even for him, body considered generally [92] is the source of all things inasmuch as its parts differ only in size and shape.

It is clear, then, from these considerations that the theory of the infinite is a proper concern of natural scientists or philosophers. With good reason, too, all of them take the infinite to be a principle. For one thing, it cannot be altogether futile, yet the only validity [11] it can have is that of a principle: everything is either a source or derived from a source; but if the infinite were derived from a source, it would have a limit. Again, the infinite cannot be generated or destroyed, any more than can a principle: what comes into being must have [65] an [initial] terminus [100]; and all destruction has a [conclusive] ending [100a]. Hence, as we have said, the infinite does not have a beginning of its own but is itself held to be a beginning of other things and to contain all things and to govern them, as those describe it who do not set up alongside the infinite some other explanatory factor such as mind or friendship; and the majority of physicists would agree with Anaximander when he says that the infinite is divine, since it is deathless and indestructible.

‖ Hence, the upshot of this view, too, is an infinite in *magnitude*.

Now, there are chiefly five lines of investigation which lead to the conviction that the infinite is something: (1) time is infinite; (2) magnitudes are divisible in such a way that mathematicians, too, work [163] with the infinite; (3) things come to be and pass away ceaselessly only because the source of their generation [and destruction] is infinite; (4) the finite is always limited by something else so that it must be without any limit that something must always be limited by something else; and (5) there is, above all, the problem which everybody raises that thought has no stopping-place in dealing with numbers, with mathematical magnitudes, or with what is beyond the boundary of the universe. In particular, the infinite beyond the boundary of the universe suggests an infinite body and infinite worlds.¶ Why, in the void, would body be here rather than there? If there is mass anywhere, it must be everywhere. Even [aside from this argument] if there is void or infinite place, still, there must be infinite body also, for there is no difference in the eternal between what may be [12a] and what is [23].

However, the fundamental difficulty which the theory of the infinite contains is this: either an outright denial or an outright acknowledgment of the being of the infinite leads to many impossibilities. Again, there is the question *how* the infinite is. Is it a primary being? Or is it an essential attribute of some nature? Or is it neither of these but nevertheless something infinite [in extent] or infinite in number?** Especially 204a does the philosopher of nature face the problem whether there is a *sensible* infinite magnitude. First, then, we must distinguish the various meanings of the "infinite." The infinite†† is (1) what by its very nature [101c] cannot be spanned, as a voice is naturally invisible, or (2) what can be endlessly spanned, or (3) what can scarcely be spanned, or (4) what can naturally be spanned, but is not actually spanned or has a limit. (5) There is, besides, an infinity by addition, and one by subtraction, or both.‡‡

¶ According to Simplicius, Archytas insisted that, if there is nothing beyond the boundary of the universe, nothing could stop him from stretching out his hand into the beyond.

** i.2.184b21, 4.187a26-5.188a19-30, 6.189b11-20; *On Generation and Corruption* i.3.318a20.

†† The account of the infinite in *Metaphysics* xi.10 is made up of extracts from *Physics* iii.4, 5, 7.

‡‡ (1) In an accidental sense (iii.5.204a14-17), (2) strictly (a character of the subject of the process), (3) more roughly (for example, a labyrinth), (4) by analogy (iii.6.207a2-7), (5) derivatively (applied to the process). Cf. iii.7.207b1 note.

5. The Infinite as Not Actual

The infinite cannot be something that is separate from perceptible things and an independent being [4d] which is itself infinite. For if infinity is neither a magnitude nor a plurality, but is itself a primary being, not an accident of it, then it will be indivisible; since the divisible is either a magnitude or a plurality. But, if indivisible, it is not infinite; except as the voice is invisible. But it is not usually so regarded, nor are we analyzing it in this sense; we regard it as incapable of being traversed. And if the infinite is an accident,* it cannot as infinite be an element of things, any more than the invisible is an element in conversation [78] because voices are invisible. And how can the infinite be by itself [2], unless number and magnitude, of which infinity is an attribute [35a], are also by themselves? Indeed, infinity would inevitably fall short of number or magnitude in this respect. And it is evident that the infinite cannot be an actuality or a primary being or a source, for then any given part of it would be infinite; since "to be [88a] infinite" and "infinite" would be the same if the infinite were itself a primary being and not attributed to a primary subject [85]. Consequently, it is either indivisible or, if it has parts, it is divisible into infinites. But the same thing cannot be many infinites; for as a part of air is air, so a part of the infinite would be infinite, if the infinite were a primary being or a principle. Accordingly, the infinite must be without parts and indivisible. But an infinite in its completeness [10] cannot be indivisible; for it must be quantitative. Accordingly, subjects [82f] must be accidentally infinite. But, if so, then, as has been said, infinity cannot itself be a principle, though it may be accidentally related to a principle such as air or even numbers. Hence, it is unreasonable to speak as the Pythagoreans do: they describe the infinite as a primary being and proceed to divide it.†

We seem to be inquiring into something general [concerning the infinite as an attribute], namely, whether there is among mathematical entities an [actual] infinite [extension] or among intelligibles without 204b magnitude [an actually infinite number]; but since our scientific investigation concerns sensible things, we are especially interested in asking whether or not there is among sensible things an infinitely large [actual] body. That the infinite is not among sensible things is clear from the following dialectical considerations. If the definition of a body is "what is bounded by planes," there cannot be an infinite body, whether intelli-

* According to another interpretation, "if the infinite is incidentally a primary being" (Simplicius), for example, by way of having air or water for its referent, it is an element only as air or water (Cod. Reg. 1947).

† iii.4.203a11.

gible or perceptible; nor a separate [or abstract] and infinite number, since the number of what has number is numerable, and if so, then the infinite can be spanned.‡ What has been said may also be clarified by the following physical considerations. The infinite can be neither composite nor simple. It cannot be a composite body, since the elements are quantitatively limited. For contrary elements must balance each other, hence neither can be infinite; since if one of the two contrary forces should fall short in power, the finite would be destroyed by the infinite (for example, finite fire by infinite air, no matter how much more *definitely* powerful a portion of fire than an equal portion of air). And it is impossible that each should be infinite: for a body is what has extension in every direction, and the infinite is boundlessly extended; so that, if the infinite is a body, it will be infinite in every direction.§ Nor can an infinite body be one and simple: either, as some say,‖ something different from the elements out of which they are supposed to be generated; or in general [105]. Some describe the infinite in this way and not as air or water, lest an infinite element destroy the others: the elements have contrarieties, air being cold, water being moist, fire being hot, and if any one of them were infinite, the others would long ago have been destroyed; as it is, these people maintain, the infinite is different from them and is their source. However, the infinite cannot be as they describe it: not because it is infinite, for this point may be made in a general [92] argument applying to air or water, and so forth, alike; but because there is no sensible body apart from the socalled "elements." Everything can be resolved into that of which it consists, and hence presumably into air and fire and earth and water and something besides them; yet no such body besides them is observed. Nor can the infinite be fire or any other element; for, aside from the question how any body can be infinite, the All, even if it is finite, cannot be or become any one of them, as Heraclitus maintains that all things sometimes become fire. The same argument applies here as to the One which the natural philosophers¶ present as independent of the elements. For everything changes from one contrary to another, for example, from hot to cold.

We must not only consider in terms of the alternative cases enumerated whether or not there can be a sensible infinite body; but that this is impossible, may also be clarified by the following general [44] considerations. Every kind of sensible body is naturally somewhere: its whole

‡ The infinitely numerable would not be an actual infinite number.

§ It is, moreover, unnecessary and untenable to assume with Anaxagoras that the number of elements in the infinite body is infinite (i.4).

‖ Anaximander.

¶ Anaximander.

and its parts have their same and proper places; for example, the earth and a clod, fire and a spark. Consequently, if the infinite body is homogeneous [57a], it must be immovable or else constantly moving. But this is impossible; for why should it rather go down than up, or move anywhere? For example, if there were a clod in it, where would this move or rest? For the proper place of this homogeneous body is infinite. Will a clod in it then occupy the whole place? And how? What, then, is its rest or movement? Will it rest everywhere? Then it will not move. Or will it move everywhere? Then it cannot stop. On the other hand, if the All has unlike parts, their proper places will also be unlike: first, the body of the All is not one except by contact; and, secondly, the parts will be either finite or infinite in kind. They cannot be finite, for then some will be infinite in quantity, such as fire or water, and others not, if the All is infinite; but such an infinite element would destroy those contrary to it (as we have said before). Hence, too, none of the natural philosophers identify the one infinite body with fire or earth but with water or air or something intermediate between them, since each of the former has a determinate proper place, whereas the resident place of the others is intermediate between up and down. But if the infinite parts are infinite and simple, their proper places are also infinite, and the elements will be infinite in number; and, if this is impossible, and the places are finite, the All must also be finite. For places and bodies cannot exclude each other: the whole place must not be larger than so much as can hold the body, and then the body would no longer be infinite; and body must not be larger than place; otherwise, there would be either a void or a body which would naturally reside nowhere.

On the other hand, Anaxagoras argues absurdly that the infinite is at rest: it stabilizes itself, he says, because it is "in itself," there being nothing else surrounding it; and where anything is, there it is naturally. But this is not true, since a thing can be somewhere not naturally but by compulsion. Even if the whole is unmoved because it stabilizes itself and is in itself (and therefore immovable), an explanation must be given as to why it is not naturally in movement: it is not enough to make the statement in question and let it go at that, since the infinite might not be in movement because it has no place to move to,** and yet there would be nothing to hinder it from being naturally in movement; thus the earth is not removed and would not be even if the earth were infinite as long as it is held in place by the center of the universe, but it would be at rest at the center not because it has no place to move to but because it naturally acts as it does, and yet it

** Other versions: "since anything else might not be in movement."

could be said to stabilize itself. If, then, the earth, supposedly infinite, would be at rest where it is, not for this reason but because it has weight, and what is heavy remains at rest at the center, and the earth is at rest at the center, then the infinite would likewise be at rest not because it is infinite and stabilizes itself but for some other reason. At the same time, it is clear that any part would have to be at rest and that, just as the infinite remains in itself because it stabilizes itself, so any given part would remain in itself; for the whole and its parts have similar places, for example, the earth and a clod (a lower place), fire and a spark (an upper place). Consequently, if the infinite has its resident place in itself, so will its parts. Accordingly, it will remain in itself.

In general, we evidently cannot speak of an infinite body and at the same time of a proper place for bodies if every sensible body has either weight or lightness. For a sensible body must move either towards the center (if it is heavy) or upward (if it is light), and the infinite, too, would have to do likewise. But either the whole or a half of the infinite cannot do either; for how will you divide it? Or how will part of the infinite be down, and part up, or part extreme, and part central? Again, every sensible body is in a place, and the kinds or differences of place are up and down, before and behind, and right and left: these are distinguished not only relatively to ourselves and by convention, but also in the whole itself; but these cannot be in an infinite body. In general [105], if there cannot be an infinite place, but every body is in a place, neither can there be an infinite body; for what is somewhere is in a place, and what is in a place is somewhere. If then the infinite cannot be quantitative, that is, a particular quantity such as two or three cubits (for this is what "quantitative" means), then also the fact that something is in a place means that it is somewhere; and this means either up or down or one of the others among the six distinguished, and each of these is a limit.††

From these considerations, then, it is evident that there is no body which is actually [9] infinite.

6. The Infinite as Potential

It is also clear that, if we deny the infinite altogether, many impossible consequences would follow. Thus, time would have a starting-point and a stopping-point; there would be magnitudes not divisible into magnitudes; and numbering would not be unlimited. Since, then, neither of

†† Other arguments may be drawn from facts of experience to show that no nonsimple or compound bodies can be infinite (*De caelo* i.5-7).

the alternatives [72e] appears possible [that there should or that there should not be such a thing as the infinite], we must mediate between these two views and distinguish [59a] how the infinite is and how it is not.

Now, "to be" may mean to be potentially or to be actually, and there "is" an infinite by addition and one by subtraction; but, as we have shown, spatial magnitude is not actually infinite but is infinitely divisible (there being no difficulty in refuting [118] the belief in indivisible lines); consequently, we must explore the remaining alternative of a *potential* infinite. However, we must not take [65] the infinite as being potential [11c] in the ordinary meaning of a potentiality which may be completely actualized, as the bronze which is potentially a statue may become an actual statue. But "to be" has many meanings, and the infinite accordingly has the kind of being which a day has or which the games have, namely, inasmuch as one after another continually comes into being: for these, too, "are" potentially or actually; thus, there "are" Olympic games both inasmuch as they may [11a] be held [116] and inasmuch as they are being held. Then, too, the infinite in time and in the generations of man clearly differs from the infinite in the division of magnitudes; although the infinite has in general the kind of being which a continually repeated process has, finite on each occasion [65], but always different. Hence, we must not take the infinite as actually individual [4b], like a man or a house; rather does the infinite have the kind of being which a day has or which the games have —that is to say, the kind of being which does not belong to a concrete [4] primary being [26] that has come into being, but the kind of being which consists in continual coming to be and passing away, which is finite on each occasion, but which even so is different. But in magnitudes, it happens [3b] that what has been taken [for example, in the division of a line] persists; whereas in time and in the generations of man, the parts taken pass away, but the supply does not fail [148a]. Moreover, within a finite magnitude, the infinite by addition is in a way the same as the infinite by division inasmuch as the addition varies inversely with the division: as we see the division going on endlessly, we observe the part marked off increasing endlessly; that is, continually taking a determinate part of a finite magnitude and inversely adding a part determined by a constant ratio (instead of keeping the parts equal) are processes which will not come to an end, whereas division in an increasing ratio (to keep the parts equal) will come to an end (since every finite magnitude can be exhausted by means of any determinate quantity).

There is no actual infinite, then, but there is an infinite potentially and by division. Still, the infinite is actual in the sense in which a day is actual or the games are actual [namely, with the possibility of the next]; but potentially, the infinite does not have the independent being [2] which the finite has, but the infinite is the matter [of the actuality]. In this respect there is a potential infinite also by addition, which we have identified with the infinite by division—but only in a way: in inverse addition, it is always possible to take something beyond what has been taken, yet without exceeding the whole magnitude; in division [in the same ratio], there will always be a magnitude smaller than any that may be specified [72]. Consequently, there cannot be an infinite by addition which even potentially exceeds every determinate magnitude; unless, indeed, there happens [3] to be beyond the boundary of the universe an actually infinite body whose essential being [26] natural philosophers declare to be air or something of the sort. But if there cannot be an actually infinite body of this sensible sort, then there evidently cannot be a body even potentially infinite by addition (except for the inverse addition which we have described). Although Plato maintains two infinites for this reason that it is possible both to add and to divide *ad infinitum*, yet Plato does not use the two infinites he maintains: there is for him no infinite by division in numbers, where the unit is the smallest; nor is there an infinite by addition, since his number system extends only as far as the number ten.

