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Physics, Or Natural Hearing

Aristotle

Translated and Edited by Glen Coughlin

WILLIAM OF MOERBEKE
Translation Series

Stuart D. Warner, Series Director

ST. AUGUSTINE'S PRESS
South Bend, Indiana
2005

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1 2 3 4 5 6 10 09 08 07 06 05

Manufactured in the United States of America.

Library of Congress Cataloging in Publication Data
Aristotle.
[Physics. English]
Physics, or, Natural hearing / Aristotle ; translated and edited by Glen Coughlin.
p. cm. – (William of Moerbeke translation series)
ISBN 1-58731-628-5 (hardcover : alk. paper) – ISBN 1-58731-629-3 (pbk. : alk. paper)
1. Aristotle. Physics. 2. Physics – Early works to 1800. I. Title: Physics. II. Title: Natural hearing. III. Coughlin, Glen, 1958– IV. Title. V. Series.
Q151.A7513 2003
530 – dc21 2002151730

∞ *The paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences – Permanence of Paper for Printed Materials, ANSI Z39.48-1984.*

St. Augustine's Press
www.staugustine.net

To my parents; may they rest in peace.

Contents

Introduction

Therefore it is necessary to follow the common;
but although the word is common,
the many live as though they had a private understanding.

Heraclitus

Part I – Aristotle's *Physics*

The *Physics* of Aristotle is, as Heidegger said, the fundamental book in western philosophy.[1] It is nevertheless difficult to read, and for many reasons. It is notoriously concise and at times obscure, and it is often mistranslated. Most importantly, it is difficult for readers of the modern, technical age to understand the kind of writing it is. It is bad enough that it is philosophy; but it is also ancient philosophy. It is therefore foreign, and, to complicate things, encrusted with commentary.

The most difficult impediment to overcome is the habit of thought which makes of modern science, which is mathematical and technical, the sole paradigm of science. Our education leads us to believe that knowledge of nature is always founded on experiments, that it is mathematical in mode (and so the domain of highly specialized "scientists"), and that it is ordered to something practical. Aristotle's *Physics* is thus unlike anything in our experience of education. How can reading this book educate us, except from a purely historical point of view, since it is founded on common experience, is non-mathematical in mode, and is purely theoretical? And if the *Physics* is such, can we even conceive the consequence, a study of nature which is not the domain of the scientist?

We may answer the last question by noting an equivocation. "Science," as we now understand the term, does not mean what a reliance on the word's etymology would imply, "knowledge." If that were the one and only meaning of

1 Martin Heidegger, "On the Essence and Concept of φύσις in Aristotle's *Physics* B, 1;" in *Pathmarks*, ed. William McNeill, (Cambridge: Cambridge University Press, 1998), pp. 183–230; p. 185.

"science," it would be a contradiction to say that there is a study of nature which is not the domain of any "scientist." The word "science" usually refers to the study of natural things. In an extended sense of "science" some other things may be included, e.g., "social science"; still, the word seems to be used here to the extent that non-natural things, like political parties, are subject to the same kind of understanding as natural things, and we do this, it seems, to the extent that we think the non-natural things as really natural and subject to "natural laws." Further, the word does not usually mean just any study of natural things, but a study of nature in which the goal is to subordinate all particulars to universal "laws," which laws permit us a sort of prescience and technical control of nature undreamed of by earlier generations. In its most developed form, the form which willy-nilly plays the role of paradigm, "science" is the pursuit of mathematical formulations which express certain constant quantitative relations between things, relations which are to be revealed through observation with measuring instruments of natural or artificially induced phenomena. (By the latter I mean "experiments.") For example, the study of animal behavior, which is not predominantly mathematical, is still subject to experimentation, and looks to mathematical physics in its general features of utility, or at least prescience, and of the representation of particulars through universal laws. Such a discipline, then, is not outside the scope of the term "science," and its existence should give us pause if we harbor the old prejudice which says "what isn't measured isn't known." The mere presence of a discipline such as behavioral biology should alert us to the possibility of other non-mathematical studies of nature.

If this is what we must mean by "science,"[2] we may then ask, whether it is the only kind of knowledge of nature? If it is not the only kind, is it the first kind? And, if it or some other kind is first, in what way is the first one first?

We do not need a lengthy discussion of modern science to see that there is knowledge which is different in nature from it and, more importantly, prior to it. We may note, to begin, that the questions we have just posed are not answerable by modern scientific methods. We have been speaking not about nature, but about the study of nature; still, it is not possible to understand nature without understanding the way in which it is to be understood. This is not to say that there cannot be any knowledge of nature without a detailed analysis of how one should proceed to study it (for then the study of nature becomes impossible), but that the best understanding certainly does suppose such an analysis. The *Physics* provides, among other things, certain general rules for the study of nature. The analysis we find in Book I, Ch. 1, concludes that we must start with the most

2 It is not what Aristotle means by the word "ἐπιστήμη," which I translate by "science." I so translate it because, despite the appropriation of the word by the enterprise called "modern science," it still carries in most minds the connotation of certainty and rigor. Aristotle lays out the conditions for truly scientific knowledge in the *Posterior Analytics*, especially Book I, Chs. 1–6.

universal notions which we have about natural things (e.g., the notions of change, nature, motion, place, time, continuum, body, mover and moved, etc.) and only afterward proceed to analyze more particular aspects of nature (e.g., the equation for free-fall, the chemical constitution of water, the habits of hummingbirds, etc.).

Thus the *Physics*, the first of Aristotle's works of natural philosophy, treats just those common notions mentioned above. Since the particular includes the universal in its notion, e.g., the falling of heavy bodies is a sort of motion and cannot be conceived apart from motion, we are compelled to start with the universal. In this way, the present work naturally and necessarily gives us the first part of the study of nature. Besides, we are more certain of the universal than of the particular: I am, for example, more certain that there is motion, that motion implies difference, that what is moving can be where it is going but is not there yet, etc., than I am of the equation of its motion. Yet the first considerations are applicable to any motion at all, even, *mutatis mutandis*, to motions which are not explicable as changes of place. I need not even know, at first, whether there are any such motions, i.e., whether there are kinds or species of motion, to know the more general claims about motion. Consequently, if there are implications to be drawn from these general considerations, they are not dependent upon, but are naturally prior to, the considerations of particular sorts of motion. If the more general were not more certain, we would have to say that what is assumed in the more particular is then less certain than what assumes it: a manifest absurdity.

We may consider the priority of Aristotle's *Physics* to modern experimental science in another way as well. The experience upon which modern experimental science depends, experiment and precisely measured observations, is a special experience which belongs to particular, highly trained specialists. The experience upon which the *Physics* depends is our common or ordinary experience of the world. While everyone has experience of bodies and motion, not everyone has experience of the trails made by protons passing through a cloud chamber, or the way a bee "dances" to signal to her fellows where the flowers are. Yet the common experience is implicit in the special, and without it one could never make sense of the special experience upon which modern science relies. Moreover, the special experience of modern science is to a certain extent contrived by the scientist, and this is done in order to inquire into some aspect of nature left hidden by common experience. We put nature in the witness stand, as Kant says, and put to it questions of our own choosing.[3] But common experience is presupposed to the very asking of these questions. For example, I could never ask whether water is composed of hydrogen and oxygen if I did not already assume that bodies exist, that some bodies are "composed" out of others, etc.

The *Physics* is prior in yet another way: simple knowledge comes before

3 Immanuel Kant, *Critique of Pure Reason*, 2nd ed., trans. Norman Kemp Smith (London: Macmillan & Co., Ltd, 1933), p. 20.

knowledge which combines different modes of procedure. To understand opera, one must first understand drama and music, since opera combines both forms of art. So, too, modern physics combines mathematics and physical speculation. By this I mean that one must use mathematical means, as is obvious, and must apply those means to the sensible world, about which we have some, albeit vague, knowledge before we ever begin scientific analysis. To understand Newton's argument for universal gravitation, one must have experience of weight in things and in oneself, of the motion of the stars and planets and moons. Knowing calculus is not enough. This hybrid science, then, comes after the consideration of nature through non-mathematical means.

This argument obviously does not apply to those branches of modern natural science which are non-mathematical. The same is true of the following argument. The "language" of modern physics and other mathematical modern sciences is not common language, not a language of words, but a technical, symbolic system. Both symbols and words are conventional signs, but they are still very different sorts of signs. For, even if we say that the quantity in such and such a case is seven units, the seven is not simply a substitute for the phrase "the quantity in this case," the way it would be a substitute for the "F" of the equation "F = ma." A sign of this is that I cannot multiply the phrase by itself, but I can multiply the seven by itself and I can even square the symbol "F," at least in a sense. And the sense in which I can do this is instructive: by writing "F^2," I simply indicate that the number to be put into this spot in the equation is to be multiplied by itself; in short, I indicate an operation to be performed upon the substitute for "F ." Yet I cannot operate mathematically on words or phrases. One might be inclined to say that "F^2" is shorthand for "the square of the quantity of that power which moves bodies faster, slows them down, or changes their direction." But it is one thing to say that the symbol stands for that which can be so expressed and another to say that the symbol expresses the latter.

Another example may help. If I write "x = n+1," where "n" stands for any even number, then every "x" is an odd number and every odd number can be put in the place of "x," as long as the appropriate "n" is put in (for the moment let us assume that one is not a number, as the ancients did[4]). But does "x" *mean* "odd number"? Not at all. It is a place holder, which I manipulate as if it were that for which it holds the place. It is like a square hole into which only square pegs can be put: the square hole does not mean "square," yet it *will* separate the square pegs from the other pegs. Even a child who does not yet distinguish shapes clearly could, if determined enough, separate all the square blocks in a pile from all the other blocks. He still would not know what "square" means.[5]

4 Cf. Euclid, *The Elements*, Bk. VII, Definitions 1 and 2. Cf. also Definition 7.

5 There is another aspect to this likeness. Just as the child does not know what he is doing, so a computer can manipulate symbols without knowing what it is doing. The computer does not understand, and does not need to understand, what "force" or "odd

In this regard, symbols are like material things in that we treat them as things we can work on or with, dividing them, etc., and we can so treat them because they stand for what is symbolized in a peculiar way. The word signifies something, but the symbol differs from the word in being treated as if it were that very thing which is symbolized. This is what I mean by saying the symbol "stands for" something. Now, material things can also "stand for" things: I might put down a pebble for every book I own and, by manipulating the pebbles, see what sorts of groupings are possible. In much the same way, I can manipulate the symbols of an equation by writing or erasing other symbols according to fixed rules, and these symbols allow me a sort of universality akin to, but not the same as, that of words. For my symbols can stand for any "F," "m," and "a." Words, on the other hand, do not "stand for" what they signify. The word "dog" stands for neither this dog "Fido" nor this dog "Rex." Rather, it names them as to what they have in common. If the name "dog" stood for the individuals, we would not say "Fido is a dog," but "Dog is Fido," as we say "'F' is 7" but not "7 is 'F'." When we say "'F' is 7," our mode of expression is used precisely because F simply held the place of 7 in the equation; we seem to wish to say "though I did not know it, 'F' was all along standing in for 7." Nor is the symbol "F" the same as a proper name, e.g., "Fido," for it stands for any of the substitutes for "F" indiscriminately, not for only one, but "Fido" names one dog only, and no others (except equivocally).[6] Thus, words and symbols are not in fact the same sort of sign, but differ in significant ways.

number" mean. So long as it is programmed to mechanically substitute certain symbols for others in a fixed way, it will perform as well or better than any physicist. In fact, so long as the computer (or the physicist) is merely manipulating symbols according to fixed rules, it is not even treating the symbol as a sign, but as a material object. The experience of performing algebra mechanically, "by rote," is probably a fairly common one.

6 The founder of modern algebra, François Viète, saw this clearly. In his *In Arte Analyticen Isagoge*, he compares calculation using numbers and algebraic calculation in the following terms: "Logistice numerosa est quae per numeros, Speciosa quae per species seu rerum formas exhibetur, ut pote per Alphabetica elementa." ("Numerical calculation is what is through numbers, 'species calculation' is what is exhibited through species or forms of things, as, for example, through the letters of the alphabet.") By "logistice speciosa," Viète means algebra. Here he is saying that what the algebraist works upon are letters, or something like them. The rules he gives for his new art are rules for manipulating letters as if they were numbers (or magnitudes). Thus, for Viète, an algebraic equation is only an assemblage of marks on a page, and algebra is the set of rules for working with these marks. This art is called the "zetetic" or "finding" art. Unlike modern algebraists, Viète goes on to give two other arts, the "exegetic" and "rhetic" arts, which produce, respectively, the magnitude or the number desired, e.g., the side of the regular pentagon to be inscribed in a given circle. Viète does not think, as do the moderns, that the algebraic, symbolic equation is the answer to the question posed, but is only a "form" or "species" which

It is clear, however, that natural language is prior to symbolic language. The latter is never directly understood, but must always be translated into our everyday language. Reflection on experience should convince us that when we are faced with symbolic language, we look for a translation into common language, but we never do the reverse, except when we are trying to determine a particular quantity or law.

The naturally first knowledge of nature, then, is what Aristotle was aiming at in the *Physics*. Is such knowledge really possible, or must we content ourselves with a purely positivistic "science," the foundations of which are ever unknowable? If so, modern science itself can never be anything but a fancy way to calculate future positions or states. If, on the contrary, the knowledge of nature which is naturally prior to the sort attainable by modern science is possible, then modern science itself may be more firmly rooted than even the scientists believe or hope. For then the basic truths about nature could be discovered and used as a context (though probably not often as premisses) for modern science. For example, the discussion of chance in *Physics* II, Chs. 4–6 (together with complementary discussions in *Metaphysics* VI, Ch. 3 and *Peri Hermeneias*, Ch. 9) shows us that the contemporary scientists' claim that nature is inherently indeterminate is fundamentally correct. Aristotle's discussions are not scientific in the modern sense of the word (they would probably be called "metaphysical" or "philosophical" by most modern thinkers), but those discussions begin with our common experience of the world and the general knowledge derived from that common experience, and so are prior to the theoretical structures of the physicist.

We have already seen that the sort of experience needed for this first knowledge is not only available, it underlies every experience. And the knowledge

can, by a sort of translation, lead to the answer. Thus, for the moderns, the answer is a symbol, but for Viète, a line or number, which he thinks sufficiently different from a symbol to require that the symbol be interpreted before the answer is truly known. (It seems to be true that Viète thought his symbols stood for some "species" which embraced both the discrete and the continuous, but this does not change his attitude towards the symbols themselves.)

Viète is ahead of the modern logicians in this. While they mistake their symbolic language for a more concise and precise language, it is really an entirely different sort of intellectual tool from ordinary speech. A sign of this is that, while the symbolic logicians interpret "Every man is an animal" to mean the same thing as "If 'x' is a man, 'x' is an animal"; the fact is that the first is a claim about reality, while the second is a claim about propositions. For the second means the same thing as "The proposition, *'x' is a man*, necessarily implies the proposition, *'x' is an animal*." Moreover, the symbolic expression brings in the third term 'x,' which must be an individual, while the common language expression does not do so.

A translation of the *Isagoge*, by the late Rev. Winfree Smith, is found in the appendix to Jacob Kline's *Greek Mathematical Thought and the Origins of Algebra,* trans. Eva Brann (New York: Dover Publications, Inc., 1992), pp. 313–53.

arising from such common experience is also assumed in all other knowledge. Moreover, the simple grasp of things which is found in such knowledge is assumed in the complex grasp of them found in modern science. And the expression of such simple, natural, and common knowledge is common speech, which is assumed by the symbolic "language" of modern science. Consequently, it would seem that such knowledge is possible, as it arises naturally from what everyone has and is presupposed to something which some people have.

The proper road to such knowledge goes from the common experiences and notions we have mentioned to conclusions of equal universality, though less obviousness. We do not proceed from these common experiences and notions to some more particular notions by way of deduction, but, remaining on the same level of universality, we go from premisses to conclusions.[7] Presupposed here is a clear grasp of the right premisses, and to get this grasp is the work of dialectic. Thus, Aristotle will usually proceed from the opinions of others and from the difficulties inherent in a matter to a clearer grasp of which premisses are the right ones and what the terms of those premisses mean. It is natural in difficult matters to go from reasonable guesses to sturdier arguments and to take advice from wise men who have explored the path before us. No one is able to become wise by himself or without long study – wisdom could leap full grown only from the forehead of a god.[8] The use of arguments taken from the opinions of others and the use of difficulties to work toward the truth is, fundamentally, the use of dialectic. This part of logic gives us the ability to judge which premisses are more central and to grasp more firmly the meanings of the terms involved. It does this by teaching us to look to premisses which are like the truth and by teaching us to note pitfalls which others have fallen into by misunderstanding terms, or by taking false, though perhaps plausible, premisses, or by putting first what should be second.

Having seen that the discussion of nature found in Aristotle's *Physics* is prior to the quantitative analysis of nature which we now dub "science," that such knowledge is possible and how it is possible, we can see more easily the desirability of understanding the contents of the *Physics*. Knowledge of the sort discussed in the *Physics* is naturally before modern science and so is presupposed to a proper understanding even of modern science.

Moreover, the great scientists have themselves been advocates of a return to such study. In fact, both Heisenberg and Bohr claim that one needs to be able to check the theories of mathematical physics against what everyone already knows of the world: "science must be based upon language as the only means of communication . . ."[9]; "even for the physicist the description in plain language

7 Cf. *Posterior Analytics*, Bk. I, Ch. 4, 73b26–74a3.

8 Cf. *Metaphysics,* Bk. II, Ch. 1, 993a30–b19.

9 Werner Heisenberg, *Physics and Philosophy* (New York: Harper and Row, 1962), p. 171.

will be a criterion of the degree of understanding reached"[10]; "all account of physical experience is, of course, ultimately based on common language;"[11]

> . . . one of the most important features of the development and the analysis of modern physics is the experience that the concepts of natural language, vaguely defined as they are, seem to be more stable in the expansion of knowledge than the precise terms of scientific language, derived as an idealization from only limited groups of phenomena. This fact is not surprising since the concepts of natural language are formed by the immediate connection with reality; they represent reality. . . . On the other hand, the scientific concepts are idealizations; they are derived from experience obtained by refined experimental tools, and are precisely defined through axioms and definitions. . . . But through this process of idealization and precise definition the immediate connection with reality is lost.[12]

Moreover, certain of the particular notions explored in Aristotle's *Physics* have once again come to the fore as being more or less in conformity with modern science. We have already noted the reality of chance and indetermination as one instance. Heisenberg notes that the best way to understand the nature of subatomic particles is through the Aristotelian notion of potency.[13] The problems involved in the discrete and the continuous found in quantum theory are discussed in detail, under the guise of the paradoxes of Zeno, in Books VI and VIII of the *Physics*.[14] The relation of mathematics to natural philosophy, which so exercised (one might almost say motivated) Einstein in his theory of relativity, is discussed in the second book of the *Physics*.[15]

Furthermore, Aristotle discusses and resolves many difficulties which strike at the very heart of natural science. Consider, for example, the paradox of Parmenides. When something comes to be, it comes to be from what is not. But what is not is non-being, and non-being does not exist. Therefore, there is no such thing as change or motion.[16] A host of similar questions are addressed by Aristotle in the *Physics*.

For example, when a thing changes color or shape, there is something which survives the change, and that thing is neither color nor shape. If, then, you and I are things, not attributes of things, and if we will die, what will there be to sur-

10 Ibid, p. 168.

11 Niels Bohr, *Essays, 1958–1962, On Atomic Physics and Human Knowledge* (New York: Interscience, 1963), p. 1.

12 Heisenberg, op. cit., p. 200.

13 Heisenberg, op. cit., p. 180.

14 233a21–31; 239b5–240b7; 263a4–b9.

15 193b22–194a12.

16 191a23–b34.

vive that change? It seems that what survives must be nothing. For if it is a thing, our deaths will not be the destruction of things, but just a change in the attributes of whatever it is that survives the change – but then you and I are not things. Yet this is patently absurd. Perhaps some such difficulties occurred to Plato when he posited, according to Aristotle, that matter is empty space.[17]

Again, if natural events occur by chance, they are essentially unforeseeable. But then how could there be any natural philosophy at all? For there can be no science of what is indeterminate as such. On the other hand, if events do not happen by chance, everything happens of necessity, and, as Laplace said[18], everything is perfectly foreseeable in principle. So no one is lucky or unlucky, and the widely accepted Copenhagen interpretation of quantum physics is fundamentally in error.[19] In fact, nothing could be prevented, even by agents having reason and free will, for what is necessary is what cannot not be and what cannot not be could hardly be impeded. We see here the disagreement between the old classical mechanics and contemporary physics. Among the ancients, the determinist view was held by Empedocles.[20]

When a thing moves, it is not at the beginning or at the end, but in between. At the beginning, it is able to be at the end; at the end, it is actually at the end. But a thing is either able to be there or it is there; there is no third possibility, and so no such thing as motion. At least, motion could be nothing other than being here and then here and then here. But on this account motion is not so much motion as disappearance and reappearance elsewhere. This seems to be the position of Bertrand Russell.[21]

Even if given an infinite time, one could never count infinite things, for

17 191b35–192a25; 209b6–17; *Timaeus*, 48e2–52d1.

18 "We ought to envisage the present state of the universe as the effect of its anterior state and as the cause of that which will follow. An intelligence which, for a given instant, would know all the forces by which nature is animated and the relative position of the beings which compose it, if it were vast enough to submit these givens to analysis, would embrace in the same formula the movements of the largest bodies of the universe and those of the lightest atom; nothing would be uncertain for it, and the future, like the past, would be present to its eyes." Pierre-Simon Laplace, *Théorie Analytique des probabilités* (Paris: 1812), Introduction, translation my own. Cf. also *Dictionary of Scientific Biography*, ed. Charles Coulston Gillispie, (New York: Charles Scribner's Sons, 1970), Vol. 15, p. 285.

19 Of course, the Copenhagen and determinist understandings are extremes, and both may be false. In fact, it seems Aristotle's own view is somewhere between these, holding as he does that change and indetermination are real, but also that the principle about contradiction is invariably true and that all events have determinate causes, even if those causes are not fully determinate in their effects.

20 195b31–198a13; 198b10–199b33.

21 200b26–201b15; Bertrand Russell, *Our Knowledge of the External World* (New York: W.W. Norton, 1929), p. 151.

there is *no end* to them. If number is that by which we count, then there could not be infinite number. But then is there a last number? Surely not. Galileo claims that such paradoxes merely show that the human mind ought not to search beyond its ken.[22]

Since bodies are three-dimensional, and the place of a body is equal to the body in the place, place must be a three-dimensional space which coincides with bodies. If so, being in place means coinciding with space. Do the lines on a chess board, then, which coincide with the supposed space just as truly as the other dimensions of the body, move in the same sense as the body does? It does not seem there is any way to distinguish the case of the body and the case of the line. On the other hand, if place is merely relative, as Descartes and Einstein say, then the entire universe can be "whirled" by a child spinning a top – the top being as good a reference as any other.[23]

If time exists, it does so because the present does; for the past and the future do not exist – the past has existed, the future will exist. The present, however, has no length. So there is no such thing as a long time or a short time. In fact, since time, if it exists, is a quantity and all quantities are divisible, it seems to follow that time does not exist. For the parts of time are the past and the future, both of which do not exist now. And if time does not exist, motion does not exist.[24]

If motion does exist, we are faced with Zeno's paradox: to go from one side of the room to the other you have to go half-way first, and before that, half of the half, etc. Thus, you cannot begin.[25]

But if motion begins, it seems to have a first part, and so an indivisible part; and we must, it seems, admit (with Bertrand Russell) the sudden disappearance of a body from this place and its reappearance elsewhere. What happens to the space in between? Or is it discrete too? Are the "teleporters" of science-fiction really the macroscopic version of motion?[26]

It seems that a body can move without anything moving it, as Newton said. For when I throw a ball, it keeps going after it leaves my hand. Nevertheless,

22 207b1–15; Galileo, *Two New Sciences*, trans. Stillman Drake (Madison, WI: University of Wisconsin Press, 1974), pp. 39–42.

23 214b24–28; 216a26–b16; cp. Isaac Newton, *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, 2 vols., trans. Andrew Motte, revised by Florian Cajori (Berkeley: University of California Press, 1962), vol. 1, Scholium to the Definitions, pp. 6, 8–12; René Descartes, *Principes*, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1971), vol. IX-2. nn. 13, 25 (pp. 69–70, 76); Albert Einstein, *Relativity: The Special and General Theory*, trans. Robert W. Lawson (New York: Crown, 1961), pp. 9–10.

24 218a3–8.

25 239b14–30.

26 236a7–36.

when something moves, it is different after from what it was before, i.e., there is something new about it. Where did this newness come from? It cannot have come from the body itself, since the body did not have it to give. There must be an agent, then, for every motion.[27]

These are some of the difficulties raised and solved in the *Physics*. This brief review of a few of the topics covered in the *Physics* should make it clear that the text does not deal only with what is now called "physics," or with what is now called "chemistry" or "biology," but with mobile being in all its generality. Still, certain of the conclusions Aristotle reaches are of significance for these more specialized fields. Ought the physicist to look for a cause of every motion? Are the definitions of time and distance given by Einstein or Newton reasonable? Are the changes of substance studied by the chemist necessarily to be understood as hidden changes of place? Ought the biologist to look for a purpose in the behavior of animals?[28]

Beyond this, moreover, there are certain more universal implications of the doctrines found in this, the first part of natural philosophy. If there is in fact no end or purpose in nature, then one natural being in whom we have particular interest, man, must arbitrarily choose an end to work toward, and there will be no reason to claim this or that end is to be preferred. For either the good is what really perfects the being for which it is a good, so that what is good for a thing is a consequence of the very nature of the thing, not of what the thing desires in abstraction from a consideration of its already determined nature, and so the thing is ordered to that good by nature, or else the good is not really perfective and so, though one may desire a thing, it is no more good really than its opposite, if one should happen to prefer that. All moral judgments would be perfectly subjective; the most heinous barbarities would be on the same moral level as the work of Mother Teresa. The doctrine of Aristotle, that there are objective goods in nature determined by the sorts of things in nature, is finally the only possible basis for ethics. Much of the debate over the real foundations of ethics is perhaps a result of a too simplistic acceptance of modern physics, with its abstraction from (not necessarily denial of) goods in nature. Where could one find a basis for ethics in a mathematical universe, when mathematics abstracts from the notion of the good? To maintain a sane view of the world, we must note that mathematical physics does not deny the existence of goods in the world, it simply does not depend on their existence for its arguments. This is no more a denial of the good than the plumber's lack of interest in carpentry is a proof that wood does not exist.

Certain arts also assume this same doctrine. Medicine is thought to be a

27 Newton, op. cit., Law I, p. 13; 241b24–243a2.

28 A further discussion of the differences between the approach to nature taken in the *Physics* and that used by modern science will be found in Appendix 1, *Method in Aristotelian and Modern Natural Philosophy*.

help to nature, to give to nature the circumstances in which it can do what it is ordered to. Healing is finally the work of the body, not of the doctor. Logic is another art which is radically affected by denying that nature works for some good, for logic is another art which intends to help nature do what it is ordered to, in this case, to know. The considerations of the end found in the *Physics* is presupposed to a proper consideration of logic, medicine, and any other arts which are directed to the achievement of natural ends.

Likewise, the proper understanding of mathematics and of its relation to natural philosophy is necessary to understand what the mathematician is up to and how he should proceed. These are questions dealt with in the *Physics*, Book II, Ch. 2. In fact, a proper understanding of Aristotle's doctrine on the differences between mathematics and physics makes non-Euclidean geometries and their use in physics intelligible. To the extent that the mathematician abstracts quantity from nature, he need not be concerned as to whether the real world is Euclidean or not – he need only look at quantity as abstracted. It may be that quantity as found concretely in the world is not unaffected by weight, temperature, or other non-mathematical aspects of physical reality – at the very least, this is a matter for discussion. Furthermore, the discussion of continuity in Book VI is fundamental to understanding mathematics and the history of mathematics, particularly the trend toward the arithmetization of geometry found in the nineteenth century, e.g., in Dedekind. Also of interest in this way is the discussion of the infinite in Book III.

Moreover, if there is to be any understanding of metaphysics as Aristotle conceived it, or even of Aristotle's conception of metaphysics, it will have to be preceded by a careful study of natural philosophy, especially its first part, the *Physics*. For it is only through considerations such as those in Book VIII (and certain considerations of the *De Anima*, a work which itself presupposes the *Physics*) that we even know there is such a thing as a being which is not material. On the other hand, if only material beings exist, then there is no first philosophy distinct from natural philosophy.[29] And, as Aristotle says, to seek what a thing is not knowing if it is is to seek nothing.[30] It is, moreover, the universal study of motion which is most helpful in understanding non-material being, since we know non-material being largely by way of negation. To say God does not melt is not as informative as to say He is immobile in every way. And if anything can be seen through seeing His immobility, it is reasonable that more will be seen by seeing His complete immobility than through seeing that He does not move in this or that way.

There are, then, many good reasons to study Aristotle's *Physics*.

The *Physics* is divided into eight books. The first chapter of the first book argues that we ought to start with what is most universal in our knowledge and

29 *Metaphysics* VI, 1, 1026a27–32.

30 *Posterior Analytics*, II, 8, 93a16–20; *Metaphysics*, VI, 1, 1025b28–30.

proceed to the more particular from that. (We have already seen that this is not a demonstrative movement, but a movement to the more concrete.) The rest of Book I deals with the principles of change. Aristotle refutes those who would reject all change (Chs. 2–3), proceeds dialectically to determine the principles of change (Chs. 4–6), then determines the truth about the principles of change (Ch. 7), and then finally shows how earlier thinkers went wrong (Chs. 8–9).

In Book II, he determines the definition of nature and how two of the principles of change are called nature (Ch. 1). He then distinguishes mathematics from natural philosophy and shows how they define their terms differently (Ch. 2). Next he reviews the kinds of cause, both *per se* (matter, form, agent, and end) (Ch. 3) and *per accidens* (luck and chance) (Chs. 4–6). He shows that the natural philosopher should use all four *per se* causes in his explanations (Ch. 7). He then shows two things which he presupposed: that nature acts for an end (Ch. 8) and that the necessity found in nature is only, or at least typically, "hypothetical" (Ch. 9). By "hypothetical" necessity, Aristotle indicates the necessity which a means has in regard to an end. For example, a saw is necessary if you are to cut wood, but it is not "absolutely" necessary, since the end, cutting wood, could just as well not be.

Thus, Book I deals with the principles of change, while Book II deals with the principles of the science of nature. For the second book is all ordered to showing the natural philosopher how to proceed, what causes to use, how to define his subject and the species of this subject.[31] After giving these principles, Aristotle goes on to speak about mobile being, first looking to what is intrinsic to mobile being (Books III–VI), then to the relation between mobiles and movers (Books VII–VIII).

Since nature is a principle of motion and rest, and rest is the privation of motion, Aristotle defines motion in Book III (Chs. 1–3) and then deals with the infinite (Chs. 4–8). The infinite is found first in the continuous (through its infinite divisibility) and the continuous is made manifest to us through motion. It is thus intrinsic to motion. Book IV takes up what are in a way measures of motion: place (which is a measure of the mobile) (Chs. 1–5), void (which, according to some men, is a condition for motion and a measure of the mobile – Aristotle disagrees vehemently) (Chs. 6–9), and time (the measure of motion) (Chs. 10–14).

Next, Aristotle divides change in two ways: first according to kinds (Book V) and then according to quantity (Book VI).

In Books VII and VIII he begins to discuss the relation of the mobile to the mover. First, he shows there is always a mover when there is motion (Bk. VII, Ch. 1), and then argues to certain assumptions he has made in that proof (Chs. 2–3). Next, he shows how one can compare one motion with another (relying on a profound discussion of what permits comparability in general) (Ch. 4), and he

31 Cf. Appendix 3, *Principles of Things, Principles of Sciences: The Division of Books One and Two of the* Physics.

enunciates certain laws of motion (Ch. 5). Book VIII constitutes an argument that there is a first mover and that the first mover is not material. Having come to this point, Aristotle abruptly stops. He is paying heed to his own determination, in Book II, that the natural philosopher should not consider those movers that move others without being themselves in motion.

Part II - Translation and Commentary

We have seen, then, what Aristotle is up to in the *Physics*, how it is possible, why it is desirable, and the order in which Aristotle proceeds. In looking at what Aristotle is doing in the *Physics*, I tried to show in outline how his work differs from that of the modern physicists. But the modern reader has two other difficulties to contend with in reading the *Physics*: the problems of commentary and of translation.

The *Physics* is encrusted with commentary, as is often stated and overstated. It is true that the tradition of Aristotelian commentary is centuries old; that does not make it bad. It is also true that much of that commentary is on the wrong track; that is only natural, and one must simply learn to distinguish the good from the bad. Of course, one must always read the text to judge the faithfulness of the commentary, though this is finally more a concern of the historian than of the philosopher. Ignoring all commentaries is not a good policy for the philosopher because the text is too difficult. Still, it is not reasonable to begin one's study with commentaries; we should first read the text and then turn to the commentators when our own powers of comprehension fail. This will not take long.

In fact, we usually find all too soon that we have not even understood well the mode of natural philosophy. We are constantly drawn back to images propounded by modern science and to puzzles posed by modern philosophy. This prevents us from reading the text "from the inside," i.e., with the disposition of those for whom Aristotle presumably wrote: ancient Greek students of philosophy. Simply bearing in mind our susceptibility to this failing is very helpful, but cannot substitute for reading the text as sympathetically as possible for a long while. It is also helpful to go to the great commentators, because they take Aristotle seriously on his own terms. This also helps habituate us to thinking things through from the beginning, starting from common experience, rather than refusing to start at all because of modern paradoxes or sophistries, or starting from modern scientific dogmas. And, of course, their particular claims about particular passages are often invaluable.

Cornell University Press is now publishing translations of the Greek Commentators on Aristotle. Of these, the best is Simplicius, the sixth century neo-Platonist. His analyses of the text, his objections, and his responses are worth reading. We should beware, however, of reading his commentaries with

too much docility. His goal is, it seems, to treat Aristotle fairly, but always with an eye on Plato as the master.[32]

The best commentator is St. Thomas Aquinas, despite the difference in language and the difference in culture. Like Simplicius, St. Thomas is at once a sympathetic and a critical reader; both are willing to say where they think Aristotle is wrong. Thomas is particularly good at laying out the order of the text as a whole and of the parts, and at expanding what are often cryptic remarks into intelligible arguments which befit the general order of the text. He is also helpful for the objections he raises (and usually solves) as well as for pointing out the relations between this work and others.[33]

The inherent difficulties of the text make a good translation all the more necessary. A good translation is one which permits the reader to hear the words of the author and to consider what he thought. The translation, ideally, is transparent. This is not really possible. The words we use to translate have different analogates than the words we are translating, and it is not always clear which group of associated words is appropriate to a given text. For example, there is no English word which has all the related meanings of the Greek word λόγος. There are several good translations, and what is good in one place may be bad in another. But one also wishes the reader to know when the same word is being used, and so one would like to translate one word by one word with perfect consistency; yet this would involve needlessly obscure renderings. It is better to be as consistent as possible given the variety of meanings the word to be translated has, and to avoid obscurity where possible.

On the other hand, a translation which simply intends to let the reader read the author as faithfully as possible should not hide difficult passages. When necessary, it should mirror the difficulty of the original in English.

The translations currently available seem to me to fail in significant ways, though they do have certain virtues. The Apostle translation[34] and the two volumes of the Oxford Clarendon Series[35] are to a certain extent suitable for a close study of the text.

The Clarendon, unfortunately, is not complete, covering only Books I–IV,

32 Cf. Richard Sorabji, *Introduction*, in *Simplicius on Aristotle's* Physics *6*, trans. David Konstan (Ithaca, N.Y.: Cornell University Press, 1989), pp. 4–5.

33 St. Thomas Aquinas, *In Octo Libros Physicorum Aristotelis Expositio*, ed. P.M. Maggiòlo, (Rome: Marietti, 1954). Translated as *Commentary on Aristotle's* Physics, trans. R. Blackwell, R. Spath, and W.E. Thirkel (South Bend, Ind.: Dumb Ox Books, 1999). This translation was originally published by Yale University Press in 1963.

34 *Aristotle's Physics*, trans. by Hippocrates G. Apostle (Grinnell, Ia.: The Peripatetic Press, 1980).

35 Aristotle, *Physics, Books I–II*, trans. Walter Charleton (Oxford: Clarendon Press, 1970); Aristotle, *Physics, Books III–IV*, trans. Edward Hussey (Oxford: Clarendon Press, 1993).

Books I–II being translated by Walter Charleton, Books III–IV by Edward Hussey. It is also problematic in certain ways. For example, Aristotle uses "κίνησις" for those changes which take place between two contrary species (e.g., black and white) and "μεταβολή" for changes between contradictories, i.e., a species and its negation (e.g., black and non-black, or wood and non-wood).[36] In the translation of Books III–IV, Edward Hussey uses "change" for "κίνησις" and "alteration" for "μεταβολή." But the English "change" seems more apt than "motion" to carry the more universal notion of "becoming other," which is common to the two notions (for when anything goes to a contrary species it also goes to a contradictory state); and "alteration" seems too particular to carry the general notion of "μεταβολή." For example, a change of place is not normally called an "alteration." Moreover, Charleton uses "change" for μεταβολή, rendering the translations inconsistent with each other.

Apostle's translation is complete and more consistent, but in some ways less desirable. The difficulties of his translation are of two main sorts. First, and what strikes the reader most immediately, the translation is needlessly obscure. Compare his translation and mine of 190b23–27, a passage from chapter 7 of Book I:

> Now the subject is in number one but in kind two; for a man or gold or matter in general can be numbered, for it is rather this [the subject] which is a *this*, and it is not as from an attribute that the thing in generation comes to be from this, but what is an attribute is the privation or the contrary. (Apostle)

> The underlying is one in number though two in species. For the man and the gold and, generally, the matter is numerable. For it is more a "this something," and what comes to be does not come to be from it accidentally. But the privation and the contrariety is accidental. (Coughlin)

I think it not unfair to say that the second translation is significantly more intelligible, despite the odd expression "this something," which is a literal translation of Aristotle's "τόδε τι."

The second sort of trouble is more difficult to spot but finally more damaging to the translation. In the paragraph just cited, Apostle is less than literal. The last clause, e.g., is literally rendered as I have rendered it. Moreover, the word εἶδος is translated as "in kind" by Apostle, where "in species," again despite an objection against it, that it is a part of a technical jargon, is better. For one thing cannot be two kinds of things, but it can have two "species." "Species" is not just a synonym for "kind," but names the kind as conceived (whence its use in logic), and one can certainly have two conceptions of the same kind of

36 225a7–b5.

thing – as we can conceive of the circle as a certain sort of the figure or as the limit of a series of polygons inscribed in such a figure. The etymologies of the Greek "εἶδος" and the Latin "species" are illuminating here: both words originally indicate the appearance or look of a thing, and so are fittingly used to name the kind as seen by the mind. This aspect of "εἶδος" is captured by the English "species" but not by "kind."

Another example of this sort of difficulty is found in Apostle's translation of "καθ᾽ αὐτό" as "essential" and "essentially." He also uses "by itself" and "in itself," both of which are much better. The expression comes from the preposition "κατά," "down from," and "αὐτό," "itself." The Latin *per se* is a good translation, meaning literally, "through itself" and being opposed to *per accidens*, "through a thing falling in with [what is in question]." The sense is that what is "καθ᾽ αὐτό" is what is not adventitious or incidental. "Essential" carries this sense, but goes beyond it to include the notion of belonging to the very nature of the thing. For example, at 211a17–19 Apostle translates: "Now a thing may be in motion (1) essentially or (2) accidentally." If a thing were in motion essentially, it would necessarily be in motion, for it would be in motion due to what it is. What Aristotle is in fact saying is that a thing may be in motion not because it is in something which is in motion, as color moves when a body moves, but, as a rock is in motion, "through itself" or, as I translate the expression, "in virtue of itself."

In translating the key words ἐνέργεια and ἐντελέχεια. Apostle uses, respectively, "*actuality* or activity" and "actuality." These Greek words are admittedly hard to translate. Sometimes they are used as synonyms[37], at other times they seem distinct.[38] The noun ἐνέργεια is derived from the words ἐν and ἔργον, "in" and "work," and so means something like "the state of being at work or in activity," "a doing"; it has a verbal form, ἐνεργεῖν. ᾽Εντελέχεια, on the other hand, means something like "completion, fulfillment, perfection, full reality," being derived from ἐν, τέλος, and ἔχειν, "in," "the end or goal," and "to have or hold," or even "to be." The first word signifies more the perfection of a thing as proceeding from and inhering in that thing; the latter the perfection as if it were a reality unto itself, i.e., the first word signifies something concrete, the second, something more abstract. The difference is in some ways like the difference between "white" and "whiteness," the adjective being concrete because it implies a subject in which the quality inheres, the noun being abstract because it signifies that very same quality as if it were a substance on its own. But the two Greek words in question are both nouns. The difference between these words is not in their mode of signifying but in what is signified. A sign of this is that there is a verbal form of ἐνέργεια (ἐνεργεῖν), but no verbal form of ἐν-

37 For example, compare 202a7–8 and 251a9 or 193b7 and 195b5.

38 For example, compare the uses of the words at 201a26–29. (It is the verbal form of ἐνέργεια which is used here, i.e., ἐνεργεῖν) Cf. also 201b32 and 257b7.

τελέχεια. This indicates that the former is more involved with the notion of a subject (since verbs signify something as inhering in and proceeding from a subject) than the latter. The formation of the words ἐνέργεια and ἐντελέχεια, even though both have verbal roots, helps explain this. The verbal root of ἐνέργεια is ἔργω, "I work," while the verbal root of ἐντελέχεια is ἔχω, "I have" or "I hold." "To work" implies some result outside the worker, and so the word ἐνέργεια , if used to speak of what is intrinsic to something, will imply some subject from which the work proceeds. Ἔχω, on the other hand, though it is transitive grammatically, is not transitive in its meaning. (Thus, we can say a triangle "has" three sides, but the three sides are really nothing beyond the triangle.) Consequently, ἐντελέχεια can be used in a more abstract way, since its verbal root does not necessarily imply a distinction between the possessor and the possessed.

Now consider the English words "act," "action," "actual," and "actuality." In one meaning of the word "act," at least, it signifies an action, which is also, of course, an actuality. For the word "actuality" means little more than "reality." (The word "actuality" is formed from the adjective "actual," which means "real;" it is opposed to "potential" (δυνατόν). The adverb "actually" is almost if not exactly synonymous with "really.") Thus, the colloquial expressions, "in reality" and "in actuality" do not differ in meaning. But while acts and actions are actualities, because they are realities, not all realities are acts or actions. A rock's lying on the ground is not an action, but it is an actuality. This same difference is found between the words ἐντελέχεια and ἐνέργεια, at least as used by Aristotle. In defining motion, Aristotle uses the word ἐντελέχεια, but later uses the word ἐνέργεια, as if the two were synonymous.[39] In defining the soul, he uses the word ἐντελέχεια.[40] One certainly would agree that motion is an actuality, and that it is close enough to action to receive the same name (For not all actions or doings are motions; e.g., thinking is an action but not a motion, if "motion" is understood strictly). But would anyone wish to call the soul an action?[41] Is it not rather that from which a certain sort of action proceeds? Nevertheless, the kinship between the words is based precisely on the fact that when a thing, whether natural, artificial, or human, is working well it is doing what is perfective of it, and the very operation is a kind of perfection. For example, sawing is the perfection of the saw insofar as the very purpose of a saw is to saw wood. Thus, Aristotle's use of these words mirrors, to some degree, our use of "act" and "actuality."

While Apostle's translation tells the reader, by using italics or regular type,

39 For example, at 251a9–10.

40 *On the Soul* II, 1, 412b4–6.

41 By "soul," Aristotle means, initially, the intrinsic principle of vital operations, whatever it is, whether eternal or not, whether shared in by animals and plants or not. He argues from this notion of soul to the definition of soul. Cf. *On the Soul* II, 1–2, 412a3–414a28.

when the word being translated is ἐνέργεια and when it is ἐντελέχεια, it fails to provide any distinction between the words. I have used "act" for ἐνέργεια and "actuality" for ἐντελέχεια, as these two English words carry the original sense of "a doing" and "fulfillment or completion" and also may be used practically synonymously.

The more recently published translation by Joe Sachs is more consistent and more readable.[42] It suffers, however, from translating key terms in odd ways. For example, ἐντελέχεια is translated as "being-at-work-staying-itself" and ἐνέργεια as "being-at-work." The justification for such curiosities is that Aristotle's vocabulary is in more direct contact with the world of experience than are the Latinate renderings which are most commonly used to translate his work (and which I have used in this translation). While this may be true, it does not follow that one ought to use the translations favored by Mr. Sachs.

Even assuming that we ought not to give any heed to the Latinate tradition of Aristotelian commentary, there are at least two reasons for going the way I have. First, words like "act" and "action," etc., are used by everyone everyday. They are not merely technical jargon. These words are stretched when used to translate Aristotle, but not beyond recognition, as I hope I have shown above. The reader is forced to deal with new shades of meaning and even new meanings for these terms, but he has a common usage of those terms to begin with and to root his speculation. Without such roots, we are bound to end up with a philosophy cut off altogether from experience and reality. The sorts of translations which Mr. Sachs uses, on the other hand, though composed of common words, do not particularly incline the mind to what is in experience or in common speech, especially when the elemental words are united by hyphens so as to form a single word. While it is true that considering the translations of Mr. Sachs can be useful in coming to grips with Aristotle's thought, it seems to me this is so only for those who are already somewhat familiar with that thought and have made a beginning using the sorts of ordinary language which Aristotle himself preferred.

The second objection is that the translations are laden with theory. In the *On the Soul*, for example, Aristotle divides the word "substance" (οὐσία, translated as "thinghood" by Sachs) into three meanings: "form" (μορφή) or "species" (εἶδος), "matter" (ὕλη), and "this something" (τόδε τι), i.e., that which is composed of matter and form.[43] How does he know things *are* composed of matter and form? This he has proven in the *Physics*, where the words he uses are "species" and "form."[44] Nevertheless, without any argument having intervened between the two texts to show the sameness of species and ἐντελέχεια, Aristotle

42 Joe Sachs, *Aristotle's Physics, A Guided Study* (New Brunswick, N.J.: Rutgers University Press, 1998).

43 *On the Soul* II, Ch. 1, 412a6–11.

44 189b30–191a22.

makes the claim, in *On the Soul*, that the species is ἐντελέχεια.[45] It seems, then, to be Aristotle's understanding that the content of the word ἐντελέχεια, at least as understood at this point in the development of natural philosophy, does not go much beyond that of "species" as used in the *Physics* text. But in the *Physics*, the only thing we learn about this form or species is that it is like the "musical" in a "musical man" and that it is whatever combines with the material to make some mobile be the sort of thing it is after a motion. It is whatever makes a new thing new, i.e., it is the term of a motion. The translation "being-at-work-staying-itself" obviously packs much more into the meaning of the word than is warranted at this point. It is possible, though I am not convinced, that the meaning which Sachs attributes to ἐντελέχεια could reasonably be imported from the *Metaphysics*, but even so, that later development would be a result of carefully following out the consequences of the more mundane considerations of natural philosophy. Failure to observe the proper order of the development of natural (and other) philosophy is, it seems to me, largely responsible for the degeneration of the Aristotelian tradition into sterile formulae. Thus, the Sachs translation runs the risk of doing just what Mr. Sachs accuses the scholastics of having done: reducing Aristotle's concrete and simple language to a technical jargon.

As with the Apostle translation, I think that setting translations of some texts side by side will show why the Sachs leaves something to be desired. Here are the translations of 201a27–29:

> . . . the being-at-work-staying-itself of what is potentially, whenever, being fully at work, it is at work not as itself but just as movable, is motion. (Sachs)
>
> the [actuality] of what exists in potency, when the being which is in actuality is in act as mobile, either according to itself or according to another, is motion. (Coughlin)

Here are those of 194b24–27:

> One way cause is meant, then, is that out of which something comes into being. . . . In another way it is the form or pattern, and this is the gathering in speech of the what-it-is-for-it-to-be . . . (Sachs)
>
> In one way, then, cause is said as that from which, being present in it, something comes to be. . . . In another way, [cause is said as] the species and the pattern; this is the account of the "what it was to be" . . . (Coughlin)

Other complete translations have their own difficulties. The Oxford translation by Hardie and Gaye,[46] for example, adds "only" to the sentence "the student

45 412a10.

46 *Physica*, in *The Complete Works of Aristotle Translated into English*, Vol. II (Oxford: Oxford at the Clarendon Press, 1930).

of nature is concerned only with things whose forms are separable indeed, but do not exist apart from matter."[47] This is to interpret the text, not to translate it; in doing so, moreover, Hardie and Gaye have resolved a long-running debate about Aristotle's view of the status of the mind of man after death. In discussing how things are in time, Aristotle says "the being (τὸ εἶναι) of it (motion) and it itself are measured by time."[48] Hardie and Gaye have this as "both it (motion) and its essence are measured by time." How can what a thing is, the essence of a thing, be measured by time? What Aristotle is saying is simply that the duration or being of motion and motion itself are measured by time. Of other things, Aristotle says that their being is measured by time but they are not.[49] Clearly the contrast is between things like horses, the duration or existence of which is measured by time though they are not (they are measured in "hands" or "feet"), and motions, the duration or existence of which are measured by time, as they are themselves. For to measure a motion is to measure (perhaps among other things) the time it takes. To compound difficulties, Hardie and Gaye go on to translate τὸ εἶναι by "being" when Aristotle speaks of measuring things other than motion. The Revised Oxford[50] makes some improvements, but not many: the translations I mention here are left unchanged.[51]

Other translations are more or less paraphrases, and are not suitable for a close study of the text. Let me merely quote the translations of some of the central tenets of Aristotle's *Physics*: "the functioning of what is potential as potential, that is 'being in movement'"[52]; "For this is what time is: *the number of precessions and successions in process*."[53] We find the famous claim that everything moving is moved by another rendered as "Anything involved in a process is necessarily brought into operation by some agency."[54] The translation includ-

47 194b11–12.

48 221a4–5.

49 221a7–9.

50 *Physica* in *The Complete Works of Aristotle, The Revised Oxford Translation*, 2 Volumes, ed. Jonathan Barnes (Princeton, N.J.: Princeton University Press, 1984), pp. 315–446.

51 The translators and the author of the introduction to the English translation of the *Commentary on Aristotle's* Physics (cf. note 33) by St. Thomas Aquinas recommend the translation of Hardie and Gaye (cf. pp. xv, xix). This recommendation was certainly reasonable at the time it was originally made (1963), but I believe that both the Apostle and my own translation work better with that commentary.

52 201a10–11 in *Aristotle's* Physics, trans. Richard Hope (Lincoln, Nebraska: University of Nebraska Press, 1961).

53 219b1–2, ibid. Emphasis in the original.

54 241b34 or 241b24, ibid. There are two versions of Book VII, chs. 1–3. I have translated the second version, given as "textus alterus" in the edition which I have translated, i.e., *Physica*, ed. W.D. Ross (Oxford: Clarendon Press, 1950); the other version

ed in the Loeb Library is even further from the Greek: motion becomes "the progress of the realizing of a potentiality, *qua* potentiality"[55]; time becomes "the calculable measure or dimension of motion with respect to before-and-afterness."[56] Place becomes completely relative: "whatever fixed environing surface we take our reckoning from."[57] In all these cases, we find a translator trying "to put into his own words" what Aristotle said, instead of just telling us what he did say. Sometimes the results are just humorous; other times they are misleading.

I have tried to avoid all these sorts of difficulties not by translating the same word by the same word in every case (this would lead to nonsense statements), but as consistently as possible. Moreover, I have tried to find words which, in English and an English not too far removed from common language, have approximately the same range of uses as the Greek words being translated. There is of course no substitute for reading the text in the original; I have translated this work for those who cannot read Greek easily or at all but still want to study the *Physics* closely.

Part III - Notes on This Edition

The present translation is based, with very minor variation, on *Aristotelis Physica* (in the Oxford Classical Text Series), edited by W.D. Ross.[58] I have made only one rather major change. Book VII of the *Physics* comes down to us in two manuscript traditions, both of which cover the same basic ground in the same basic order. I have used as my principle text what Ross made the "textus alter" (alternative text). My reason is simply that I find the argument in this version to be a little clearer. Lest the reader worry about my acumen, I have included also Ross's primary text as an alternative text at the end of the translation.

Readers who would like to look into the background of the *Physics* would do well to read *Metaphysics* I, 3–10, 983a24–988a17. A basic source book is *The Presocratic Philosophers*, by Kirk, Raven, and Schofield.[59] This, of course, will not help much with post-Socratic philosophers like Plato; the text cited from the *Metaphysics* will give the reader Aristotle's understanding of Plato. The *Timaeus* contains Plato's most extensive physical speculation. Very helpful, too, is Ross'

is presented after the translation of the rest of the *Physics* as "Alternative Text of Book VII, Chs. 1–3."

55 201a10–11 in *The Physics*, 2 volumes, trans. Philip H. Wicksteed and Francis M. Cornford (Cambridge, Mass.: Harvard University Press, 1970).

56 219b1–2, ibid.

57 212a20–21, ibid.

58 W.D. Ross, *Aristotelis Physica* (Oxford: Oxford University Press, 1950).

59 G.S. Kirk, J.E. Raven, and M. Schofield, *The Presocratic Philosophers*, 2nd Ed. (New York: Cambridge University Press, 1983).

Aristotle's Physics, which contains a detailed commentary on both the Greek and on many of the references, some of which are only implicit.[60]

The present translation was undertaken in order to provide a more literal and more "English" version of Aristotle's *Physics* to serious readers. To that end, I have included in the translation itself a minimum of interpretative materials. What is not part of the original Greek is included in square brackets, thus: [. . .]. When I have thought it helpful to include either alternative translations or the original Greek words, I have included these in curved brackets, thus: {. . .}.

The endnotes to each book are found after the translation of that book. These notes are intended to provide either a reference which Aristotle leaves unmentioned or interpretation of some of the more obscure texts. Lengthier discussions of some fundamental points are put into the appendices. These are not intended to address debates among contemporary scholars, but to reflect on some of the reasons Aristotle would hold what he does, especially with an eye to the positions of the modern scientists. Naturally, much more could be said on these topics than is included in this volume; I hope, however, that the reader will find the reflections helpful in seeing what Aristotle is up to and why he holds some of the positions he does. The glossary is intended to indicate how I translated certain key terms, and in some cases why I have translated them as I have. The index provides a way to check what Aristotle has to say in various places about some of the more important issues dealt with in the *Physics*.

I would like to acknowledge the help given me on this work by my colleagues at Thomas Aquinas College in Santa Paula, California, especially Mark Berquist, Ron Richard, John Nieto, Paul O'Reilly, and Tom Kaiser. If I have understood something of Aristotle's thought, the thanks are primarily due to my teachers at Thomas Aquinas College, Mark Berquist, and Tom Dillon, and those at Université Laval in Québec City, Canada, especially Warren Murray and Louis Brunet, and to the many students with whom I have discussed this text. I would also like to thank my sons Ben and Pat and my secretary, Mimi Price, for their help with the typescript. Finally, but by no means least, I would like to thank my wife Maureen for her patience during the time it took to complete this work.

I originally translated this text for the students of Thomas Aquinas College, each of whom is required to spend a year studying the text of the *Physics*. I hope others may also find the work useful.

60 Sir David Ross, *Aristotle's Physics: A Revised Text with Introduction and Commentary* (Oxford: Oxford University Press, 1936). This volume contains much on the background of the *Physics*, the manuscript tradition, as well as the Greek text, an analysis (which sometimes leaves something to be desired), and a commentary on the Greek text and on the references. Sir David and W.D. Ross are one and the same.

Book I

Chapter 1

In every inquiry in which there are principles or causes or elements, 184a9
understanding and science occur from knowing these. For we think
we know each thing when we know the first causes and first princi-
ples and have reached the elements. It is clear, then, that in / natural a15
science as well one must try to determine first what concerns the
principles.

The natural path is to go from the things which are more known
and certain to us toward things which are more certain and more
knowable by nature. For the more known to us and the simply know-
able are not the same. Whence, it is necessary to proceed in this way,
from what is less certain / by nature but more certain to us toward a20
what is more certain and more knowable by nature. But the things
which are first obvious and certain to us are rather confused, and from
these, the elements and principles become known later by dividing
them. Whence, it is necessary to go from the universal to the particu-
lars.

For the whole is more known / according to sensation, and the a25
universal is a certain whole. For the universal embraces many things
within it as parts.

In a way, the same thing happens / in the relation of a name to its 184b9
account. For the name signifies indistinctly some whole, as "circle"
[does], but the definition of this divides into the single parts.

And children at first call all men "fathers" and all women "moth-
ers," but later they distinguish each of them.[1]

Chapter 2

But[2] it is necessary that there be one principle or many, and if one, 184b15
either immobile, as Parmenides and Melissus say, or moving, as the
students of nature say, some saying the first principle is air, some,
water. But if many, either they are finite {limited} or infinite {unlim-
ited}, and if finite but more than one, either two or three or / four or 184b20

some other number; and if infinite, either, as Democritus says, one in kind {genus} but differing in shape or else differing in species or even contraries.

And those who ask how many beings there are are asking a similar question. For they ask whether those first things from which beings exist are one or many, and if many, [whether] finite or infinite;
184b25 / whence, they are asking whether the principle and the element is one or many.

185a1 To look into whether being is one and immobile, then, is not to / look into nature. For just as for the geometer there is no longer an argument with regard to one who denies the principles, but [this job belongs] either to a different science or to one common to all, so neither [with regard] to one who denies the principles [here]. For there is no longer a principle, if there is only one thing and it is one in this way.[3] For a principle is a principle of some thing or things.

a5 Looking into whether being is thus one, then, is similar to discussing any other position upheld for the sake of argument, like the position of Heraclitus, or if someone should say being is one man. Or [it is like] solving a sophistical argument,[4] which the arguments of
a10 both Melissus and Parmenides are. For the arguments of both / grant what is false and are unsyllogistic. Rather, the argument of Melissus is crude and presents no problem, but granting one strange thing the others follow. But this is nothing difficult.

It must be granted by us that either all or some natural things are moving. This is clear from induction. At the same time, however, it is
a15 not fitting to attend to all [difficulties], but / only whichever ones someone draws falsely from the principles; whichever ones are not [such], not. For example, the squaring of the circle through segments is for the geometer to refute,[5] but Antiphon's proof is not for the geometer.[6] But since, though they do not speak about nature, difficulties about nature do still occur from their arguments, perhaps it is
a20 well / to discuss them a little, for the inquiry is philosophical.[7]

But since being is said in many ways,[8] the most proper beginning of all is [to ask] those who say all things are one whether all things are a substance or an amount or a quality[9]; and again, whether one
a25 substance, like one man or one horse or / one soul, or is this being one quality, like white or hot or some other such thing. For all these are very different and all are impossible to say. For if it should be substance and quality and amount, whether these be separated from each other or not,[10] there will be many beings. But if all things are quality
a30 or amount, whether being substance / or not being substance, there is something strange, if one must call an impossibility a strange thing. For none of these are separable except substance. For they are all said

of substance as something underlying.[11] But Melissus says that the being is infinite. So the being is some amount: for the infinite is in [the genus] "amount." But substance or quality or / passion cannot be 185b1
infinite, except, if some amount is together with them, accidentally. For the account of the infinite uses amount, but not substance or quality.[12] If, therefore, it is both substance and amount, being is two and not one. If, however, it is substance alone, / it is not infinite, nor does b5
it have any magnitude at all: for [then] it would be a certain amount.

Moreover, since "one" itself is said in many ways, just as "being" is, one must look into the way in which they say the all is one. What is called one is either the continuous or the indivisible or those of which the account, the "what it was to be,"[13] is one and the same, like "vintage" and "wine."[14] If, therefore, / it is continuous, the one is b10
many: for the continuous is infinitely divisible. (But there is a difficulty about the part and the whole, perhaps not related to this argument but just in itself, [namely,] whether the part and the whole are one or many, and how they are one or many, and if many, how they are many; [the problem pertains] also to the parts of the non-continuous. / And if each part is one with the whole as indivisible from it, b15
they will be [so] with each other as well.)[15]

But indeed, if [one] as indivisible, nothing will be an amount or a quality.[16] Neither, then, is the being infinite, as Melissus says, nor finite, as Parmenides says; for the limit is indivisible, not the finite {limited}.

But indeed, if all / beings are one in account, as "tunic" and "garb20
ment,"[17] then the statement of Heraclitus will be what they too are saying. For it will be the same to be good and to be evil, and to be good and to be not good. Whence, good and not good, and man and horse will be the same. And the argument will not be about beings being one, but about [their being] / nothing. And to be a certain qual- b25
ity and to be a certain amount will be the same.[18]

Even the later of the ancients were troubled that the same thing might turn out for them to be at once one and many. Whence, some did away with "is," as did Lycophron, and some changed speech, [saying] "the man whitened," not "the man is white," or / "walks" instead b30
of "is walking," whence, they would not make the one many by adding the "is," as if "one" and "being" were used in one way. But beings are many either in account (as to be white and to be musical are other, but the same thing is both: so the one is many), or by division, like the whole and the parts. But already / at this [latter] point 186a1
they were at a loss, and confessed that the one is many, as if one and the same thing could not be many, though not opposites. For the one is both in potency and in actuality.[19]

Chapter 3

186a5 Taking things thus, then, it appears impossible that / beings are one.

And the things from which they show [their position] are not hard to solve. For both Melissus and Parmenides syllogize sophistically. For their arguments assume false things and are unsyllogistic, or rather, the argument of Melissus is crude and presents no problem, a10 but granting one strange thing / the others follow. But this is nothing difficult.[20]

That Melissus argues illogically, then, is clear. For he believes that if it be accepted that everything which comes to be has a principle, [then] what does not come to be does not have one.[21] And, next, this is strange, that the beginning of everything is a beginning of the a15 thing and not of the time (and not of / simple coming to be but even of alteration, as change does not come to be in a moment). Again, why is it immobile if it is one? For just as the part which is one, [as] this water, is moved in itself, why not also the whole? Moreover, why would there not be alteration? But indeed, neither is being able to be a20 one in species, except in "that from which."[22] / (In this way even some of the students of nature say it is one, though some do not.)[23] For man is different in species from horse and contraries from each other.[24]

In regard to Parmenides the same way of argument [applies], even if some others are proper to him. And the solution is, in one way, that his premise is false, and in another way, that the argument does not follow.

a25 It is false insofar as he / takes being, which is said in many ways, to be said simply.

It is inconclusive because, if only white things be taken, white signifying one thing, nonetheless, there are many white things, not one. For the white will not be one by continuity nor in account. For to be white and to be receptive of white will be different. And there will a30 not be / anything separate from the white, for the white and that in which it is present are not other insofar as they are separable, but [are other] in being. But Parmenides had not yet seen this.