In consequence of these considerations, the infinite is contrary to what 207a is usually described as such: there is an infinite, not when there is nothing left over and beyond, but when there is always something over and beyond! This is exemplified by the bezel-less rings which people characterize as "endless" because it is always possible to take a part beyond that taken, although this use of the term is based only on an analogy to the "infinite" in its strict meaning: the condition stated must be supplemented by the further condition that the same part is not to be taken a second time; the latter condition is not fulfilled in the case of the circle, where a part "always different" is only a neighboring part. Accordingly, *that is infinite of which it is always possible, in regard to quantity, to take a part outside what has already been taken.* On the other hand, when there is nothing left over and beyond, there is something "complete," that is, a "whole"; and a "whole" (for example, a whole man or a whole box) is, by definition, what has nothing wanting [23a]. It is in this same sense of an individual "whole," but with pre-eminent significance, that the universe is a "whole" which leaves nothing out; whereas that which has anything external whatever absent from it, is not "all." "Whole" and "complete" are either identical or akin in

meaning [101]; but nothing is "complete" which does not have an "end," and an "end" is a "limit." Hence, the view of Parmenides that the whole, being equal in every direction from the middle, is limited, is to be preferred to the view of Melissus that the whole is infinite. To connect [137c] the infinite with the "All" or the "whole" is not at all to relate commensurables. The dignity [53] and all-embracing quality of the whole is only ascribed to the infinite because of a [33] superficial [4] confusion [57] of the infinite with the whole. Being the matter of the completeness belonging to a magnitude, the infinite is a whole only potentially—not actually, since division and inverse addition go on endlessly; it is a finite whole, not of itself [2], but because of something else. As infinite, the infinite does not contain but is contained; as infinite, it is therefore also unknowable, for matter is formless. Evidently, then, the infinite is to be treated [90] as an *aspect* [22] rather than a whole; for a material is an aspect of a whole, as "bronze" is an aspect of a "bronze statue." For the infinite to contain sensible things, it would also be requisite for the great and small to contain intelligible things; and it would be absurd and impossible for the unknowable and indeterminate to do any containing and determining.

7. The Infinite and Its Subjects

It is reasonable for us to conclude that there is no infinite by addition in the sense of a magnitude greater than any magnitude but that there is an infinite by division. Like a material aspect, so infinity is "contained" 207b [as belonging to a determinate subject]; what "contains" it, is a "form" [20].*

With good reason, too, we hold that in counting we may proceed from a minimum to an ever greater number; but that, contrariwise, a magnitude is infinitely divisible but not infinite in prolonged dimensionality. The reason is that a unit of any sort is undivided (for example, a man is one man, not many), whereas a number is a number of units (that is, so many of them), so that numbering necessarily starts [111] from an undivided whole; so "three" or "two" or any other number-name is an abstract noun, and it is always possible to think of a greater number. The infinity of numbering may be understood in terms of the continual bisection of a line, [which guarantees the endlessness of the process]. Consequently, the infinity of numbering is potential; it is never

*Infinity is primarily ascribed to a quantitatively determinate subject ("the continuous and sensible") which can participate in a continually repeated process where each term of the series implies the possibility of the next; secondarily, to such a continually repeated process as well as to such abstract terms as number, time, and movement or change.

actual, but consists in the fact that a number can always be found which is greater than any number suggested. But there is no separate infinite number, nor is the infinity of numbering a permanent actuality; instead it is a process [in which one part after another continually comes into being], as in the case of time and the reckoning of time. The infinity of numbering forms a contrast to the supposed infinity of increasing magnitude: although a continuum is infinitely divisible, a magnitude is not infinitely producible. A potential extension can be only as great as the greatest possible actual extension. Consequently, since there is no sensible infinite magnitude, there can be no actual infinite magnitude greater than any and every determinate magnitude, for then there would be something greater than the universe.†

Moreover, the infinite is not the same in magnitude as in movement and time, as if the infinite were some single nature; but the subsequent rests upon the prior. Thus, movement is infinite because the magnitude is infinite over which movement or alteration or increase takes place, and time is infinite because movement is so. For the present, we shall not make use of these distinctions [but shall content ourselves with calling attention to the application of the concept of infinity to such abstract terms as movement and time]; later‡ we shall also ask what this means in each case as well as why every magnitude is divisible into magnitudes.

This account does not, by denying an actual inexhaustible infinite of prolonged dimensionality, take away from the mathematicians their theoretical pursuits in which they neither need nor use such an infinite. Mathematical requirements are met by a figure which may be of any size without ceasing to be determinate. Any line, however short, may be divided on the same principle [90] as any other, however large. For the purpose of their demonstrations, therefore, it will make no difference to the mathematicians that there is no actually existing infinite magnitude.

Since, among the four kinds of fundamental factors in inquiry, the infinite is evidently a fundamental factor in the sense in which a material is, "being infinite" is a "privation" [not a perfection but the absence of a limit]; and its essential [2] definite subject [85] is the continuous and sensible.§ Evidently, too, all other thinkers make use of the infinite as a material factor; hence, it is absurd of them to present the infinite as a container‖ instead of something contained [as a character having a possessor].

† Thomas Aquinas: "non . . . est in materia prima potentia nisi ad terminatam quantitatem."
‡ vi.1, 2, 4.
§ Thomas Aquinas: ". . . ne aliquis intelligat, quod infinitum est materia, sicut materia prima. . . ."
‖ iii.4.203b11, 6.207a18-32.

8. The Infinite and the Finite

It remains for us to attack the arguments* for the view that the infinite is not merely potential but is a separate being [72d]. Some of the arguments are not at all conclusive, and others can be countered by further valid objections.

An actually infinite sensible body is not needed to provide for unfailing coming to be and passing away. The coming to be of some things may be the passing away of others. And the whole may very well remain finite. Moreover, touching and being limited are different. Since everything that touches, touches something, therefore touching is relative to something else; and touching is an accident of only some of the things that are limited. But what is limited, is not limited in reference to something that surrounds it;† and not anything and everything that is limited touches anything and everything else. As for the infinite in our thinking, it would be absurd to rely on it for an actual infinite. There is not in any state of affairs, but only in the thinking referred to, something greater than the greatest or less than the least. Someone might suppose any of us to be infinitely many times his own size; but if anyone has a size greater than ours, it is not because someone thinks so, but because anyone is the size he is. The thinking is incidental. Moreover, the reason why time, movement, and thought are infinite is because any part that is taken does not persist. Finally, magnitude is not, either by division or by supposed [169d] increase, actually infinite.

We have thus shown how the infinite is, how it is not, and what it is.

* iii.4.203b16-30.
† iii.1.200b32-201a15, 6.207a8-14.

IV. BOOK DELTA

Place, the Void, and Time

1. Place and Its Classification

A natural scientist must inform [181a] himself not only on the infinite but also on place. Is there such a thing or not; and if so, how is it, and what is it? People generally suppose existing things to be somewhere and nonexisting things to be nowhere,* for where would a goatstag or a sphinx be? Moreover, the kind of "movement" involved in all the types of change and most strictly so called is change of place or (as we are accustomed to designating it) "local motion." However, the question "What is place?" is fraught with many difficulties. All the facts [82f] appear to give rise to divergent theories [187]. Besides, nothing has come down to us from our predecessors either by way of a statement or by way of a solution of the problems concerning place.

208b Nevertheless, it clearly seems to be a fact that place "is." First, there is displacement. *Where* now there is water, *there* will be air when the water has gone (as out of a vessel); and then again some other body will occupy the same place. The place, therefore, seems to be different from all the bodies which successively displace one another. That "in" which the air is now, is that "in" which the water was before. Consequently, the place was clearly something; that is, the location was different from the bodies which, by passing into and out of it, changed places. Secondly, the motions [121] of the simple bodies (fire, earth, and so forth) show not only that place is something but also that place has some kind of functional significance [11].† Unless interfered with

* Plato *Timaeus* 52.

† Thomas Aquinas: "quod locus habet quamdam virtutem conservandi locata."

each of the simple bodies moves up or down to its appropriate place. The six directions, up and down and so forth [right and left, before and behind], are parts or kinds of places; and they are such not only relatively to ourselves, but they are up and down, right and left, and so forth. For us, they do not always remain the same but change as we change our position; so that often even the same thing may be both right and left, both above and below, both before and behind. But in nature each of these is distinct independently of our own position. Not any chance direction is "up," but that in which fire and light bodies move; so, too, not any chance direction is "down," but that in which heavy and earthy bodies move. Thus, these distinctions of place do not only differ conventionally but also depend upon the ways in which [bodies] act [11]. This is also clarified by mathematical representations: though they do not have their being [1a] in a place, they nevertheless have distinctions of position (like "right" and "left") relative to us; they have their "position" therefore in concept [169a] only, but they do not have any position in their own nature. Thirdly, those who believe in the existence of a void acknowledge the existence of place inasmuch as a void would be a place stripped of every body.

For these reasons, then, we may regard place as something distinct [74] from bodies themselves and every sensible body as being in place. We may also credit Hesiod with rightly stressing the pre-eminence of his primordial abyss. He writes:

> First of things was chaos made, and then
> Broadbreasted earth.

This judgment, that beings must first of all have location, was due to his acceptance of the popular view that everything is somewhere, that is, in a place. If such is the status of place, it must have a functional significance [11] surpassing that of the most astonishing phenomenon. If nothing else can continue in being without it whereas it remains when anything else vacates it, place must indeed rank first; for place 209a does not perish with the perishing things in it.

Yet even if we grant that place is, it is difficult to tell what place is: there is the question whether place is some sort of "bulk" of a body or is some different sort of a "nature"; and we must first ascertain the genus of place. Now, despite its length, width, and depth, which are precisely the three dimensions by which every body is defined, a place nevertheless cannot be a body: in that case, two bodies would coincide. Besides, if a body has a place or space, so will a surface or any other limit of the body, and for the same reason; since where the planes of water were, there those of air will be. On the other hand, the fact that we cannot distinguish between a point and its place implies that a place,

which cannot differ from a point, cannot differ from a line or a plane or a body either; therefore, a place cannot be anything different from any limit of the body. What, then, could we possibly deem place to be? Having the sort of nature described, place cannot be an element or a compound, whether corporeal or incorporeal: a place has size but has no body; but the elements of sensible things are themselves bodies, and intelligible elements cannot form a size. Again, for which of existing things would anyone take place to be an explanation? It does not have any of the four types of explanatory import: it is not a material of anything, since nothing is composed of it; it is not a form or definition of things; it is not their completion; and it does not move things. Then there is this difficulty: if place is itself a being among beings [4d], then place, too, must be somewhere. Zeno's problem requires attention [90]: if every being is in a place, then a place will clearly also have its place, and so on indefinitely. Finally, as every body is in a place, so every place has a body in it; what shall we say, then, about growing things? Their place would have to grow along with them if nothing has a place smaller or larger than itself.

Because of these difficulties, then, we must still consider our questions: What is place? And is there such a thing as place?

2. Place Not Form or Matter

We may give an account [36] of anything "by itself" [2] or with reference to something else; in particular, we distinguish "place" considered generally [92], in which all bodies are, from the specific [42] "place" in which a body is directly [17a].* Thus, you are in the cosmos because you are under the sky, which is in the cosmos; you are under the sky because you are on the earth; and you are on the earth because you are in your particular place, which contains nothing in addition to yourself. If a place, then, is what directly contains any body, it would be a limit; so that the place of each body might be thought to be its form or shape, by which its magnitude or the material of its magnitude is defined, since the form is the limit of each. But whereas, so considered, the place of anything is its form, the place, considered as the extension of the magnitude, is [the latter's] material. This is different from the magnitude: it is what is contained and defined by the form, as by a limiting plane; and the material or the indeterminate† is such because, when the boundary and the properties of a sphere are removed, nothing remains but its material. This is why Plato in the *Timaeus*‡ identifies matter and space: he identifies "what participates"§ with "space," although in his so-called "unwritten teachings" he gives a different account of "what participates"; at any rate, he identifies "place" and "space." All, indeed, agree that place is something; but Plato alone undertook to say *what* place is. In view of all this, it would seem very difficult to find out what place is if it is either matter or form, for these are hard to tell apart; so that the question requires the closest attention.

Nevertheless, we can readily see that place cannot be either form or material. (1) Form and material cannot be dissociated from that to which they belong, as place can: water can take the place of air, and vice versa, as we have pointed out, and other bodies can likewise change places; so that the place of any body is not any of its parts or any of its states but is distinct from it. (2) Place seems to be like a receptacle, which is a movable place but which is not itself a part of its contents. Thus, as distinct from the body whose place it is, place is not the body's form; and as the body's container, place differs from the body's material. In general [135], what is [1] somewhere is one [15a] thing [4]; what surrounds it, is quite [16] another [4]. Plato, by the way, ought to tell us why forms and numbers are not in place if "what participates" is place (whether "what participates" is the great-and-small or, as he says in the *Timaeus*, is matter). Again (3), how can anything move to its appropriate place if place were material or form? Neither of these can be place since there is no [local] motion to or from them and no distinction of up or down in them; it is among affairs which own these distinctions that we must look for "place." (4) If a thing's place were in it, as place would have to be if it were a thing's shape or material, then place would be in place: both a thing's form and its indeterminate aspect change and move along with the thing and do not remain in the same place but are wherever the thing itself is; hence, place would have a place. Again (5), when air is transformed into water, [a part of] its place would vanish,‖ since the new body is not in the very same place; but what would this disappearance be?

Thus, we have shown why place must be something and why it is difficult to tell what [26] place is.

3. Place Not in Another Place

We must at this point distinguish different senses in which we say that one thing is "in" another. A finger is in a hand as a part is in a

* Simplicius: We learn "of what sort" anything is from the features which belong to a subject "directly," that is, "primarily."