It is necessary, then, not only to grant that being signifies only one [thing], of which it be predicated, but also [that it signify what is] a35 truly being and what is truly one.[25] For what is accidental / is said of something underlying; whence, that in which being occurs will not be. 186b1 For it will be / other than being. So something not being will be. What is truly being will, then, not be present in another. For being itself will not be if being does not signify many things in a way such that each is some thing.[26] But it is assumed that being signifies one thing.

b5 If, then, what is truly being / is an accident of nothing but the oth-

ers of it, why will "what is truly being" signify being rather than non-being? For if what truly is is the same and white, to be white is not truly being, for being is not able to occur in being, for what is not truly being is no being; so the white is not being, and not so as to be just some non-being, but it is wholly / non-being. So what is truly b10
being is not being. For it is true to say that it is white, but white signified not being. Whence, white, too, signifies what truly is. So being signifies many things.[27]

Neither, therefore, will being have magnitude, if being is what truly is. For the being of the parts is different for each part.

But it is apparent that what truly is is also divided in account into other things / that truly are; for example, if man is what truly is, it is b15
also necessary that animal be what truly is, and also biped. For if they are not things which truly are, they will be accidents. Either, then, [they are] in man or in some other underlying thing. But this is impossible. For that is called an accident which can be present or / not, or b20
else what in its account contains that to which it occurs, as, for example, sitting is a separable [accident], but in the snub there is the account of the nose in which we say snub occurs. Moreover, the account of the whole is not in the account of those which are in the defining account / or from which the latter is, as the account of man b25
in biped or the account of white man in white. If, therefore, these things are this way, and biped is accidental to man, it must itself be separable; whence, man might not be biped, or else the account of man will be in the account of biped. / But this is impossible, for the b30
latter is in the account of the former. But if biped and animal are accidental to another thing, and each is not something which truly is, man also will be one of the accidents of another. But let what truly is be an accident of nothing, and let what is composed from these [predicates] / be said of that of which both and each are said. So is the b35
whole made of indivisibles?

Some, however, gave in to both arguments, to this one, that all 187a1
things are one if being signifies in one way, that non-being is, and to the one from bisection, making magnitudes to be uncuttable.[28]

It is apparent, however, that it is not true that nothing will be non-being, even if being signifies one way and it is not possible that / a a5
contradiction be at the same time. For nothing prevents non-being from being not this being, though it may not be being simply.

It is strange to say, then, that all things will be one if nothing is beside being itself. For who understands being itself except as being something which truly is? But if so, still nothing prevents being from being / many, as was said. It is clear, then, that it is impossible that a10
being be one in this way.

Chapter 4

187a12 As the students of nature say, there are two ways [of generating things from principles]. For some, making being one underlying body, either a certain one of the three[29] or another which is denser than fire but
a15 rarer than / air, generate others, making them many by density and rarity. These latter are contraries, and are, universally, excess and defect, just as Plato claims the Great and the Small are,[30] except that he makes these [two] material and the species one, but the others make the underlying material one and the differences and species the
a20 contraries. / Others, though, segregate the inhering contrarieties from the one, as Anaximander says, and whoever says one and many are, like Empedocles and Anaxagoras. For these thinkers also segregate other things from the mixture. But they differ from each other in this,
a25 that the one[31] makes a cycle of these [changes], / but the other[32] [has the change happening] only once. And the one has infinite like-parted and contrary things,[33] but the other only has the things called elements.[34]

It seems Anaxagoras believed things to be infinite in this way because he accepted as true the common opinion of the students of nature, that nothing comes to be from non-being. For it is because of
a30 this that they say / "all things were together,"[35] and laid down that coming to be was this sort of thing, i.e., alteration, though for some it is collection and separation.[36]

Moreover, he was led to this also because contraries come to be from each other; so they were present.[37] For if it is necessary that all things which come to be either come to be from beings or from non-beings, but one of these is impossible, that coming to be is from non-
a35 being (for all [who speak] about nature / agree with this opinion), they thought the remaining [position] right away happened of necessity, that coming to be is from beings and from things which are present,
187b1 but / from things insensible to us because of the smallness of their bulks. Whence, they say that all things are mixed in all things, because they saw everything coming to be out of everything.

[Anaxagoras says] different things appear different from each other and are named from what is most excessive in multitude in the
b5 mix of infinites. For there is / nothing unmixedly white or black or sweet or flesh or bone, but that of which each thing has more, this seems to be the nature of the thing.

If, then, the infinite as infinite is unknowable, the infinite in regard to multitude or magnitude is a certain unknowable amount, the
b10 infinite in species is a certain unknowable quality. / But, the principles being infinite both according to multitude and according to

species, it is impossible to know the things [which are] from these [principles]. For we believe we know a composite when we know from what and how many it is.

Furthermore, it is necessary that that of which the part can be of any greatness or smallness, can itself be so as well. / (I mean such b15
parts: those into which, being present, the whole is divided.) If, then, it is impossible that an animal or a plant be of any greatness or smallness, it is apparent that neither can any part. For the whole will be so too. But flesh and bone and such things are parts of animal, and fruits of plants. / It is clear, therefore, that it is impossible that flesh or bone b20
or some other part be of any size whatever, either towards greatness or towards smallness.

Moreover, if all such things are present in each other and do not come to be, but, being present, are separated, though a body is named from that of which it has more, and anything comes from anything, as water / is separated from flesh and flesh from water, and any finite b25
body is taken away by [continually subtracting] finite body, it is apparent that each thing cannot be in each thing. For if flesh be carried off from water, and again more flesh be made by separation from the remainder, even if what is taken away be always less, / still it will b30
not exceed in smallness a certain magnitude. Whence, if the separation comes to a stand, not everything will be in everything, for flesh will not be present in the remaining water. But if it does not come to a stand but there is always subtraction, there will be an infinite number of finite equal parts in a finite magnitude. But this is impossible. / In addition, if it is necessary that every body becomes less by sepa- b35
rating something, and the amount of flesh is determined both as to greatness and smallness, it is apparent that no body will be separated from / the least flesh, for [otherwise] there will be something less than 188a1
the least. Moreover, infinite flesh and blood and brain would be already in the infinite bodies, yet separated from each other and nonetheless beings, and each infinite. / But this is unreasonable. a5

That being separated will never be thorough is said unknowingly, but rightly.[38] For passions are inseparable. If, then, colors and habits are mixed, should they be separated, something would be white or healthy and nothing else; nor [would it be said] of a subject. Whence, Mind is strange, seeking impossible things, if it / wishes to a10
separate, but it is impossible to do this, both according to amount and according to quality, according to amount because there is no least amount, according to quality because passions are inseparable.

Nor does he rightly grasp the coming to be of what is similar in species. For in one way, this happens as clay is divided into [pieces of] clay, / but not in another way. And not [always] in the same way; a15

in the same way that bricks come from a house or a house from bricks, water and air are and come to be from each other.

And it is better to take fewer and a finite [number of principles], which Empedocles does.

Chapter 5

188a19 All thinkers, then, make the contraries principles, some saying
a20 the all / is one and not moving (for even Parmenides makes hot and cold principles, though he calls them fire and earth) and some speaking of the rare and the dense. And Democritus speaks of the full and the void, one of which he says is being, the other is non-being. Moreover, [he says things differ] by position, shape, and order. But
a25 these are genera of contraries: up and down, / before and behind are of position; angled, unangled, straight, curved, of shape. It is clear, then, that all thinkers somehow make contraries principles.

And [they say] this reasonably. For the principles must be neither from each other nor from others, and all things must be from them. But these [characteristics] belong to the first contraries[39]: through
a30 being first things, they are / not from others; through being contrary, they are not from each other. But one must also see by argument how this occurs. One must first grasp, then, that, among beings, nothing is naturally apt to make or to suffer any chance thing from any chance thing, nor does anything whatever come to be from anything whatev-
a35 er, unless someone should take things accidentally. / For how would white come from musical, unless the musical also is accidental to not-white or to black? But white does come from not-white, and, of this,
188b1 not from every one, / but from black or one of the colors between, and musical comes from not-musical, though not from every one but from unmusical, or, if there be something between these, [from one of these]. Neither, then, is it corrupted into the first chance thing, as
b5 white is not corrupted into musical, except perhaps / accidentally, but into non-white, and not into any chance one, but into black or what is between, as musical is also corrupted into non-musical in this way, and not into any chance one but into unmusical or, if there be something between these, [into one of these]. This is so also in the other
b10 cases, since things which are not simple among beings but / composite have the same account. But because the opposite dispositions are not named, this fact can escape notice. For it is necessary that all consonant things come to be from dissonant things and the dissonant

from the consonant, and that the consonant be destroyed into the dissonant, and this not into any chance one but into / the opposite. It b15
makes no difference whether we speak about the consonant or the ordered or the composite, for it is apparent that the account is the same. But indeed, a house and a statue and any other [such] thing comes to be in the same way. For the house comes to be from what is not composed but is divided in a certain way, and the statue and something shaped / from the unshaped. And each of these is either an b20
order or a certain composition. If, therefore, this is true, everything which comes to be would come to be, and everything which is destroyed would be destroyed, from contraries or into contraries and the things between these. But the things between are from the contraries, as colors are from white and / black. Whence, all things which b25
come to be by nature either are contraries or are from contraries.

Up to this point, then, most of the other thinkers were close to having followed this argument, as we said before. For they all said that the elements and what they called principles were contraries, even if they put this down without an account, / as if constrained by b30
truth itself.

But they differ from each other by some taking prior things and some posterior, and some things more known according to reason and some [things more known] according to sense. For some put down hot and cold as causes of coming to be, others wet and dry, and others odd and even or / strife and friendship. These differ from each other in the b35
way said.

Whence, in a way, they say the same thing and something different from each other; different as it seems to most men, but the same / 189a1
as analogous. For they take [the contraries] from the same column {line of predication[40]}, for some of their contraries contain but some are contained. In this way, then, they speak similarly and differently, and worse and better, and some [put down principles] better known according to reason, / as was said earlier, and some, according to a5
sense. For the universal is better known according to reason, but the particular according to sense, for reason is of the universal but sense is of the particular. For example, the Great and the Small [are better known] according to reason, the rare and the dense according to sense. It is apparent, then, that the principles / must be contraries. a10

Chapter 6

The next thing would be to say whether [the principles] are two or 189a11

three or more. They cannot be one, because the contraries are not one.[41] Nor can they be infinite, because being would not be understandable; and in every one genus there is one contrariety, and substance is one certain genus; and because [whatever] can be from/ finite [principles] is better from finite things, as Empedocles says, than from infinite things. For he thinks he can render all things which Anaxagoras renders from infinite things. Moreover, some contraries are prior to others, and some come from each other, like sweet and bitter and white and black. But the principles must always / remain. From these [considerations] it is clear that they are neither one nor infinite.

But since they are finite, there is some reason not to make them be only two. For someone would be at a loss as to how either density is naturally apt to do something to rarity or rarity to density. So too for any other of the contrarieties. For friendship does not gather strife / and make something out of it, nor does strife make something out of friendship, but both [work on] some other third thing. Some thinkers even take more than one such thing from which they build up the nature of beings.

Besides these [considerations], moreover, unless someone will assume another nature other than the contraries, he will be at a loss. For we see that the contraries are not the substance of any beings. / But the principle must not be said of something underlying. For there will be a principle of the principle. For the underlying is a principle, and it seems to be prior to the predicate. Moreover, we do not say that substance is contrary to substance. How, then, could substance be from non-substances? Or how could non-substance be prior to substance?[42]

Whence, if someone thinks the / first argument[43] is true and this one[44] too, it is necessary, / if he intends to save them both, to assume some third thing, as those claim who say the all is some one nature, such as water or fire or something between these. But it seems to be rather what is between. For fire and earth and air and water are already / entwined with contrarieties. Whence, those who make the underlying other from these are doing this not without reason. Of the others, some use air, for of the others air has the least sensible differences; and next, water.

But all thinkers shape this one by contraries, by density and rarity, and / by more and less. But these, generally, are clearly excess and defect, as was said before. And this opinion, that the one and excess and defect are the principles of beings, seems an old one, though [it is] not always [held] in the same way. The ancients say the two make and the one suffers, but some / of the later thinkers say rather the con-

trary, that the one makes and the two suffer.[45] By looking at these and other such [considerations], then, there seems to be some reason to say that the elements[46] are three, as we said.

But [that they are] more than three is no longer [reasonable]. For, in regard to suffering, one is adequate. But if, four things existing, / there will be two contrarieties, there will need to be some different b20
middle nature for each separately.[47] And if, being two, the contrarieties can come to be from each other, one of the contrarieties would be superfluous.

At the same time, it is impossible that there be many first contrarieties. For substance is one certain genus of being. Whence, the principles / can differ from each other as prior and posterior alone, but not b25
in genus. For there is always one contrariety in one genus, and all the contrarieties seem to be reduced to one.[48] It is apparent, then, that the element is neither one nor [are there] more than two or three [elements]. But, as we said, which of these is true poses much difficulty.

Chapter 7

So, then, having come to this point, let us speak first about every 189b30
coming to be. For it is according to nature to speak first about common things, and so to consider that which is proper to each thing.[49]

For we say that something comes to be from another and something different from something different either speaking of simple things or of composite things. I mean this thus: man can come to be / musical, non-musical can come to be musical, or / non-musical man b35/190a1
can come to be musical man. So I call what is coming to be, the man and the non-musical, simple; and also what they come to be, the musical, simple. But when we say the non-musical man comes to be a musical man, / both what it comes to be and what is coming to be a5
we call composed.

But of these, in one case it is not only said that this comes to be, but also [that this comes to be] from that, as musical from non-musical. But this is not said in all cases. For musical did not come to be from man, but the man came to be musical.

Of things coming to be in the way in which we say simple things come to be, some come to be while / enduring, but others do not a10
endure. For a man endures when man is coming to be and is musical, but the non-musical and unmusical endure neither simply nor as a composite.[50]

These things being determined, one can grasp from all the cases of coming to be, if he looks into [the matter] as we say, that there must
190a15 / always be something underlying the coming to be. And this is not one in species even if it be one in number. For by "in species" and "in account" I mean the same thing. For it is not the same to be man and to be unmusical.[51]

The one endures but the other does not endure. The one which is not opposite endures, for the man endures, but the non-musical and
a20 the / unmusical do not endure, and neither does what is composed of both, like the unmusical man.

That something comes to be from something, and not that something comes to be something, is rather said of things which do not endure, as the musical comes to be from the unmusical, but not from man. But even so, we sometimes speak of what endures in the same
a25 way. / For we say that the statue comes to be from the bronze, not the bronze [comes to be] the statue. Nevertheless, the one [coming to be] from an unenduring opposite is spoken of in both ways: both this [coming to be] from that and this [coming to be] that. For musical comes to be from the unmusical and the unmusical comes to be musical. Whence, [we speak] in this way of the composite as well, for
a30 musical is said to come to be from unmusical / man and unmusical man is said to come to be musical.

But coming to be is said in many ways. Some things do not come to be but come to be this [sort]; to come to be simply pertains only to substances. In other cases, it is apparent that there must be something
a35 underlying the coming to be. For amount and quality and / relation and when and where come to be in something underlying, because it
190b1 is only substance that is not said of something underlying, / but all the others are said of substance.[52]

But it would become apparent by looking into it that substances and whatever else are simply beings also come to be from something underlying. For there is always what underlies, from which what
b5 comes to be [comes to be], as plants and animals [come to be] / from seed.[53]

Things which come to be simply, however, come to be either by change of shape, like statues from bronze, or by addition, like things which grow, or by subtraction, like the Hermes from the stone, or by composition, like a house, or by alteration, as things which turn [into
b10 something else] due to their material. But it is apparent that / all things which come to be thus come to be from something underlying.[54]

Whence, it is clear from what has been said that everything which comes to be is always composed. And there is something com-

ing to be and there is something which comes to be this, and the latter is twofold: for it is the underlying or the opposite. I say that the unmusical is opposed and the man underlies, and / the unshaped and b15
the unformed and the unordered are the opposite, but the bronze or the stone or the gold is the underlying.[55]

It is then apparent that, if there are causes and principles of things which are by nature,[56] from which things they first are and come to be, not accidentally, but what each is according to its substance, all things / come to be from the underlying and form. For b20
musical man is in some way composed from man and musical. For you resolve the accounts into the accounts of these. It is clear, then, that things which come to be would come to be from these.

The underlying is one in number though two in species. For / the b25
man and the gold and, generally, the material is numerable. For it is more a "this something," and what comes to be does not come to be from it accidentally. But the privation and the contrariety is accidental. And the species is one, such as the order or the musical or some other of the things predicated thus.[57]

Whence, it must be said that, in a way, there are / two principles, b30
but, in a way, three. And they are, in a way, the contraries, as though someone said that the musical and the unmusical or the hot and the cold or the consonant and the dissonant [are principles], but, in a way, not. For it is impossible that the contraries suffer by each other. This also is solved by the other being the underlying. For this is not / a con- b35
trary. Whence, the principles are in some way not more than the contraries, but, so to speak, two in number. They are not, however, in every way two, / because there is a difference in their being, but three; 191a1
for it is different to be man and to be unmusical, or to be unshaped and to be bronze.

It has been said, then, how many principles of natural coming to be there are, and in what way they are so many. And it is clear that something / must underlie the contraries and the contraries must be a5
two. But in another way, this is not necessary. For one of the contraries is sufficient to make the change by its absence and presence.

The underlying nature, however, is scientifically knowable according to proportion {analogy}. For as bronze is to statue or as timber is to bed or as material and the formless before it takes on form is / to whatever else has form, so is this underlying nature to a10
substance and "this something" and a being. This, then, is one principle, though it is not one or being as a "this something" is[58]; and one is the [principle] which is the account; and, moreover, [one principle is] what is contrary to this, the privation. How these are two / and how a15
more has been said above.

First, then, it was said that the contraries alone were principles[59] and later that it is necessary that something else underlie and that there be three principles.[60] From what has now been said it is apparent what the difference between the contraries is, how the principles are related to each other, and what the underlying is. It is not yet clear
191a20 whether the species / or the underlying is the substance.[61] But it is clear that the principles are three and how they are three and in what way they are principles. How many, then, and what the principles are ought to be considered from the foregoing.[62]

Chapter 8

191a23 After these things we should say that the difficulty of the ancients is solved in this way alone.[63] For the first ones who sought the truth and
a25 the nature of things / philosophically went astray, as if they went off on some other path, due to inexperience; and they say that nothing among beings comes to be or is destroyed because it is necessary that the thing coming to be either comes to be from being or from non-
a30 being, but it is impossible that it be from either of these. / For being does not come to be (for it already is) and nothing can come to be from non-being, for something must be underlying. And thus, then, gradually building up this result, they said that there are not many things but only being itself. So those ones held this opinion because of the things [just] said.

a35 We say, however, that the [phrases] / "to come to be from being or from non-being," or "non-being or being does or suffers something
191b1 or comes to be any 'this'," do not differ, / in one way, from the [phrases], "the doctor does or suffers something" or "from the doctor something else is or comes to be." Whence, since this latter is said in two ways, it is clear that "from being" and "being does or suffers" are also [said in two ways]. The doctor builds a house, then, not as doctor but
b5 / as house-builder, and he comes to be fair not as doctor but as dark; but he cures or comes to be a non-doctor as a doctor. Since most properly we say that the doctor does or suffers or comes to be something from doctor when he suffers or does or comes to be these things as doctor, it is clear that "to come to be from non-being" also signi-
b10 fies this, / "as non-being." Not noting this, those thinkers went astray; and because of this ignorance they became so ignorant as to believe that nothing of the others [besides being itself] comes to be or is, but they do away with all coming to be. We ourselves, however, say that

nothing comes to be from non-being simply; nonetheless, somehow there is coming to be from non-being, / as accidentally. For something b15
comes to be from its privation, which is in virtue of itself non-being, not being present [in what comes to be]. But this is wondered at, and it seems impossible that something comes to be in this way, from non-being. So too, neither does being come to be from being, except accidentally. But being does come to be thus, in the same way as if an animal / should come to be from an animal, and some animal from some b20
animal, as if dog came to be from horse. For the dog would come to be not only from some animal, but also from animal, but not as animal. For this is already present. But if something is to come to be an animal not accidentally, it will not be from animal. And if something [is to come to be] a being, it will / not be from being, nor from non- b25
being. For it was said by us what "from non-being" signifies, that it means "as non-being."[64] Moreover, we do not do away with [the claim] that everything either is or is not.[65] This, then, is one way [to solve the difficulty]. (Another is [to note] that the same things can be spoken of according to potency and according to act. But this has been determined with greater precision in other works.)[66] / Whence, b30
as indeed we said, the difficulties due to which the thinkers in question were constrained to do away with some of the things being discussed are solved. For it was due to this difficulty that earlier thinkers were so far led away from the path of coming to be and destruction and, generally, of change. For, this nature[67] having been seen, all their ignorance would have been dissolved.

Chapter 9

Others,[68] too, touched upon this [nature], then, but not sufficiently. 190b35
For, first, they agree, insofar as [they think that] Parmenides speaks rightly, that for something to come to be simply is [to come to be] / from non-being. Further, it appeared to them that if a thing is one in 191a1
number, it is also only one in potency {power}.[69]

But this is very different. For we say that material and privation are different, and that of these, one, the material, / is non-being acci- a5
dentally, but privation is non-being in virtue of itself, and that the one, the material, is close to and somehow is substance, but the other [is substance] in no way.[70]

These thinkers make the Great and the Small[71] alike non-being, whether [taking them] both together or each separately. Whence, this

triad and that one [which we hold] are completely different. For, having come up to here, / that there must be an underlying nature, they
191a10 make this one. For if someone[72] makes it a dyad, calling it the Great and the Small, nonetheless he does the same thing, for he overlooks the other.

For the enduring is a joint cause with the form of things which come to be, like a mother. But the other part of the contrariety[73] might
a15 / often be imagined, if, in thought, one stares at its evil doing, not to be at all. For, there being something divine, good, and desirable,[74] we say the contrary of this exists,[75] and also another[76] exists which by its nature strives for and desires this {what is divine, good, and desirable}.[77] But for these [thinkers],[78] it happens that the contrary desires
a20 / its own destruction.[79] And neither can the species desire itself, because it is not lacking, nor [can] the contrary[80] [desire it], for contraries are destructive of each other. But this [which desires] is material, as the female [desires] the male and the base the noble. Yet it is not in virtue of itself base, but is so accidentally, and it is not in virtue
a25 of itself female, but is so / accidentally.[81]

Material is in a way destroyed and comes to be, but in a way not. For as what is in it, it is destroyed in virtue of itself. For the privation, which is what is destroyed, is in this. But as being according to potency, it is not destroyed in virtue of itself, but it is necessary that it be indestructible and ungenerable. For if it came to be, there must be
a30 some first underlying thing, present in it, / from which [it came to be]: but this is its own nature, whence, it will be before it comes to be. For I call "material" the first thing underlying each thing, present in it, from which something comes to be, not accidentally.[82] And if it is destroyed, it will pass into this in the end, whence, it will have been destroyed before it is destroyed.

It is the work of first philosophy to determine precisely the prin-
a 35 ciple according to species, whether it be / one or many and what it is or what they are.[83] Whence, [the inquiry] should be set aside for the
192b1 right time. / But we shall speak about natural and destructible species in the following expositions. Let it be taken as thus determined by us, then, that there are principles and what they are and how many they are in number. Let us speak again beginning from another beginning {principle}.[84]

Endnotes

1. This chapter constitutes an introduction not only to the work called the *Physics*, but to all Aristotle's natural works. Cf. Appendix 1, *Method in Aristotelian and Modern Natural Philosophy*, for a fuller discussion of this chapter.

2. As background to the rest of Book I, the reader may want to look at *Metaphysics* I, 3–10, 983a24–988a17 and *The Presocratic Philosophers*, 2nd Ed. G.S. Kirk, J.E. Raven, and M. Schofield (New York: Cambridge University Press, 1983).

3. Aristotle is referring to the way in which Parmenides and the other Eleatics thought of being as one. Their view, which forms a substantial part of the background of Book I, was that there only existed one being and that it did not change in any way.

4. Sophistical arguments are those based on fallacious reasoning. The conclusions of such arguments are often known to be false; the job of the philosopher in these cases is therefore to expose the failure of reasoning more so than to refute the conclusion.

5. Cf. Sir Thomas Heath, *A History of Greek Mathematics* 2 Vols. (New York: Dover Publ., 1981), Vol. 1, pp. 183–200. Aristotle's point is that one should refute an erroneous proof if it does not sin against the original basic assumptions of a discipline. He speaks of this in the *Posterior Analytics*, I, 12, 77a36–78a15.

6. Cf. Heath, *op. cit*., pp. 221–23.

7. This is a modest claim; in fact, the resolution of Parmenides' problem is one of the main achievements of the first book of the *Physics*. Cf. 191a23–b34.

8. This is a standard Aristotelian phrase for a word which has many connected meanings. Confusing the meanings of a term is a primary source of sophistical arguments.

9. For the division of beings into the ten "categories" or "predicates," i.e., the ten highest genera, cf. *Categories*, Chs. 4–9. For an analysis of the sufficiency of that division, cf. St. Thomas Aquinas, *In octo libros physicorum Aristotelis expositio* (Rome: Marietti, 1965), Book III, Lectio 5, and the slightly different account in *In duodecimum libros metaphysicorum expositio* (Rome: Marietti, 1950), Book V, Lectio 7.

10. That is, whether they be separated in position or whether the quality, e.g., inheres in a substance.

11. That is, it is impossible that quality or quantity should exist separated from substance or themselves be substances. They are by their nature attributes or "accidents" which inhere in another.

12. That is, since quantity is in the definition of infinite, the infinite is a quantity *per se*, or through being what it is; but quality and substance are not in the definition of the infinite, and therefore it is at most *per accidens* a substance or quality, i.e., what is infinite may also be a substance or have a quality, but it is not due to what it is that the infinite is substance or quality.

13. A standard Aristotelian expression for what we might call whatness or essence or nature (in the sense in which we speak of the "nature" of a triangle).

14. The Greek words here are more perfectly synonymous than "wine" and "vintage."

15. In the face of this parenthetical remark, it is important to see that the Eleatics would not, if they were consistent, admit that a whole can have parts in any sense. If any part is being, they would say, any other part, in whatever sense of other, since it is other than being, must be non-being. But non-being does not exist; therefore, there are no other parts.

16. Not a quantity because quantity is divisible; not a quality because quality inheres in a quantity, e.g., color exists in a surface, temperature in a body.

17. Again, the Greek words are more closely synonymous than my English renderings.

18. Perhaps the argument is as follows. If one is to have one material principle explain all things, as Heraclitus perhaps holds, then that principle (for Heraclitus, fire) will have to be deprived of all the natures it can take on. For example, if fire is to become blood, it cannot *be* blood. But since it is the one principle of *all* things, it will itself have no nature. On the other hand, since there is only one principle, it must be the moving cause as well, and so must have the nature it gives, as man begets man. Then fire must have all natures, since it can beget all things. So fire must be everything and nothing, and must contain all contradictions really within it.

19. Aristotle seems to mean that the "one" can be either actual or only potential. Thus, an undivided line is actually one, but because it is able to be divided into many lines, it is many potentially.

20. These words are a practically a repetition of 185a8–12. Sir David Ross argues that they should be excised from the present text. Cf. *Aristotle's* Physics*: A Revised Text with Introduction and Commentary* (Oxford: Oxford University Press, 1936), pp. 462, 470.

21. Aristotle seems to understand Melissus to have argued that being is eternal as follows: what comes to be has a principle, therefore (this is the *non sequitur*) what does not come to be does not have a principle; what does not have a principle is eternal (here Melissus is equivocating on ἀρχή which means "principle" or "beginning," as does "principio" in Latin); therefore, what does not have a principle is eternal. But being does not have a principle, since the principle must be other than that of which it is a principle, and the only thing which could be other than being is non-being, which does not exist.

22. "That from which" is a standard Aristotelian expression for "material."

23. Certain of the pre-Socratics, referred to by Aristotle as *physiologoi* ("students of nature") because of their concern with coming to be, are contrasted with the Eleatics precisely because the Eleatics did not so much study coming to be as attempt to deny its existence. The students of nature all claim there is some underlying material which is the stuff from which things come to be. For example, Thales says it is water, Heraclitus that it is fire, Empedocles that it is the four elements (earth, water, air, and fire). The first two are also examples of those who say that "that from which" is "one in species."

24. Aristotle is taking it as obvious that being is not one in definition ("account"), since, e.g., horse and man differ in definition. The only way all of nature can be taken as one in account is by looking to the material out of which all things are made – *this*

may be one in account, as many of the pre-Socratics urged. Aristotle will accept this pre-Socratic view, with modifications: the stuff is not itself a thing. (cf.191a12–13)

25. That is, that it signify that being which, according to the Eleatics, is one in every way, since they say that being and one only mean one thing.

26. That is, what is most truly thought to exist, namely substances like horses and men, will not exist if their accidents exist and "that which exists" is one in every way. For the substance and its accidents are different from each other, and if accidents exist, everything else, including substance, will not exist.

27. If anything at all can be said of the "being" of the Eleatics, and if what is predicated of that being is not that being but an accident of that being, then that accident is non-being, because, according to the Eleatics, only the "being" exists. But since that accident can be said of the being, and since the accident is non-being, we can say that being is non-being. The resolution of this sort of problem, says Aristotle, is to be found in a fact overlooked by Parmenides: being is not univocal.

28. Perhaps Aristotle is referring to the Atomists, Leucippus and Democritus, who seem to have thought themselves constrained to hold that "non-being exists as truly as being." (*Metaphysics*, I, 4, 985b7–8) On this view, because they could not escape Parmenides' argument that non-being would exist if motion existed, but held that motion does exist, they posited the real existence of non-being, which they called "the void" or "the non-being"; and because they could not escape his argument that if a magnitude were divisible, there would be differences between the parts, and difference cannot exist unless non-being exists, they held that what is really a being is indivisible.

29. None of the early philosophers made earth the underlying body; "the three" are the other three elements of Empedocles, water, air, and fire. Cf. *Metaphysics* I, 8, 989a5–12.

30. *Metaphysics* I, 6, 987b18–22.

31. Empedocles.

32. Anaxagoras.

33. Anaxagoras, who held that the ultimate materials were infinitely small particles of each sort of homogeneous substance, e.g., earth, skin, or hair.

34. Empedocles, who held that the ultimate materials were the four elements, earth, water, air, and fire.

35. Anaxagoras, Fr. 6.

36. Thus, since they did not wish to assert that anything could come to be from nothing, they thought they could not affirm that any new thing came to be; consequently, they were constrained to say that all change was change of quality (alteration) or of place (collection and separation), but never of substance, or of the thing itself into something else. Akin to this is the position of the Atomists, Leucippus and Democritus.

37. How, e.g., can light skin become dark? Anaxagoras thought the only explanation was that the dark was present already, but hidden.

38. Anaxagoras held that Mind began to separate all things from each other at some time, and that the process would never be completed.

39. By "first contraries," Aristotle means those contraries from which other contraries are derived. For example, those who hold that rare and dense are the fundamental contraries would perhaps say that hot and cold are derived from these.

40. The reference may be to the Pythagorean "columns" or categories. Cf. *Metaphysics* I, 5, 986a22–b1.

41. The previous chapter has shown evidence that the principles are contraries.

42. That is, if contraries are the only principles, then no principle is a substance. But then substance must come from non-substance, or else there must be a contrariety prior even to substance.

43. The argument which concluded that the principles are contraries.

44. The argument which concluded that there must be some principle other than the contraries.

45. The older thinkers, e.g., Anaximenes, held that the one (e.g., air) received the contraries, e.g., rare and dense, and by receiving the contraries made air into this or that, e.g., dense air was perhaps water. Plato later said that "the one," which is form, e.g., the form of air, was received by "the two," which he called "the great and the small" so as to form different parts of air, or perhaps even different kinds under a genus. An example of the latter might be the form of justice being found in the great (the city) and the small (the individual man) in the *Republic*, 368e–369a.

46. "Element" should be taken here to mean whatever enters into the constitution of something. It cannot be understood to mean exclusively material constituents.

47. Perhaps the idea is that each set of contraries will have its own underlying subject, because if they do not, one could presumably derive one set from the other.

48. Cf. *Metaphysics* X, 4, 1055a3–b29.

49. This is in accordance with the order of procedure established in Ch. 1 of this Book.

50. That is, neither unmusical nor unmusical man endure when musical (or musical man) come to be.

51. That is, what underlies the change from unmusical man to musical man is a man, who is the same *one* as the unmusical from which the change begins; nevertheless, to be unmusical is not the same in definition as to be man.

52. Here Aristotle is referring to the ten most generic names listed in the *Categories*. (1b25–2a10) Of those ten names, nine name things which only exist in another thing, e.g., a quality like musical only exists in a subject like man. But the names in the genus "substance" name what are "things" in the fullest sense, things which do not exist by inhering in another, e.g., man, horse, or tree. It is clear, then, that with regard to any changes which are in the nine "accidental" genera there must always be a subject of the change, since these genera name things which cannot exist except in some subject.

53. One might think that the seed is what underlies the change, but this cannot be Aristotle's meaning. The seed is either the unfertilized seed, which no longer exists when the plant or animal comes to be, or it is the fertilized seed, in which case it has already changed what it is. What Aristotle probably means is that there is a "prepared" or "disposed" matter from which the plant or animal comes to be. A seed is a good example of such a disposed matter. If the term from which the change begins and the term to which the change tends had nothing in common, no common material element, there would simply be the annihilation of what was at first and the creation, *ex nihilo*, of what comes next. Whence, if there were *nothing* underlying the change, there could be no explanation of the need for a disposed matter.

54. This argument, like the previous, seems at first to be defective. For we are investigating the generation of substances, and the examples Aristotle gives are, most of them, from "accidental change," i.e., change of the attributes of a substance, e.g., its quality or quantity. And yet Aristotle begins by saying that he is speaking of things which change simply, i.e., of "substantial change." Perhaps, then, it is best to understand the examples not as examples of substantial change, but of ways in which substantial change can occur. Aristotle uses examples from accidental change because they are more manifest to us. Do things change substantially in the ways mentioned? Yes: one can destroy an animal or plant by changing its shape too much; one can change food into an animal by "adding" it to the animal, causing growth; by removing parts of an animal we can destroy it; by composing things, e.g., by putting together egg and sperm, we can generate something new; and we can destroy or generate new things by changing the quality of a substance, e.g., by heating it or electrifying it. Thus, we can induce that the ways in which something can change substantially imply some underlying matter. The difficulty is that the changes named, even if some one of them must be present for every substantial change, are none of them substantial changes, and so one might think that there is no underlying matter common to the two terms of the substantial change (e.g., man and corpse) even if there is one which underlies the alteration or change of shape which precedes the substantial change. Here, however, we may understand Aristotle to be giving an argument akin to the preceding one. For the mere fact that there are *ways* of substantial change (alteration, etc.) implies that what comes before the term at which the substantial change terminates is of some importance to the fact that there *is* a substantial change, and to the fact that it is *this* substantial change. For example, if we combine two volumes of hydrogen with one of oxygen, we get water; but if we combine it with two volumes of oxygen, we get hydrogen peroxide. Thus what comes before the substantial change determines what comes after, and that can only be because there is something in what comes after which is linked with what came before. Again, if this is not so, there would be no reason for determinate means to produce determinate changes, but heating a piece of paper might produce, not ashes, but an elephant or any other chance substance (even a new piece of paper).

55. That is to say, the term from which the change begins is twofold because it is composed of the underlying material and the lack of whatever it is that later comes to be in that underlying material. Thus, musical man comes to be from unmusical man, and the latter is both what underlies the change, man, and what is opposed to what comes to be, e.g., unmusical is opposed to musical.

56. Cf. 184a10–16.

57. That is, the privation is accidental because it does not enter into the composition of the result of the change, and because nothing is really composed out of a negation, which is what a privation is. Consequently, the underlying is more a principle and is more one than the privation; nevertheless, since the privation is joined to the underlying, we can say that the term from which the change begins is both one and many – one in subject, but two in definition. So there is some ambiguity about whether to call the term from which the change begins one or two. The third principle of change (or the second, if we count the two aspects of the term from which as one) is the term to which the change tends, the "form," as Aristotle goes on to say. It is worthy of note that in this context, "form" simply names the term of a physical change.

58. It is often very difficult to bear this in mind. The material which underlies a change of substance, e.g., the change of mass into energy or the death of a man, cannot itself be mass or energy, and yet some such material there must be. It is not a "this something," but only a principle of a "this something" or substance. Because our knowledge of a thing is dependent upon its being real, and this stuff is only a principle of what is real, it can only be known by argument and analogy. Moreover, if it is not itself a thing, it is not "one" the way a thing is. One might compare it to water, which has no shape or form of itself, but cannot be without a shape, and which cannot be considered as one in abstraction from its shape. (Perhaps this is one reason Thales held that the ultimate material of the universe was water.) In some way, similar remarks might be made about the form of a substance, since it too is not so much a thing as a principle of a thing, though a different sort of principle from the material.

59. In Ch. 5.

60. In Ch. 6.

61. In one sense, of course, the substance is neither the matter nor the form, but rather the composite. Still, all three can be called substance by an extension of the term (Cf. *On the Soul* II, 1, 412a3–6), and form or matter may be called substance more properly than the other (cf. 193a9–193b21).

62. At this point, one can see how good is the example which Aristotle used at the beginning of the chapter, i.e., the coming to be of musical man from unmusical man. First, the example leads us to see that we should go beyond the sort of composition (of bodies) which Empedocles advocated. For no one would think of man and musical as two bodies which form musical man by mixing. Secondly, we see that the "elements" in the composition are not as Empedocles thought. For though he does speak of the harmony of the elements, which harmony would be a formal principle of the composition of bone (to use his example), Empedocles does not think of the harmony as a formal principle; rather, he seems to see harmony as accidental to the earth, air, etc., which make things up. The example of musical man leads us to see that we need a new *sort* of principle, a formal one, not just another principle of the old sort. Thirdly, we see that the material of the change is not just any sort of material, but has a determinate potency and is ordered to the form. For a man can become musical because of what a man is, while a tree, e.g., cannot, and to become musical is a sort of perfection for him. Thus, we can begin to see how matter is ordered to form.

63. Aristotle is referring to the Eleatic problem which led Parmenides and his followers to deny all change and difference. It is remarkable that Aristotle makes such a sweeping claim. Cf. Appendix 2, *Matter and the Reality of the Physical World.*

64. A thing does not come to be something new except in some respect in which it is not. A man cannot become a musician if he already is one, nor can an animal become an animal, though it might become a different kind of animal. Further, it is not precisely as non-animal that it becomes an animal, nor precisely as non-musical that a man becomes musical, for then being would come from non-being as such. Since everything which is not true as such must be true through something else, which is obvious, then the question arises: in virtue of what precisely does the thing which changes change? Aristotle has merely argued that it is not in virtue either of the privation nor of some positive form which is shared by both terms of the motion. The *per se* principle of change here is the underlying, though Aristotle does not explicitly say so. This is reasonable because he has rejected as the *per se* principle from which the change begins both of the other two principles he discovered in the previous chapter.

65. Though Aristotle had said above that the problem of the Eleatics is beyond the scope of physics (184b25–185a1), he has here solved it. A more complete solution would require discussions appropriate to metaphysics; it is likely that Aristotle said the problem is beyond physics because a complete resolution (including the discussion of act and potency as such) is beyond physics.

66. Perhaps Aristotle is referring to *Metaphysics* IX, and V, 7, 1017a35–b9.

67. That is, the underlying material, which is, as such, ability or potency.

68. Aristotle seems to be referring to Plato. Cf. *Timaeus*, 48e–52c, esp. 50d–e.

69. The claim appears to be that the Platonists agreed with Parmenides and the Eleatics that if coming to be is real, and not just an illusion, it necessarily starts from pure non-being. For this reason, and because they did see that any change has as a *per se* principle the material, they identified matter with non-being. (Thus, later Aristotle will cite the unwritten teachings of Plato as claiming that place, which many think of as a three-dimensional nothingness, is the same as material. Cf. 209b6–17 and *Timaeus*, 52a–b.) They added, however, a second argument: that if a thing is one "in number," i.e., is one in the way in which we say this line AB is one line, or that dog Fido is one dog, they say it is also one in potency or ability. This is tantamount to saying that a thing only can be what it already is. This position may be thought of as a conclusion from Parmenides' position, since if non-being is a *per se* principle of change and is not at all real, there is no change and everything (or rather, the one being) is really only able to be what is already is.

70. Material is non-being accidentally because the material is not some *thing,* but is not, on the other hand, nothing at all; it is also close to or "somehow" substance because it is one of the two principles of substance, the other being form. Privation, however, is the very absence of something in another, e.g., blindness is a privation because it is the absence of sight from the eye. Thus, privation is non-being in its own nature, and it is substance in no way because it is neither a substance nor a principle of substance.

71. Aristotle here makes it clear that he is referring to the Platonists.

72. Plato.

73. The privation.

74. The form.

75. That is, the privation exists.

76. The material.

77. The form.

78. The Platonists.

79. The material, which Plato says is non-being, desires its own destruction because material desires form, which is the principle of being. This is taken to be an absurdity. Plato's notion of matter conforms to his teaching about the soul, namely, that the body, the material element of man, is opposed to the soul, the formal element. Cf., e.g., *Phaedo*.

80. The privation.

81. The female and the base are thought by Aristotle to be deprived of the perfections characteristic of the male and the noble. The material, being deprived of the form, which is a perfection or good, desires that perfection, expressed here as the male and the noble. The material, however, is only accidentally deprived, that is, it has a privation but is not in its nature a deprivation. Thus, in desiring the form, the material is not desiring its own contrary, but its perfection. Plato, having identified the material with non-being or deprivation, is forced to say, according to Aristotle, that the material desires its own destruction, since it desires form, which is opposed to non-being.

82. "Present in it" excludes the agent cause; "from which it comes to be" excludes the formal cause; and "not accidentally" excludes the privation.

83. The reference may be to *Metaphysics*, Bks. VII–XI and XII, Ch. 7–9.

84. Cf. Appendix 3, *Principles of Things, Principles of Sciences: The Division of Books One and Two of the* Physics, for a discussion of the difference between Book I and Book II.

Book II

Chapter 1

Of things which are, some are by nature and some through other causes. 192b8
The animals and their parts and / the plants and the simple bodies, b10
such as earth, fire, air, and water, are by nature. For we say these and such things are by nature. But all these things clearly differ from things not constituted by nature. For each of these has in itself a principle of motion and standing, some according to place, / some according b15
to growth and diminution, and some according to alteration. A bed and a cloak, however, and anything else of this kind, insofar as they are subject to each predicate [mentioned] and inasmuch as they are from art, do not have any inborn impulse for change at all. But insofar as they happen to be of rock or earth or / a mixture of these, b20
they do have one, and just to that extent, as nature is a certain principle and cause of moving and of resting in that in which it is, primarily, in virtue of itself, and not accidentally.[1]

I say "not accidentally" because someone who is a doctor might become the cause of health for himself. / But still, it is not according b25
as he is healed that he has the art of doctoring, but it just happens that the same one is the doctor and the one being healed. Whence, also these are sometimes separated from each other. So too for each of the other things which are made. For no one of them has the principle of the making in itself, but for some this principle is in others and is from outside, / like a house and each of the other things wrought by b30
hand, but for some, whatever might become causes for themselves accidentally, this principle is in them but not in virtue of themselves. Nature, then, is what was said.

Whatever things have this sort of principle have a nature. And all these are substance. For there is something underlying, and nature is in an underlying.

Both these things and whatever is in them in virtue of themselves b35
are according to nature, as being borne up is in fire. For this is neither / nature nor has a nature, but is by nature and according to nature. 193a1
It has been said, then, what nature is, and what is by nature and what is according to nature.

But to try to show that nature exists is laughable. For it is appar-

193a5 ent that among beings there are many such things. Showing / the manifest through the unmanifest is not being able to discern what is known through itself and what is not known through itself. That it is possible to suffer this is not unclear. For someone blind from birth might syllogize about colors. Whence, it is necessary that, for such people, the argument is about names and is without understanding.[2]

a10 To some it seems that the nature / and substance of beings which are by nature is the first thing present in each, in virtue of itself unorganized, e.g., the nature of a bed is the timber, of the statue, the bronze. Antiphon says a sign of this is that if someone buried a bed in a15 the earth and the rotting stuff took power / to send up a sprout, not a bed, but timber would come to be, as the one, the disposition according to rule and art, belongs accidentally, but the substance is rather that which remains, while continuously suffering these things. And if each of these things suffered this same thing in relation to something else, as bronze and gold in relation to water, bones and timber to a20 earth, and so too / in any of the other cases, that other thing is the nature and substance of them. Whence, some say fire is the nature of beings, some say earth, some air, some water, some some of these, some all of them. For that which, of these, someone assumed to be a25 such, whether one or more, this and so many he said was / substance entire; all other things, however, he said were passions and states {possessions, habits} and dispositions of these. And he said any one of these was eternal, for there is no change from these to the others, but other things come to be and are destroyed times without number. In one way, then, nature is said thus, as the first underlying material a30 in each thing among those having in themselves a / principle of motion and of change.

But in another way, nature is the form and species according to account. For just as "art" is said to be what is according to art and the artistic, so too "nature" is said to be what is according to nature and the natural. We would not yet claim, in the former case, that the bed has a35 anything according to art if it is only a bed potentially and had not / yet the species of a bed, nor that it is "art," and neither would we do so in things constituted by nature. For what is potentially flesh or bone does 193b1 / not yet have its own nature, before it takes on the species according to account, by which, when defining, we say what flesh or bone is; nor is it [yet] by nature. Whence, in another way, nature would be the form and species of things which have in themselves a principle of motion, b5 [which species is] not / separable except according to account. What is from these is not nature, but by nature, e.g., man. And this {form} is more nature than the material. For each thing is named [by its name] when it is in actuality, rather than when it is in potency.

Moreover, man comes to be from man, but not bed from bed. Whence, also, they say that the nature / is not the shape but the tim- b10
ber, because if the bed sprouted, not a bed but timber would come to be. So if this is art, the form also is nature. For man comes to be from man.

Moreover, nature, said as coming to be, is the road to nature. For [nature is] not like doctoring, which is the road to health, not to the art of doctoring. / For it is necessary that doctoring is from the art of b15
doctoring, and does not lead to the art of doctoring. However, nature is not related to nature thus, but what is born, insofar as it is born, goes from something into something. What, then, is born? Not that from which, but that into which. So the form is the nature.

But form and nature are said in two ways. For even the privation is somehow / species. But whether there is a privation and something b20
contrary in simple coming to be or not must be looked into later.[3]

Chapter 2

But since the number of ways in which nature is said has been deter- 193b22
mined, after this one must consider in what the mathematician differs from the student of nature.[4] For natural bodies also have surfaces and solids and lengths / and points, which are what the mathematician b25
looks into.

Moreover, is astronomy other than or a part of natural science? For it would be strange if it is for the student of nature to know what the sun or the moon is, but not [to know] any one of the accidents which are of these in virtue of themselves, both otherwise and because those who speak about nature also clearly speak about the shape of the moon and of the sun, / and about whether the earth and b30
the cosmos are spherical or not.

The mathematician, then, is also concerned with these things, but not as each is a limit of natural body, nor does he consider their accidents insofar as they occur in such beings.

Whence, he also separates [his objects]. For they are separable from motion in thought. And / this makes no difference, nor, separat- b35
ing, do they become false.

But this escapes the notice of those who speak about and make the Ideas. For these thinkers / separate natural things, which are less 194a1
separable than the mathematicals.

And this would become clear if someone tried to say the terms

{definitions} of each, both of these and of their accidents. For the odd and the even and the straight and the curved, and, moreover, number
194a5 / and line and shape will be without motion, but flesh and bone and man are no longer [such], but these latter are like snub nose, not like curved.

The more natural of the mathematical sciences, like optics and harmonics and astronomy, can also make this clear. For these are in a
a10 way the converse of geometry. For / geometry looks into natural lines, but not as natural, but optics looks into mathematical lines, but not as mathematical, but as natural.

But since nature is twofold, being both the species and the material, one must consider nature thus, as if we were looking into "what it is" in the case of snubness: whence, such things are not without
a15 material nor according to / material.

For someone might be at a loss also about this claim, then: since natures are two, with which is the student of nature [concerned]? Or with what is [made] from both? But if with what is [made] from both, also with each: does it belong to the same science, then, or to different ones to know each?

On the one hand, looking into the ancients would make it seem
a20 that the study of nature is about material. / For Empedocles and Democritus only touched upon the species and the "what it was to be" to a slight extent.

If, however, art imitates nature,[5] and it is of the same science to know the species and the material up to a point, as it is for the doctor to know health and bile and phlegm, in which health is, and, so too, it
a25 is for the house-builder to know / the species of house and the material, that it is bricks and timber, and so in other arts, so too, it would be for the student of nature to know both natures.

Moreover, that for the sake of which and the end, and whatever is for the sake of these, are of the same [science]. But nature is an end and that for the sake of which. For of whatever thing, being in con-
a30 tinuous motion, there is an end of the motion, / this extreme is also that for the sake of which. Whence also, the poet laughably went so far as to say "he has the end for the sake of which he was born."[6] For one does not intend every last thing to be an end, but [only] the best [thing]. And since arts make the material, some making it simply and some making it workable, and we use all existing things as if they
a35 were / for our sake (for we are somehow an end, for that for the sake of which is twofold, as was said in the works of philosophy),[7] there
194b1 are two / arts which govern and know material, the one using it and the one directive of the art of making [it usable]. Whence, the one using it is also somehow directive, but the arts differ insofar as one,

the directive, knows the species, but the one [directive] as making knows / the material. For the pilot knows and prescribes what sort the b5
species of the rudder is, but the other artist knows from what sort of timber and from what motions the rudder will be. In things according to art, then, we make the material for the sake of the work, but in natural things it is already present.

Moreover, material is among things relative, for there is a different material for a different species.

To what / extent, then, must the student of nature know the b10
species and the "what it is"? Or [must he not know] as the doctor knows sinew and the smith bronze, up to knowing what each is for the sake of? And he knows about things which are separable in species, but are in material, for man and the sun beget man. It is the work of first philosophy / to determine how and what the separable is. b15

Chapter 3

Having determined these things, one must look into the causes, of 194b16
what sort and how many they are in number. For since our undertaking is for the sake of understanding, and we do not believe that we know each thing before we can grasp the "why" of it (this is / to grasp b20
its first cause), it is clear that this must be done by us with regard to coming to be and destruction and all natural change, whence, knowing the principles of these, we may try to reduce each one of the things sought to these [principles].[8]

In one way, then, cause is said as that from which, being present in it, something comes to be, like the / bronze of the statue and the sil- b25
ver of the bowl and the genera of these. In another way, [cause is said as] the species and the pattern; this is the account of the "what it was to be" and the genera of this (as of the octave, [the ratio] two to one, and, generally, number) and the parts which are in the account. Moreover, that whence is the / first beginning of change or of rest [is b30
called a cause], as the counselor is a cause, and the father of the child, and generally, the one making of the one made and the one changing of the one being changed. Moreover, [cause is said] as the end. This is that for the sake of which, as health is [the cause] of walking. For why does he walk? "That he might be healthy," we say and, speaking thus, / believe we have given the cause. And also, then, when another b35
thing moves, whatever things come to be between the mover and the end, as thinning, / purging, drugs, and tools are means for health. For 195a1

all these are for the sake of the end. But they differ from each other as being operations or tools. Perhaps, then, "cause" is said in so many ways.

195a5 Things being called causes in many ways, it happens that / many things are the cause of the same thing, not accidentally, as both the art of sculpture and the bronze are causes of the statue, not as something else, but as statue. But they are not causes in the same way, but one as material, the other as that whence is the motion. Some things are a10 causes of each other, as exercise of well-being and well-being / of exercise, though not in the same way, but the one as end, the other as beginning of motion. Moreover, the same thing [is cause] of contraries. For what is a cause of this by its presence, we sometimes blame for the contrary of this by its absence, as the absence of the pilot is the cause of the shipwreck, the presence of whom was the cause of the ship's safety.

a15 All the causes just mentioned fall into four most apparent types. For the letters of syllables, the material of artifacts, fire and such things of bodies, the parts of a whole, and the suppositions of conclusions, are causes as that from which. Of these [things mentioned], a20 some are [causes] as / underlying, like the parts; some as the "what it was to be," like the whole and the composition and the species; the sperm, the doctor, the counselor, and, generally, the maker, are all [causes as] that whence is the beginning {principle} of change or standing or motion; some are [causes] as the end and good of others. a25 For one intends that for the sake of which to be the best / and end of the others. (Let it make no difference to say the good itself or the apparent good.) These, then, are the causes and they are so many in species.

The modes of causes are many in number, but, being brought under headings, they are fewer. For cause is said in many ways, and / a30 those of one kind are prior and posterior the one to the other, as the doctor or the artist is the cause of health, and the ratio two to one or number is the cause of the octave, and, always, the containing things in relation to the particular things.

Moreover, the accidental and their genera, as Polycleitus is the cause of the statue in one way, but the sculptor is the cause in anoth- a35 er way; because to be Polycleitus / happens to the sculptor. And what contains the accident [are causes], e.g., if man be the cause of a stat- 195b1 ue, or, / generally, animal. And there are among accidental causes some further and some closer than others, as if white or musical were said to be the cause of the statue.

All, however, both those properly called [causes] and those called b5 so accidentally, are said some / as being potential and some as being

in act, as [the cause] of the house being built is the builder or the builder building. And those of which the causes are the causes will be spoken of in a way similar to the things said. For example, [a cause is said to be the cause] of this statue, or of statue, or of image generally; and of this bronze or of bronze or of material generally. And so too of the accidentals.

Moreover, both the latter and the former will be spoken of as b10
intertwined; for example, not Polycleitus or sculptor, but the sculptor Polycleitus.

But nevertheless, all these are six in number, being said in two ways. For the cause is spoken of as particular, or as a genus; as an accident, or as the / genus of an accident; as these things intertwined b15
or simply. And all are either things acting or are according to potency.

Actual and potential causes differ this much: the ones in act and particular are and are not at the same time as that of which they are the causes, as this one who is curing with this one who is being cured and this one who is building / with this which is being built. But the b20
ones in potency are not always so. For the house builder and the house are not destroyed at the same time.

One must always seek the ultimate {most precise} cause of each thing, just as in other things. For example, man builds because he is a house-builder, and he is a house-builder according to the art of house-building: this, then, is the prior / cause. And so in all cases. b25

Moreover, the genera are [causes] of the genera and the particulars of the particulars, as sculptor of statue, and this [sculptor] of this [statue]; and those in potency are of those in potency, but those in act look to those in act. Let this, then, be for us a sufficient determination of the number and modes of the causes.

Chapter 4

Luck {τύχη} and chance {αὐτόματον} are also said to be among the 195b31
causes, and many things both are and come to be through luck and through chance. One must, then, look into the way in which luck and chance are in these causes, and whether / luck and chance are the b35
same or different, and, generally, what luck and chance are.

For some are at a loss even as to whether these things exist or not. / For they say, then, that nothing comes to be by luck, but there is 196a1
some definite cause for everything which we say comes to be by

chance or luck. For example, of going into the market place by luck, and meeting someone one wished but did not hope [to meet], the
196a5 cause is wishing / to go and buy. The case is similar, too, in the other things said to be by luck: there is always something which we can take as a cause, but not luck.

And someone would be at a loss as to why it is that none of the ancient wise men who spoke about the causes of coming to be and
a10 destruction / determined anything about luck, since, indeed, this situation would seem strange, if luck existed, as it truly is strange. But it seems those thinkers, too, thought that nothing was by luck.

But this too is to be wondered at. For many things both come to be and are by luck and by chance, though no one is ignorant of the
a15 fact that they can be brought back to some cause / of coming to be, as said the ancient argument which did away with luck. Nevertheless, everyone says that some of these things are by luck and some are not by luck. Whence, it was up to these thinkers to have made mention of luck in some way or other. But indeed, none of these thinkers thought luck was something, like friendship, strife, mind, fire, or one of the /
a20 other such things.

The situation is strange, then, whether they assumed luck does not exist or, believing it does, omitted mention of it, though they sometimes used it, as Empedocles says that the air is not always gathered in the upper region, but as it may chance. For, indeed, he says in his cosmology that, "So it ran together at that place then, but often otherwise."[9] And he says that most of the parts of animals came to be by luck.

a25 There are some / who say chance is the cause of this heaven and of everything in the cosmos. For they say that the vortex and the motion which distinguished and arranged the all into this order comes to be from chance.

But this [claim] is very worthy of wonder. For, saying that ani-
a30 mals and plants / do not exist or come to be by luck, but that the cause of these things is either nature or mind or some other such thing (for not just any chance thing comes to be from the seed of each thing, but an olive comes from this sort and a man from that sort), they say that the heaven and the most divine of visible things comes to be by
a35 chance, but there is / no cause of this sort for animals and plants. And yet, if this is the way things are, this is itself worthy of being dwelt
196b1 upon, and something / might well be said about it.

For, besides the fact that what is said is strange in other ways, saying these things is still stranger, as we see nothing in the heaven coming to be by chance, but in the things which [they say] do not come to be by luck we see many things occurring by luck, whereas it
b5 is fitting that / the opposite come to be.

There are some to whom luck seems to be a cause, yet unclear to human thought, as being something divine and rather godlike. Whence, one must look into what each is, and whether chance and luck are the same or different, and how they fall among the causes determined.[10]

Chapter 5

First, then, since we see that some things always come to be in the same way, but some do so for the most part, it is apparent that luck is called the cause of neither of these; nor are these by luck, either what is by necessity and always, or what is for the most part. But since there are things which come to be besides these and everyone says these are by / luck, it is apparent that luck and chance are something. For we know that such things are by luck and that things which are by luck are such things. 196b10 b15

Of things which come to be, some come to be for the sake of something and some do not. Of the former, some [come to be] according to choice, and some not according to choice; but both sorts are among those which are for the sake of something. Whence, it is clear that, even / in those which are beyond the necessary and what is for the most part, there are some about which "that for the sake of which" can be present. Whatever could be done by thought or by nature is for the sake of something. b20

Such things, then, when they come to be accidentally, we say are by luck. For just as what is exists either in virtue of itself / or accidentally, so also can it be a cause. For example, the art of house-building is the cause of the house in virtue of itself, but accidentally, white or musical is. What is a cause in virtue of itself, then, is determinate, but what is so accidentally is indeterminate, for infinite things may happen to be in one thing. b25

As was said, then, when this comes to be among things / which are for the sake of something, then it is said to be by chance and by luck. The difference between these must be determined later. But now let this be apparent, that both are among things which are for the sake of something. For example, a man caring for a common fund would have gone [to a certain place] for the sake of getting silver, if he had known. But he did not go there for / the sake of this; it happened to him to go and to do this for the sake of getting the money. [He did] this, however, neither going to / the spot for the most part nor by b30 b35 197a1

necessity. The end, collecting the money, is not among the causes in him but is among things which are chosen and are by thought. And then he is said to have gone by luck; but if he had chosen and gone for the sake of this, or if he always or for the most part went there to
197a5 collect money, [he would] / not [be said to have gone] by luck.[11]

So it is clear that luck is an accidental cause in things which are for the lesser part, for the sake of something, [and] according to choice. Whence, thought and luck concern the same thing. For choice is not without thought.

It is necessary, then, that those causes from which something comes to be by luck are indefinite. Whence also, luck seems to be
a10 indefinite / and unclear to man.[12]

And it is thus that nothing seems to come to be by luck.[13] For all these things are said rightly, because reasonably. For there are things which come to be by luck, for they come to be accidentally, and luck is an accidental cause. But simply it is a cause of nothing.[14] For exam-
a15 ple, the house-builder is the cause for the house, / but accidentally, a flute-player is; and of going to get the silver, when he did not go for sake of this, the causes are infinite in multitude. For he may be wishing to see someone, or be pursuing someone, or fleeing someone, or going to see a spectacle.

And saying that luck is something beside reason is right. For rea-
a20 son is of what is always or of what is for the most part, but / luck is in things coming to be beyond these. Whence, since causes of this sort are indefinite, luck also is indefinite.

Nevertheless, about some cases someone might be at a loss: whether, then, any chance things can come to be causes of luck? For example, the cause of health is fresh air or heat from the sun, but not
a25 getting a haircut. For, / among accidental causes, one may be closer than another.

Luck is called "good" when something good comes out, "bad" when something bad comes out. "Good fortune" and "bad fortune" occur when these [results] have magnitude. Whence also, to miss getting a great evil or good by only a little is either "to be fortunate" or "to be unfortunate," because thought says [the expected effect] belongs.
a30 For / the little by which the result is missed seems to be nothing.

Moreover, that good fortune is uncertain is reasonable. For luck is uncertain. For none of the things which are by luck can be always or for the most part.

As was said, then, they are both causes accidentally, both luck
a35 and chance, in those which happen to come to be neither simply / nor for the most part, and of those among these [sorts of things] which would come to be for the sake of something.

Chapter 6

They differ because chance is in more. For everything by luck is by 197a36
chance, but not all the latter are / by luck. For luck and what is by luck 197b1
are in those to which being fortunate and, generally, action can belong. Whence, it is also necessary that luck concerns the practical. A sign of this is that good fortune seems to be either the same as happiness or close to it, and / happiness is a certain action, for it is doing b5
well. Whence, what cannot act cannot do anything by luck.

And because of this fact neither the unsouled nor a beast nor a child does anything by luck, because they do not have choice.[15] Neither good fortune nor bad fortune belongs to them, except according to a similarity, as / Protarchus said the stones from which the b10
altars [are built] are fortunate, because they may be honored, but their fellows are trampled under foot. But suffering something by luck belongs somehow even to these, when the one doing something with them acts by luck; but not otherwise.

But chance is in the other animals and in many unsouled things. / For example, we say the horse came by chance, because, coming, it b15
was saved, but it did not come for the sake of being saved. And the tripod fell by chance, for it stood for the sake of being sat upon, but did not fall for the sake of being sat upon.

Whence, it is apparent that in things which come to be for the sake of something simply, when things whose cause is outside come to be / not for the sake of what happens, then we say [they come to b20
be] by chance. But, of these, we say that whatever choosables come to be by chance in those which have choice, come to be by luck.

A sign of this fact is the expression "in vain" {τὸ μάτην} because this is said when that for the sake of which another is does not come to be for the sake of that. For example, if taking a walk is for the sake of evacuation of the bowels, and if this does not come to be in the one walking, / we say he walked "in vain" and the walking was "in vain," b25
as if what is in vain is what is by nature for the sake of another when it does not carry through to the end what it was for the sake of and was naturally apt [to carry through to the end], since it would be laughable if someone said his bathing was in vain because the sun was not eclipsed. For this is not for the sake of that. Thus, then, chance {αὐτόματον}, even according to its name, occurs when something / comes to be vain in itself {αὐτὸ μάτην}. For the rock fell not for the b30
sake of striking; so the rock fell by chance, because it might have fallen through someone's doing and for the sake of striking.

Chance is most separated from what is by luck in things which come to be by nature. For when something comes to be against nature,

197b35 we do not say that it is by luck / but rather that it is by chance. And this too is another thing: for the cause of the one is outside, but of the
198a1 other, inside. / What chance is, then, and what luck is, and in what they differ from each other, has been said.

Of the types of cause, each of these is among those whence is the beginning {principle} of motion. For they are always causes of what
a5 is something by nature or of what is by thought. But / their multitude is indeterminate.