† iii.7.207b35.

‡ 52.

§ 210a1.

‖ Cp. iv.1.209a27.

whole; and a whole is in its parts inasmuch as there is no whole beyond its parts. A species (for example, "man") is in a genus ("animal"); and a genus is in a species as, more generally, an [essential] aspect [22] of a species is in the definition of the species. Health is in hot and cold [bodily parts] as a form is in a material; the affairs of the Greeks center in a king as events center in their primary agent; and activities culminate in what they are good for as in the perfection towards which they tend. But in the strictest sense of "in," contents are in a receptacle as a body is in a place.*

In this connection, someone may ask: Can anything be in itself?† Or can nothing be in itself; but is any one thing either nowhere or else in something else? However, the question is ambiguous. It may mean: Can anything be in itself essentially? Or it may mean: Can one aspect of a thing be in another aspect of the same thing? Now, when a whole has one of its parts in another part, the whole may be said to be "in itself." In general, it is not uncommon to attribute traits of a part to a whole, for example, to characterize a man as "white" because of the color of his skin or as "scientific" because of his specialized training [176]. So there is a sense in which a "bottle of wine" is "in itself," although neither the bottle nor the wine is "in itself": since one part [the wine] is in the other part [the bottle], both are parts of the same thing [the bottle of wine]. In this way, then, a thing can be "in itself"; but not strictly [17a], in the sense in which whiteness is "in" a body. The [white] skin is "in" a body, whereas disciplined intelligence [179] is "in" a way of life [154]; but because both body and soul are "parts" [or "aspects"] of a man, we also [indirectly] speak of the traits of either as being "in" a man [as a whole]. To be sure, a bottle and wine when separate are not parts of a whole; but when together they are. Thus, it is only when there are parts [in a relation of this sort] that a whole is said to be "in itself"; just as it is [indirectly] that a man is white because of his body, and his body because of its skin, whereas whiteness is "in" the skin directly. Yet a surface and its whiteness differ in kind, each having its own nature and function.‡ Accordingly, inductive investigation discloses that nothing is "in itself" in any of the meanings of "in" which we have distinguished. We may also clarify this result by argument. Were it possible for anything to be [literally] "in itself," each part would have to be both: the bottle would have to be both the receptacle and its contents; and the wine would have to be both the wine and the bottle. Even if in some sense each is in the other, the

* Thomas Aquinas observes that what is "in time" ("the measure of motion") is reducible to what is "in place" ("the measure of what is mobile").
† iii.5.205b3; Plato *Parmenides* 138A, B5, 145B, C.
‡ The surface is analogous to a "container"; whiteness, to the "contents."

bottle contains the wine not inasmuch as the bottle but inasmuch as the wine is wine; and the wine is in the bottle not inasmuch as the wine but inasmuch as the bottle is a bottle. Clearly, then, each differs from the other in its being, for a container and its contents are differently defined. Not even accidentally§ is it possible for anything to be [literally] "in itself," for in that case two things would be in the same container: the bottle would be in itself, if what is naturally a receptacle [12] can be in itself; and the contents [12] would be in the bottle also, for example, wine (if the receptacle is a wine bottle). Clearly, then, it is impossible for anything to be "in itself" in the primary sense of "in."

Moreover, it is not difficult to solve the problem raised by Zeno; namely, if place is something, it will be "in" something.‖ There is, indeed, nothing to hinder a primary place from being in something else. Yet it is not therefore in a place! It may be in something as a healthy state [33a] is in warm bodily parts¶ or as a warm temperature [35a] is in a body. Hence, the question raised does not require an infinite regress [with a consequent denial of place].

This, too, is evident: since a receptacle is no part of what it contains (inasmuch as a container in the strict sense differs from what it contains), place is neither a material nor a form but is something different from both of these. Matter and form are aspects of the thing which is in a place.

Let this suffice as a statement of the difficulties concerning place.

4. Definition of Place

In order that it may become evident to us what, after all, place is, let us now go over [65] the facts [82f] which seem truly essential to place. Thus, a place surrounds [33e] that whose place it is; a place is not a part of what it surrounds; a thing's primary place is neither smaller nor greater than it; a place can* be left behind by a thing and be dissociated from it; and every place is either up or down, since each of the [simple] bodies moves up or down to come to rest in its resident [55] place. These facts [85] provide the foundation on which we must construct our theory. We must, moreover, try to manage our inquiry in such a manner that it will not only yield the definition we desire, but will also solve the problems raised, bring out the factual basis of what is commonly believed about place, and uncover the reasons for the

§ ii.1.192b23-27. A place cannot be "in itself" even in the accidental sense in which a physician becomes his own patient.
‖ iv.1.209a23-25.
¶ iv.3.210a21. Thus, the question raised points to the pattern of spatial relations.
* MSS. FGI: place [taken simply] cannot.

perplexing questions asked about it. This may be the best way of insuring the demonstration of each pertinent point.

To begin with, we must keep in mind that, but for local motion, there would be no place as a subject matter of investigation. The principal reason why even the heavens are believed to be in place† is because they are always in motion. However, besides local motion, "movement" includes increase and diminution in which, too, there is change of place or change in the lesser or greater spaciousness attained. Moreover, some things are in movement by their own activity, but others incidentally; and of the latter in turn, some can be in movement by themselves, for example, parts of the body or a nail in a ship, whereas others can be in movement incidentally only, for example, whiteness or science, which change their place only in the sense that that in which they inhere changes its place. Furthermore, when we say that we are in the "universe" as in a "place" because we are in the sublunary atmosphere, which is in the universe, we mean that we are in the innermost surface (but not in the whole) of the atmosphere which surrounds us; for if the whole of the atmosphere were a place, the place of anything would not be equal to that thing. But we think of a thing's place as equal to it, and a thing's primary place is equal to it. Then, too, when that which environs a thing is not detached from it but is continuous with it, the thing which it environs is not in its surroundings as in a place but as a part in a whole. But when the two are in contact only, the thing encompassed is directly in the innermost surface of what encompasses it; this surface is not a part of the thing encompassed; but it is equal to it in extent, since the limits at which things are in contact are coincident. Also, a part continuous with a whole moves not "in" but *with* the latter, for example, a pupil with an eye or a hand with a body; whereas what is separable, for example, water or wine, moves *in* a container,‡ regardless of whether the container is in motion or not.

It is evident from these considerations what place is. Place must be one of four things: a form, a material, an interval between the extremities of the surrounding body, or those extremities themselves if there is no such interval apart from the extension of the surrounded body. Three of these, however, place evidently cannot be. First, because it circumscribes things, place appears to be a form: the extremities of the circumscribing and of the circumscribed body coincide; and both form and place are limits. Yet form and place do not limit the same thing; form is the limit of the thing circumscribed; place is the limit of the circumscribing body. Secondly, because a distinct content (like water)

† But cf. iv.5.212a31-b11.

‡ The examples given are noted in 211b1-5, which in large part repeats 211a34-b1 and which may be spurious.

may often change while the container remains the same, the interval between the extremities of a container appears to be definitely distinct from a displaced content. But there is no such [separate] interval; rather do the bodies changing their places and naturally fitting the container replace one another. If there were such an independent natural interval abiding in the same place, there would be an infinite number of [coinciding] "places." When water and air are in the process of replacing each other, each of their parts would behave within the whole just as would all the water in the vessel: [each part would leave an independent empty interval behind]. Then, too, the "place" would change; consequently, a place would have a place, and many "places" would coincide. Yet the place within which a part moves when the whole vessel moves does not become a different place but remains the same; air and water or the parts of the water replace each other in the place in which they are, not in the place to which the vessel is moved and which is part of the place of the whole cosmos. Thirdly, matter might be thought to be place if one were to view it as in a body which is at rest and which is not detached from but "continuous" with its environment. Just as we recognize the definite being of a material in a qualitative change when something black becomes white or something soft becomes hard, so we come to believe in the being of place through a similar experience [173]: we recognize matter because *what* was air is now water; and place, because *where* there was air there now is water. But as we have said before,§ a thing's material is neither dissociated from it nor anything that contains it; place, however, is both. Finally, if place is none of these three things, not form or material or a distinct permanent interval independent of the extension of the displaced body, then place must be the one of the four that remains: the limit of the surrounding body (at which this body is in contact with the body it surrounds),‖ provided that the surrounded body is capable of local motion.

Now, place is regarded as something important but hard to grasp because matter and form appear with it; because a moving body is displaced in a stationary container, which apparently can have an interval distinct from the moving bodies; and because the supposed incorporeal character of air seems to imply that place is not simply the [inner] boundaries of a receptacle but also the supposedly empty interval between them. But as a receptacle is a place which can be transported, so place is a receptacle which cannot be transported. Hence, when a body moves and changes its place within something in motion

§ iv.2.209b23, 31.

‖ The relative clause seems to be spurious.

(for example, a boat in a river), the [immediately] surrounding body functions as a receptacle rather than as a place; whereas place tends to be motionless (so that it is a whole river which, being motionless as a whole, functions as a place). Thus, *the place of anything is the first unmoved boundary of what surrounds it.*

This is the reason why¶ the center of the cosmos and the inner surface of the rotating celestial system are conceived as functionally [55b] down and up for all men, because the former is always stationary and the latter remains coincident with itself. Since light bodies naturally tend upwards and heavy bodies downwards, the surrounding boundary towards the center of the cosmos and the center itself are "down," whereas the boundary towards the outermost part of the cosmos and the outermost part itself are "up." For this reason, too, place seems to be a sort of surface as if it were a receptacle or container. Furthermore, place is in some sense coincident with the thing whose place it is, for boundaries are coincident with what they bound.

5. Ways of Being in a Place

A body is in a place if another body surrounds it; otherwise, it is not. Hence, even if water were not surrounded by anything, its parts could be in movement, since they surround one another; but the whole could be in movement only in one sense, but in another sense it could not. The cosmos does not as a whole change its place, but it can rotate; [212b] and the circle [or the outer surface of the celestial system] functions as a place for its parts.* Some of its parts, then, do not move up and down but are in circular motion; but other parts also move up or down as they are rarefied or condensed.

We have previously† pointed out that some things are in a place only potentially; others, actually. The parts of a continuous homogeneous body are in a place only potentially; whereas parts which are detached yet in contact, as in a heap, are in a place actually.

Moreover, some things are essentially in a place, namely, all bodies capable of local motion or of increase; but the cosmos (as we have said) is not as a whole anywhere or in any place, since there is no body enclosing it. The circle in which the cosmos moves functions as a place for the parts, which are contiguous with one another. Some things are

¶ 210b32-211a6.

* Alexander: "ultima sphaera nullo modo est in loco." Avicenna: "motus ultimae sphaerae non est motus in loco, sed motus in situ." Avempace: "superficies convexa sphaerae contentae, est locus primae sphaerae." Averroes: "ultima sphaera est in loco per accidens." Themistius: "ultima sphaera est in loco per suas partes." (Thomas Aquinas)

† iv.4.211a17-b5.

only incidentally in a place, for example, the soul and the cosmos. All the parts of the cosmos are somehow in a place, since one contains another on the circle. Hence, the celestial sphere moves in a circle, yet the All is not anywhere: what is somewhere both is something and must also have something else encompassing it; but beyond the All there is nothing outside the All. Thus, all things are in the cosmos, since the cosmos is the All; yet the place [of the things in the heavens] is not the heavens, but the inner surface of the heavens which is in contact with the movable body as its unmoving limit. Hence, earth is in water; water, in air; air, in ether [or fire]; and the ether, in the heavens—but the heavens are not in anything else.

It is evident from these considerations that all the problems which have been raised‡ concerning place have a solution on the basis of this account. A place need not "grow" with a growing body. A point need not have a place. Two bodies need not coincide in place. There need not be a bodily interval, since what is between the boundaries of the place is not an interval in a body but any body which may happen to be there. Place, too, is somewhere, though not in the sense of being in a place but in the sense in which there is a limit in what is limited; for not everything is in a place, but only a movable body. We may also with good reason hold that each [simple] body tends to its appropriate place: the elements which are in nonviolent succession and contact are akin;§ and, unlike things which form an organic unity, those in contact are capable of acting upon and of being acted upon by each other. So, too, we may with good reason hold that everything remains naturally in its resident place: a given part is in a whole place as a detached part is related to its whole; this is exemplified when we move a part of water or air. So, too, air is related to water, and the latter is like matter, [213a] and the former, like form: in a sense, water is the matter of air, and air is an actualization of water; for water is potentially air, and air is in a different way potentially water. (These distinctions will be elaborated elsewhere;‖ so that what must here be mentioned, even though obscurely stated, will there become clearer.) Thus, the same thing is matter and actuality: water is both, but is air potentially and is water actually; so that water is in a way related to air as part to whole. That is why they are in contact; whereas, when two things become actually one, they form an organic unity.

So much for the fact that place is and for an account of what place is.

‡ iv.1.209a2-30, 4.211b7, a4-6.

§ Earth is dry and cold; water, cold and wet; air, wet and hot; fire, hot and dry.

‖ *On Generation and Corruption* i.3.

6. Arguments against and for a Void

Like the theory of place, so the theory of the "void" [or "vacuum"] must be recognized as falling within the province of the natural philosopher: the natural philosopher must investigate whether or not there is such a thing and, if so, how and what it is. Moreover, as in the theory of place, so in the theory of the void, the negative or positive convictions [183] which men hold may be traced to the different assumptions they make. Thus, those who maintain the existence of a void regard the void as a sort of place or receptacle which is full when it contains what it is capable of holding, but which is empty when its contents have been removed from it. On this view, what is "empty," what is "full," and a "place" are the same thing; although being empty, being full, and being a place are admittedly not the same. We must, therefore, at the beginning of this inquiry try to grasp the intent [36] of those who argue for the existence of a void as well as the intent of those who argue against it and, in the third place, the commonly held opinions concerning these issues.*

Those who undertake to disprove the existence of a void, like Anaxagoras and others who argue in his manner, succeed in refuting not what people mean [177] by the "void" but only what people mistakenly say about it. Positively, those thinkers demonstrate that air is something, they do this by distending wine-skins and then by proving the resistance of the air as well as by letting air into water-siphons. But what people mean by a "void" is an interval in which there is no perceptible body; thinking that every being is a body, people characterize that in which there is "nothing at all" as "empty"; consequently, what is filled with air is [according to them] a "void." Hence, what needs to be proved is not that air is something, but that there is no independent actual interval different from bodies which breaks the continuity of the bodily universe (as Democritus and Leucippus and many other physical theorists say) or which may even extend beyond the continuous bodily universe [as the Pythagoreans say].