Since chance and luck are causes of that of which either mind or nature would come to be a cause, when something comes to be a cause of these very things accidentally, and nothing accidental is prior to what is in virtue of itself, and it is clear that no accidental cause is
a10 prior to a cause in virtue of itself; so / chance and luck are posterior to mind and nature. Whence, if it is true that the cause of the heaven is mostly chance, it is necessary that mind and nature is the prior cause both of many other things and of the all.[16]

Chapter 7

198a14 It is clear that there are causes and that the number of them is what /
a15 we say. For the "why" enfolded so many in number. For "why" is ultimately reduced to the "what it is" in immobile things, for example, in mathematicals. For each one is reduced ultimately to the "what it is" of the straight or the commensurable or something else. Or else [it is reduced] to the first mover. For example, "Why did they start the
a20 war?" "Because there had been a raid." / Or else "for the sake of what?" "That they might rule." Or else, in things which come to be, [the "why" is reduced to] material. It is apparent, then, that the causes are these and so many.[17]

Since there are four causes, it is for the student of nature to know about all [of them], and, reducing the "why" to all, the material, the species, the mover, and that for the sake of which, he will render [an account] according to the mode of natural science.

a25 Three of these often come / together in one. For the "what it is" and "that for the sake of which" are one, and that first thing whence is the motion is the same as these in species. For man generates man.

And generally, whatever things move by being moved, [pertain to natural science] and whatever are not such no longer pertain to natural science. For such things move [others], not by having in themselves motion or a principle of motion, but being immobile. Whence,

there are three / studies, one about immobile things, one about things a30
which move but are indestructible, and one about destructible things.[18]

Whence, the "why" is rendered by reducing to the material and to the "what it is" and to the first mover.

For men mostly look into the causes of coming to be in the following way: what comes to be after what? And what / first made or a35
what suffered? And so on in this way. The principles of moving in a natural way are two, of which one is not natural, / for it does not have 198b1
a principle of motion in itself. Something is such if, not being moved, it moves, as what is wholly immobile and the first of all things, and the "what it is" and the form. For this is the end and that for the sake of which.[19] Whence, since nature is for the sake of something, / one b5
must know this also.[20]

And one must render the "why" in all ways, as that from this, this is necessary ("from this" either simply or for the most part); and if this is going to be, that [other thing] will be, just as from the premises the conclusion [follows], and that this was the "what it was to be"; and because it is better thus, not simply, but in relation to each substance.[21]

Chapter 8

First, then, one must say why nature is among causes which are for 198b10
the sake of something, next, about the necessary, how it is in natural things.[22] For all thinkers reduce to this cause, [saying] that, since the hot and the cold and each such thing are by nature of a certain sort, these other things are and come to be by necessity. For even if / they b15
speak of another cause, one mentioning Love and Strife,[23] another Mind,[24] they touch upon it and bid it good-bye.

But there is a difficulty: what prevents nature from acting not for the sake of something nor because it is better so, but as Zeus sends the rain,[25] not so the grain might grow, but by necessity? For what rises must cool, and the cooled, / coming to be water, must fall down. But, b20
when this comes to be, growth occurs in the grain. So too, if the grain on the threshing-floor is destroyed by this, it did not rain for the sake of this, that it might be destroyed, but this just happened. So what prevents the parts in what is by nature from being like this, for example, teeth arising by necessity, / the front ones sharp and fitted for cutting, b25
the molars flat and useful for grinding food, since they did not come

to be for the sake of this, but they just fell together [like this]? And so too in the cases of the other parts in those in which that for the sake of which seems to belong. Wherever, then, everything came together
198b30 / as if it came to be for the sake of something, these were saved, being suitably constituted by chance. But whatever was not of this sort was destroyed and is destroyed, as Empedocles says man-faced ox-progeny was.[26] This, then, and any other of this sort, is the argument due to which someone might be at a loss.[27]

b35 But it is impossible that this is the way things are. / For these and all things which are by nature come to be in a certain way either always or for the most part, but none of the things which are by luck
199a1 and chance do this. / For to rain much during winter does not seem to be by luck or by a coincidence, but during the dog-days; nor for there to be burning heat during the dog-days, but if during the winter. If, then, these things seem to be either by coincidence or for the sake of
a5 something, and if these things are not able to be / by coincidence nor by chance, they must be for the sake of something. But indeed, all such things are by nature, as even those saying these things admit. So there is "that for the sake of which" in things which are and which come to be by nature.

Moreover, in things in which there is an end, the prior and successive things are done for the sake of this. As a thing acts, therefore,
a10 / so is it naturally apt [to act]; and as it is naturally apt [to act], so each thing acts, unless something impedes it. But it acts for the sake of something, so it is also naturally apt to act for the sake of something. For example, if a house were among the things which come to be by nature, it would come to be as it does now by art. If, on the other hand, things which come to be by nature could come to be not only by nature but also by art, they would come to be in the way in which as
a15 they are / naturally apt to. So one thing is for the sake of another.

And, generally, art carries to an end some things which nature cannot work out,[28] and imitates others. If, then, things which are according to art are for the sake of something, it is clear that things according to nature are too. For the posterior is to the prior in a similar way in what is according to art and in what is according to nature.

a20 / But this is most apparent in the other animals, which act neither by art, nor by inquiring, nor by deliberating. Whence, some people are at a loss as to whether spiders and ants and such things work by mind or by something else. Going along according to small steps, it is
a25 apparent even in plants that what is brought together comes to be / for the end, as the leaves are for the sake of shading the fruit. Whence, if the swallow makes its nest and the spider its web by nature and for the

sake of something, and plants their leaves for the sake of the fruit and the roots go not up but down for the sake of food, it is apparent that / this sort of cause is in things which come to be and are by nature. a30

And since nature is twofold, being, on the one hand, material and, on the other, form, the end being the latter, and other things being for the sake of the end, this will be the cause "that for the sake of which."[29]

Mistakes come to be even in things which are according to art, for the grammarian may not write correctly and the doctor / may not a35 pour the drug correctly. Whence, it is clear that mistakes can happen even in things which are / according to nature. If, then, there are some 199b1 things which are according to art, in which what is done rightly is for the sake of something, but in those which are done mistakenly, one sets to work for the sake of something, but it is missed, the case can be similar in natural things, and monsters are mistakes of that which is for the sake of something.[30] / So in the things constituted from the b5 beginning, the "ox-progeny,"[31] if they were not able to arrive at some term and end, came to be by some principle being spoiled, as now happens when seed is spoiled. Moreover, it is necessary that the seed come to be first, but not right away the animals, and the "first undifferentiated things"[32] were seeds.[33] Moreover, even in / plants that for b10 the sake of which exists, though less articulated. Did, then, even in plants, "olive-headed vine-progeny" come to be, just as "man-faced ox-progeny," or not? For that would be strange. But it must have been so, if this happened among animals. Moreover, even among seeds, whatever chanced must have come to be.

The one who speaks thus / wholly does away both with the things b15 which are by nature and with nature.[34] For those things are by nature which, continuously being moved from some principle in themselves, reach some end. But the same end is not reached from each principle in each case, nor any chance end: rather, each thing always reaches the same end, unless something impedes it. But that for the sake of which and what is for the sake of this can come to be by luck, / as we b20 say that the stranger came by luck, and, having freed the captive, went away, when, coming, he acted as if for the sake of this, though he did not come for the sake of this. And this is accidental, for luck is among accidental causes, as we said earlier. But when this comes to be always or for the most part, / it is not accidental nor by luck. Yet in b25 natural things it is always thus, unless something impedes it.

It is strange not to believe that something comes to be for the sake of something if the mover is not seen deliberating. For even art does not deliberate. If the ship-building art were in the timber, it

199b30 would act by nature in the same way. Whence, / if that for the sake of which is in art, it is also in nature. This is most clear when someone cures himself. For nature is like this.[35]

It is apparent, then, that nature is a cause, and in such a way that it acts for the sake of something.

Chapter 9

199b35 But is what is by necessity necessary by hypothesis or / also simply?[36]
200a1 For now people believe that what is by necessity is / in the coming to be, as if someone were to think that a wall came to be by necessity because heavy things are naturally apt to be carried down but light things up, whence the stones and the foundation are below, but the
a5 earth, because of its lightness, is above, and the / timber is furthest up. For it is lightest.[37]

But, although it did not come to be without these things, it did not come to be through these things, except as through material, but it came to be for the sake of sheltering and guarding some things. So too in all other things in which that for the sake of which exists: these do not come to be without what have a necessary nature, yet they do not
a10 come to be through these latter, except as / material, but for the sake of something. For example, why is a saw such? That this may be and for the sake of this. Still, it would be impossible that "that for the sake of which" come to be were the saw not of iron. So it is necessary, if there is to be a saw and its work, that the saw be of iron. What is necessary, then, is so by hypothesis, but not as an end. For necessity is in
a15 the material, but that for the sake of which is / in the account.[38]

The necessity in mathematics and the necessity in what comes to be according to nature are in a certain way close together. For since the straight is this, it is necessary that the triangle has angles equal to two rights. But [it does] not [follow that] since the latter is, the former is; but if the latter is not, neither is the straight [what it was said to be]. In things which come to be for the sake of something, the reverse is
a20 the case: / if the end will be or is, what is before it will be or is; but if not, just as there, if the conclusion is not, the principle will not be, so here the end and that for the sake of which [will not be]. For this is itself a principle, not of the action but of the reasoning (but, in the other case, [the principle is the principle] of the reasoning [only]; for there are no actions). Whence, if a house will be, it is necessary that
a25 / these things come to be or are; or, generally, that the material which

is for the sake of something exists, e.g., the bricks and stones, if a house will be. Still, the end is not through these except as material, nor will it be through these. Nevertheless, generally, neither the house nor the saw will be, if these are not (the house if stones are not, the saw if iron is not). For neither, in the other case, are / the principles, a30
if the triangle does not have angles equal to two rights. It is apparent, then, that what is said to be as material and the motions of this are the necessary in natural things. And both these causes must be stated by the student of nature, but more so that for the sake of which. For this is the cause of the material, but not the latter of the end.

And the end is that for the sake of which, and the / beginning is a35
from the definition and the account; just as in things according to / art, since the house is such, these things must come to be and exist by 200b1
necessity, and since health is such, these things must come to be by necessity and exist. So too, if man is this, these things must be, and if the latter [exist], these others [must be]. Perhaps what is necessary is also in the account. / For, the work of sawing being defined as a sort b5
of division, this division will not be if the saw will not have such teeth. But these will not be if the saw is not of iron. For there are also in the account some parts which are as material of the account.[39]

Endnotes

1. It is worth noting that Aristotle uses both "primarily" and "in virtue of itself" (or "per se") in defining nature. "In virtue of itself" is explained in the next few sentences. "Primarily" may be added to indicate that one ought to refer a motion to something of the nature first. For example, one ought to refer the falling of a horse to its nature as composed of weighty things, its getting back up to its being an animal with feet, and its producing young horses to its being a horse. Nature as defined here is the nature of this or that thing, like a horse or a stone, not some generalized idea like "mother nature."

2. The existence of nature, then, is not something to be proved, but something to be granted from experience. The blind man who argues about colors is an example of someone who does not know what is better known, in this case, the fact that colors exist and are what we see, and so speaks of it from what is less known, the definition of color, for example. If the existence of nature is merely a matter of experience, then no one would fail to know that it exists, but one might think something else is better known and try to show the existence of nature from that.

3. Cf. 224b35–225b11. It seems that the issue in question is whether, in simple coming to be, i.e., substantial change, the term from which is both a privation and a contrary. For that it involves privation is clear from Book I, Ch. 7.

4. For Aristotle, there are three speculative disciplines, natural philosophy, mathematics, and metaphysics, which differ by way of their manner of definition. Cf. *Metaphysics* VI, 1. Perhaps Aristotle only considers the first two here because it is not yet shown that there are immobile (and so immaterial) beings, and, as he says in the *Metaphysics* text, "If, therefore, there is no other substance besides the ones formed by nature, natural philosophy would be the first science. But if there is some immobile being, this would be prior and first philosophy [would be about this]; and [it would be] universal in this way, because [it would be] first. And to look into being as being, what it is and what belongs to it as being, would belong to this [science]" (1026a27–32). Thus, without a proof that there are immobile beings, which proof would have to be provided by natural philosophy or mathematics, there is no science besides the latter two.

5. Aristotle often uses, sometimes explicitly, as he does here, the principle that art imitates nature. This claim may be understood in more than one way. The artist may attempt to produce products like the ones nature produces, as a sculptor may reproduce the shape of a human head. This is not so in all arts, though; for example, the rhetorician produces a speech. There are also cases where the artist helps nature produce its end, as a doctor aids the body in healing itself. Here the artist does not just imitate nature by making a likeness of something which nature makes, but imitates it in aiming at the same end. Perhaps most universally, the artist imitates nature by using the sorts of processes which nature uses. As Aristotle says elsewhere, "if a house were among the things which come to be by nature, it would come to be as it does now by art. If, on the other hand, things which come to be by nature could come to be not only by nature but also by art, they would come to be in the way in which as they are naturally apt to" (199a12–15). Thus, the artist imitates nature in using an ordered series of steps to bring about a determinate end.

6. The "end" in question is death.

7. *On the Soul* II, 4, 415b20–21; or perhaps Aristotle has in mind his lost dialogue, *On Philosophy*.

8. Cf. 184a9–16; *Posterior Analytics* I, 2, 71b9–12; II, 1–2, 89b23–90a31.

9. Empedocles, Fr. 53.

10. Thus, there are three opinions discussed in this chapter: first, the one which says there is no such thing as luck; second, the one which says that all things come about by luck; and third, the one that says luck is divine.

11. Some things come about accidentally and for the least part, but, since they are not for the sake of something, we do not say they are by luck. For example, suppose you go to the store: you may pass in the aisle the person who lives at 123 Elm Street, and this usually does not happen and is accidental to your intention and to his. Yet, because you have no interest in him, we do not say this is "lucky" or "unlucky." It would only be so if you wanted to meet or avoid him, i.e., if meeting him was among the things you acted for (or against). Without this qualification, we have merely "random" events. In both cases, we have accidental effects, but those which we have no interest in do not raise a question of whether there is some new kind of cause here.

Whence, Aristotle discusses chance and luck in addition to the considering accidental causes in general in Ch. 3.

12. Thus, the third opinion mentioned above at 196b5–7.

13. The first opinion mentioned above at 195b36–7.

14. In one sense, then, there are events which have no cause, in the sense that they have no *per se* cause. What is accidental from the perspective of a lower cause may, however, be *per se* from the perspective of a higher one. If you go to the store and meet the girl of your dreams, you're in luck, and, maybe, so is she. But if some meddling match-maker sent you both there at the same time on purpose though unbeknownst to both of you, the meeting is not finally by luck. Whether there is some such higher ordering principle for the material world is a question for another place.

15. Aristotle denies that children have choice because they lack the ability to deliberate about their ends, and so, though they act out of desire, they do not "choose," strictly speaking. Cf. *Nicomachean Ethics* III, 2, 1111b6–9.

16. This is in response to the second opinion cited above at 196a24–28. Cf. Appendix 4, *Chance and the Indeterminacy of Nature* for a consideration of the bearing of Chs. 4–6 on Aristotle's views of nature.

17. Here Aristotle has given an implicit argument for the four causes he listed in Chapter 3. Since a cause is an answer to the question "why," and this can be understood in four basic ways, there must be four sorts of cause.

18. It is important to see that here Aristotle is dividing the sciences less formally than he does in the *Metaphysics*, or even in Ch. 2 of this Book. The three sciences he gives here seem to be metaphysics, astronomy, and natural philosophy. The first deals with immobile things, the second with things indestructible (according to Aristotle's opinion) but mobile, and the last with things both destructible and mobile. This is a less formal division because the middle term of a science is the definition, and so the mode of giving a definition will determine the nature of a science. But even in astronomy as conceived of by Aristotle, there is material in the definition, as when an eclipse is defined as the privation of light on the moon due to the earth's screening it. (Cf. *Posterior Analytics* II, 8, 93a29–b7.) Sometimes astronomy is understood to be part of mathematics, and sometimes to be part of natural science. It seems, though, that it is more properly part of natural science, since, though it uses a mathematical mode, it intends to understand natural things.

19. The "what it is" and the form are final causes, since reproduction and maturation are for the sake of this, but it is a natural principle. The "one" which is not a natural principle is the immaterial cause of motion, the existence of which is shown in Book VIII (practically *in toto*, but see especially 267b17–26) and the nature of which is further discussed in the *Metaphysics* XII, 6–10, 1071b3–1076a4.

20. Aristotle's assumption that nature acts for an end will be further justified in Ch. 8.

21. This chapter makes it clear that the natural philosopher should reduce to all four causes; it may be debated how this last paragraph expresses this fact, but that it is intended to do so seems clear enough.

22. Aristotle is establishing some things he assumed: first, that nature acts for an end, and secondly, that there is a kind of necessity following from the assumption of an end. The latter is perhaps seen at 198b7; if not, it seems the discussion of the necessity consequent upon the assumption of an end is not dictated by earlier statements, but by the general fact that science only deals with the necessary. Cf. *Posterior Analytics* I, 6, 74b5–18.

23. Empedocles.

24. Anaxagoras.

25. An idiomatic expression; the sense, at least for the present purpose, is distinctly not that of a provident Zeus sending rain for the sake of the crops, as the rest of the text makes clear.

26. This position, and others like it, combine chance and necessity to explain everything. One position would be that each thing acts out of necessity, but the conjunction of their actions is by chance; another would be that each individual event happens by chance, but, given enough time, everything must happen sooner or later, as that the teeth come up sharp in front by chance, but this will necessarily happen to something at some time. The first explains necessity in nature through determination, the second through indetermination.

27. The parallel to Darwin can hardly be missed. Darwin himself cites this passage, but mistakenly takes it to be Aristotle's own position. Cf. *The Origin of Species*, "An Historical Sketch" (New York: Penguin, 1968), pp. 53–54.

28. For example, the art of medicine can aid nature in bringing about health when nature is insufficient.

29. Perhaps it is worth noting immediately that Aristotle argues that nature acts for an end without invoking an intelligent cause of nature. Rather, he argues from the phenomena of regularity, analogy to art, etc., to the presence of final cause in nature. To go on to argue that, because nature acts for an end, there must be an intelligence behind nature is to go beyond the arguments of this chapter.

30. This paragraph answers the implicit question, "if nature acts for an end, why does it sometimes produce things which do not function well?" The argument seems to indicate that the very fact that we can recognize something as a "mistake" implies that the agent is acting for an end.

31. This is Empedocles' term for animals which the mindless work of Love and Strife produced, which animals died out because they were not well suited to survive.

32. Empedocles, Fr. 62.

33. Perhaps Aristotle is objecting to a false analogy implicit in Empedocles' thinking. He seems to think that animals first came to be like artifacts, by being composed out of ready-made parts, the way we put a car together. But, as Aristotle here points out, it is rather the case that they come to be organically from seeds.

34. Note that Aristotle is claiming that those who deny that nature acts for an end are implicitly denying the existence of nature.

35. Here Aristotle is answering the implicit objection that nature does not deliberate, but everything which acts for an end does deliberate, therefore, nature does not act for an end. On this chapter, cf. Appendix 5, *The Final Cause in Nature*.

36. The necessary "simply" is what is necessary on the assumption of something prior to the thing necessitated, as we might say that if this is the diameter of the square, it is necessary that it be incommensurable with the side of the square; the necessary "by hypothesis" is what is necessary on the assumption of something posterior to the thing necessitated, as we might say, that if you are want to cut wood, it is necessary that you have a saw. The grammatical form expressing the two situations may be the same, as in the examples I have given.

37. The then current position, Aristotle is saying, is that the necessity found in nature is simple necessity.

38. The necessity, that is, is in the material, not in the end, though it is from the end.

39. The beginning of the analysis of a natural thing will be from its definition, which will, if it is complete, include its end, as the definition of the eye includes seeing. But while the end makes the material necessary, the necessary material will also be in the account or definition, since the material is also part of what a thing is. In the *Posterior Analytics*, Aristotle discusses cases wherein one may demonstrate from one definition of a thing to another (Bk. II, Ch. 8, 93a1–b20). In the case of the eye, for example, one might argue from its being an organ of sight to its material being transparent.

Book III

Chapter 1

200b12 Since, however, nature is a principle of motion and of change, and our inquiry is about nature, what motion is must not escape notice. For it
b15 is necessary, being ignorant of this, to be ignorant / also of nature.[1]

Having determined what concerns motion, in the same way one must try to go on to the next things. Now, motion seems to be among continuous things, and the infinite appears first in the continuous.[2] Whence, it also happens to those who define the continuous often to
b20 use in its account the account of the infinite, / as the continuous is what is divisible to infinity.[3] In addition to these, it is impossible that motion be without place and void and time.[4] It is clear, then, that, both because of these [considerations], and because all these things are common to all and universal, one must look into each of these by taking them in hand. For consideration of what is proper is posterior to
25 consideration about what is / common.[5] And first, as we said, about motion.

There is, then, something which is only in actuality, and something in potency and in actuality, one a "this something," one an amount, one a quality, and so too with regard to the other attributes {predicates, categories} of being. Of relatives, one is said according
b30 to excess and defect, another, / according to activity and passivity, and, generally, according to what is motive and what is mobile. For the motive is motive of the mobile and the mobile is mobile due to what is motive.

Motion is not beyond the things. For the thing changing always changes according to substance or amount or quality or place. But one
b35 can grasp nothing common / in these, as we say, nothing which would
201a1 be neither "this" nor amount / nor quality nor any of the other attributes. Whence, neither the motion nor the change of anything will be beyond the things named, there being nothing beyond the things named.

Each thing is in every [genus] in two ways, as, e.g., the "this," for
a5 one is the form of it, the other, the / privation; or according to quality, for the one is white, the other, black; or according to amount, the one is perfect, the other, imperfect. So too, according to locomotion,

the one is up, the other, down, or the one light, the other, heavy. Whence, the species of motion and of change are as many as are those of being.

Having distinguished, according to / each genus, between what is a10
in actuality and what is in potency, the actuality of what exists in potency, as such, is motion.[6] For example, [the actuality] of the alterable, as alterable, is alteration[7]; of the growable and of its opposite, the decreasable (for there is no name common to both), growth and diminution; of what can come to be and of the destructible, coming to be and / destruction[8]; of what can be borne, locomotion. a15

That this is motion is clear hence: for when the buildable, insofar as we name it such, is in actuality, it is being built, and this is building; so also learning and healing and rolling and jumping and ripening and aging.

Since, however, some things / are both in potency and in actuality, though not at the same time or not according to the same [respect], but, for example, hot in actuality but cold in potency, right away many things will act on and be swayed by each other. For all [these] will be at the same time active and passive. Whence, what is in a natural way a mover will also be mobile, for all such things move while themselves / being moved. It seems to some, then, that every mover is a25
moved[9]; indeed, about this the situation will be clear from other [considerations], for there is something which is a mover and is immobile.[10] But the [actuality] of what exists in potency, when the being which is in actuality is in act, not as itself but as mobile, is motion.

By the "as" I mean the following. For the bronze / is in potency a30
a statue, yet it is not the actuality of bronze as bronze that is motion. For to be bronze and to be some mobile in potency are not the same, since, if these were the same simply and according to account, the actuality of bronze as bronze would be motion. But these are not the same, as was said.

This fact is clear / in contraries. For to be able to be healthy and a35
to be able / to be ill are different, else being ill and being healthy 201b1
would be the same, but the underlying, both what is able to be healthy and what is able to be ill, whether it be humor or blood, is one and the same. Since these are not the same, just as color and the visible are not [the same], / it is apparent that motion is the actuality of the potential as potential.[11] b5

It is clear, then, that motion is this actuality, and that something happens to be moving when the actuality is this one, and neither before nor after. For each thing can sometimes be in act and sometimes not, e.g., the buildable; and the act of the buildable as buildable / is building. For the act of the buildable is either building or the b10

house. But whenever the house is, the buildable is no longer. However, it is what is buildable that is being built. It is necessary, then, that the act be building. And building is a motion. And the same
201b15 account will suit the other / motions.

Chapter 2

201b16 That this was well said is clear both from what others say about motion and from the fact that it is not easy to define motion otherwise. For neither would someone be able to put motion and change in
b20 another genus. This fact is clear from looking at how / some thinkers lay down [what] motion [is], saying that motion is otherness or inequality or non-being, not one of which is necessarily moving, not even if a thing be other or unequal or non-being. Nor is change to these or from these any more than from their opposites.

b25 The cause of putting it down among these is that motion / seems to be something indeterminate; however, the principles of the second column[12] are indeterminate because they are privative. For none of these is a "this" or a quality nor among the other attributes {predicates, categories}.

The cause of this, that motion seems to be indeterminate, is that one cannot put it either among beings in potency nor among beings in
b30 act. / For neither what is potentially an amount nor what is an amount in act is necessarily moving. And motion seems to be some act, but imperfect. The cause is that what is potential, that of which motion is the act, is imperfect. And because of this, then, it is difficult to grasp what motion is. For it is necessary to put it into privation or potency
b35 or / simple act, but none of these seems possible. There remains, /
202a1 then, the way said: that it is a certain act, but the sort of act we said, difficult to know, but able to be.

Every mover which is potentially a mobile is also moving, as was said. And of this sort of mover the immobility is rest. For in that to
202a5 which / motion belongs, immobility of that thing is rest. For to be at work {to act} on the mobile as such is to move it. But the mover does this by touch; whence, it also suffers at the same time. Whence, motion is the actuality of the mobile as mobile.[13]

This occurs by the touch of what is motive: whence, the latter suffers at the same time. The mover will always bear some species,
a10 either / a "this" or a quality or an amount, which will be a principle

and cause of motion, when it moves [another]. For example, the man in actuality makes man from what is man in potency.

Chapter 3

And [the solution of] the difficulty is apparent, that motion is in the 202a13
mobile.[14] For the actuality is of this and from what is motive. / And a15
the act of what is motive is not other. For there must be an actuality of both. For it is a motive thing by being able; but it is a mover by being in act {at work}.

But the motive thing causes the act of the mobile; whence, the act of both alike is one, just as the interval from one to two and from two to one is the same, and what is uphill and / what is downhill. For these a20
are one, though the account is not one. So too in the case of the mover and the moved.

But there is a logical difficulty. It is necessary, perhaps, that there be some act of the doer and of the sufferer: the one, then, is a doing, the other, a suffering; the work and end of the one is a thing done, but of the other, a passion.

Since, then, both are motions, if they are different, what are they a25
in? For either both are in what is suffering and being moved, or the doing is in the doer and the suffering is in the one suffering. If one must call this last "doing" as well, the word would be equivocal.

But if the latter, the motion will be in the mover, for the same argument applies to the mover / and to the moved. Whence, either all a30
movers will be moved, or, having motion, they will not be moved.

But if both the doing and the suffering are in what is moving and suffering, both the teaching and the learning, being two, in the one learning, first, the act of each thing will not be in each thing. Further, it is strange that it will be moving by two motions at the same time. / a35
For what will be the two alterations of the one thing and to one species? But this is impossible.

But the act will be one. But / it is unreasonable that there be one 202b1
and the same act of two things differing in species. And if the teaching and the learning are the same, so will the doing and the suffering be the same; and to teach and to learn are the same, and to do and to suffer; whence, it will be necessary / that the teacher learn everything b5
[he teaches] and the doer suffer [everything he does].

Yet it is not strange that the act of one thing be in another. For

teaching is the act of the teacher, yet it is in someone [else] and is not a thing cut off, but is [the act] of this thing in that thing.

Nor does anything prevent one same [act] from being of two
202b10 things, not so as their being is the same, but as / what is in potency is in relation to what is acting. Nor is it necessary that the teacher learn, not even if to do and to suffer are the same, though [these are] not [the same] in the way in which the account which says the "what it was to be" is one, e.g., as raiment and dress [are one], but as the road from Thebes to Athens and the road from Athens to Thebes [are one], as
b15 was said before. For not / all the same things are present in things the same in any way [at all], but only in those for which to be them is the same.

But indeed, not even if teaching and learning are the same are to learn and to teach [the same], just as neither if there is one distance between things standing apart is the being distant of here from there and of there from here one and the same.

b20 To speak universally, neither is teaching properly the same / as learning nor doing properly the same as suffering; but that in which these are, motion, [is the same]. For the act of this in that and the act of that from this are different in account.[15]

What motion is, then, has been said, both universally and according to the part. For it is not unclear how each of the species of motion
b25 will be defined. / For alteration is the actuality of the alterable as alterable. Moreover, in more known terms, the actuality of the potentially active and passive, as such, simply and again in each case, is either building or doctoring. Each of the other motions will be spoken of in the same way.

Chapter 4

202b30 Since, however, the science of nature is about magnitudes and motion and time,[16] each of which is necessarily either infinite {unlimited} or finite {limited}, even if not everything is infinite or finite, e.g., a passion or a point (for perhaps not one of such things is necessarily among either of these), it would be fitting for the one concerned /
b35 with nature to consider the infinite, whether it is or not, and, if it is, what it is.

203a1 Here is a sign that the consideration of this is / proper to this same science: for all who seem to have touched upon this sort of philosophy in a worthy way have produced an account of the infinite.

And all put it down as a certain principle of beings; some, like the

Pythagoreans[17] and Plato,[18] in virtue of itself, / not as an accident in some different thing, but [as] the infinite itself being substance. a5

Yet the Pythagoreans [say that it is] in the sensibles, for they do not make number separate, and [say] that what is outside the heaven is infinite; but Plato [says that] no body is outside, nor are the Ideas, because these are not somewhere; nevertheless, [he says that] the infinite is both in the / sensibles and in those [Ideas]. a10

And the Pythagoreans say the infinite is even. For the latter, being cut off and shut in by the odd, [makes] the infinite present in beings.[19] What happens in the case of numbers is a sign of this: for, gnomons being placed around the one, and separately, at times the species / come to be always other, at times one.[20] Plato, however, says a15 there are two infinites, the Great and the Small.

However, all those [speaking] about nature always put under the infinite some other nature among the things called elements, e.g., water or air or what is between these.[21] Of those making the elements finite, no one makes [any one of the elements] infinite. Yet whoever / makes the elements infinite, like Anaxagoras and Democritus, the a20 one[22] [making it] from the like-parted things, the other[23] from the "seedbed of shapes," says that the infinite is continuous by touch. And the one,[24] due to seeing anything coming to be from anything, says any of the parts is a mix in the same way as the whole. For, from this, / it seems, he says that at some time all things were together, as this a25 flesh and this bone, and so anything; and all things, then, [were together], and, further, at the same time. For not only for each thing is there a beginning of separation, but also of all things. For since what comes to be comes to be from / such a body, and there is coming to a30 be of all things, though not at the same time, there must also be some principle of coming to be. This principle, however, is one, as is what that man calls Mind, and Mind, in thinking, works from some principle. Whence, it is necessary that all things are together at some time, and began to move at some time. Democritus, however, says that, among the first things, nothing different comes to be from something else. But nevertheless, for him, the principle of all things is the common body, / differing in magnitude and in shape according to its parts. 203b1 It is clear from these [considerations], then, that this consideration is one befitting the student of nature.

Reasonably, too, do all put it down as a principle. / For neither is b5 it possible that it be in vain, nor that another power belong to it except that it be a principle. For everything is either a principle or from a principle, but there is no principle {beginning} of the infinite. For this would be a limit of it. Moreover, as being a certain principle, it is ungenerable and indestructible. For it is necessary both that a thing

coming to be come to an end {term}, and there is a finishing of every
203b10 destruction. / Whence, just as we say, there is not a principle {beginning} of this, but this seems to be [a principle] of others and to contain all things and to steer all things, as those say who do not make other causes, like mind or friendship, besides the infinite. And it is
b15 divine. / For it is immortal and incorruptible, as Anaximander and most of the natural philosophers say.