On the other hand, whereas the thinkers [who argue in the manner of Anaxagoras against the "void"] fail even to hit the door in their attack upon the problem, those who defend the existence of a "void" do much better in this respect. In the first place, the latter say, there would be no change of place, either by local motion or by expansion, since there would be no motion if there were no void and since what is full cannot admit anything more into itself. If the latter were possible, there would not only be two bodies in the same place, but any number of bodies might be together (since there is no specifiable point at

* The analysis of the "void" also presents striking parallels to that of the "infinite."

which this principle [36] would cease to hold). If this is so, then the smallest body could admit the largest, because "many a little makes a mickle"; and therefore, if there could be many equal bodies in the same place, there could also be many unequal bodies in the same place. It is along these very lines that Melissus, by the way, argues that the All is independent of movement: if it were subject to movement, then according to him there would have to be a void which, however, is not to be found among beings. This, then, is one way in which the thinkers under discussion seek to prove that there is a definite "void." Another way is by pointing out that some things appear to contract and to be compressed. They say, for example, that a cask will hold both wine and wine-skins; this, they say, shows that a compressed body contracts into its own internal voids. Again, growth or expansion seems to all these men to depend upon there being a void: food is a body, they argue, and two bodies cannot be in the same place. By way of further evidence, they represent ashes [put into a receptacle] as capable of holding an amount of water equal to that which fills the receptacle when there are no ashes in it. Finally, the Pythagoreans, too, maintained that there is a void. They taught that the void enters the universe, which inhales it [as it does the breath in living things] from the infinite air; that the void divides [72e] different "natures" by somehow separating [73] or differentiating [71] discrete [136b] things; and that the void performs this function primarily with respect to "numbers," whose "nature" it keeps discontinuous [72e].

Such and so many are the chief considerations from which men have argued for or against the [independent] existence of a void.

7. Definition and Nonbeing of a Void

In order to decide between the two kinds of views just contrasted, we have to determine what the term "void" signifies. Some hold the "void" to be "a place in which there is nothing." The reason for this is because people conceive being as bodily and every body as being in a place and the "void" as therefore a place in which there is no body; hence, if in some place there is no body, they think that there is a void there. They also conceive every body as tangible, that is, as heavy or light. It follows by syllogism, then, that what has nothing heavy or light in it is a void. Although this follows by syllogism (as has been said), still, it would be an absurdity for a point to be a void; in that case, a point would have to be a place in which there could be an extension [consisting] of a tangible body. However that may be, we note, at any rate, that a "void" is described in one sense as "what is not filled with

a tangible body," that is, with something heavy or light. But, we may ask, what is to be said about an extension having in it color or sound: is it a void or not? Clearly, would we not rather have to say that if such an extension *could* hold a tangible body, then it would be a void; but if it could not, then it would not be a void? In another sense, the "void" is described as "that in which there is no particular primary being" [4b], that is, in which there is no particular [4] bodily [102] being [26]. Hence, those who define "place" in the same way* say that the "void" is the material of a body. However, this cannot be right: the material of things cannot be divorced from them; and what these men are seeking is an independent "void."

Now, in our analysis of place, we have shown that the void must be a place if it is deprived of body and also in what sense there is and in what sense there is not such a thing as "place"; with the evident result that in this sense there is no "void," either independently or not independently [of bodies in it]. What is meant by a "void" is evidently not a body but an interspace [111c] of body. This is the reason why the void is held to be something; especially since place, too, is for the same reason held to be something. It is the fact of local motion which these men find most useful, both for the purpose of asserting that place is something independent of bodies occupying it and for the purpose of asserting that the void is something. They believe that the void is a necessary condition [83] of movement in the sense that movement occurs in a void; and this would be exactly the sort of thing which some declare "place" to be. However, there is no such necessity that, if there is to be movement, there must be a void. A void is unnecessary for any "movement" in a general sense, since (as Melissus failed to see) what is "full" is capable of undergoing qualitative alteration. A void is even unnecessary for local motion, since bodies can take one another's place without there being any extension separate from the bodies in motion; this is clearly so even in rotations of continuous things, as in those of liquids. Nor is a void necessary for contraction: bodies can be "packed" through expulsion of things contained in them (for example, of the air in water). So, too, things may expand not only by something entering into them but also by qualitative change (as when water turns into air).† Indeed, the argument from the expansion of bodies by growth (like the argument from the water poured on ashes) defeats itself: not every part of a growing body would grow; or [if it did], things would grow otherwise than by addition of body; or else two bodies would be in the same place (in which case our opponents are requiring the solution of a difficulty they share with others, instead of proving the existence of a void); or, if it is in every part and by means of a void that a body grows, then the whole body would have to be a void![‡] (The same analysis applies to the argument about the ashes.)

Thus, it is evident that the arguments for the existence of a void are readily refuted.

* iv.2.209b11-16, 4.211b29-212a2.

† *On Generation and Corruption* i.5.321a9-29.

8. No Independent or Occupied Void

Let us continue our argument against those who ascribe independent existence to a "void." If each of the simple bodies naturally moves in a definite direction (fire upward, and earth downward and towards the middle of the universe), it is clear that a void cannot explain local motion: since the void is thought to explain local motion but not any of those mentioned, which local motion, then, does it explain? Again, if a "void" is a sort of "place deprived of body," where would a body placed in a void move to? Surely not into the whole of the void! The same argument applies here that was used against the conception of a place as an independent something into which things are transported: how would anything placed in it start moving or stop moving? The same argument is no less applicable [56a] to "up" and "down" and to the "void"—for those who maintain the existence of a void represent it as a place.* Then, too, how can anything be "in" a place or a void? This does not happen when a whole body is located in a supposedly severed place and abiding body: any part not separately located there would not be in a place, but in the whole [of which it is a part]![†] Then, again, if a place has no [segregated] existence, neither does a void.

Indeed, as against those who say that a void is necessary if there is to be movement,[‡] reflection shows the very opposite: were there an independently existing void, there would not be a single movement! Just as the earth is stationary (according to the arguments of some) because of the uniformity of its medium, so, too, in a void [sharply demarcated from bodies] there would have to be complete stability: since there would be no differences there, neither would there be any place for anything to move to rather than to some other place. Another reason [in support of our contention] is the difference between violent and natural motion: being contrary [74] to natural motion, violent mo-

‡ *On Generation and Corruption* i.5.321b27.

* Besides 214b12-24, note especially 215a25-31 and 216a8-21 as well as *De caelo* i.2.268b20-24; ii.13.294a12-26, b3-6, 14.296a31; iii.2.301a20-b31; iv.2.308b13-28, 309a27-b18, 4.311a16-27. Cf. Lane Cooper *Aristotle, Galileo, and the Tower of Pisa* (Cornell University Press, 1935).

† iv.4.211b20.

‡ Plato *Timaeus* 40, 63.

tion presupposes [18] the latter in the sense that if there is violent motion there must also be natural motion; and therefore, if the various natural bodies do not have their natural motions, they will not be capable of violent motion either. But how can there be natural motions in a void or in an infinite in which there are no differences? No more than an infinite as such has any up or down or middle, does a void as such have any difference of up or down: just as there are no differences in nothing, so there can be none in nonbeing, and the void seems to be a sort of nonbeing or privation. But natural motions are differentiated; and their distinctions [of up and down] are natural. Either, then, nothing has a natural motion, or else there is no void! Again, projectiles continue to move even after what has propelled them is no longer in contact with them. Some explain this phenomenon by mutual replacement. Another explanation may be that the air which has been pushed pushes projectiles with a motion more vigorous than their motion to their resident place.§ But none of these things can happen [82f] in a void: there a body can continue moving only as long as it is propelled by something else. Again, it would be impossible to state any reason why anything set in motion would stop anywhere. Why would it stop at one place rather than at another? Hence, a body would either continue in its state of rest or would necessarily continue in its motion indefinitely, unless interfered with by a stronger force. Again, things are held to move into a void because of its yielding character. However, a void would yield equally everywhere; so that any motion in it would be in every direction.

There are further considerations which make what we have said even more evident. We see a body of a certain weight moving at a faster or slower rate for one of two reasons: either, on the one hand, because of a difference in the medium, for example, in earth or water or air; or, on the other hand, because of a difference in the moving bodies compared such that, other things being equal, one body is heavier or lighter than the other.

On the one hand, then, the medium explains [different velocities] because of its resistance; especially when the medium is moving in an opposite direction, but also even when the medium is in a state of rest. This is especially true of a medium which is not easily divided or which, in other words, is relatively dense. Thus, a body (B) will move through a medium such as water (W) in a given time (T_w), and through a thinner medium such as air (A) in a different time (T_a), namely, in proportion to the density of the hindering body (provided W and A are equal in length): the thinner and less solid the air than the water, the faster will B move through A than through W; one speed has

§ viii.10.266b27-267a12.

the same ratio to the other that the air has to the water. Hence, if the air is twice as thin as the water, the body will move through W in twice the time it takes to move through A; and the time T_w will be twice the time T_a. Likewise, always, the less solid and resistant and the more readily divided the medium, the faster will be the motion. There is no definite ratio, however, in which a void stands to a body. So zero is in no ratio to a number: although 4 exceeds 3 by 1, and 2 by more than 1, and 1 by still more, there is no ratio by which 4 is greater than 0; but inasmuch as the greater has to be made up [75] of the less and the remainder, 4 would consist of 0 and that by which 4 is greater than 0. So, too, a line is not "greater than" a point, unless a line were composed of points. By the same token, therefore, as there is no ratio between the "empty" and the "full," so there is no ratio between movement through the former and through the latter]; on the contrary, if a thing moves through the thinnest medium over a certain distance in a certain time, then it will move through the void with a velocity beyond any ratio! Let V be a void equal in magnitude to W and to A. Then if B is to move through V in a time T_v which is less than time T_a, the "void" would be in that ratio to the "full." But in a time equal to T_v, B would move through a part P of the medium A. Also, in time T_v, B would span any body V which is thinner than air by as much as time T_a is longer than time T_v; for if the body V is as much thinner than A as T_a exceeds T_v, B would move through V (if at all) in a time inverse to the speed, that is, in a time equal to T_v. If V is empty, then, B will pass through it still faster. But the assumption was that B passed through V when V was empty in time T_v. Consequently, B would move through V in an equal time regardless of whether V was full or empty. But this is impossible. Evidently, then, if there is a time in which anything moves through a part of a void, this impossible result will follow: a body will move over a certain distance, full or empty, in equal times, since there will be some body bearing to the other body the same ratio which the one time bears to the other time. In short, the reason for this result is clear: any motion stands to another in a certain ratio, since the motions occur in time and there is a ratio between any finite times; but there is no ratio [of density] between anything that is empty and anything that is full.

On the other hand, having considered what follows from the differences among the media,‖ let us turn to consider the difference [148] between one moving body and another, together with its consequences.

‖ Thomas Aquinas: "In hoc autem libro agitur de corpori mobili in communi. . . . Vel potest dici, quod hic etiam procedit secundum opinionem antiquorum philosophorum, qui ponebant rarum et densum prima principia formalia. . . ."

We see that, other things being equal, heavy and light bodies mov
with unequal velocities over an equal space in the ratio which the
magnitudes have to each other. Hence, they must do so even whe
moving through a void. But this is impossible. Why should one of the
move faster than another? To be sure, one of them does necessari
move faster in a [space] full [of matter] because the greater body d
vides the medium faster by reason of its force; for a body moving nat
rally or a projectile divides a medium as it does by reason either
its shape or of its [upward or downward] tendency. But [in a void
everything would, accordingly, move with equal velocity. But this
impossible.¶

Evidently, then, the supposition of a void leads to a result which
opposed to what the defenders of a void want to establish. They thin
that if there is motion there would be an independently existing voi
But this amounts to saying that place is an isolated something, whic
we have shown** to be impossible.

Then, too, if we critically examine the so-called "void" by itself, w
shall find it to be truly "empty." When a cube [of wood] is placed int
water, it displaces [a volume of] water equal to [the volume of the sub
merged part of] the cube. The same [effect is produced] in air, excep
that in this case the effect is not evident to sense perception. In fac
any body which can be displaced [by another inserted into it] must
if it is not compressed, be displaced in the direction natural to it: down
ward, if it is of earth; or upward, if it is of fire; or else in both direction
(regardless of the sort of thing that is inserted into it). Since a void
however, is incorporeal, this effect cannot be produced in it. Instead
the void would necessarily have penetrated the cube to the distance t
which the space [now filled by the cube] had extended before within
the void; just as if water or air, instead of being displaced by a wooden
cube, had gone all the way through it. But the size or volume of the
wooden cube exactly equals the amount of the void it occupies; yet i
differs in its being, although it is not cut off, from its attributes (such
as hot or cold, heavy or light). Hence, if it were parted from its attri
butes (such as heaviness or lightness), it would occupy a portion of a
place or of a void equal to itself. What, then, would be the difference
between the body of the cube and the void or place equal to it? And
if these two coincide, why should not any number of things likewise do
so? This is one absurd and impossible [consequence of the theory of a
void occupied by bodies]. Again, it is evident that a cube, like all othe
bodies, has the same volume even if it is displaced. Therefore, if this

¶ Aristotle does not contend that heavy bodies would drop faster in a vacuum than light bodies but that there can be no actual independent vacuum.

** iv.4.211b18-29.

does not differ from its place, why should we ascribe to bodies a place distinct from their own volume (if their volume is without attributes)? Such an equal extension connected with the cube would be gratuitous. (Again, though a void ought to be a clear [deliverance of experience], yet it is nowhere observed in the world of moving bodies; for air is something even though it may not seem to be [so to sight]—just as there would not seem to be any water if fishes were of iron, since the tangible is discriminated by touch.)††

It is clear, then, from the reflections presented, that there is no independently existing void.

9. No Void within Bodies

Some think that the existence of a void is evident from that of tenuous and dense bodies. They argue: without anything tenuous or dense, there could be no contraction or compression; and if this sort of change were impossible, then there would be no movement, or else the universe would bulge (as Xuthus maintained), or air and water would have to be transformed into equal quantities (so that transformation of a cupful of water into air would have to be balanced by transformation of an equal amount of air into a cupful of water), or [they insist] there must be a void as a necessary condition of densification and rarefaction. However, if they mean by a "tenuous" body one which "has many independent voids," then there evidently cannot be anything "tenuous" in this sense any more than there can be an independent void or a place having an extension all its own.* On the other hand, if they are thinking of a nonindependent void within a tenuous body, this would seem less impossible. Still, such a void would be a condition of upward motion only: a tenuous body is light; and they say that it is for this reason that fire is light. Also, such a void would not be a medium conditioning [83] motion; rather would things be carried upward on it somewhat as nets float upward on inflated wine-skins. Yet how could a void move or have a place to move into? And would not such a place in the meantime be a void without a void? Again, what explanation would these men give for the downward motion of heavy bodies? Then, too, if the speed of the upward motion varies proportionately with the tenuity or emptiness of the moving body, a body altogether void would evidently move at the fastest rate of all. But it is as impossible for a void to move as it is for anything to move in a void, since the speeds [of a solid and of a void] would be incommensurable.

†† The passage here enclosed in parentheses may be spurious.

* iv.4.211b18-29.

Now, although we deny the [independent] existence of a void, we agree that the other alternatives have been correctly stated: if there were no densification or rarefaction, there would be no movement, or else the universe would bulge, or it would always be in equal amount that water would be transformed into air and air into water. Clearly the air into which water is transformed is greater in volume than the water. Hence, if there were no compression, the successive parts would be pushed outward until at the last there would be a bulge; or somewhere else air would be transformed into an equal amount of water so that the total volume of the whole would remain equal; or else no process would take place at all. Displacement would always have the result described unless, indeed, it is circular;† but, so far from being always circular, motion sometimes is linear. However, in contrast to those who for the reasons stated maintain the existence of an actual [4] void, we hold a different position [36] in line with our principles [85]:‡ a single material is the subject of contraries [or of the limits within which a change occurs] such as hot and cold or any of the other natural opposites; a thing changes from what it is potentially to what it is actually; a material is not disjoined [from its changing qualities], although its being differs from theirs; and a numerically single material may happen to have a certain color and to be hot and to be cold.

Now, then, it is clearly the same material which is the subject of a larger and of a smaller bodily size. Thus, transformation of water into air is not an affair of a given material having added [65h] to itself something else which it becomes; it is an affair of the same material becoming actually what it had been potentially. This is also the sort of thing that happens in the opposite transformation of air into water. But in the former transformation, there is a change from a smaller to a larger volume; in the latter, from a larger to a smaller volume. Likewise, therefore, when air contracts or expands, what happens is that the material which was potentially smaller or larger becomes [actually] smaller or larger. Analogously, it is the same cold body which, being potentially hot, becomes actually hot, and the same hot body which, being potentially cold, becomes actually cold, as by the same token it is the same hot body which becomes still hotter: there is nothing in the material which, when the body was less hot, was something not hot and which thereupon becomes something hot. So when the curvature of a ring becomes the curvature of a smaller ring (whether or not it keeps its identity intact), there is nothing which in the meantime was straight or nonconvex and in which convexity then comes into being—as if

† iv.1.208b2, 8.215a15.
‡ i.9.

quality had to cease to be in order to assume different degrees of more or less. So, too, we do not find in a white-hot flame any part from which heat and whiteness are absent. Just so, an earlier and a later degree of heat are related [by a passage from the potential to the actual]. Accordingly, when a large or small sensible bulk is expanded, it is not because something else has been added to the material, but because the material is potentially large or small. And consequently, it is the same body that is now dense, now tenuous; and it is the same material which is [potentially] dense or tenuous. Moreover, what is dense is heavy, and what is tenuous is light. But just as the contraction of a ring's curvature is not an addition of something else which is convex but is an affair of something present being contracted, and as a fire is hot in any part of it one may select, so what concerns us here is all an affair of the same material contracting and expanding. There is also another type of connection between density and weight: for both what is heavy and what is hard are dense, and both what is light and what is soft are tenuous; yet heaviness and hardness fail to go together in lead and iron.

In view of what we have said, there evidently is no independent void either absolutely [105] or within tenuous bodies; neither is there a potential void, unless one finds it desirable to speak of a "void" in a general way as a "ground" [83] of local motion. But when the "void" is taken in this sense, its referent would be heavy or light material as such. It is because [39a] their material may be heavy or light [50b] that bodies, with their varying degrees of possible density or tenuity, can [189] move [121]; and it is because their material may be hard or soft that they can be impervious [35d] or readily subject [35a] to changes [120a] other than local motion.

This completes our account of the sense in which there is and the sense in which there is not a "void."

10. Time Not a Whole or Change

After the preceding analyses, we take up the topic of time. It is well for us to take off with the difficulties concerning time which are raised in nonacademic discussions. Is time to be included among beings or not? And what is its nature?

Certain arguments may lead us to suspect that time is a nonentity or is at least shadowy and indistinct. Thus, infinite time as well as any selected [65] period of time comprises the past, which no longer is, and the future, which is not yet. But if anything consists of nonbeings, it cannot itself be held to participate in being. Then, too, when a whole divisible into parts is present, all or at least some of its parts must be

present. But of the "parts" into which time is presumably divisible, none is present [in nature]: past events have come and gone [116]; future events are still to appear [134c]. The present is not a "part" of time: a part is a measure of the whole, whereas the present is not such a measure; and a whole must be composed of its parts, whereas time does not seem to be composed of "nows." Again, it is not easy to see whether the present, which appears to divide past and future, always remains the same or is always different. Let us, on the one hand, suppose the present to be always different. But if no two "parts" of time are simultaneous (except that a shorter period of time may be comprehended in a longer one) and if what heretofore was but now is-not has necessarily at some time ceased to be, then the "nows" cannot be simultaneous with each other [any more than can the "parts" of time]; but the earlier "now" must have been always perishing. However, the earlier "now" cannot have ceased to be within itself, since at that time it was; nor can it have ceased to be in another "now," for we must recognize it to be just as impossible for one "now" to be next to another as it is for one point to be next to another point [in a line]. If, then, the earlier "now" has not ceased to be in the "now" next to it but in some other "now," it would be simultaneous with the infinitely numerous "nows" between the two; and this is impossible. Let us, on the other hand, suppose the present to remain always the same. This, too, is impossible. Nothing determinate that is divisible has but one limit, whether it is continuous in one or in more than one dimension; but the "now" is a limit, and we can select a limited period of time. Also, if to be simultaneous is to be in the same "now" (neither earlier nor later) and if both earlier and later events are in this particular "now," then the events of ten thousand years ago would be simultaneous with today's events, and then no event would be earlier or later than any other.

Having gone over the difficulties which pertain to the facts [82f] of time, we also find that the traditional views have left no less obscure the problem: What is time? or, what is its nature? Some [like Plato] identify time with celestial revolution; others [like the Pythagoreans] with the universal sphere itself. But although even a part of a celestial revolution is "a" time, it is not a revolution; and what is selected is part of a revolution, not a revolution. Moreover, if there were many worlds [as Democritus says], the course [109] of any one of them would be time just as much as the course of any other would be time; so that many worlds would imply many times at the same time. Next, the reason why time was identified with the universal sphere is because all things are in time as well as in the universal sphere. But this view is too trivial for us to consider the many impossibilities it involves. On the other hand, we may examine the more influential view [of Plato] which identifies time with some kind of movement [109] or change [115]. But contrary to this view, a change or movement of anything is in the changing thing only or is where the moving or changing thing itself is; whereas time is everywhere and in all cases alike. Also, unlike time, change is fast or slow. We define "fast" or "slow" by reference to time: that is "fast" in which there is much going on [109a] in a short time; that is "slow" in which there is little going on in a long time. But we do not define time by reference to so much time or to such and such a kind of time. Hence, time is evidently not movement or change. (We need not, in the present context [23c], state how movement and change differ.)

11. Time as Dependent on Events

In spite of such considerations, time is not independent of change. Thus, when we have no sense [170] of change or are inattentive [205] to any change, we have no sense [175b] of the passing of time. We are in this respect like the people in the legend who, on awakening out of their long sleep in the presence of the heroes in Sardinia, link [137c] the earlier with the later time into a unified present, in disregard [118c] of the interval to which they have been insensible. As there would be no time, then, if there had been no diversified but only a single self-identical present, so we do not recognize an interval of time when we fail to note a "now" distinct from the present one. Accordingly, we are heedless of time in circumstances in which we do not discern a change because the self [154] appears to continue in a single undivided state; but we do acknowledge the passing of time in circumstances in which we sense and discriminate a change. Evidently, then, time is not independent of movement or change.

Here we have a point of departure for exploring what time is: time is evidently neither identical with nor independent of movement; so that it remains for us to determine how time is related to movement. For we experience [165] movement and time together. Even when in gross darkness we do not feel any bodily interaction [35] but only some kind of mental [154] process [109], we realize that some time has passed. Conversely, when we realize that some time has passed, we realize that some process has taken place. Time is therefore either a process or is somehow dependent upon a process; and since it is not the former, it must be the latter. Now, anything that is going on has a start and comes to a stop, and any magnitude is continuous; and so a "movement" corresponds [177] to a magnitude. Since a magnitude is

continuous, so is a movement; and because of the continuity of the movement, time is also continuous, for we estimate how much time has passed by the amount of movement that has occurred. Accordingly, we distinguish "before" and "after" primarily in place; and there we distinguish them by their relative position. But movement must also have in it a distinction of "before" and "after" analogously to that in magnitude; and so must time, because of its correspondence with movement. The order of "before" and "after" *which* is in process is, existentially [1d], the process; although, indeed, *what* the distinction between "before" and "after" is [88a] differs from [*what*] a process [is].* As we, then, discriminate a process with the aid of the distinction between "before" and "after," we become familiar with time; for we acknowledge the passing of time when we perceive something coming before and something coming after in a process. The distinction between "before" and "after," in turn, impresses itself upon us in the recognition that the extremes it involves are distinct both from each other and from something intermediate between them. When we, accordingly, apprehend [169a] the extremes as distinct from what intervenes between them and when we mentally [154] mark [36a] them as two "nows" (one coming earlier and the other coming later), it is then that we acknowledge and identify time. For time (let us submit) is what is limited by the "now." On the one hand, then, when we experience the present as one only, and when we either do not experience the "now" as prior and subsequent in the process or do not even experience the "now" as having an identity related to something prior and to something subsequent, then no time seems to have passed because no process seems to have occurred. On the other hand, when we note something "before" and something "after," then we acknowledge time. For this is what time is: *the number of precessions and successions in process.*

Thus, time is not sheer process but is a numerable aspect of it. This is indicated by the fact that, as we discriminate "more" and "less" by number, so we discriminate "more" and "less" movement by time. Hence time is a kind of number. But by "number" we may mean a concrete numbered or numerable plurality or an abstract number by which we count. Time, however, is not sheer number by which we count but is something counted (which is quite different from the former). Furthermore, like movement, so time has a continually sequential [16b] character. To be sure, all simultaneous time is the same: the present, whatever it may then be [1e], is the same; but the respect in which it is diversified is in its being [88a] the "now" [of different events]. Yet

* Thomas Aquinas: "Sic igitur prius et posterius sunt idem subjecto cum motu, sed differunt ratione."

[time is not sheer "before" and "after"; but] the present determines time in its discrete character as earlier or later [and therefore also in its simultaneity].

Accordingly, the present is in one sense the same, but in another sense it is not the same. The present is different "nows" inasmuch as it inheres in one ["whiling"] and then in another, which is precisely what it meant for it to be [88a] the present; but, in being what at some time is [1d] now, the present is the same.† For a movement, as we have said, corresponds to a magnitude; and time, as we maintain, corresponds to a movement. Just so, a moving body [121], by which we recognize a process as well as what comes before and after in it, corresponds to a [mobile] point [*in the drawing of a line*]. The moving body, in being what it at some time is, is the same (a point, a stone, and so forth); but the moving body differs in the account which may be given of it [from time to time],‡ as the Sophists take "being Coriscus in the Lyceum" to differ from "being Coriscus in the market-place." The moving [point or] body differs in being now here and now there, and the present corresponds to it as time corresponds to the movement; for it is by reference to the moving body that we recognize what comes before and after in the movement, and it is in so far as the "before" and "after" can be counted [as two] that there is a present. Consequently, in what comes before and after, the present remains the same in being what-at-some-time-is-now, since the present is precisely what comes before and after in movement; yet the present is diversified in its being, namely, in the order of being successively "now" at distinguishable earlier and later stages. Moreover, it is the present with which we are most familiar. For a process is recognized by what is in process, as a local motion is recognized by what is changing its place: such a body is a particular primary being [4b], whereas a movement is not a particular primary being. Thus, like a moving [point or] body, the present is in one sense always the same; in another sense, it is not always the same.

It is evident, too, that if there were no time there would be no present, and vice versa. As a moving [point or] body and a motion go together, so do the numerable aspects of the moving body and of its motion; for time is a number belonging to a movement, whereas the present corresponds to the moving body and is a sort of unit [by which a multiplicity is differentiated]. Moreover, time depends upon the present both for its continuous and for its discrete character. In this respect,

† Thomas Aquinas: "nunc est idem subjecto, sed alterum et alterum ratione."

‡ Thomas Aquinas: "ex ea parte, qua est quoddam ens, quodcumque sit, est idem, scilicet subjecto; sed ratione est alterum."

too, the analogy with the moving [point or] body and its motion holds: the continuity of the motion depends upon the unity of the account that may be given of the moving body (though not upon the individual unity of the body [1d], since the movement of the latter may also be discontinuous); and it is the moving body which [at a particular stage] divides a movement into earlier and later aspects. The "now" and the moving body correspond in this respect to the point inasmuch as the point at once holds the line together and divides it, since the point is both the beginning [of the part of the line still to be drawn] and the end [of the part of the line already drawn]. However, [the analogy breaks down inasmuch as] taking a single point as both a beginning and an end requires a stop; whereas the "now" continually changes its character with the things in process. Consequently, time is "number," not like the dual character of the point, but rather like the "number" formed by the extremities of the line, instead of by its parts. For in distinguishing two parts of a line, the middle point must be stressed as two; and this requires a stop. And the "now" is evidently no more a "part" of time than a section is part of a movement or than points are parts of a line; instead, it is two lines which are parts of one line. Accordingly, a terminal "now" is not time but an accident of it, whereas a "now" by way of "reckoning" is a number,§ for boundaries belong to that alone which they bound, whereas [abstract] number (for example ten) belongs to "these horses" and to what-not.