Conviction that the infinite is something would happen mostly by looking into [the question] from five [considerations]: from time (for this is infinite)[25]; and from division in magnitudes (for the mathematicians too use the infinite)[26]; moreover, by this, that only thus
b20 would coming to be and destruction not fail, if that whence / what is coming to be is taken away is infinite[27]; moreover, by this, that the finite always comes to a limit in relation to something; whence, it is necessary that no one thing be a limit, if it be necessary to limit one thing by another. Mostly, however, and chiefly, what makes a common difficulty for all: for, through not failing in thought, number seems to
b25 be infinite, / and mathematical magnitudes, and what is outside the heaven. What is outside being infinite, however, both body and the worlds seem to be infinite. For why [would they be] here rather than there in the void? Whence, if bulk is in some one place, bulk is also everywhere. At the same time, however, if void and place are infinite,
b30 it is necessary also that body be infinite. / For in eternal things, to be possible and to be differ not at all.

The consideration of the infinite poses a difficulty, however. For many impossible things occur both to those who assume it does not exist and also [to those who assume] it does. Moreover, in what way is it, as a substance or as an accident in virtue of itself in some nature? Or [does it exist] in neither way, but nonetheless an infinite thing or
204a1 the infinite / in multitude exists?[28] But the student of nature must mostly look into whether there is an infinite sensible magnitude.[29]

First, then, one must determine in how many ways infinite is said. In one way, then, it is what is impossible to go through, by not being naturally apt to be gone through, just as sound is "invisible." In
a5 another way, / what has an imperfect way through, or what [can] barely [be gone through]; or what has the natural aptitude, but does not have a way through or a limit.

Moreover, every infinite is either according to addition or according to division or both.[30]

Chapter 5

It is not possible, then, that the infinite, being a certain "infinite- 204a8
itself," be separated from the sensibles. For if the infinite is neither
magnitude nor / multitude, but is itself substance and not an accident, a10
it will be indivisible. For what is divisible will be either magnitude or
multitude. If it is this sort of thing, however, it is not infinite, except
as sound is invisible. But those saying the infinite exists do not affirm
it, nor do we seek it, in this way, but as what can be gone through.[31]
If, however, the infinite / is accidental, it would not be, as infinite, an a15
element of beings, just as neither is the invisible an element of con-
versation, though voice is invisible.

Moreover, how can something be infinite-itself, if number or
magnitude, of which the infinite is a certain passion in virtue of itself,
is not [like this]? For this is still less necessary than that / number or a20
magnitude be [like this].

It is also apparent, however, that the infinite cannot be as a being
in act and as substance and principle. For, whatever part of it be taken,
this will be infinite, if it be partible. For to be infinite and the infinite
are the same, if the infinite is substance and is not [said] of something
underlying. Whence, it is either indivisible or else / divisible into a25
infinites. However, it is impossible that the same thing be many infin-
ites. But indeed, just as part of air is air, so too a part of the infinite is
infinite, if in fact it is substance and principle. So it is unpartible and
indivisible. But it is impossible that the infinite be a being in actuali-
ty; for it is necessary that it be some amount. The infinite, then, exists
accidentally. / But if so, it was said that one cannot call it a principle, a30
but that in which it happens to be, the air or the even, [is a principle].
Whence, those who speak thus, as the Pythagoreans speak, would
speak strangely. For at the same time they make the infinite a sub-
stance / and they divide it into parts. But perhaps this is a general a35
question, if the infinite can be in the mathematicals / and in the intel- 204b1
ligibles and in things having no magnitude. We, however, are looking
at the sensibles, and at what we are making an inquiry about, whether
there is or is not in these an infinite body in the direction of growth.
By looking at it logically, then, from the following sorts [of consider-
ation], / it would not seem to exist. For if the account of body is what b5
has been defined by surface, there could not be an infinite body,
either intelligible or sensible. But indeed, neither does number exist in
this way, as separated and infinite. For the numerable is the number
or what has number. If, then, the numerable can be numbered, the
infinite would / also be able to be gone through. b10

By considering more naturally from the following [considerations, the truth will be clear]. For it is not possible that it be either composite or simple. The infinite body will not be composite, then, if the elements are finite in multitude. For it is necessary that there be many, and that the contraries always be equal, and that no one alone
204b15 of these be infinite. For if, / by any amount, the power in one body falls short of another, e.g., if fire is finite and air infinite, and equal fire is however many times equal air in power, so long as there is some number, it is apparent nevertheless that the infinite will exceed and
b20 destroy the finite. However, for each to be infinite is impossible. / For a body is a thing having dimensions in every way, but the infinite is stretched out without limit. Whence, the infinite body will be stretched out to infinity in every way. But indeed, neither can an infinite body be one and simple, neither, as some say, what is beyond the elements, from which these [others] come to be, nor simply. For there
b25 are / some who make the infinite this, but not air or water, lest the others be destroyed by that which is infinite among them.[32] For they have contrariety towards each other, e.g., air is cold, water wet, fire hot; of which, if one were infinite, the others would already be destroyed. Now, however, they say there is a different one from which these ones
b30 are. It is / impossible, however, that such a thing exist, not because it is infinite (for about this one must say something common about all similarly, about both air and water and whatever else), but because there is not such a sensible body besides the things called elements. For that from which everything is, into this everything is also
b35 resolved; whence, it would be there beside air and fire / and earth and
205a1 water. Yet nothing appears. Nor, then, can fire or any / of the other elements be infinite. For generally, and apart from a certain one of them being infinite, it is impossible that the all, even if it be finite, either be or come to be a certain one of them, as Heraclitus says everything at some time comes to be fire. The same argument, how-
a5 ever, / applies to the one, such as the students of nature make beyond the elements. For every change is from contrary to contrary, e.g., from hot to cold.[33]

However, one must look, in every case, into whether there can or cannot be an infinite sensible body from the following [considerations]. But it is clear from the following that, generally, it is impossi-
a10 ble that there be an infinite sensible body. / For every sensible thing is naturally apt to be somewhere, and there is a certain place for each, and the same for the part and for the whole, e.g., for the whole earth and for one clump, and for fire and for a flame.[34]

Whence, if the infinite body is of the same species {homogeneous}, it will be immobile or be always moved locally. And this is

impossible, for why [should it move] down rather than up or to whatever [place]? I mean, / e.g., if it be a clump of earth, where will this a15
be moved or where remain? For the place of the body of the same kind as it is infinite. Will it then occupy the whole place? And how? What, then, and where will the resting or the motion of it be? Or will it remain in every place? Therefore, it will not be moved. Or will it be moved to every place? Therefore, it will not stand.

But if the / all is dissimilar {heterogeneous}, places too are dis- a20
similar. And first, the body of the all will not be one except by touching. Next, these things will be finite or infinite in species. It is not possible, then, for them to be finite, for some will be infinite and some not, if the all is infinite, e.g., the fire or the air. However, such a thing is destruction to its / contraries, as was said before.[35] And because of a25
this no one of the natural philosophers made fire or earth one and infinite, but either water or air or what is the middle of these, because the place of each of the former was clear, determinate, but the latter admit both up and down. If, however, they are infinite / and simple, places a30
too are infinite, and the elements will be infinite.[36] If, however, this is impossible and places are finite, it is necessary that the whole be finite also. For it is impossible that the place and the body not fit exactly. For neither can the whole place be greater than however big the body is able to be (at the same time the body will no / longer be infinite), nor a35
can the body be greater than the place. For either void will be some- 205b1
thing or there / will be a body naturally apt to be nowhere.

Anaxagoras, however, speaks strangely about the resting {remaining} of the infinite. For he says the infinite itself fixes itself; this, however, because it is in itself, for nothing else contains it; as though wherever something is, there it is naturally apt to be. / But this b5
is not true. For something can be somewhere by force and not by being naturally apt. If, then, it is most true that the whole is not moved (for what is fixed in itself and is in itself is necessarily immobile), still, why it is not naturally apt to be moved must be said. For it is not sufficient, speaking thus, to leave off. For it could be that, not moving, it does not have / another place to move, but nothing prevents its b10
being naturally apt to move, since even the earth is not moved locally, nor would it be if it were infinite, being held fast by the middle, but not because there is not somewhere else whence it would be borne would it remain in the middle, but because it is naturally apt to do so. Nevertheless, one would be able to say that it fixes itself. If, then, in the case of the earth, / being infinite is not the cause, but that it has b15
weight, and the heavy remains in the middle, and the earth is in the middle, so too the infinite would also remain in itself due to some other cause, and not because it is infinite and itself fixes itself.[37]

At the same time, it is clear that any part [of it] should remain.
205b20 For as the infinite remains / fixed in itself, so too, whatever part be taken, it will remain in itself. For the places of the whole and of the part are of the same species, e.g., of the whole earth and of a clump, down, of an entire fire and of a flame, up. Whence, if the place of the infinite is "in itself," the part is "in itself," too. So it will remain in itself.[38]

Generally, however, it is apparent that it is impossible to say at the
b25 same time / that there is an infinite and that there is a certain place for bodies, if every sensible body has either heaviness or lightness, and if, on the one hand, it be heavy, it has locomotion to the middle by nature, if, on the other hand, light, upwards. For this is necessary also for the infinite. However, it is impossible that the whole be either [up or in the middle], or that half receive either [predicate] singly. For how
b30 / do you divide it? Or how will there be up and down of the infinite, or extreme and middle?[39]

Moreover, every sensible body is in place, and the species and differences of place are up and down and before and behind and right and left. And these are determined not only in regard to us and by
b35 position but also in the whole itself. / However, it is impossible that these be in the infinite.

206a1 Simply, however, if it is impossible that / place be infinite, and every body is in place, it is impossible that some body be infinite. But indeed, what is somewhere is in place, and what is in place is somewhere. If, then, the infinite cannot be an amount (for it would be a
a5 certain amount, e.g., two feet or three, for amount / signifies these), so too [it is necessary that] what is in place is somewhere, and this is either up or down or in a certain other one of the six directions. Each of these, however, is a certain limit. It is apparent, then, from these [considerations] that there is no infinite body in act.

Chapter 6

206a9 It is clear, however, that if the infinite simply is not, many impossible
a10 things / happen. For there will be some beginning and finishing of time, and magnitudes will not be divisible into magnitudes,[40] and number will not be infinite. Whenever, being so determined, a thing does not appear to be possible in either way, one needs an arbiter, and it is clear that in a way the thing is and in a way it is not.

a15 Both what is in potency and what is / in actuality, then, are said

to be. And the one infinite is by addition, another by division. Now, it was said that magnitude is not infinite according to act; but by division, it is. For it is not difficult to refute the indivisible lines.[41] It remains, then, that the infinite is in potency.

One must not, however, take "being in potency" as [meaning that, e.g.,] if this / statue is able to be, this statue also will be, and so also a20
the infinite is what will be in act, but [rather], since being is in many ways, as a day and the games exist by different [parts] always coming to be, so too does the infinite. For in these too the thing is both in potency and in act. For the Olympics exist both by the games being able / to come to be and by their coming to be. a25

The infinite is manifest otherwise in time and in the case of men, and in the division of magnitude. For generally the infinite exists in this way, by always taking different [parts]; and what is taken is always finite, but always different. Moreover, being is said in many ways, so that one must not take / the infinite as a "this something," a30
like man or house, but in the way a day and the games are said to be, in which being has not come to be as a certain substance, but is always in coming to be or destruction, [what actually is] being finite, but always different. But / in magnitudes this happens by what is taken 206b1
remaining; but in the cases of time and of men, being destroyed, [the infinite exists] in a way such that they do not give out.

The infinite according to addition is somehow the same as the one according to division. For [the latter] comes to be conversely / in b5
what is finite according to addition. For insofar as the thing being divided is seen [going] to infinity, by this [division] that which is being added to what is determinate appears. For should someone, taking what is determinate in a finite magnitude, take again in the same ratio, not taking some same magnitude of the whole, he will not go through the finite. If he should / so increase the ratio, however, as b10
always to take some same magnitude, he will go through, because every finite thing is used up by any determinate thing. The infinite, then, is not otherwise, but thus, in potency and by lessening. And it is actuality as we say the day and the games are; and / in potency thus, b15
as material, and not in virtue of itself, as is the finite. And thus the infinite according to addition is, then, in potency, which infinite we say is the same, in a certain way, with that according to division.[42] For one will always be able to take something outside.

Nevertheless, it does not exceed every magnitude, as it does / go b20
beyond every determinate thing in the case of division, and there will always be a smaller.

Whence, to exceed everything according to addition is not possible in potency, if there be not an infinite in actuality accidentally, as

the natural philosophers say that what is outside the body of the cosmos is infinite, of which [thing outside] the substance is air or some
206b25 other such thing. But if it is / not possible that there be an infinite sensible body in actuality in this way, it is apparent that neither would there be one in potency according to addition, except, just as was said, conversely to division; since even Plato made the infinites two[43] because of this, because both in the direction of growth and in the direction of lessening it seems to go beyond and go on to infinity. /
b30 Nevertheless, making [them] two, he does not use two. For neither does the infinite belong to numbers in the direction of lessening (for the unit is least) nor in the direction of growth (for he makes number [only] go up to ten).

The infinite happens to be the contrary to what they say. For the
207a1 infinite is / not that of which nothing is outside, but that of which something is always outside.

This is a sign: for they call rings infinite, those having no setting, because one can always take something outside, speaking according
a5 to a certain likeness, yet not properly. / For both this and at no time taking the same [part] must be present. In the circle, however, this is not so, but always the successive part alone is different. The infinite, then, is that of which one can always take something outside, taking according to amount.

That of which nothing is outside, however, is perfect and whole.
a10 For thus do we define a whole, that of which / nothing is absent, like a whole man or box. But as the particular [whole is], so too is what is properly [a whole], as the whole is that of which nothing is outside. That of which there is something absent outside, whatever be absent, is not all. Whole and perfect, however, either are entirely the same or are close in nature. Nothing not having an end is perfect, but the end
a15 is a /limit.

Whence, one must opine Parmenides to have spoken better than Melissus. For the latter says that the whole is infinite, the former that the whole is finite, "well matched from the middle."[44] For to join the infinite to what is entire and whole is not "to join a string to a string."[45]

a20 Yet they take the dignity of the infinite, / its containing all things and having all in itself, from here, through its having a certain likeness to the whole. For the infinite is the material of the perfection of magnitude and is the whole in potency, but not in actuality. It is divisible both in the direction of lessening and in the converse direction of addition. It is whole and finite not in virtue of itself but in virtue of
a25 another. And, / insofar as it is infinite, it does not contain but is contained. Whence, it is also unknowable as infinite. For material does

not have species. Thus it is apparent that the infinite is rather in the account of part than [in that] of whole. For the material is part of the whole as the bronze is of the bronze statue.

Yet if the infinite contains in the sensibles, in the intelligibles / the Great and the Small must contain the intelligibles. But it is strange a30
and impossible that the unknowable and indefinite contains and determines.

Chapter 7

It happens according to reason also that the infinite according to addi- 207a33
tion does not seem to be infinite so as to exceed every / magnitude, a35
but in division it does go beyond [every limit]. For material and the
infinite / are contained and inside, but species contains. 207b1

It is also reasonable that there is in number a limit in the direction of the least, / but in the direction of the more one can always b5
exceed every multitude, but in the case of magnitudes the contrary [happens], towards the least one can go beyond every magnitude but toward the greater there is no infinite magnitude. The cause is that the one is indivisible, whatever the one may be (e.g., a man is one man and not many). Number, however, is many ones and some amount. Whence, it is necessary to come to a stand in the direction of the indivisible. For "three" and "two" are denominative names, and so too each of the other / numbers. b10

In the direction of more, however, one can always think [of a greater]. For the bisections of magnitude are infinite. Whence, the bisection is in potency, but not in act. But what is taken always goes beyond any determinate multitude. But this number is not separable from the bisection, nor does the infinity remain but it comes to be, as do / time and the number of time. b15

In the case of magnitudes the contrary is the case. For the continuous is divided to infinity, but it is not infinite in the direction of the greater. For however much it can be in potency, so much also can it be in act. Whence, since no sensible magnitude is infinite, there cannot be / an exceeding of every determinate magnitude. For some- b20
thing would be greater than the heaven.

The infinite, however, is not the same, i.e., some one nature, in magnitude and motion and time, but the posterior one is said according to the prior one, e.g., motion [is called infinite] because the magnitude over which the mobile is moved or altered or grows [is infi-

207b25 nite], and the time through / the motion. Now, then, we use these terms, later we will say what each is and why every magnitude is divisible into magnitudes.[46]

The argument destroying the infinite thus, that there be in act in the direction of growth a thing which cannot be gone through, does b30 not remove the consideration of the mathematician. For now / they do not need the infinite (for they do not use it), but only a finite magnitude as great as they wish. But another magnitude of whatever size can be cut according to the same ratio with the greatest magnitude. Whence, in regard to proof, the existing of the infinite in existent magnitudes will make no difference to those thinkers.

b35 Since, however, the causes were divided / in a four-fold way, it is 208a1 apparent that the infinite is a cause as material, and that / to be infinite is a privation; what underlies [the infinite] in virtue of itself is the continuous and sensible. All other thinkers clearly use the infinite as material. Whence, it is also strange to make it not what is contained, but what contains.

Chapter 8

208a5 What remains is to go through the arguments according to which the infinite seems to be not only in potency but also as something determinate. For some of these are not necessary, some have certain different true replies.

For it is not necessary that there be an infinite sensible body in a10 act so that coming to be might not give out. For the destruction / of one can be the coming to be of another, the all being finite.

Moreover, touching and being finite are different. For one is related to something and of something (for everything touching touches something), and among finite things, happens {is accidental} to a certain thing; yet to be finite is not to be related to something. Nor will any chance thing touch any chance thing.

a15 Believing [the infinite to be in act] by means of thought / is strange. For the excess and defect are not in the thing but in the thought. For someone might think each of us is many times bigger than himself, growing to infinity. But there is not something outside the town or of as great a magnitude as the magnitude which we have just because someone thinks so, but because it is so; thinking this is accidental.[47]

a20 Time and motion are infinite,[48] and understanding, but what is taken does not endure.

Magnitude is infinite neither by lessening nor by growth in the understanding. But it has been said about the infinite how it is and how it is not, and what it is.

Endnotes

1. This is especially so since nature has been defined as a *principle* of motion (192b2–23), and a principle can only be known as such in relation to that of which it is a principle.
2. It seems that the infinite is first understood by negating the limits of something finite such as a line. But perhaps Aristotle says the infinite first appears in the continuous because he does not think there are magnitudes infinite in extent, but he does grant that continuous things are infinitely divisible, at least potentially. Cf. 206a9–b20; 207a33–35.
3. 202b30–208a23.
4. For place, cf. 218a27–213a11; for void, 213a12–217b28; for time, 217b29–224a17. While we should determine the more general before the less general (184a23–24), there is a priority among things which are of equal generality. Here, motion, place, and time all belong to all mobiles, but place and time follow upon motion and so are treated after it.
5. 184a9–b14.
6. For a discussion of this definition of motion and of how Aristotle arrives at it, cf. Appendix 6, *The Definition of Motion*.
7. Note that "alterable" here cannot mean "able to be altering," because then the definition would be circular. Rather, it means "able to be other." So too with growable, etc.
8. Later, Aristotle will say that generation and corruption, or simple coming to be and simple destruction, are not strictly motions. Here he speaks of them as motions either because he has not yet determined the truth about these, or because there is a way in which even these are motions, namely, insofar as the processes which lead to generation and corruption are motions. The death of a man, e.g., is a corruption, but is brought about through various motions. Cf. 224a21–225b5.
9. This can be taken in more than one way, for the movers we observe around us move others by being themselves in motion, as my hand moves a stick by itself moving, and movers are also moved in return by what they move, as the stick makes an impression in my skin. Here it seems Aristotle is speaking of the mover being in motion in the second sense.
10. Cf. Book VIII, Ch. 5–6, esp. 259b20–28.

11. For a discussion of the phrase "as such" in the definition of motion, cf. Appendix 6, *The Definition of Motion*.

12. *Metaphysics* I, 5, 986a22–b1.

13. Here Aristotle has argued that the definition of motion can be reformulated using "mobile" for "the potential." The advantage of the latter is that it does not already contain the idea of motion.

14. The difficulty arises because we see that the mover is also mobile, and because we see that the motion, which is in the mobile, is somehow what the mover does, and so is its act. So the difficulty is whether motion is the act of the mobile or of the mover.

15. Aristotle has argued that the act of the mover is in the mobile. The hot iron heats the water, and though the iron is cooled in return, this is accidental to it as a mover. Moreover, since the action of heating is in the water, not in the iron, the act of the mover as a mover is not in itself, but in the patient, the thing which undergoes the motion. All of this leaves open the possibility that there be an unmoved mover, though it does not establish that there is one or even that one is finally possible. For there may be other objections which we have not thought of. We will not finally establish this possibility, or that of an immaterial being, until we show that there really is such a thing. Cf. 256a4–267b26.

16. Cf. 200b15–25.

17. Cf. *Metaphysics* I, 5, 985b23–986b8; 987a9–27.

18. It is unclear what, if any, text Aristotle is referring to. He may be depending on his personal acquaintance with Plato. On the other hand, at 206b27–33 and 203a15–16, Aristotle says the Great and the Small are both infinite. Insofar as the Great and the Small are the material principles for Plato, it would seem reasonable that they are in sensibles, and insofar as they are named at all they must share in some supra-sensible form. On Plato, cf. *Metaphysics* I, 6, 987a29–17.

19. Perhaps the idea is that the even is divisible into (two) parts, and so again, until we get to units. If a unit be added, the number becomes odd and indivisible (by two); whence, the odd, containing the even, makes the infinite present in things.

20. We might also translate, "gnomons being placed around and separate from the one...." In any case, it is not clear what is meant. A "gnomon" is the "L" shaped portion of a rectangle which is left over after cutting out a smaller rectangle from the corner of a larger one. On the various explanations offered by the Greek commentators, cf. Ross, *Aristotle's* Physics, *ad. loc*.

21. It seems unlikely that Aristotle means that all the natural philosophers before him held that there was an infinite; rather, he probably means that those who did posit an infinite did not make it substance, but an attribute (or "accident") of some body like air or water.

22. Anaxagoras.

23. Democritus.

24. Anaxagoras.

25. Cf. 251b10–28; 219b1–2.
26. If we divide a line into two parts, we can then divide it into two again, and then again, etc., so it seems there is some sort of infinity in the line.
27. This position is usually attributed to Anaximander.
28. Presumably the first option is that the infinite is a substance, the second that it is a property of some substance, the third that it is a purely accidental attribute of some substance.
29. The consideration of an imaginary mathematical infinite or of an infinite thing utterly separated from the physical world is not a consideration for the physicist to make.
30. That is, a line, e.g., can either be infinitely long or infinitely divisible or both.
31. That is, what has parts which are external to each other, like the units of number or the left and right sides of a line.
32. Perhaps the view of Anaximander.
33. If we were to posit another body, from which the entire universe comes or into which it is resolved, then that other body would have to have some sort of contrariety relative to the bodies we see around us, for change is from contrary to contrary. (189a9–10) But then the supposed other body would, by the argument just given, destroy everything else.
34. The argument to follow assumes Aristotle's teaching about natural place. Cf. 212b29–213a10.
35. 204b10–205a7.
36. But they are not: 189a12–20.
37. At the very least the sort of reason given when saying that the infinite cannot move because there is no place for it to go is only accidental; a explanation which gets to the roots of things would have to be in terms of the natures of the things we are speaking of.
38. But if every part is immobile, then nothing moves, which is manifestly false.
39. Thus, the positing of an infinite place destroys the possibility of natural locomotion. This is the position of, among others, Democritus and Isaac Newton. Aristotle will discuss place and natural place more at 208a27–213a11.
40. That is, some magnitudes will not be divisible into magnitudes; for if every magnitude is divisible, but not infinitely divisible, then there will be some magnitude the parts of which cannot be divided, and so will be not be magnitudes. Consequently, that magnitude will be divisible, but not into magnitudes.
41. Cf. 231a21–b18.
42. That is, number arises from the division of magnitude, and as the divisions are potentially infinite and we never come to a smallest part, so the numbers which come from the divisions are potentially infinite and one never comes to a largest number.
43. The Great and the Small; cf. 203a15–16.

44. Melissus, Fr. 8, line 44.

45. A Greek proverb meaning to match things which are naturally similar.

46. For magnitude, cf. 231a21–b18; for motion, cf. 201a10–11; for time, cf. 219b1–2.

47. The point made here, while obvious, is fundamental. It is not uncommon, especially given the fact that modern mathematical science tends to involve the imaginative creation of hypothetical entities, to find serious thinkers falling into this error. It is perhaps for this reason, e.g., that Aristotle says that the advocates of the void "make it up." (Cf. 216a22 as well as the *Introduction* and Appendix 1, *Method in Aristotelian and Modern Natural Philosophy*.)

48. Cf. 250b10–252b6. Aristotle's teaching that motion and time are eternal seems reasonable enough, given the restriction of his consideration in the *Physics* to natural causes.

Book IV

Chapter 1

So too, it is necessary that the student of nature know about place, just 208b27
as about the infinite, whether it is or not, and how it is, and / what it b30
is.[1] For all assume beings to be somewhere, for non-being is nowhere; for where is the goat-stag or sphinx? And the most common and the chief sort of motion is that according to place, which we call "locomotion" {bearing, carrying}.[2]

But what place is poses many difficulties. For it does not appear the same to those considering it from each of the things present in it.[3] Moreover, we have nothing / from others about it, neither a bringing 208b1
forth nor an overcoming of difficulties.

That, then, place exists seems to be clear from mutual replacement. For where water now is, when it goes out from there as from a jar, next air is, but at times some other body occupies this same place. This [place], then, seems to be other than all those / which come to b5
be and are changing in it. For in what air now is, water was before, so that it is clear that the place was something and the space into which and out of which they changed was different from both.[4]

Moreover, the locomotions of the natural and simple bodies, e.g., of fire, and of earth and of such things, not / only make clear that b10
place is something, but also that it has some power. For each of these bodies, when they are not impeded, is borne to its own place, in one case upwards and in another downwards; and these are the parts and species of place: up and down and the rest of the six directions. Such directions, however, up and / down and right and left, are not only rel- b15
ative to us. For they are not always the same with respect to us, but, whichever way we might turn, they come to be according to our position: whence also, the same thing is often left and right, and up and down, and before and behind. But in nature each is separately determined, for not any chance thing is "up" but whither / fire and light b20
things are carried; so too, "down" is not any chance thing but whither things having heaviness and earthy things [are carried], as if they do not differ only by position but even by power.[5] The mathematical objects can also make this clear. For although mathematical objects are not in place, they nevertheless have position to the left and right

with respect to us; whence, not having by nature each of these [positions], the position of these is / only understood.[6]

208b25

Moreover, those who claim that void exists say place exists. For the void would be a place deprived of body. Someone might assume because of these [considerations], then, that place is something beside bodies, and that every sensible body is in place.

b30

Hesiod, too, might seem / to speak rightly, making chaos {gap} first. He says, in fact, "Of all things, chaos came to be first of all, then broad-breasted earth,"[7] as though there must first be space for beings, through thinking, as the many do, that all things are somewhere and in place. However, if place is such, the power of place would be something wonderful and / prior to all things. For that without which not one of the others is, but it is / without the others, is necessarily first; for place does not perish when the things in it are destroyed.[8]

b35

209a1

But indeed, even if place exists, there is difficulty about what it is, whether some bulk of body or some different nature. For one must seek first the genus of it. On the one hand, then, it has / three dimensions, length, breadth, and depth, by which all body is defined. But it is impossible that place be a body, for then there would be two bodies in the same [place].[9]

a5

Moreover, if there is a place and space of body, it is clear that there is one of surface and of the remaining limits. For the same argument will fit: for where the planes of the water / were before, those of the air will then be. But indeed, we find not one difference between a point and the place of a point. Whence, if the place of this is not different, neither is that of any one of the other [things mentioned], nor is place something besides each of these.

a10

For what in the world will we put down place as being? For what has such a nature cannot be either an element or / from elements, whether bodily or unbodily. For it has magnitude, yet it is not a body. Yet the elements of sensible bodies are bodies, but from the intelligibles no magnitude comes to be.

a15

Moreover, of what among beings would someone put down place as the cause? / For no cause among the four belongs to it: for [it is] not [a cause] as the material of beings (for nothing is constituted from it), nor as the species and account of things, nor as the end, nor does it move beings.[10]

a20

Moreover, if it is something among beings, where will it itself be? For the difficulty of Zeno begs for some account. For if every being is in place, / it is clear that there will be a place of place, and so on to infinity.

a25

Moreover, as every body is in a place, so there is a body in every place.[11] How, then, will we speak about growing things? For it is nec-

essary, from these [considerations], that the place grow along with them, if the place of each thing is neither greater nor less than it. Because of these arguments, then, / it is necessary to be at a loss not a30
only as to what it is, but even as to whether it is.[12]

Chapter 2

However, since one thing is said in virtue of itself but another is said 209a31
in virtue of another, and place is either common, in which all bodies are, or proper, in which a thing is first (I mean as you are now in the heaven because in the air, but this is in the heaven, and in the air because / in the earth, and so too, in this because in this place / which a35/209b1
contains nothing more than you), if, then, place is the first thing containing each of the bodies, it would be some limit; whence, place would seem to be the species and form of each thing, by which species the magnitude and the material of the magnitude is determined. For this is / the limit of each thing. To those who look into [the b5
question] in this way, then, place is the species of each thing.

But insofar as place seems to be the dimension of a magnitude, it is material: for this is different from the magnitude; this is what is contained and has been defined by the species {form, figure}, as by a surface or limit. Material and the undetermined are of this sort. / For b10
whenever the limit and passions of a sphere are removed, nothing remains besides the material.[13] Because of this, Plato says in the *Timaeus*[14] that material and space are the same; for the thing capable of sharing and space are one and the same. Though speaking of what is capable of sharing in a different way there and in the / unwritten b15
teachings, he nevertheless asserted the identity of place and space.[15] For while all say place is something, he alone tried to say what it is.

Fittingly does it seem difficult, to those looking into it from these [considerations], to know what place is, if it is either of these, either material / or species. For in other ways they require the most elevated b20
view, and are not easy to know separately from each other.

But indeed, that it is impossible that either of these be place is not difficult to see. For the species and the material are not separated from the thing, but the place can be. For in that in which air was, water comes to be next, / as we were saying, the water and the air b25
being replaced by each other, and so too the other bodies; whence, place is neither a part nor a state of each thing, but is separate from each thing. For place seems to be something of this sort, i.e., like a jar,

209b30 for a jar is a transferable place. But the jar is / nothing of the thing. Insofar, then, as it is separable from the thing, by this is it not species; insofar as it contains, by this is it different from material.[16] And, always, what is somewhere seems to be both something itself and different from what is outside of it.

One must say to Plato, if one must speak in a digression, why are b35 the species and the / numbers not in place, if place is what is partak-
210a1 ing, whether what is partaking is the Great / and the Small, or material, as is written in the *Timaeus*?[17]

Moreover, how could a thing be borne into its own place, if place is material or species? For it is impossible that there be place of that a5 of which there is neither motion nor up and down; whence, / one must seek place among such things. If, however, place is in this [mobile] (for it must be, if place is either form or material), place will be in place. For both the species and what is indeterminate change and move together with the thing, not always being in the same place, but wherever the thing is; whence, there will be a place of place.

a10 Moreover, whenever / water comes to be from air, place perishes, for the body coming to be is not in the same place. What destruction is this, then? It has been said, therefore, from which [considerations] it is necessary that place be something, and from which someone might be at a loss about the substance of it.

Chapter 3

210a14/a15 After these things, one must grasp in how many ways one thing / is said to be in another. One way, then, is as the finger in the hand and, generally, the part in the whole. Another is as the whole in its parts: for the whole is not beside the parts. Another way is as man in animal and, generally, the species in the genus. Another is as the genus in the a20 species and, generally, the part of the species / in the account. Moreover, as health in the hot and cold and, generally, the species in the material. Moreover, as the affairs of the Greeks in the king and, generally, in the first motive thing. Moreover, as in the good and, generally, in the end; this is "that for the sake of which." The most proper of all is as in a jar and, generally, in place.[18]

a25 Someone might be at a loss, however: can something be in itself, or is nothing [in itself] but everything either nowhere or in another?[19] This is in two ways, either in virtue of itself or in virtue of something different. For whenever one part of a whole is that in which and

another part what is in this, the whole will be said to be in itself. For a thing is spoken of according to its parts, as it is called "white" because / the surface is white, and "knowing scientifically" because a30
of the reasoning power. The cask, then, will not be in itself, nor the wine, but the cask of wine will be. For "that which" and "that in which" are both parts of the same thing. Thus, then, something can be in itself.

Primarily,[20] however, this cannot happen; [it happens] as white in the body, / for the surface is in the body, and science is in the soul: the 210b1
appellations are according to these, these being like parts in man. The cask and the wine, being separate, are not parts; but when they are together [they are parts]. Whence, whenever there are parts, the same will be in itself, as white is in / man because it is in body, and in this b5
because in surface; yet it is not again in this [surface] in virtue of another. And these, the surface and the white, are different in species, and each has a different nature and potency.

Looking into [the question] inductively, then, we see that nothing is in itself according to any of the determined [modes]. And it is also clear / by reason that it is impossible. For it will be necessary that both b10
be each, i.e., the cask must be both the jar and the wine and the wine must be both the wine and the cask, if, indeed, something can be in itself; whence, if [it be true] that they are in each other as much as possible, the cask will receive the wine not as wine itself but / as the b15
former, but the wine will be in the cask not as the cask itself but as the former. It is clear, then, that they are different according to being {what they are}. For the account of that in which and of what is in this are different.

But indeed, neither can this happen accidentally. For two things will be together in the same [place]. For the cask itself / will be in b20
itself, if that of which the nature is receptive can be in itself; and, moreover, so will that of which it is receptive, e.g., if of wine, the wine. It is clear, then, that it is impossible that something be in itself primarily.[21]

What Zeno was at a loss about, that if place is something, it will be in something, is not difficult to resolve. For nothing prevents the first / place from being in another, yet not as in that place, but as b25
health is in the hot as a state and heat is in body as a passion; whence, it is not necessary to go on to infinity.

That other point is apparent, that since a jar is nothing of what is in it (for "that which" primarily [is in] and "that in which" are other), / place can be neither material nor species, but something different. b30
For these, both material and form, are something of that which is in [the place]. Let these be difficulties.[22]

Chapter 4

210b32 What place is, then, may become apparent as follows. Let us grant about it anything which truly seems to be in it in virtue of itself.[23] We
211a1 deem worthy, then, that place is the first / container of that of which it is the place and that it is nothing of the thing. Moreover, the first place is neither less nor greater. Moreover, it can be left behind by each and is separable. In addition to these, every place is either up or
a5 down and each of the bodies moves to and / remains in its own place by nature: this is what makes [a place] either up or down.[24] With these things supposed, one must consider what remains.

One must try to make the consideration such as will demonstrate the "what it is," so as to solve the difficulties, and [such that] what
a10 seems to be in place will be so, and, / moreover, [so as] to make apparent the cause of the perplexity and of the difficulties about it. For thus most beautifully would each thing be shown.

First, then, one must understand that place would not be sought if there were not motion according to place.[25] For it is mostly due to this that we opine the heaven to be in place, because it is always in motion.
a15 Of this motion, / one sort is locomotion and one growth and diminution. For even in growth and diminution a thing changes [place], and what before was "there" is next shifted into a lesser or a greater [place].

What is moving is, in one case, in act in virtue of itself and, in another, accidentally; accidentally, in one case, what can be moving /
a20 in virtue of itself, such as the parts of a body and the nail in the ship and, in another, what cannot be moving so, but is always moving accidentally, e.g., as whiteness and science. For these things change place thus, because that in which they are changes.

Since, however, we say something is in the heaven as in place
a25 because it is in the air, and / this is in the heaven; and that it is in the air, not in all of it, but because we say the extreme of the air, and that which contains, is in the air (for if all the air were place, the place of each thing and each thing could not be equal, yet they do seem to be equal); the first [place] in which a thing is is of this sort.

a30 Whenever, then, what contains is not divided but / continuous, [a thing] is not said to be in that as in a place, but as a part in a whole. Yet whenever it is divided and touching, it is in the first extreme of what contains, which extreme is neither a part of what is in it nor greater in dimension, but equal. For the extremes of what touches are in the same [position].[26]

a35 And the continuous / is not moved in that [whole] but with that [whole], but what is divided is moved in that; and this is no less true whether the container be moved or not.

Moreover, whenever it is not divided, it is spoken of as a part in 211b1
a whole, as the pupil is in the eye or the hand in the body, but when it is divided, as the water in the barrel or the wine in the wine jar. For the hand is moved with the body, / but the water in the barrel. b5

From these [considerations], therefore, it is right away apparent what place is. For there are just four things of which it is necessary that place be one. For it is either form or material or some dimension between the extremes of the body or, if there be no dimension besides the magnitude of the body coming to be in [the place], it is the extremes.[27] / That it cannot be three of these is apparent. b10

But because of containing it seems to be form. For the extremes of what contains and of the contained are in the same [position]. Both are limits, then, but not of the same thing, but the species is the limit of the thing, and the place is the limit of the containing body.

But because what is contained / and is divided [from the con- b15
tainer] often changes, while what contains remains, as water [moves] from the jar, what is between [the extremes] seems to be a certain dimension, as being something besides the body being shifted.

But this is not so; but a chance body falls in, one of those which are able to be shifted and are naturally apt to be touched.[28] If, however, / there were some dimension naturally apt [to receive] and remain- b20
ing, infinite places would be in the same [place]. For, with the shifting of the water and the air, every part will do in the whole what the whole water did in the jar.[29]

And the place will be changing at the same time; whence, there will be another place of the place, and many places / will be together.[30] However, when the whole jar is shifted, the place of the part, in b25
which it is moved, is not other, but the same. For the air or the water or parts of the water replace each other in that in which they are, but not in the place in which they come to be, which is a part of the place which is the place of the whole heaven.[31]

And material / might seem to be place, especially if someone b30
were to look into it in a thing which rests, and not in what is separated, but in what is continuous. For just as, if a thing is altered, there is something which is now white and later black, and now hard, and later soft, whence we say material is something, so too place seems to be because of some such appearance, / except that in the former case we b35
say this because what was air is now water, in the other we say place exists because where air was, there is now water. But the material, / as was said in what went before, is neither separate from the thing nor 212a1
contains, but place does both.[32]

If, therefore, place is none of these three, neither the species nor the material nor some other dimension always existing beside that of

212a5 the thing being shifted, / it is necessary that place is what remains of the four [alternatives], the limit of the containing body. By "the contained body," I mean a body which is mobile according to locomotion.

What place is seems to be something great and difficult to grasp both because it appears along with material and form and because the a10 shifting of what is borne / comes to be in a resting container. For it appears there can be some dimension between, other than the magnitudes moved. The air seeming to be unbodily contributes something [to this view]; for it appears that not only the limits of the jar are place, but also, as a void, what is between.

a15 However, just as a jar is / a transferable place, so is place an immovable jar. Whence, when what is within moves and changes in a moving thing, as a ship in a river, it uses the container more as a jar than as a place. One intends place, however, to be immobile. Whence, a20 the whole river is more the place, because / the whole is immobile.[33]

Whence, place is the first immobile limit of the containing [body].

And because of this the middle of the heaven and the extreme, towards us, of what is borne in a circle seems to be, more properly than all else, one of them up, and the other down, because the one always remains, but the extreme of what is borne in a circle, always a25 disposed {related} in the same way, remains. Whence, since / the light is what is borne up by nature, the heavy, down, the limit which contains toward the middle and the middle itself are "down," and what is towards the extreme and the extreme itself are "up." And because of this, place and what contains seem to be a certain surface and to be a30 like a jar. Moreover, the place is together with the thing. / For the limits are together with the limited.

Chapter 5

212a31 Whatever body, then, has some other body outside it containing it is in place, but whatever does not, is not in place.[34] Whence, if water came to be like this, the parts of it would be moved (for they are contained by each other), but the whole would in a way be moved and in 212b1 a way not. For as a whole at once it does not change its place, but / it is moved in a circle, for this is the place of the parts. And some move not up and down, but in a circle; some (whatever has condensation and rarefaction) move both up and down.[35]

As was said, some things are in place according to potency, some

according to act.[36] Whence, whenever / what has similar parts is continuous, the parts are in place according to potency, but when they are separated but touching, like a heap, [they are in place] according to act. b5

And some [are in place] in virtue of themselves, e.g., all bodies mobile in virtue of themselves according to locomotion or according to growth are somewhere; but the heaven, as was said, is not somewhere as a whole nor in some place if, indeed, no body contains it. / As it is moved, in this way is there place for the parts, for among the b10 parts, one part is contiguous to another. Some, however, are in place accidentally, like the soul and the heaven: for all its parts are somehow in place, for on the circle one part contains another.

Whence, the uppermost thing moves in a circle, but the whole is not somewhere. For what is somewhere / is something, and, moreover, b15 there must be, besides this, something in which it is, which thing contains; but there is nothing outside of the all, alongside the all and the whole. / And because of this, all things are in the heaven, for the heav- b20 en is equally the all. But place is not the heaven, but some extreme and resting limit of the heaven touching mobile body. And because of this, the earth is in the water, and this is in the air, and this is in the aether, and the aether is in the heaven, but the heaven is not again in another.[37]

It is also apparent from these [considerations] that, place being spoken of thus, all the difficulties can be solved. For it is not necessary that place grows along with [what grows], nor that there is a / place of a point, nor that two bodies are in the same place, nor that b25 place is a certain bodily dimension: for what is between within a place is a chance body, but not a dimension of body. And place is also somewhere, but not as in a place, but as a limit in the limited. For not every being, but [only] mobile body, is in place.

And each thing / is borne to its own place reasonably, then, for b30 what is in succession and is touching, not by force, is of the same kind, and what are of a similar natural aptitude are impassible; things that touch, however, are passive and active toward each other.

And not unreasonably, then, does everything remain in its proper place by nature; for a part does so, and what is in place / is as a divid- b35 ed part is in regard to the whole, as when someone moves / a part of 213a1 water or of air. Thus also is air related to water: for the one is as material, the other as species. Water is the material of air: air is a certain act of the former, for water is air in potency, but air is, in another way, water in potency. One must determine these things / later, but for the a5 sake of due measure it is necessary to speak [of it now]; what is obscurely said now will be more clear then.[38] If, then, the same thing

is both material and actuality (for water is both, but the one in potency and the other in actuality), it would be, in a way, as a part is to a whole, whence there is also touch in these things[39]; but there is a
213a10 growing together when both come to be / one in act. And so, about place, both that it is and what it is have been said.

Chapter 6

213a12 In the same way also, it must be assumed that it is for the student of nature to consider the void, whether it is or not, and how it is, and what it is, just as about place[40]; for, because of what was assumed, we
a15 / disbelieve or believe in void in a similar way. For those who speak of the void put it down as a certain place and jar; it seems to be "full" when it has the bulk of which it is receptive, when deprived [of this], it is "void," as if void and full and place are the same, but to be these is not the same.[41]

a20 One must begin / the inquiry by grasping what those say who affirm void to be and, next, what those who do not affirm it to be [say], and, third, the common opinions about these matters.

Those, then, who try to show that void is not do not confute what the men who wish to speak of void mean, but they speak erroneous-
a25 ly, as Anaxagoras and / those disproving void in the same way [as him] do. For they show that air is something, straining wineskins and showing that air is strong, and cutting it off in clepsydras.[42] But men intend void to be a dimension in which there is no sensible body.
a30 Believing that every being is a body, they say that / that in which there is nothing at all is void, whence, what is full of air is void.[43] One must not, therefore, show this, that air is something, but that there is no dimension different from bodies, either separable or existing in act, which dimension interrupts {divides} every body so as to be non-con-
213b1 tinuous (as Democritus and Leucippus say, and / many others who argue about nature) or even something outside all body, if these are continuous.

These ones, then, do not come to the door of the problem as it is posed, but rather those [do so] who affirm that the void exists. For one thing, they say that motion in place (this is locomotion and growth)
b5 would not / be [if void were not], for there would not seem to be motion, if void were not; for it is impossible that what is full can receive something. If something is received and two bodies will be in the same place, any number of bodies could be together; for one can-

not name a difference due to which what is said [i.e., that any number of bodies could be together] would not be. But if this / can be, the b10
least will receive the greatest; for the great thing is many small things. Whence, if many equal things can be in the same [place], so can many unequal things. Melissus, then, even proves from these [considerations] that the all is immobile. For if it will be moving, it is necessary, he says, for void to be; but the void is not among beings. One way, / then, that they show that void is something is from these [considera- b15
tions].

Another way is that some things clearly contract and come together, as they say a wine-jar receives the wine together with the wine-skins, as if a condensing body contracts into the voids present in it. Moreover, growth seems to everyone to come to be through void; for food / is a body and two bodies cannot be together. What happens b20
to ashes is also a witness: ashes [in a jar] receive as much water as does an empty {void} jar.

The Pythagoreans also said the void exists, and that it goes into the heaven from the infinite air as if by [the heaven] inhaling the void, / which void determines natures, as if void were a certain separation b25
and determination of things which are successive. And this is [true] first in numbers, for the void determines the nature of these.[44] [The considerations], then, from which some men say void is and some say void is not are perhaps such and so many.

Chapter 7

To see which way things stand, one must grasp what the name signi- 213b30
fies.[45] Void, then, seems to be place in which there nothing. The cause of this is that they believe that being is body: all bodies are in place, and that place in which there is no body is void; whence, if there is no body somewhere, nothing is there. Again, / they believe that every 214a1
body is tangible; but such is what would have heaviness or lightness. By syllogism, then, it happens that this is void, that in which there is nothing heavy or light. These things, then, as we also said before, occur by syllogism.

But it is strange if the / point is void, for void must be place in a5
which there is a dimension of tangible body. But it then appears that void is said in one way as what is not full of body sensible according to touch; the sensible according to touch, however, is what has heaviness or lightness.

Whence also, if someone were at a loss, what would they say, if
214a10 a dimension / had a color or sound in it, would it be a void or not? It is clear that if it might receive tangible body, it is void, but if not, it is not void.

[Void is said] in another way, as that in which there is not a "this something" or a bodily substance. Whence, some say the void is the material of bodies (whoever says also that place is this same thing),[46]
a15 not speaking well. / For the material is not separable from things, yet they seek the void as something separable.

Since, however, we have determined about place, and, if void is, it is necessary that it be place deprived of body, and it has been said how place is and how it is not, it is apparent thus that void is not,
a20 either separated or inseparable.[47] For / one wishes void to be, not body, but a dimension of body; whence, the void seems to be something because place is, and due to the same things. For, in fact, motion according to place is present to the minds both of those who say that place is something besides the bodies falling in and of those who say
a25 void is. They believe that the void is the cause of motion / as that in which a thing is moving; and this would be such as some say place is.

Yet there is no necessity that if motion is, void is. Generally, then, as to all motion, in no way [is it necessary], due to what Melissus also missed – to be altered can happen to the full. But, then, neither [is it necessary] according to motion according to place; for it can happen
a30 that the bodies simultaneously make way / for each other, there being no dimension separate from the moving bodies. And this is clear also in the whirling of continuous things, as well as in that of watery things.

However, becoming more dense can happen not [by motion] into the void but because the bodies within / are squeezed out, as the air
214b1 within [is squeezed out] when water is pressed together. And growing can occur not only by something coming in but also by alteration, as when air comes to be from water.[48]

In general, however, the arguments about growth and about water
b5 poured into the ashes / get in their own ways. For either not every part grows, or not by body, or else two bodies can be in the same place. They claim, then, to solve a common difficulty, but they do not show that the void is: or else the whole body must be void, if it grows in every part and it grows due to the void. The same argument, howev-
b10 er, applies also to / the ashes. It is apparent, then, that it is easy to resolve [those considerations] from which they show the void to be.

Chapter 8

That there is no void thus separate, as some say, let us say again.[49] For 214b12
if there is some locomotion by nature for each of the simple bodies,
as up for fire and down / and towards the middle for earth, it is clear b15
that void would not be the cause of locomotion. Of what, then, will
void be the cause? For it seems to be [the cause] of motion according
to place, but it is not [the cause] of this.

Moreover, if it is something, like a place deprived of body, when
void is, where will a body put into it be borne? For surely [it will] not
[be borne] in every way.[50] And the / same argument applies to those b20
who believe that place is something separate into which a mobile is
borne. For how will what is put in it be borne or remain {rest}? And
the same argument will be fittingly applied to the up and the down
and to the void. For those who say the void is make it a place.

And how, then, will things be present either in place / or in void? b25
For when some whole body is put in a separate place, this [same dif-
ficulty] does not occur: for the part, unless it be put apart, will not be
in place but in the whole.[51] And if place is not [such], neither will void
exist.

What happens to those who say the void is necessary if motion
will be is rather the opposite, / if someone looks into [the matter]: if b30
the void were, not one thing could be moving. For, as some say the
earth rests because of similarity, so also things must rest in the void.
For there is not that from which it will be moved [one way] more
rather than less; for, as void, it has no / difference [among its parts]. 215a1

Next, [void cannot be] because all motion is either by violence or
according to nature. It is necessary, however, if there be violent
motion, that there also be motion according to nature (for the violent
is beside nature, and what is beside nature is posterior to what is
according to nature); whence, if there is / not motion according to a5
nature in each of the natural bodies, neither will any one of the other
motions be. But indeed, if there is no difference between parts in the
void and the infinite, how will [motion] by nature exist? For as infi-
nite, nothing will be up or down or middle, but as void, there is no dif-
ference between up and down. / For just as there is not one difference a10
of nothing, so also of the void; for the void seems to be a certain non-
being and privation.[52] But [one] locomotion is different [from anoth-
er] by nature; whence, there will be differences by nature. Either,
then, locomotion to anywhere is not by nature in anything, or, if there
is, the void is not.

Moreover, projectiles are moving now without what throws /
touching them, either because of mutual replacement, as some say, or a15

because of the pushed air pushing with a motion faster than the locomotion of what is pushed [i.e., faster than the locomotion] according to which it is borne to its proper place. In the void, however, none of these are present; nor could anything be borne {moved locally} except as what is carried.[53]

Moreover, no one could say why what is moved will come to a
215a20 stand / somewhere; for why here rather than there? Whence, either it will rest or it is necessary that it be borne to infinity, unless something more powerful impedes it.[54] Moreover, at present a body seems to be borne into the void because of [the void] yielding; but in the void such a thing is so in every way similarly; whence, a body will be borne in every way.

Moreover, what is being said is also apparent from these [con-
a25 siderations]: / for we see the same weight and body being borne faster because of two causes: either by that through which differing, e.g., through water or earth or through water or air; or by what is borne differing, other things being equal, through an excess of heaviness or lightness.

That through which the mobile is borne, then, is a cause because
a30 it impedes, / most when being borne against [the mobile], but also if remaining {resting}; and what is not easily divisible [impedes] more,
215b1 and such is the thicker [stuff]. / A, then, will be borne through B in time C, but through D, being more subtle, in E, according to the proportion of the impeding body, if the length of B is equal to D. For let
b5 B be water and D air; then as much as / air is more subtle and more unbodily than water, so much faster will A be borne through D than through B. Let the speed stand to the speed, then, in the same ratio as the air to the water. Whence, if it is twice as subtle, it will go through
b10 B in twice the time it goes through D, and time C will be double / E. And always, then, as much as that through which it is borne is more unbodily and less impeding and more easily divided, [so much] faster will it be borne.

The void, however, has no ratio by which it is exceeded by body, just as neither does nothing in relation to a number. For if four
a15 exceeds three by one, and two by more, and, / moreover, one by more than it exceeds two, still, it does not have a ratio by which it exceeds nothing; for it is necessary that the exceeding be divided into the excess and the exceeded; whence, four will be how much it exceeds by and nothing [will be the exceeded]. For this reason, also, a line
a20 does not exceed a point, unless it be composed of points. So too, / the void is not able to have any ratio to the full.

Whence, neither will there be motion, but if something is borne in so much time through so much of the most subtle medium, through

the void the speed will exceed all ratio. For let F be void, equal in magnitude to B and D. If A, then, will go through and be moved in a certain time G, / a time less than E, the void will have this ratio to the b25
full. But in so much time, as much as G, A will go through T, [something] of D. It will go through some medium which is in the space F, then, [a medium] differing from air in being more subtle, according to the same proportion which the time E has to G. / For should the b30
body in space F be subtler than that of D by as much as E exceeds G, A will go through F / with an inverse speed in time G, if it be borne. 216a1
If, therefore, there be no body in F, it will go still faster. But it crossed F in G. Whence, it will go through both the full and the void in an equal time. But this is impossible. It is apparent, therefore, that, if anything is borne through the void in some time, / this impossible a5
thing will follow: for there will be taken something which will go through the full in the same time as [through] the void; for there will be some body proportional to the other as the time is to the time.

As was said at the beginning, the cause of this happening is clear, that all motion has a proportion to motion / (for they are in time, and a10
there is a proportion of every time to a time, if both are finite), but there is no proportion of the void to the full.

These things happen, then, insofar as those through which the mobiles are borne differ. But according to the excess of the thing borne, the following things happen. For we see that, other things being similar / in the shapes, the thing having the greater inclination a15
either of heaviness or lightness is borne faster through an equal space, and this according to the ratio which the magnitudes have to each other; whence, also through the void. But this is impossible: for due to what cause will it be borne faster? For this happens in the full by necessity, for the greater divides faster by its strength: for it divides either by its shape or by the inclination which / the thing borne or the a20
projectile has. So all will have the same speed. But this is impossible.[55]

It is apparent, then, from what has been said that what happens, if the void exists, is the opposite of the reason for which those saying the void is make it up. They believe, then, that void exists, separated by itself, if there is to be motion according to place; but this is the same thing / as to say that place is something separated. That this is a25
impossible was said before.

And even looking into [it] in virtue of itself, the so-called void would appear truly void. For just as, if someone should put a cube in water, an amount of water equal to the cube will be displaced, so also in air, but this is not manifest to sense. And / always, then, in every 216a30
body having the ability to shift, it is necessary that it shift to its natu-

ral place, if it be not pressed upon, shifting either always down, if its locomotion is down, like earth, or up, if fire, or in both ways, or according to whatever sort of thing be put in. In the void, then, this is impossible (for it is not a body): because the mobile must have gone
216a35 through / a dimension equal to that of the cube, which dimension was
216b1 before / in the void, as if neither water nor air would be displaced by a wooden cube, but would go right through it. But indeed, the cube has as much magnitude as the void occupies, which, even if it be hot
b5 or cold or heavy or light, is / nonetheless different from all of these passions in being, even if it is not separable [from them] (I mean the bulk of the wooden cube); whence, even if it be separated from all the others and be neither heavy nor light, it will occupy an equal void and will be in the same part of the place and in the part of the void equal
b10 to itself. How, then, would the / body of the cube differ from the equal void and place? And if two are such, why will not any number be in the same place? This is, then, one strange and impossible thing.

Moreover, it is apparent that the cube will have this [size] even if it be shifted, which all other bodies also have; whence, if this [size] differs in no way from its place, why must one make a place for bod-
b15 ies / besides the bulk of each body, if the bulk is impassible? For nothing [new] happens if there is, besides it, another such equal dimension.

Moreover, it must be clear that there is something like the void among moving things. But now it is nowhere in the world. For the air is something, though it does not seem to be; neither would water, if
b20 fishes were iron.[56] For the discernment of the tangible / is by touch. It is clear, therefore, from these [considerations] that there is no separated void.

Chapter 9

216b22 Some men, due to the rare and dense, believe that it is apparent that the void exists.[57] For if the rare and the dense are not, neither is it pos-
b25 sible to contract and to be compressed. If void / were not, either there would be no motion at all, or the whole [cosmos] would bulge, as Xuthus said, or air and water must always be changed into equal amounts (I mean that if, for example, air has come from a cup of water, at the same time so much water must have come from an equal amount of air), or else the void must be by necessity. For to be compressed and to be expanded cannot be otherwise.

b30 If, then, they say that what is rare is what has many separated

voids, it is apparent that the rare does not exist in this way, if no separable void can exist just as no place having separate dimensions of itself can.[58]

However, if the void be not separable, but void nevertheless is something within [bodies], this is less impossible.[59] Yet it happens, first, that void is not / the cause of all motion, but of upward motion b35
(for the rare is light, whence, / they also say fire is rare). Next, the 217a1
void will not be a cause of motion as that in which, but as wineskins are, which, being carried up themselves, carry what is continuous with them; in this way the void bears things up. And yet how is it possible that the void is borne or that there is a place of void? For there comes to be a / void of the void, into which the [first] void is borne.[60] a5
Moreover, how will they give an account of being borne down, in the case of the heavy? And it is clear that, if a thing will be borne upwards insofar as it is more rare and vacuous, it would be borne fastest when it is wholly void. Probably, however, it is impossible that the void be moved; for the argument is the same: just as everything is immobile in the void, so / also the void is immobile, for the speeds would be a10
incomparable.[61]

However, since we do not affirm that the void exists, but the other things have been truly posed as difficulties (that if condensation and rarefaction are not, then either there will be no motion, or the heaven will bulge, or an equal amount of water will be from air and air from water (for it is clear that more air comes to be from water; / therefore a15
it is necessary, if compression is not, either that the contiguous {successive} thing be thrust out, producing bulging, or that somewhere else an equal amount of water changes from air, so that the whole bulk of the whole is equal, or that nothing is moving; for, when something is displaced, this will always happen, unless the mobile be borne in a circle: but locomotion is not always in a circle, / but it is also in a a20
straight line; those men, then, say void is something because of these things), we say, from the things laid down, that there is one material of contraries, of hot and cold and of the other natural contrarieties; and that being in act comes to be from being in potency; and that material is / not separable but to be material is different; and that a25
material is one in number [even] if it should chance to be [the material] of color and of heat and of cold.[62]

The material of a large body and of a small body is the same. This is clear: for when air comes to be from water, it is not by taking something additional that the material came to be something else, but what was in potency came to be in act; and, again, water from air similarly; / sometimes [the material changes] from smallness to greatness, a30
sometimes from greatness to smallness. So too, therefore, even if

much air comes to be of smaller bulk, and from the smaller comes a larger, the material, due to being in potency, comes to be both.

For just as the same material becomes hot from being cold and cold from being hot, because it was in potency, so too, from being hot
217b1 it comes to be / more hot, even though nothing in the material comes to be hot which was not hot when it was less hot, just as, should the circumference or curvature of a greater circle come to be that of a smaller circle, whether it is the same [curve] or a different one, the
b5 curved does not come to be in anything which was not / curved but straight. For the less and the greater are not due to lacking. Nor can one take some bit of a flame in which heat or brightness are not present. The prior heat, therefore, is related to the later heat in this way; whence also, the magnitude and smallness of sensible bulk are stretched out not by the material taking on something additional, but
b10 because the material is in / potency to both. Whence, the same thing is both dense and rare, and there is one material of these.[63]

The dense is heavy, the rare is light. (Moreover, just as a circumference of a circle contracted to a smaller does not take on the concave, but what was there is contracted, and everything which one
b15 might take of a flame is / hot, so too every contraction and expansion is of the same material.) For two things are [found] in each case, i.e., in the cases of the dense and the rare: for the dense seems to be both heavy and hard, and the rare the opposites, both light and soft. However, the heavy and the hard do not go together in lead and iron.

b20 From what has been said, then, it is apparent that a separated void does not exist, whether simply or in the rare, nor [does it exist] in potency, unless someone entirely wishes to call the cause of being borne void. Thus the material of the heavy and the light, as such a material, would be the void: for the dense and the rare are, according
b25 to this contrariety, / productive of locomotion; according to hardness and softness, of passion and impassivity, and not of locomotion but rather of alteration. And about the void, how it is and how it is not, let it have been determined in this way.[64]

Chapter 10

217b29/b30 Of the things mentioned, the next one is to approach time.[65] / First it would be well to raise difficulties about it through arguments from outside [our school], [as to] whether it is among beings or among non-beings, [and] further, [as to] what the nature of it is.

Someone might suspect from the following, then, that it either does not exist at all, or exists scarcely and faintly. For one part of it has come to be and is not, but the other part will be and is not yet; / but from these are composed the time which is infinite[66] and any 218a1
given time. But it seems impossible that what is composed from non-beings share in substance {being}.

Besides these [considerations], it is necessary that either all the parts or some parts of every divisible thing exist when it exists, if indeed it does exist. / But some parts of time have come to be, and a5
some will be, and not one is, though time is divisible. (The now is not a part. For a part measures, and the whole must be composed from the parts, but time does not seem to be composed from "nows.")[67]

Moreover, whether the now, which appears to distinguish the past and the future, / endures always one and the same or is always differ- a10
ent is not easy to know. For if the now is always different, and none of the different parts of time are simultaneous ([I mean] parts which do not contain while another is contained, as the lesser time is contained by the greater), and it is necessary that a now which is not but was before has been destroyed at some time, / the nows too will not a15
be simultaneous with each other, but it is always necessary that the prior now has been destroyed. The prior now could not have been destroyed in itself, then, because it existed then, and it cannot be that the prior now has been destroyed in another now. (For let it be impossible that the nows be contiguous to each other, just as point [cannot be contiguous] to point.)[68] If, then, / it is not destroyed in a successive a20
now but in another, the [two] nows would be together in the infinite nows between. But this is impossible.

But indeed, neither is it possible that the same now endure always. For of no finite divisible thing is there one limit, whether it be continuous in one or in more [dimensions]. But the now is a limit, and / one can take a finite time. Moreover, if to be together according to time a25
and neither before nor after is to be in one and the same now, if the prior things and the later things are in this now, the things which came to be ten thousand years ago would be together with the things coming to be today, and nothing would be before or after / another. Let so a30
many, then, be the difficulties about the things which belong to time.

What time is and what the nature of it is are as unclear from what has been handed down as it is from those difficulties which we, as we went along, first met with. For some say time is the motion of the whole, / others, the sphere itself. 218b1

Yet even part of the revolution is a certain time, but it is not a revolution; for what is taken is a part of a revolution, but not a revolu-

tion. Moreover, if there were many heavens, the motion of any one of
218b5 these would be time in a similar way; / whence, many times would be simultaneous.

But the sphere of the whole seemed to be time to those who said this because all things are in time and also in the sphere of the whole. But what is said is rather too foolish to look into the impossibilities about it.

b10 But since time seems most to be motion and / a certain change, one must look into this. The change and motion of each thing, then, is only in that very thing which is changing, or where what moves and changes happens to be; but time is similarly both everywhere and
b15 with all things. Moreover, change is faster and slower, but time / is not. For the slow and fast are determined by time, what is fast being moved much in little time, what is slow, little in much time. But time is not determined by time, neither by being some amount nor by being some sort. It is apparent, then, that it is not motion. For the present,
b20 let it make no difference for us to say "motion" or / "change."[69]

Chapter 11

218b21 But indeed, neither is time without change. For whenever we do not change our thought or, changing, fail to notice, time does not seem to have come to be for us, just as neither does it seem to be, when they have been awakened, to those who are said in the myth to sleep in
b25 Sardinia among the heroes. / For they join the later now to the earlier now and they make them one, removing what is between because of their lack of sensation. So just as, if there were not another now, but one and the same now, there would not be time, so too, since its being different escapes notice, the time between does not seem to be. If,
b30 then, it happens that we do not believe / time to be whenever we do not distinguish any change, but the soul seems to endure in something one and indivisible, and whenever we have sensation of and we distinguish [change], then we say time has come to be, it is apparent that
219a1 time is not without motion and change. / It is apparent, then, that time neither is motion nor is without motion.