It is evident, then, that time is the number of precessions and successions in process and that, since time is a number belonging to something continuous, time is therefore itself continuous.

12. Quantitative Time and Things in Time

Time is not like abstract [105] number, in which the smallest [plurality] is two; time is rather like concrete [4] number, which sometimes has a minimum and sometimes does not have a minimum. For example, the smallest number of a line as regards the plurality [6b] it has is two, if not one; but the line has no minimum in magnitude, since every line is indefinitely divisible. So *time* [*reckoned*] has a minimum number which is one or two; but there is no minimum length [142a] of *time*. Evidently, too, we do not describe time as fast or slow but as much or little or as long or short. Continuous time is long or short; and quantitative time is [reckoned by] many or few [periods of time]. But there is no fast or slow time, any more than even the number with which we count is fast or slow. Furthermore, time is the same everywhere at

§ By which we count many specific durations, whatever their specific character.

any one time, but no time is the same before and after: not only do past and future change differ from present change; but time is not a number with which we count but is something counted, which is always different before and after because the "nows" differ. Analogously, a hundred horses and a hundred men are the same in number; but the things counted, the horses and the men, differ. Yet the same time can recur in the sense in which the same process can; this is true, for example, of a year, of a spring, of an autumn.

Moreover, we not only measure movement by time but we also measure time by movement, because [measured time and movement] determine each other. A time marks a process as its number; and so a process marks a time. We speak of much or little time, measuring it by the movement just as we determine the number of horses in a group by using a single horse as a unit. As we know the size [6b] of a group of horses by their number, and their number by using a single horse as a unit, so we measure a movement by the time it takes, and the time by means of a movement [as a unit]. There is a good reason for this: a movement corresponds to a magnitude and time to a movement because all these are quantitative, continuous, and divisible, movement being so because magnitude is and time being so because movement is; and we measure a magnitude and a movement by each other, saying that the way is long if the journey is long, and vice versa, and therefore that the time is [much or little] if the movement is [much or little, respectively], and vice versa. But time measures a movement, along with its being in process, by determining a movement which will "measure" the whole movement, just as a cubit measures a length by determining a magnitude which will "measure" the whole.

For any movement or process "to be in time," then, means that it and its being [23] are measured by time: the movement and its being are "timed" together; and this is what it means for it to be [88a] in time, namely, that its being is measured. Clearly, then, this is also what it means for other things to be in time, namely, that their being is measured by time. Now, "to be in time" may mean either to be when time is or else to be in time as some things are said to be in a number-system, namely, either if they belong to number as a part [22] or attribute [35a] or element [4] of "number" or if they have a number. Thus, since time is a "number," the present, the past, and so forth, are in time as elements in it, just as a unit and the odd and even are in number as elements in it; and events [188c] are in time in the sense of being numerable and are therefore comprehended by time [or in a temporal structure] as things in place are comprehended by place [or in a spatial structure]. But to be in time evidently does not mean to be *when* time is, any

more than to be in process or in a place means to be when a process or place is: in such a case, all things (for example, the heavens) would be in anything (for example, in a millet seed); whereas, in the case [3b] of what is "in time" (or "in process"), there is *necessarily,* not coincidentally, a time (or a process) when *it* is.

Since being in time is like being in a number-system, there is a sense in which time may be viewed as greater than anything in time; that is, everything temporal is necessarily bracketed [33e] by time [in a pattern 30 of temporal relations], just as everything local is encompassed by place [in a structure of spatial relations]. Moreover, things in time are somehow affected by time: in our way of speaking, things are ravaged and 221b aged and cast into oblivion by time, not made progressively wiser or younger or better; we attribute [83a] destruction to time because time is a number belonging to movement, and a movement is a removal [111d] of what is [82f]. Consequently, things which are continually are as such evidently not in time: they are not bracketed by time, that is, their being is not measured by time; and the fact that they are not in time is shown by the fact that they are not affected by time. On the other hand, rest is in time since time, which is a measure of movement, indirectly measures rest: what is in time need not, like what is in move- 10 ment, undergo a process; and time is not identical with movement but is a number belonging to movement. It is quite possible, therefore, even for what is at rest to be numbered by the number of movement. But as we have said before,* not everything unmoved is at rest but only what is naturally capable of the movement absent [106] from it. What is in time is measured by time as something is in a number-system: it has a number and if its being is measured by the number; and time measures the changing as changing and the enduring as enduring because it measures their movement or their rest by so much. Strictly speaking, what is in movement is not measured in its own quantitative 20 aspect by time but only in so far as movement has a quantitative aspect. Consequently, things not subject to movement or rest are not in time; for "to be in time" means "to be measurable by time," and time is the measure of movement and rest. Hence, too, it is evident that at least some of the things that are-not, are not in time; among them, things which can only "non-be," like the commensurability of a square with its side.

In general, since time measures movement directly [2] and other things indirectly [3], the things whose being time measures are clearly in motion and rest; and the things that come and go, that at one time 30 are and at another time are-not, necessarily are in time, since time

* iii.2.202a4.

a sense extends beyond their being and beyond the time which measures their being. Of the things not actual but bracketed by time, some (like Homer) at one time were, others (like a future event) will be; and the 222a pattern of time extends in both directions, so that some things may be both past and future. But things in no way bracketed by time are not past or present or future; they continually are-not, as their opposites continually are. For example, the incommensurability of the diagonal of the square with its side continually is; and since this will not be in time, neither will the commensurability, but the latter forever is-not because it is opposed to the former which forever is. On the other hand, things whose opposites are not eternal may or may not themselves be; and such things are subject to generation and destruction.

13. Definitions of Temporal Terms

As we have previously pointed out,* the present is time's continuity 10 since it holds past and future together and is their common boundary as the beginning of the future and the end of the past; yet this is not as evident as it is with a point in a line because the point is stationary. The present is also a potential dividing of time and is as such always different, although as unitive it is always the same. Just as mathematically a point when regarded as dividing a line is treated as if it were two, but when regarded as one is treated as in every respect the same, so the present functions in one way as potentially a dividing of time and in another way as the common boundary and unity of both "parts." And it is the same thing that at once both divides and unites, although 20 "being divisive" and "being unitive" are not the same. Besides having this meaning, "the present" has an extended sense in which it includes a time near the "present" in the first sense [as distinct from the more remote past or future or both]. Thus, we say of one who will come today or who has come today that "he will come now" or that "he has come now"; but we do not so refer to the events narrated in the *Iliad* or to the final cataclysm because, in spite of time's continuity, they are remote from the present. Then, too, it is with reference to the "present" in its first meaning that time is determinate, however indefinitely we refer an event to "some time" in the past, for example, the capture of Troy, or to "some time" in the future, for example, the final cataclysm. There will be or was so much time from the present to a future or past event. But if there were no time which is not some time, then every period of time would be determined.

* iv.11.220a5.

Will time, then, run out? Or is it not rather the case that time will not run out since there is always some process going on? Is time, then, always different or does the same time frequently recur? Clearly, time corresponds in this regard to movement: if the same movement sometimes recurs, the time, too, will be the same; if the same movement does not recur, then time will not be the same either. Since the present is the end and the beginning of time, though not of the same time, but is the end of the past and the beginning of the future, therefore time is always both at a beginning and at an end, just as a curve is both convex and concave. This is the reason why time seems to be always different, because the present is not the beginning and the end of the same time; if it were, it would at the same time and in the same respect be opposites. And because time is always at a beginning, it will never run out.

Expressions like "presently" and "just now" relate a near future or past to an indivisible [41] present, as when we reply to a question about the time of a walk: "I shall go for a walk presently" or "I have just now come from a walk"; but we do not say that "Troy has just been captured," because this event occurred in a past too far removed. "Lately" also has reference to a past near the present, as in reply to a question about a recent journey; but "long ago" has reference to a distant part of the past. "Suddenly" implies a change from a former condition in a temporal interval so small as to be imperceptible. Yet all change is naturally a change from a former condition [111d]! All things that come into being and pass away do so in time. Some have therefore called time the wisest of things;† but Paron the Pythagorean more aptly called time the most stupid of things because in time we also forget. Clearly as we have said before, time is more especially a destroyer since change is a change from a former condition; only incidentally is time to be credited with what comes into being and with what is. This is sufficiently shown by the fact that nothing comes into being independently of some activity or process, whereas things can be destroyed even without undergoing a process. This is what we mean when we speak of things being "destroyed by time": not that time is a destructive agent; but even this sort of change happens to take place in time.

Such is our account of the being and definition of time, of the meaning of the "present," and of the use of such terms as "at some time," "lately," "presently," "long ago," and "suddenly."

† Simonides.

14. Temporal Distinctions as Relative and Objective

In the light of these distinctions, it is evident that every change or movement necessarily takes place in time. Thus, every change is evidently fast or slow; and we attribute a relatively "fast" movement to a body which, moving an equal distance and along a similar path relatively to another body, arrives sooner at the terminus [85] than does the other body (for example, if both move along the circumference of a circle or along a straight line, and so forth). But what is earlier is in time: both "earlier" and "later" are relative to a present, which is the common boundary of the past and the future; so that, since any present is in time, what is at some remove from the present, whether earlier or later, is also in time. To be sure, there is a contrast between an earlier and a later past and future: whereas the earlier past is farther removed from the present than is the later past, it is the later future that is farther removed from the present than is the earlier future. Since what is "before" in time and since in every movement there is something "before" something else, it evidently follows that every change or movement takes place in time.

However, we may well ask how in the world time is related to a living self [154] and why time seems to be everywhere, in heaven, earth, and sea. Undoubtedly time, as a number, is an attribute or state of a process; heaven, earth, and sea are all subject to movement because they are in place; and the things potentially or actually in time and those potentially or actually in process are, respectively, identical. Then, as to the former question, would there be any time if there were no living self? Without a being able to count, there would seem to be nothing countable, and therefore no number (since concrete "number" is what has been or may be counted); hence, in the absence of a living or rational being to do [101c] the counting, time would seem to be impossible. Still, there might be time in the sense of whatever time would be in such a case [1d].* Thus, there might be time as the order of "before" and "after" in process in so far as these are "numerable," provided that there can be movement in the absence of a living self.

We may also ask: Of what sort of process is time the number? Undoubtedly of every sort. Things come into being and pass away in time, and they grow, are qualitatively altered, and move from place to place in time. Hence, time is the number of each sort of process in so far as it is a process; and therefore time is the number of continuous process simply, not of any one sort of process exclusively [4]. However, if each of two simultaneously completed processes might have a number of its own, would it not seem to follow that there would be two different

* In the sense of what underlies time, namely, movement.

equal times at once? Not at all! Equal and simultaneous times are the same time. Indeed, even times not simultaneous may be one in kind just as seven dogs and seven horses are the same in number. So, too, processes having simultaneous limits take the same time even if one is fast and the other is slow and even if the one is a local motion and the other is a qualitative alteration: the time they take is the same since it is equal and simultaneous; however different and mutually independent the processes, the time is everywhere the same because the amount of time which equal and simultaneous processes take is everywhere the same.

Now, processes include local motion, which in turn includes motion in a circle. Moreover, we "number" anything by means of something single which is homogeneous with it: units, by means of a single unit; horses, by means of a single horse; and therefore also a period of time, by means of some limited duration. But as we have previously said,† we measure time by movement, and movement, by time; and we can do this because it is by means of a movement determinate in time that "so much" of movement as well as of time is measured. If, then, what is primary [in any genus] is the measure of everything in the same genus, uniform circular motion is the best measure [of all movement and therefore of time] because the "number" belonging to it is best known. Qualitative alteration, growth, and origination do not have the uniformity which [the circular mode of] motion has. This is also the reason why time has been identified by some with the motion of the celestial sphere: other movements are measured by means of it, and time, by means of this motion. This is also the reason why human affairs and all things that come and go in the natural course of events are commonly said to move in cycles: all affairs are judged in terms of time; and they come to a stop and then start afresh in cyclical fashion. Some even look upon time itself as in some sense a cycle: time measures and is measured by circular motion; and the cyclical theory of events implies a circle of time in the sense of time measured by circular motion. For, in what is measured, we observe nothing other than the measure; and the whole of it amounts to measures many times repeated.

However that may be, we may at any rate restate another point which is rightly made: if the number of a group of sheep and the number of a group of dogs are equal, the *number* of both is the same, although it is not (for example) the same *ten*. So, too, an equilateral and a scalene triangle are not the same [kind of] *triangle;* they are, however, the same [kind of] *figure,* for they are both triangles. Two things are the same [kind of] thing if they do not differ by a differentia [of their kind],

† iv.12.220b23.

but not if they do! Thus, triangles differing by a differentia of triangle are different triangles; they are not different figures, however, but are in the same subdivision of "figure." One kind of figure is the circle; another kind, the triangle. One kind of triangle in turn is equilateral; another kind, scalene. These are the same [kind of] figures, then, since they are triangles; but they are not the same [kind of] triangles. Just so, two groups have the same number if their number does not differ by a differentia of number; but they are not therefore the same [sort of] ten, since the groups numbering ten each may differ in that the one may be a group of dogs and the other may be a group of horses.‡

So much, then, for time both as far as time itself is concerned and with respect to the considerations appropriate to the analysis of time.

‡ Periods of measured time are not kinds of events.

V. BOOK EPSILON

Classification of Movements

1. Types of Changes and Processes

21 Changes* are of three types: (1) accidental change [115], as when a musician turns from his music to taking a walk; (2) internal [105] change due to a change in a part, which changes the whole, as when the whole body is restored by the healing of an eye or of the chest; (3) essential change, as when a being is moved which is essentially movable. Essential change includes qualitative alteration and other kinds 30 which in turn differ among themselves; for example, a thing may be alterable in quality by being healed or heated.

There are the same kinds of agents or movers: accidental, partial, and essential. The second is exemplified by a hand striking; the last by a physician healing.

Any movement involves an immediate agent, a thing moved, a time 224b of change, a starting-point, and a culmination. For every single movement has a definite beginning and a definite ending; and we may distinguish in it an immediate subject (like wood) which undergoes the movement, the end to which it tends (like heat), and the condition from which it starts (like cold). Accordingly, it is clear that a movement belongs inherently to a subject:† a movement does not inhere in a form, since a form or a place or a quantity neither initiates nor undergoes a movement; but a movement has a mover or agent, a subject, and a culmination. Although a movement also has a starting-point, yet it gets its name from its end: when a perishing thing changes from being to

* Large parts of v.1-3 are duplicated in *Metaphysics* xi.11, 12.
† iv.11.219b29, 30.

nonbeing, it is said to "perish"; and a change from nonbeing to being 10 is called a "generation."

We have previously stated‡ what "movement" is; but the forms, the modes, and the places into which things are carried by their movements are themselves unmoved (for example, knowledge and heat do not move). One might object that modes [35a] such as whiteness are movements and that therefore there are changes to movements. However, whiteness is not a movement [or process]; the movement which ends in whiteness is whitening. Moreover, like changes and their effective agents, so their ends are of three types: accidental; partial, that is, dependent on something else; and essential, that is, independent of something else. Thus, what is growing white, becomes an object of thought accidentally, since being thought of is incidental to color; what 20 is growing white, changes to a color, that is, to a part [or kind] of color (just as one going to Athens may be said to be going to Europe, of which Athens is a part); but primarily and essentially, what is growing white, is changing to white color.

It is clear, then, in what sense a movement, its effective agent, and its subject are such essentially and incidentally; in what sense they are such directly, with reference to themselves, and indirectly, with reference to something else; and also that movement is not in the form of a thing but in the thing moved, that is, in what is actually [39a] functioning [9] as a movable thing. We must, however, dismiss accidental change from consideration, since it is present in anything, at any time, and in respect of anything.

Nonaccidental changes are not to be found inherently in all things, but take place between contraries or their intermediates and between contradictories. We may convince ourselves of this by induction. A 30 change may take place from an intermediate which functions [163] as a contrary to either extreme, since an intermediate is in a way both of the extremes: a middle note is low compared with the highest and high compared with the lowest; and gray is light compared with dark and dark compared with light. Then, too, every "transformation" has a 225a definite initial and terminal limit, as the term "transformation" itself suggests. Hence, changes take place (1) between substantives [85], (2) between nonsubstantives, (3) from a nonsubstantive to a substantive, and (4) from a substantive to a nonsubstantive. By a "substantive" I mean what is referred to in a positive assertion. Since change from one nonsubstantive to another nonsubstantive is really not a change, involving neither contraries nor contradictories and hence no opposition [64b], this leaves three types of change. A change from a nonsubstantive into 10

‡ iii.1.210a10, 27-29.

a substantive (its positive contradictory) is generation. Such change, when absolute [105], is the generation of a whole new subject or substantive; when partial (for example, from nonwhite to white), it is a partial [4] generation. Change from a substantive to a nonsubstantive is destruction, absolute change being absolute destruction and a partial change being partial destruction.

Though "nonbeing" has several senses, there is no way in which a nonbeing can be in process [109a], whether it be the nonbeing involved in [false] predication [64g] or disjunction [75], or whether it be the nonbeing of potentiality, which is opposed to complete being. To be sure, nonwhite and nongood can undergo movement incidentally, in so far as a "nonwhite" may be a moving man; but in so far as it is not a positive substantive, or "this" [4a], it cannot be moved. Hence, nonbeing cannot be moved; and, if this be so, generation cannot be movement, since it is from nonbeing that generation starts. For, even admitting that some generation is accidental, it remains true that any absolute generation must begin [82f] in nonbeing.§ Similarly, nonbeing cannot come to rest. These consequences are troublesome; and so is the fact that everything that is moved is in a place, but "nonbeing" is not in a place, for then it would be somewhere. Hence, destruction is also not movement; for the contrary of a movement is another movement or rest and of destruction the contrary is generation.

We must conclude, therefore, that since processes [109] are changes [115] and changes are of the three types mentioned, those changes which are generations and destructions are not processes.‖ A process moves from one thing to its contradictory; hence, only the change from one substantive to another is a process. And these substantives are either contraries or their intermediates, for even privation is to be put down as a contrary; and privations can be expressed [59] positively, such as "naked," "bald," "black."

If the categories are divided into primary being, quality, place, relation, quantity, activity or passivity, there must be three kinds of change [109]:¶ in quality, in quantity, in place.

2. Kinds of Movement and the Immovable

There is no change [109] with regard to primary being, because primary being has no contrary; nor is there change in relation, since it is possible that if one correlative changes [115] what was true of the other is no longer true, although this other does not itself change, so that in such cases the change [109] is accidental. Nor is there change from agent to patient, or from mover to moved; because there is no movement of movement or generation of generation or, in general, change of change.

Now there could be movement of movement in two ways: first, as change of subject matter, in the sense in which, for example, a man is a changed being when he changes from fair to dark; similarly, a change might be said to become hot or cold or to change its place or to increase or decrease. But this is impossible; for a change [115] is not literally [4] a subject. Or, secondly, some other subject might change from a change into some other state of being [20]; for example, a man changes from becoming ill to recovering health. But this, too, is impossible, except incidentally. For every movement is change from something to something else; and so are generation and destruction, except that these are changes into opposites of one sort, whereas movements are changes into opposites of another sort.* A thing that changes from health to illness would, then, change at the same time from this very change into another. Accordingly, it is clear that when it has become ill it will have changed to some other change (although it is, indeed, possible for it to remain at rest), and moreover to a change that is never forthcoming; and that further change will be from something to something else. Consequently, it would be the opposite change, that of recovering health. But such change is accidental: there is a change from remembering to forgetting because that to which the process belongs undergoes a change—at one time to knowledge, at another to ignorance.

Besides, if there is to be change of change and generation of generation, the process will go on to infinity. Thus, whatever a later stage is the earlier must be also; that is, if generation itself was ever being generated, then what was becoming generation itself was also at one time being generated. Consequently, it was not yet the process of generation itself, but only the generation of some particular being [4], past or present. If this were true, there was a time when generation was being generated; consequently, it was not yet generated at that specific time when it was being generated. But since there is no first in the infinite the first will not be; consequently, there will not be a second either. Neither generation, then, nor movement would be possible, nor any change.

Whatever suffers a given change [109] or state of rest also suffers the contrary change or state; so what is generated is destroyed. Consequently, what is being generated begins to perish when it has been in

§ i.7.190b3-5.
‖ But cp. Plato *Laws* x.894ff.
¶ Single "movements," distinguished into kinds according to specific beginnings and ends, include only movements in quality, quantity, and place.

* v.1.225a35-b1.

the process for some time; for it does not begin to perish either in the very first stage of being generated or later, since what is perishing must for a while be. And there must remain some material constant underneath the generation and changes. What, then, could it be? What is it that is generated as movement or generation, as a body or a self is which undergoes alteration? And again, what is it into which they move? It must be the movement or generation of something [4a] from something to something. And how? For the movement of learning cannot be learning, and the movement of generation cannot be generation. Finally, since there are three kinds of movement, the nature persisting in the supposed movements as well as the goals to which they tend would have to be one of them; for example, local motion would be qualitatively altered or moved from one place to another.

In general, since movements are of three types, accidental, partial, or essential, change itself would only be change accidentally, as when a man recovering his health runs or learns. But we have already† dismissed accidental change from consideration.

Since there is no movement, therefore, in primary being or relation or activity and passivity, it remains that movement is in quality and quantity and place; for each of these can have contrariety. Let us call a movement in quality a "qualitative alteration" [120], which refers to both [extreme ends of the movement]. By quality [28], I do not here mean what is in the primary being (for even the differentia is a quality), but a passive quality [35c] with regard to which something is said to be acted upon [35] or to be incapable of being acted upon [35d]. Movement in quantity has no such common designation but is named after one or the other of its extremes [of largeness and smallness], either an "increase" or a "decrease," respectively. Movement in place has no name which is derived from its extremes taken either together or separately; but we may call it a "carrying" [121], although in the strictest sense only those things are "carried" from place to place which cannot stop or move themselves. Change to a greater or a lesser degree within the same kind may be classified as a qualitative alteration, for a movement may be from one contrary to another in either an unqualified or a qualified sense. A thing changing to a lesser degree of a quality may be said to change to the "contrary," whereas a thing changing to a greater degree of a quality may be said to change "from" the contrary towards the quality itself; whether the change is in a qualified respect or not, makes no difference, except that the contraries in the former case have to be present in a qualified sense only. "Greater" or "less" means the presence [82h] or absence of "less" or "more" of a contrary.

† v.1.224b26.

From these considerations, then, it is clear that there are but three kinds of "movement."

The "immovable" is (1) what is wholly incapable of being moved (as voice is invisible), or (2) what is moved with difficulty after a long time or begins slowly (and is said to be "hard to move"), or (3) what can naturally be moved, but is not moved when and where and as it naturally would be. Only this last kind of immovable being I would call "being at rest"; for rest is contrary to movement, so that it must be a privation of what is capable of receiving [12] movement.

It should be evident now what movement and rest are, how many types of changes there are, and which sorts of changes are "movements."

3. Succession, Contact, Contiguity, and Related Distinctions

Let us now state what it means [87] for things to be together, apart, in contact, between, in succession, contiguous, or continuous, and to what sorts of things each of these naturally belongs.

Things are "together in place" when they are in one primary place; and "apart," when they are in different places. Things "touch" when their extreme ends are "together."

That is "between" at which a thing undergoing change, if it undergoes continuous change according to its nature, arrives naturally before it arrives at the extreme [18a] towards which it is changing. Thus, "between" implies at least three terms: for the terminus [18a] of a change is a contrary; and a thing moves "continuously" when it leaves no part or hardly any part of its "path" [188c] uncovered [148a]. I do not say "of the time" (since there is nothing to prevent the time from being interrupted [148a] or to prevent a high note from being sounded immediately after a low one), but I say "of the path" [188c] in which the movement takes place. This is evident in local changes as well as in all other kinds of change. That is "contrary in place" which is most distant in a straight line; for the shortest line, being determinate [131a], serves as a measure.

That is "in succession" which is after a beginning, as determined [72d] by position or form or in some other way, and has nothing of the same kind "between" it and what it succeeds; for example, lines if it is a line, units if it is a unit, or a house if it is a house. But there is nothing to prevent something of a different kind from being between. For what is in succession is in succession to something and comes after it, for one does not succeed two, nor does the first day of the month succeed the second, but the latter succeeds the former.

That is "contiguous" which is "in succession" and "touches." Also since all change is between opposites, and these are contraries or contradictories, and contradictories have no middle term, it is clear that what is "between" is between contraries.

The "continuous" is something contiguous. I call things "continuous" when their limits touch and become one and the same and are contained in each other (which is impossible when the limits are distinctly two); so that it is clear that continuity belongs to things out of whose mutual contact a unity naturally arises. And the whole is a unity in the same way in which the continuous is a unity, whether by having been nailed or glued or mixed or having grown together.

It is evident also that of these concepts it is being "in succession" that comes first: for what is in succession does not necessarily touch, but what touches is in succession, which is why there is succession but no contact among things like numbers which have a logical [90] priority, and if anything is continuous, it touches, but if it touches, it is not necessarily continuous, since extremities which are together need not be one whereas extremities which are one must be together. Consequently, natural union [101f] comes last in the order of genesis: for extremities naturally united must touch, but not all things that touch are naturally united; and it is clear that there is no natural union in things in which there is no touching. Hence, if there are independently existing points and units as some say, a point is not the same as a unit:* for touching would belong to points, but not to units, which are only in succession; and there is something between points (since every line is between points), but not necessarily between units (since there is nothing between one and two).†

So much for the definitions of "together," "apart," "touching," "between," "in succession," "contiguous," and "continuous," and so much for the sorts of things to which each of these belongs.

4. Movements as Unified and Diversified

A movement [or process] may be "one" in various ways which correspond to the various meanings of "unity."

Movements are generically one when they are in the same category. For example, all local motions are generically one, whereas qualitative alterations differ generically from local motions.

* The Pythagoreans defined a "point" as "a unit having position" and a "unit" as "a point not having position."

† The Pythagoreans held "numbers" to be "separated from one another" by the "void."

Movements are specifically one when, besides being one in genus, they are in the same indivisible species. For example, since colors have specific differences, becoming black and becoming white differ in species; but inasmuch as whiteness is not further divided by specific differences, every process of becoming white is one in species with every other. In the case of [intermediate] genera which are also species, it is clear that movements are one in species, but in a qualified sense. Among such are processes of learning; for knowledge is both a species of apprehension [174] and a genus of the various sciences. One may object: if movements are one in species when the same subject undergoes a change from the same beginning to the same end, when (for example) the same point [or particle] shifts again and again from one identical place to another, then motion in a circle and motion [back and forth] in a straight line would be the same; and so would rolling and walking. But have we not already implied [72e] that motions differing specifically in their courses differ in species; and would not motions in a circle and motions in a straight line, then, differ in species?

Having shown in what senses movements are one generically and are one specifically, we may by means of further distinctions explain what sorts of movements are inherently [105] one, that is, numerically single in their being [26]. In describing a movement (or process), we specify "what" changes, and "in what respect" as well as "when." Thus, since a movement must have a subject, we distinguish "what" undergoes the movement (a man or gold); also, "that in which" it undergoes the movement (in place or in quality); and, likewise, "when" it undergoes the movement (since all movement takes time). But whereas the generic or specific unity of movements depends upon the way [188c] in which they occur, and their continuity depends upon the time, their inherent unity depends upon all three of the considerations distinguished: the species of such a movement must be single and indivisible; the time of the movement must be single and uninterrupted [148a]; and the subject of the movement must be single. However, the unity of the subject must not be accidental only, as in the case of "white Coriscus" taking a walk and turning dark. Nor must the unity of the subject consist in an association [92] only, as when two people are recovering from ophthalmia at the same time and in the same way; their simultaneous recovery is not a single process but is one in species. As for the objection that Socrates may undergo the same kind [20] of qualitative alteration at different times, this movement would be unitary only if, after having ceased, it could arise again as the numerically single movement it was; if not, it is indeed the same [in kind and as regards its subject], but it is not unitary. A related question is whether our health or whether

bodily dispositions and states generally are unified in their being [26], even though bodies themselves are apparently subject to movement and flux:* thus, if the state of our health is one and the same at the dawn of day and in this very instant, why should it not be numerically one with the health we may have lost and after a while recovered? But the same argument holds in this case. There is only this difference: if the states are distinctly two, the corresponding [movements or] activites [9] must also be distinctly two (since only a numerically single subject can perform a numerically single activity); but if the state is single, it does not follow that the [movement or] activity is therefore single also (for when a man stops walking, the walking ceases until he resumes it). If the latter were one and the same, then it would be possible for anything, while remaining one and the same, repeatedly to perish and again to be. But such questions are beyond the scope of our inquiry.

More pertinently, since every movement, being [infinitely] divisible, is continuous, therefore an inherently single movement must also be continuous; and if it is continuous, it must also be single. Not that any movement can form a continuous movement with any other movement any more than any chance thing can be continuous with any other chance thing. Their extreme ends must be unified. Some things have no extreme ends, whereas others have extreme ends differing in kind; and how can the "end" of a line and the "end" of walking touch or become one, even though both are called "ends"? Movements differing in species or genus may, indeed, be consecutive; for example, one may become feverish after running. So, too, the "legs" of a relay race are consecutive, not continuous. For, by definition, only those things are "continuous" whose extreme ends are one. Thus, consecutive or successive movements are such by reason of a temporal continuity; but to be continuous, the movements must themselves be continuous in the sense that the extreme end of each becomes one with that of the other. Hence a movement that is inherently continuous and single must be identical in species, must have a single subject, and must take place in a time that is single. The time must be single, lest a pause [109e] intervene in which the movement would have come to a halt and be suspended; movements with intervals of rest are not single but many; and therefore any movement broken up by a standstill, as it would be in an intervening time, is neither single nor continuous. On the other hand, even if a specifically different movement is temporally uninterrupted, unity of the time does not affect the specific difference of the movement; for a single movement must be of a single kind, although a movement single

* Heraclitus.

in kind is not necessarily single in an unqualified sense. So much for the inherent "unity" of a movement.

Again, we identify a single movement as such when it has been completed [14].† This may be so with respect to its genus, or its species, or also its being [26]. It is in this way, too, that we identify any other [subject matter]; namely, as a unity which is a complete whole. Still, we sometimes ascribe unity to an uncompleted movement, provided that the movement is continuous.‡

Finally, movements have another type of unity besides those already examined; namely, when they are uniform. A uniform movement (such as movement in a straight line) is more properly characterized as one than is a nonuniform movement, which can be analyzed [into distinct movements]. But the difference seems to be one of degree [that is, of more or less irregular movements]. Moreover, any kind of movment may be uniform or nonuniform: qualitative alteration; local motion, as in a circle or in a straight line; and growth and decline. Sometimes a movement is nonuniform in its path, as when its path is a broken line or a spiral or any other spatial magnitude whose parts taken at random do not fit upon [56b] other parts taken at random; for a movement cannot be uniform unless its path is so. But sometimes a movement is nonuniform, not in its subject§ or time or goal, but in its rate, which may be fast or slow: movement at a uniform rate is uniform; at a nonuniform rate, nonuniform. Hence, differences of rate, which accompany [77] all the different species of movement, do not constitute species or differentiae of movement. Hence, too, earth does not, because of any difference in weight [or in rate of tending] in the same direction, differ in species from earth, or fire from fire. Even a nonuniform movement, then, like a motion in a broken line, may be one if it is continuous; but it is less unified than a uniform movement, and in anything "less" there is always a mixture with a contrary. But if every unitary movement is capable [12a] of being either uniform or nonuniform, consecutive movements which differ in species cannot be one and continuous. How could a qualitative alteration and a local motion coalesce [32] in a uniform movement? Component parts ought to exhibit a harmony [56b].

† Pythagoreans, Platonists.

‡ Thomas Aquinas: "Et ratio hujus est: quia unum potest attendi vel secundum quantitatem, et sic sola continuitas sufficit ad unitatem rei: vel secundum formam substantialem, quae est perfectio totius, et sic perfectum et totum dicitur unum."

§ Preferable to the reading: "place."

5. Movements Contrary to Each Other

We must next determine what sorts of movements are contraries to each other and then deal in the same way with rest. (1) Are movements contrary to each other when the starting-point of one (for example health) is identical with the other movement's end? If so, then [contrary] movements would in this respect be like [5b] generation and destruction. Or (2) are movements mutually contrary when their starting-points are contraries (one movement starting from health, and the other from disease)? Or (3) when their ends are contraries (one movement ending in health, and the other in disease)? Or (4) when one movement starts from one of a pair of contraries (health) and the other ends in the other contrary (disease)? Or (5) when one movement proceeds from one to the other of a pair of contraries (from health to disease) and the other movement proceeds from the latter contrary to the former (from disease to health)? Movements must be contrary to each other either in one or in more than one of these ways, there being no other way in which they can be mutually opposed [64b].

However, a movement (4) from one of a pair of contraries (health) is not contrary to a movement to the other contrary (hence, ending in disease): these movements are the same; although their ways of being [23] differ, just as changefulness [115] in health differs from changing tendencies to disease. Nor are movements contrary when (2) they start from contraries: movement *from* a contrary is incidental to movement *to* a contrary or to an intermediate (as we shall explain presently); contrariety in movements is better accounted for [83] by change *to* a contrary, which represents a gain of a contrary, than by change *from* a contrary, which represents a loss of a contrary; and a change gets its name from its culmination rather than from its starting-point (for example, "getting well" or "falling ill"). There remain the third and the fifth alternatives. However, movements which (3) end in contraries (as we were about to explain) also start from contraries; but their way of being is distinct, since "to health" is not identical with "from disease," nor is "from health" identical with "to disease." Now, then, a "change" differs from a "movement" in that a movement is a change from something [4] positive [85] to something positive.* Therefore movements are contrary to each other whenever (5) one movement proceeds from one to the other of a pair of contraries (from health to disease) and the other movement proceeds from the latter contrary to the former (from disease to health).

We may show inductively of what sorts the contrary terms [in contrary movements] are: falling ill is contrary to getting well, since these move-

* v.1.225a4, b2.

ments have contrary outcomes; being taught is contrary to being deceived by another, for it is possible to get knowledge or misinformation by one's own activity or by another's; and upward motion is contrary to downward motion in length, motion to the right is contrary to motion to the left in breadth, and forward motion is contrary to backward motion [in depth].† On the other hand, a process which is only *to* a contrary (for example, "being white") inasmuch as the starting-point lacks positive determination [4], is a [partial] "change" rather than a "movement" [in sense (3)]. Where there are no contraries [but contradictories], there a "change" *from* something is contrary to a "change" *to* the same thing: thus, generation is contrary to destruction, as the loss of a thing is contrary to its acquisition; but these are [absolute] "changes," not "movements" [in sense (1)]. Where there are intermediates between the contrary terms, a movement to an intermediate is to be treated [64] as a movement to a contrary, since an intermediate operates [163] as a contrary in a movement, in whichever direction the change takes place: thus, gray operates as would black in a movement from gray to white or from white to gray, and as would white in a movement from black to gray; for a mean is in a way one of the extremes relatively to the other, as we have said before.‡ In fine, two movements are contraries only when (5) one movement passes from one to the other of a pair of contraries and the other movement passes from the latter contrary to the former.

6. Movement and Rest, Natural and Violent

Not only are there contrary movements; but rest and movement, too, are contraries which call for discrimination. Strictly, a movement is contrary to a movement. But rest is also opposed to movement; for "rest" is "privation of movement," and a "privation" is in some sense a "contrary." Also, a certain kind of rest is opposed, respectively, to a certain kind of movement; for example, resting somewhere, to moving somewhere. Yet this statement is too simple. Does rest at a given place have for its opposite a movement away from or towards that place? But clearly, since a movement has two limits [85], movement from a given place to another [50] has for its opposite resting in the given place, whereas movement from elsewhere [50] to the given place has for its opposite resting in the other place. Moreover, these two rests are contrary to each other; it would be an absurdity that there should be mutually contrary movements but no rests which are mutually opposed. States of rest in contraries are mutually opposed: thus, (1) remaining in

† *De caelo* ii.2.284b24, 25.
‡ v.1.224b32-35.

good health is contrary to remaining in bad health; and (2) remaining in good health is also contrary to movement from good to bad health. For (2) remaining in good health cannot without incongruity be contrary to movement from bad to good health: a movement to a state of stability is rather a coming to rest, and coming to rest is at least simultaneous with movement to a state of stability; but remaining in good health must be contrary to one or to the other of these movements. However, (1) remaining white is not contrary to remaining in good health.

Where there are no contraries, there a "change" *from* something is opposed to a "change" *to* the same thing, that is, change from being is opposed to change to being; but this is not a "movement," and therefore there is also no "rest" [as the contrary] but only changelessness [115a]. If there were a positively identifiable [4] substantive [85], its changelessness in being [1] would be contrary to its changelessness in nonbeing [1b]. But if there is no identifiable nonbeing, we may ask: what is it to which changelessness in being is contrary? And is changelessness in being, a state of rest? If so, then either not every rest is contrary to movement, or else generation and destruction are "movement." Clearly, then, since generation and destruction are not "movements," changelessness in being is not "rest" but is something like it and is contrary either to nothing or else to changelessness in nonbeing or to destruction; but it is not contrary to destruction, since destruction has changelessness in being for its starting-point whereas generation has it for its stopping-point.

There is also this objection: Why should there be natural and contra-natural [74] movements and rests in local changes but not in others as well? Why is there no contrast of the natural and the contra-natural among qualitative alterations? Getting well is not more natural or contra-natural than falling ill; or becoming white, than becoming black. Why not among processes of growth and decline? Neither is thus contrasted with the other, any more than is one kind of growth with another. Why not in generation and destruction? Becoming does not differ from perishing as a natural from a contra-natural occurrence (for growing old is natural); nor do we observe generations which are either natural or contra-natural. However, if change by violence is "contra-natural," would not violent destructions, being "contra-natural," be contrary to natural destructions? Are there not accordingly also productions which, so far from being inevitable, are forced and are thus contrary to natural productions? Are there not processes of forced growth and decline; for example, when growth is hastened by indulgence or when the growth of plants is artificially hastened? Likewise, are there not natural and violent qualitative alterations; as when one patient recovers from a fever during a crisis and another gets rid of his fever at another time? But, it may be objected, will there then not be destructions which are contrary to other destructions, instead of to generations only? Yes! And why not? Is not passing away pleasantly contrary to passing away painfully; not, indeed, in the sense of an absolute contrast between one passing away and another, but in the sense of a contrast between one kind [5] of passing away and another kind?

So there are contraries among movements and states of rest generally [44], as we have already explained. Thus, in the category of place, upward motion is contrary to downward motion, as is rest above to rest below; and therefore the natural upward motion of fire is contrary to the natural downward motion of earth as well as to the contra-natural downward motion of fire. Likewise, there will be rests [contrary to motions]: thus, rest above is contrary to motion downward; and therefore the contra-natural rest of earth above is contrary to its natural motion downward, just as the natural upward or downward motion of anything is contrary, respectively, to its contra-natural motion in the reverse direction. The question may be raised: Is every rest that is not eternal generated, as in a process of coming to a standstill? If so, a contra-natural rest (as of earth above) would be generated; so that earth, when violently carried upward, would be coming to a standstill! However, in coming to a standstill, a body moves at an ever increasing rate; whereas, under compulsion, a body moves at a decreasing rate. Therefore, the rest of such a body is not the result of a process of coming to rest. Moreover, stabilization would seem to be concomitant if not identical with a body's natural movement to its proper place.

As regards coming to a standstill,* someone may ask: Is rest opposed to contra-natural as well as to natural motions? If not, this would seem absurd; for a body may be at rest under violence. Hence, there would be a noneternal state of rest which is not the result of a process [of coming to rest]. But it is clear that this is so; for as there is contra-natural motion, so a body can be in a contra-natural state of rest. Now, some things have both a natural and a contra-natural motion; for example, fire has a natural upward motion and a contra-natural downward motion. Is it the latter, then, or is it the natural downward motion of earth, which is contrary to the former? Clearly, both are contrary to it, although in different ways: the natural downward motion of earth is contrary to the natural upward motion of fire; whereas the upward motion of fire, as natural, is contrary to the downward motion of fire, as contra-natural. Similar considerations would hold for the corresponding cases

* This passage (231a5-17) seems to be a different version of 230b10-28.

of rest. Yet there is perhaps a sense in which motion is opposed to a state of rest.

230b28 There is also a difficulty in the view† that rest at a given place is contrary to motion from that place. When a body is leaving a place or
30 is losing something, it appears to be still having what it is losing. Hence, if the rest at the given place is contrary to a motion away from it, the moving body will at the same time have both contraries, the rest and the motion. Or is not the situation rather such that, as long as the changing thing remains [in its place or in its initial state], it is still in some respect at rest? And, in general, is not a body in motion partly
231a at its starting-point and partly at its goal? This is why it is movement rather than rest that is contrary to movement.

So much for the unity of movement and of rest, and so much for their contrariety.

† 229b28-31.

VI. BOOK ZETA

Continuity of Movement

1. The Continuous as Infinitely Divisible

No continuum can be made up of indivisibles. For, in accordance with 21
our distinctions,* things are "continuous" when their ends are one; they "touch" when their ends are together; and they are "in succession" when they have nothing of their own kind between them. Thus, a line, which is continuous, cannot be made up of points, which are indivisible. For no point can have an end which could become one with that of another, because what is indivisible cannot be divided into ends and other parts. Nor can any point have an end which could be together with that of another, because what is without parts cannot have any end at all since its end would differ from that whose end it would be. Again, in order to make up a continuum, points (like any other indivisi- 30
ble things) would either have to be continuous with one another or would at least have to touch. But, for the reason already stated, points 231b
cannot be continuous; and a whole touches a whole, or a part touches a part, or a part touches a whole. But since anything indivisible is without parts, therefore, in the contact of indivisibles, a whole would have to touch a whole. However, when a whole touches a whole, this is not a continuity; a continuity requires distinct and locally separate parts. Again, points cannot even be in succession in such a way as to constitute a length, any more than moments can be in succession in such a way as to constitute a time [or a continuous duration]. Only those things are "in succession" which have nothing of their own kind

* v.3.227a17-23.