However, since we seek what time is, one must begin from here: what time is of motion. For we sense motion and time together. For
a5 even if it were dark and / we suffered nothing through the body, but there was some motion in the soul, it would immediately seem that

some time had come to be together with [the motion]. But indeed, whenever some time seems to have come to be, together with it some motion seems to have come to be; whence, time is either motion or something of motion. Since it is not motion, then, it is necessary / that a10
it be something of motion.[70]

Since, however, what is moving is moving from something to something and every magnitude is continuous, motion follows magnitude.[71] For because of magnitude being continuous, the motion too is continuous, and because the motion is, the time is. For however great the motion is, the time always seems to have come to be that great.

The / before and after, then, are in place first; they are there, then, a15
by position.[72] But since the before and after are in magnitude, it is necessary that the before and after are in motion, proportional to the ones there. But the before and after are also in time because of the one of these [,time and motion,] always following the other.

But the before and after in motion, as to subject, are motion; nev- a20
ertheless, to be this [,the before and after,] is different and not motion.[73]

But indeed, we even know time when we determine motion, by determining the before and after. And we say time has come to be when we have sensation / of the before and after in motion. a25

We determine it, however, by taking one [now] and another and something between different from these. For when we understand the extremes of the middle to be different and the soul says the nows are two, one before and the other after, then we [also] say this is time. For what is determined by the now seems to be time; / and let this be sup- a30
posed. Whenever, then, we sense the now as one, and not as before and after in a motion, or as the same but as of something before and of something after, no time seems to have come to be, because neither does motion [seem to have come to be]. When, however, [we sense] the before and / after, then we say there is time. For this is time: the 219b1
number of motion according to the before and after.[74] So time is not motion, except insofar as motion has number.[75] Here is a sign: for we judge the more and less by number, but we judge / more and less b5
motion by time; so time is a certain number.

However, since number is twofold (for what is being numbered and the numerable we call number, and also that by which we number), time is then what is being numbered and not that by which we number. That by which we number and what is being numbered are different.[76]

And just as motion is always / other, so is time. However, every b10

simultaneous time is the same, for the now, as a subject, is the same (though the being of it is [always] different)[77]; yet, insofar as it is before and after, the now measures time.[78]

The now, however, is in a way the same and in a way not the same. For insofar as it is always in something different, it is different (for this is what the now was in itself), but as a subject, the now is the same.

219b15 For, as was said, motion follows magnitude, and time follows motion, as we say. And so too, then, what is borne follows the point, by which we know motion and the before and after in motion. This, as a subject, is the same (for it is either a point or a stone or some-
b20 thing else of this sort), but in account / it is different, just as the sophists assume that Coriscus in the Lyceum and Coriscus in the market-place are different. And this [subject], then, is different by being in one place and in another place. However, the now corresponds to what is borne, just as time corresponds to motion. For we know the
b25 before and after in motion by what is borne, / and insofar as the before and after are numerable, the now exists. Whence, even in these [,the before and after], the now, as to subject, is the same (for it is what is before and after in motion), but its being is different (for it is insofar as the before and after are numerable that the now exists.)[79]

And the now is most known. For so too is motion known through
b30 / what is moved, and locomotion through what is borne. For what is borne is a "this something," but motion is not. The now is in a way always the same, then, but in a way it is not the same; for so too is what is borne.

It is also apparent that if time were not, the now would not be,
220a1 and if the now were not, / time would not be. For just as what is borne and the locomotion are together, so too are the number of what is borne and the number of the locomotion. For time is the number of the locomotion, and the now is as what is borne, like the unit of number.

a5 And time, then, is / continuous by the now, and is divided according to the now. For this also follows locomotion and what is borne, for motion and locomotion are one by what is borne; because it is one (and not [just] as to subject, for it might pause, but in account).[80] For this [mobile] determines the prior and the posterior motion.

a10 The now also / corresponds, in a way, to the point. For the point too both continues and determines the length, for it is the beginning of the one [part] and the end of the other. But whenever someone takes the point so that he uses the one point as two, it is necessary that the mobile come to a stand, if the same point will be beginning and end. However, because what is borne is moving, the now is always dif-

ferent; whence, / time is number, not as of the same point, because it a15
is beginning and end, but rather as the extremes of the line; and not as [determining] the parts [of the line], because of what was said. For one will use the middle point as two: whence, it will happen that it rests.[81]

Moreover, it is also apparent that the now is no part of time, nor is the division a part of motion, / just as neither is a point a part of a a20
line, but two lines are parts of the one. Insofar as the now is a limit, it is not time, but an accident in time; but insofar as it numbers, it is a number. For the limits of each thing are only of what they are the limits, but the number of these horses, the ten, is also elsewhere.[82]

It is apparent, therefore, that time is / the number of motion a25
according to before and after, and is continuous, for it is of the continuous.

Chapter 12

The least number, simply, is two, but a certain number in a way has a 220a27
least, but in a way does not, just as, in multitude, the least [amount] of line is two or one, / but there is no least in magnitude. For every a30
line is always divided; whence, time is also like this; for one or two is the least according to number, but according to magnitude there is no least.

It is also apparent / that time is not called fast or slow, but many 220b1
and few, and long and short. For as continuous, it is long and short, but as number, many and few. But it is not fast or slow. For neither is any number by which we number / fast or slow.[83] b5

And the same [time] is everywhere at once,[84] but the before and after are not the same, because the change which is present is one, but what has gone by and what is future are different. Time, however, is not the number by which we number, but that which is numbered, and the latter happens to be before and after, [and is] / always different, b10
for the nows are different. The number of a hundred horses and of a hundred men is one and the same, but what it is the number of is different, the horses from the men.

Moreover, as motion can be one and the same again and again, so too can time, as a year or a spring or an autumn.

Not / only do we measure motion by time, however, but also time b15
by motion, because they are determined by each other. For the time determines the motion, being the number of it, but the motion [deter-

mines] the time. And we, measuring, say the time is much or little by
220b20 the motion, as also the number by what is numbered, e.g., / the number of horses by one horse. For we know the multitude of the horses by the number, and again, [we know] the number itself of the horses by the one horse. So too in the case of time and motion. For we measure the motion by the time and the time by the motion.

b25 And this happens reasonably. / For motion follows magnitude and time motion, in being some amount and continuous and divisible. For because the magnitude is of this sort, the motion suffered these things {received these predicates}, and because of the motion, the time. And we measure both magnitude by motion and motion by magnitude. For
b30 we say / the road is long if the passage takes long, and that the latter is long, if the road is long; and the time, if the motion, and the motion, if the time.

221a1 But since time is the measure of motion / and of moving, and it measures motion by determining some motion which will measure the whole, just as the foot measures the length by determining some magnitude which will measure the whole, and to be in time for motion
a5 is to be measured / by time, both it and the being of it[85] (for time measures the motion and the being of the motion simultaneously; and this, for motion, is its being in time: the being measured of its being), it is clear that even for other things this is to be in time, the being
a10 measured by time of their being.[86] For to be in time is / one of two things: one is to be when time is, one is as we say that some things are in number. The latter [expression] signifies either a part and passion of number, and generally that a thing is something of a number, or else that there is a number of it. But since time is a number, the now
a15 and the before and any other such [objects] are in / time as the unit and the odd and even are in number. For the ones are something of number, the others are something of time. But things are in time as in number. If so, they are contained by number as things in place by place. However, it is apparent that to be in time is not to be when /
a20 time is, just as neither is to be in motion or to be in place to be when motion or place is. For if to be in something should be like this, all things will be in anything and the heaven in a grain. For when the grain is, the heaven is. But this just happens, but the other necessari-
a25 ly follows, both, for the being which is / in time, that there is time when it is, and, for the being which is in motion, that then there is motion.[87]

Since, however, what is in time is in as in number, some time may be taken greater than that of every being which is in time. Whence, it is necessary that everything in time is contained by time, just as also any other things which are in something, e.g., the things in place are

contained / by place.[88] And a thing, then, suffers something by time, a30
as we are accustomed to say that time wastes things away, and all
things grow old by time, and things are forgotten due to time, but / not 221b1
that one learned nor that something new or good comes to be. For
time, according to itself, is rather the cause of corruption. For it is the
number of motion, and motion removes what is.[89] Whence, it is
apparent that the beings which always are, insofar as they always are,
are not in time, for they are not contained by / time nor is the being of b5
them measured by time. A sign of this is that they do not suffer any-
thing by time, as if they are not in time.

However, since time is the measure of motion, it will also be acci-
dentally the measure of rest. For all resting things are in time. For it
is not the case that, just as what is in motion is necessarily moving, /
so too is what is in time. For time is not motion, but the number of b10
motion, and even what is resting can be in the number of motion. For
not every immobile thing rests, but what is deprived of motion though
naturally apt to be moving, as was said in the foregoing.[90] However, to
be in number is for there to be / some number of the thing and for the b15
being of it to be measured by the number in which it is; whence, if it
is in time, by time. Time, however, will measure what is moving and
what is resting, the one as moving, the other as resting. For it will
measure the motion and the rest of these things, a certain amount; so
that what is moving will not be simply measurable by time, / insofar b20
as it is some amount, but [it will be measurable by time] insofar as the
motion of it is some amount. Whence, whatever things neither move
nor rest are not in time. For to be in time is to be measured by time,
and time is the measure of motion and rest.

It is apparent, then, that not all non-beings are in time, such as
whatever is not able to be otherwise, as that the diameter / is com- b25
mensurate with the side. For generally, if time is the measure of
motion in virtue of itself, but of other things accidentally, it is clear
that of whatever it measures the being, being for all those things will
be in resting or in moving. Whatever things, then, are corruptible and
generable and, generally, sometimes are and sometimes are not, are
necessarily in / time. For there is a certain greater time which will b30
exceed the being of these and will exceed the time which measures the
substance of these. Of non-beings which time contains, some were, as
Homer at some time / was, and some will be, as something in the 222a1
future; it contains in one of the two directions. And if in both, both: it
was and it will be. However, whatever it does not contain in any way,
neither was nor is nor will be. There are such things among non-
beings: the opposites of whatever always are, as / the diameter being a5
incommensurable always is, and this will not be in time. Neither,

therefore, is its commensurability. Whence, it always is not, because it is contrary to what always is. Of whatever the contrary is not always, these are able to be and not to be, and there is coming to be and destruction of these things.

Chapter 13

222a10 The now is the connection of time, as was said. For it connects the time passed and the time which will be, and is the limit of time. For it is the beginning of the one and the end of the other. But this is not apparent as in the case of the point, which remains.

Yet the now divides in potency. But insofar as it is like this, the
a15 now is always different, / but as it ties together, it is always the same, just as in the case of mathematical lines. For the point is not always the same in the understanding. For, [the line] being divided, the point is always other, but insofar as [the line is] one, the point is wholly the same. So too the now is the division of time according to potency, and is the limit and unity of both parts. The division and union are the
a20 same and according to the same, / but to be these is not the same. One of the nows, then, is spoken of thus; in another way, when the time of this [occurrence] is near. He will come "now," because he will come today; he has come "now," because he came today. But the things in the *Iliad* did not come to be "now," nor did the flood come to be "now." Still, time is continuous up to these events; but [there is this difference] because they are not near.

a25 However, / "sometime" is a time determined in regard to a prior "now," as in "Troy was taken at some time" and "the flood will be at some time." For it must be determined in relation to the now. So there will be some amount of time from this to that, and there was [some amount] to the past now.

However, if there is no time which was not "some time," every
a30 time would be finite. Will it, then, give out? / Or will it not, if, indeed, there is always motion? Is the time other, then, or often the same? It is clear that as the motion is, so is the time. For if one and the same motion sometimes comes to be, the time too will be one and the same,
222b1 but if not, it will not be. However, since the now is the end and / the beginning of time, but not of the same time, but it is the end of the past and the beginning of the future, just as the circle somehow has in itself the convex and the concave, so too time is always in its beginning and in its end. And because of this it seems to be always other. /

For the now is not the beginning and end of the same thing; for contraries would be together and according to the same thing. And time will not give out, then, for it is always in its beginning. b5

What is "just now" is the part of the future time which is close to the indivisible now. "When are you walking? Just now," because the time in which he intends [to walk] is near. And it is the part of the / past not far from the now: "When are you walking? I walked just now." But to say that Troy was taken just now – we do not say that because it is much too far from the now. b10

And what is "lately" is the part of the past close to the present now. "When did you go? Lately," if the time be close to the present now. "Long ago" is what is far away. / "Suddenly" refers to what is displaced in a time insensible because of its smallness. b15

But change, by nature, displaces all things. For all things come to be and are destroyed in time. Whence also, some men called it most wise, but another, Paron the Pythagorean, speaking more correctly, called it most indisposed to learning, because things are also forgotten in it. It is clear, then, that, / in virtue of itself, it will be rather more the cause of destruction than of coming to be, as was also said before (for change too, in virtue of itself, displaces), but of coming to be and of being it is [the cause] accidentally. A sufficient sign of this is that nothing comes to be without itself somehow being moved and acting, but a thing is destroyed even when nothing is moving. And we are mostly accustomed / to call this destruction by time. But, indeed, neither does time do this, but this change happens to come to be in time.[91] b20 b25

It has been said, then, that time is and what it is, and in how many ways "now" is said, and what "sometime" and "lately" and "just now" and "long ago" and "suddenly" are.

Chapter 14

These things being thus determined by us, it is apparent that every change and everything in motion is in time. For faster and slower are in every change, for it is apparent thus in all. I say that what first is changed / to the subject[92] {term} according to the same distance, and is moving according to the same rule of motion, is moving faster, as, in the case of locomotion, if both move according to revolution or both according to a straight line. So too in the other cases. But indeed, the "before" is in time. / For we say before and after according to the 222b30 223a1 a5

interval to the now, but the now is the term of the past and of the future; whence, since the nows are in time, the before and the after will also be in time. For the interval of the now is in that in which the now is. ("Before" is said in the opposite way according to past time / 223a10 and according to the future. For we call "before" in the past what is further from the now, but what is closer is "after;" in the future, however, what is closer is "before," and what is further is "after"); whence, since the before is in time, and the before follows upon every a15 motion, it is apparent that every change / and every motion is in time.

It is worth looking into how time is related to the soul, and why there seems to be time in all things, both in the earth and in the sea and in the heaven.

It is because it is some passion or possession of motion, being a number, and all these things are mobiles, for they are all in place, / a20 and time and motion (both according to potency and according to act) are together.[93]

However, someone may be at a loss as to whether time would or would not be, were there no soul. For, should it be impossible that there be something numbering, it is also impossible that there be something numerable; whence, it is clear that neither would there be a25 number. For number is either what has been numbered or the / numerable. However, if nothing else is naturally apt to number except the soul (and, of the soul, the mind), it is impossible that time exists, if soul does not. But only that which is time as a subject would be, i.e., if motion can be without soul. However, the before and after are in motion, and time is these insofar as they are numerable.[94]

a30 Someone may be at a loss, however, / as to what sort of motion time is the number of. Or is it of any sort? For even coming to be is in time, and being destroyed, and growing, and altering, and locomotion. Insofar as there is motion, then, there is a number of each motion. Whence, time is simply the number of continuous motion, / 223b1 and not of a certain motion. But another thing could have been moved now: of each of which [mobiles] there would be a number of motion. There is a different time, then, and two equal times would be simultaneous.

Or is this not so? For a time equal and simultaneous is one and the same time, and those not simultaneous are [same only] in species. b5 For if / there were dogs and horses, and seven of each, the number would be the same. So too, however, there is the same time of motions which are limited {finished} together, but the one is, perhaps, fast, and the other not; and the one, a locomotion, the other, an alteration. Still, the time is the same, if the number, the one of the alteration and b10 the one of the locomotion, is also equal and together. / And because

of this the motions are different and separate but time is everywhere the same, because the number of motions which are equal and together is one and the same everywhere.

However, since there is locomotion, and of this, revolution, and each thing is numbered by some one thing of the same kind, units by a unit, horses by a horse, so too, time / by some determinate time, and, b15
as we said, time is measured by motion and motion by time (this is because the amount both of the motion and of the time is measured by a motion determinate in time); if, then, the first is the measure of all things same in kind,[95] the regular revolution will most be a measure, because the number / of this is best known. Neither alteration nor b20
growth nor coming to be is regular, then, but locomotion is.[96] Whence also, time seems to be the motion of the sphere; because the other motions are measured by this motion, and time by this motion.[97]

The customary way of speaking also occurs because of this. For they say / human affairs are a circle and there is a circle of things hav- b25
ing natural motion and coming to be and destruction. However, this is because all these are discerned by time, and take their end and beginning as if according to some cyclic path. For even time itself seems to be a certain circle. This seems so, again, / because time is the meas- b30
ure of such locomotion and is itself measured by such; whence, saying that what comes to be is a circle of things is saying that there is a certain circle of time. This, however, [is said] because time is measured by a revolution. For the measured appears to be nothing / else 224a1
besides the measure; the whole is but many measures.

It is also rightly said that the number of the sheep and of the dogs is the same, if both are equal; the group of ten, however, is not the same, nor are they the same ten, as neither are / the equilateral and the a5
scalene the same triangle, though the shape is the same because both are triangles. For those are called the same which do not differ by a difference of that [which is in question], but not those which do differ by that [sort of difference], as triangle differs from triangle by a difference (wherefore they are different triangles), but not [by a difference] of shape, but they are in one and the same division. For one / sort of shape is a circle, another a triangle, and of this, one sort is a10
equilateral, another scalene. The shape, then, is the same, and this is triangle, but the triangle is not the same. And the number, then, is the same. For the number of these does not differ by a difference of number. The [group of] ten, however, is not the same. For that of which it is said / differs. For these are dogs, those horses. We have spoken both a15
about time itself and about what is proper to its consideration.

Endnotes

1. Cf. 200b15–25.
2. Because locomotion is the most common sort of change, the discussion of it, in *On the Heavens*, is next in order after the *Physics*; because all mobiles can at least change place, and can change in other ways as a result of locomotion (for the mover and mobile have to be properly situated relative to each other for any change to occur), place is a principle not only of locomotion but of all motion. This is one reason it is appropriate to treat place in the general discussion of changeable things, the *Physics*, even though place is more proximately a principle only of a species of change, locomotion. That locomotion is the chief sort of change is argued at 260a26–261a28.
3. That is, present in it as attributes are present in a subject. If we look to the immobility of place, e.g., we might think it is one sort of thing; if we look to its containing others, we might think it is something else.
4. The existence of place is first seen as a result of motion. Unless what is in a place moves out of that place, we might well think it is a part in a whole instead of a thing placed in a place.
5. There is something about the place which affects the body, not necessarily as an agent affects a patient.
6. The mathematical objects, unlike physical bodies, do have only relative position. The imaginary sphere of the mathematician has no tendency to move up or down; its motion is entirely dependent on the will of the mathematician. A physical sphere does have such a tendency (at least in certain environments), the principle of which tendency is precisely its nature. Cf. 192b19–23.
7. Hesiod, *Theogeny*, ll. 116–17.
8. Place would be a being prior to body, since it can be without body, but not body without it. This is the view which gained popularity during the scientific revolution, culminating in Newton's "absolute space," identified by him and others with "God's immensity." Cf. Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore: Johns Hopkins University Press, 1957), pp. 300–301, note 3; p. 257.
9. "Defined" could also be translated "determined." Aristotle seems to be pointing to a difficulty in definition, as the reference to a "genus" indicates. Both place and body are things with three dimensions, then, and this seems like a genus. What could be the specific difference? If there is none, place and body would both be bodies, and so two bodies would be in one place. Cf. Appendix 7, *Place*.
10. Aristotle does think some places are natural for bodies, as it is natural for earth to be down, and he thinks this is a good for them, because the place preserves them (212b29–213a10). Why, then, does he here explicitly reject the notion that place is a final cause? Perhaps he wants us to reflect on *how* it is a final cause. Some things are final causes as being the thing which is benefitted, as the dweller is the one who benefits from the house, while others are final causes as being the thing which is for the

one benefitted, as the house is for the benefit of the dweller. Both the house and the dweller are final causes, then, but in different ways (cf. *On the Soul* II, 4, 415b20–21). Place is not benefitted by the body, but what benefits the body.

11. Given that Aristotle spends Chs. 6–9 of the present book arguing against the possibility of void space, it would seem the claim that "there is a body in every place" either assumes the later discussion or is taken here only dialectically.

12. It seems Aristotle thinks the first part of the chapter establishes the reality of place, but that, when pressed to say just what place is, we might begin to wonder if there is such a thing as place.

13. That is, if we imagine a physical sphere, e.g., a wooden one, and we remove in our imagination the sensible qualities like color, texture, etc., we are left with a purely abstract or mathematical sphere. If we go even further and remove the spherical surface, the "limit," then we have left an indeterminate magnitude, which can be determined by the shape or form of the surface but which in itself is not determinate. That magnitude is thus "material."

14. Plato, *Timaeus*, 48e2–52d1.

15. Cf. also 192a6–12, where Aristotle points out that Plato identifies matter and non-being. Since empty space seems to be non-being, the further identification of matter and space seems to be a likely consequence of Plato's initial error.

16. Matter is more contained than containing because it is determined by another.

17. Cf. *Timaeus*, 48e–51c.

18. What is common to all the meanings of "in" is that what a thing is in "fixes" or "determines" it and is extrinsic to it. Whence, we see that "in" implies something which determines another and is extrinsic to it. Perhaps in order to drive home the extrinsic nature of place, Aristotle goes on to consider whether a thing can be "in itself."

19. Aristotle may have in mind that Anaxagoras said (205b2) that the infinite is "in itself," or that Plato, in the *Parmenides*, argued both that the One cannot be "in itself" (138a–b) and also that it must be "in itself" (145b–c). The subsequent discussion has more than historical significance, though, because it manifests that place and the placed are exterior to one another, though always correlative, as "in" and "out," or "contained" and "container."

20. That is, not in virtue of parts, but as a whole thing in itself as a whole.

21. To summarize the argument about things being in themselves: a thing might be thought to be in itself in two ways: through its parts or as a whole (i.e., not through its parts). In the first case, it could be in itself insofar as we speak of the parts as the whole, as we call a thing white because its surface is white. So we can say a whole jar of wine is in itself because the wine is in the jar. If we ask whether a thing can be in itself as a whole, i.e., "primarily," this can be understood in two ways: either in virtue of itself, or accidentally. In the first case, the thing would be in itself simply as a whole and in virtue of no other thing. Inductively, we see that this is not so. A

species is not its own genus, an agent is not its own effect, etc. Further, each part, the container and the contained (and to speak intelligibly of "in" we have to think of something in some sense containing another thing), would have to be both container and contained; and yet these are opposed notions. Could it be in itself as a whole but accidentally, i.e., because it contains something else? (Cf. 209a31–209b1.) No, for then two things, the thing itself and the thing in it, would be in the same place primarily.

22. The last sentence is a sign that Aristotle will now move on to determine the truth about place.

23. The search for a definition will begin with reflection on certain *per se* properties.

24. The last of these is most debatable. If we begin from our own experience, and not by assuming that the "experts" (here they are physicists or cosmologists) are necessarily right, it seems clear that bodies do have natural motions to determinate places; the rejection of this view is not so easy nor so unproblematic as we, under the influence of modern imagination, might think. For a consideration of some of the questions concerning natural place, cf. Appendix 7, *Place*.

25. Thus, we know motion somehow better than place; this principle will often be used in the discussion of place.

26. Though we are probably at first inclined to think of the place as equal to the placed in the same way as one body is equal to another, by having equal volumes, here Aristotle points out that the interior surface of a containing body is also equal to the contained, not in volume but in capacity: the surface is able to contain as big a body as the one which it in fact contains. This fits our experience well, for a jar is a kind of place and is equal to the contained only in the sense outlined here, not by itself having the same volume.

27. Cf. Appendix 7, *Place*, for a consideration of the four candidates for the genus of place.

28. Since natural philosophy has to refer to sensation as an ultimate foundation, Aristotle points out that when a body leaves a place, another sensible body takes its place, and there is no obviously empty place. To contend that a place is or even can be empty is thus a matter for argument or experiment. For a consideration of the view that place is a separate space, cf. Appendix 8, *Void*.

29. As the whole body of water coincided with the supposed dimensions stretching from one side of the container to the other, so will half the body of water, after the other half has been poured out, coincide with half the dimensions, and a quarter with a quarter, etc. (For the sake of simplicity, assume the container surrounds the water on all sides, like a cup with a lid.) But the divisions of the underlying dimensions have to be actual, or else there is no place equal to the placed. So all the possible divisions have to be actual, and there will be infinite places together. We have to say, then, either that somehow the dividing of the body also divides the non-bodily dimensions, or else that, even without such a division, the space nevertheless can be equal to the placed. Cf. Appendix 7, *Place*.

30. Aristotle seems to be assuming a fairly primitive notion of space, a notion in which

the separate dimensions which are space move with the container when it moves.

31. That is, the water in the jar is not simply in a new place when the jar is moved, though it is in a new place insofar as it is in the jar which is in a new place relative to the whole heavens (or whatever other common place we wish to consider).

32. The principle that place is known through motion is crucial in rejecting the first three alternatives. That place is separable from the mobile shows that it is neither material nor form; that the parts of bodies are moved only *per accidens* is used in showing that place is not a separate space. This is clearer at 214b24–27.

33. Since the limit of the containing body moves along with the containing body, but place cannot itself move (or else we will have an infinite regress), Aristotle now must try to explain how the limit of the containing body can be immobile. When the container moves, the common, immobile place is "more" the place. But place must also be equal to the placed, so more must be said. Aristotle leaves us only the principles of a solution, not a completely worked out answer. Cf. Appendix 7, *Place*.

34. Note that, for Aristotle, there is not even empty space outside the heaven, since empty space, as he will argue in the next few chapters, does not exist. What would it be but subsisting non-being?

35. Aristotle has his eyes on the question of how the outer sphere, which he thinks contains the entire universe, can be in place, as it must be if it changes place through rotation.

36. Cf. 211a29–34.

37. Cf. 240a29–b7.

38. Cf. *On Generation and Corruption* I, 3, 318a35–319a3. The naturalness of places relies on the distinctions of the elements. The general discussion of the natural world given in the *Physics* does not make such distinctions, so the discussion of natural place here is necessarily cursory.

39. Cf. *On Generation and Corruption* I, 6, 322b26–323a34; 258a20–21.

40. Cf. 208a27–29.

41. That is, they are the same in subject but different in definition.

42. The clepsydra or "water-thief" was a device for carrying water or wine from one container to another. It had holes at the bottom and a hole at the top which could be stopped with a finger. After letting in the wine from the bottom, the top hole was stopped and the clepsydra carried to the new container. Once the top hole was stopped, the wine would not flow out of the holes at the bottom. If the clepsydra was not full, there would be air "cut off" at the top of the container.

43. Because air seems to be nothing, that in which there is only air seems to be void.

44. Cf. *Metaphysics* XIII, 6, 1080b16–21, 30–33.

45. For Aristotle, this is particularly important in the case of the void, since he does not think there is such a thing. He must therefore begin from what people who believe in void think and respond to that.

46. Aristotle probably has Plato in mind. Cf. 209b6–17; 201b32–210a2; 192a3–12.

47. This remark indicates the Aristotle thinks his treatment of place was sufficient to refute the existence of void. Cf. also 216a24–26; 216b30–33.

48. Neither explanation is really Aristotle's, since he does not think that the expansion of water into air is alteration nor that condensation only occurs by squeezing small bodies out. He is merely trying to show that the void is not the only possible explanation for the phenomena brought forth in favor of the void.

49. Since Aristotle has not yet, in the chapters dealing with void, shown that void does not exist, but only that the arguments for it do not conclude necessarily, he must be referring to the chapters on place.

50. Perhaps Aristotle is thinking that someone might think that things move in a certain direction because there is less pressure in that direction and so conclude that things move in a void because there is no pressure in the direction of the void. But then they would have to move in all directions in a complete void.

51. Perhaps Aristotle is thinking that the parts of a body would coincide with the parts of space just as would the whole body, so that the parts and the whole would be in place in the same way. But if so, the parts will move in the same sense as the whole moves, that is, *per se*, and so any change of place will involve an infinity of motions. This does not happen in Aristotle's view, since the parts are not in place except accidentally. Moreover, what is most basic about place is that things are in it, while in the view that place is space, things will not be in place but will coincide with place. Place, insofar as it implies "in" and "out," implies exteriority, not coincidence. Because this is so, and because place has to be equal to the placed, it seems that only Aristotle's definition of place can account for the facts about it.

52. The belief in the real existence of a void, then, seems to be the postulation of a subsisting non-being. To exclude this, some have tried to identify space with some immaterial being, like God, especially since both are "infinite." Cf. Appendix 7, *Place*. But can an immaterial thing have dimensions?

53. This argument clearly assumes that every motion requires the actual contact of a mover which is in contact with the mobile. On this, cf. 241b24–248b28 (or the alternative text, 241b34–248a9, which I have placed at the end of this translation); 254b7–256a3; 257b6–11; Appendix 10, *A Brief Note on Inertia*, and Appendix 11, *A Note on Contact between the Mover and the Moved*.

54. The similarity between this statement and the law of inertia is apparent. Cf. Appendix 10, *A Brief Note on Inertia*.

55. The last two arguments are those which are most often identified as Aristotle's reasons for rejecting the existence of void. Galileo, e.g., attacks only these arguments in *Two New Sciences*. Cf. Galileo, *Two New Sciences*, trans. Stillman Drake (Ann Arbor: The University of Michigan Press, 1974), pp. 65–80. Given Galileo's propensity for mathematical physics, this is fairly predictable. Reading the text of the *Physics*, however, makes it clear that these are not even the most fundamental of Aristotle's arguments. It should also be noted that the assumption of the arguments is that all resistence to motion is due to the medium, but elsewhere Aristotle points out

that difference in heaviness is also a factor. Cf. 249b30–250a9. Perhaps this indicates that the present arguments are intended to be dialectical responses to particular positions taken up by some of Aristotle's contemporaries. On the other hand, for Aristotle, weight would not be a principle of resistance in the downward motion of heavy bodies, but rather of their fall. It is perhaps worth noting that Newton's law of gravitation implies that a greater force is exerted on a more massive body at the same distance from the earth; only the equivalence of gravitational and inertial mass, which is for Newton an accident and for Einstein a principle, accounts for the observation that heavier and lighter objects do fall at the same speed when dropped from the same height.

56. If fishes were as hard as iron, the water in which they dwell would make so little impact on their senses that it would seem as nothing, as air sometimes does to us.

57. Having considered the position that void must be to explain locomotion from place to place, Aristotle now considers the view that void must be to explain rarefaction and condensation.

58. Once again, Aristotle considers the treatment of place to have sufficiently excluded the possibility of void.

59. If void is not a separate set of dimensions, but something (still dimensional?) connected to body, we at least do not have the problems outlined in the treatment of place or in the previous chapter.

60. If void is not a separate set of dimensions, it is an inseparable set. But then it is carried around with the body in which it is, and there will be a proper place of a proper place.

61. Cf. 215a24–216a21.

62. Cf. 187a12–192b4.

63. The thought is that dimensions are themselves formal with respect to material, so that, just as one material can be hot or cold, so it can be greater or lesser without the addition or subtraction of material. It is not possible to imagine this, but it is possible to think it.

64. On the void, cf. Appendix 8, *Void*.

65. Cf. 200b15–25.

66. Aristotle will argue for the infinity of time in Book VIII, Ch. 1, 250b11–252a5.

67. This will be shown later. Cf. 230a21–232a22; 232b26–233a10.

68. Ibid.

69. Aristotle will distinguish these in the next book, at 225a35–225b5.

70. In fact, time seems to be an object of sense because everyone is aware of it, and, because everyone is aware that every motion is in time without any argument, it seems to be something which is sensed along with motion. Cf. Appendix 9, *Time*.

71. As he does at 208a31–32, Aristotle assumes that locomotion is the primary sort of change, a claim he will argue for at 260a26–261a28.

72. Note that the names "before" and "after" contain the roots "fore" and "aft." Magnitude, because it is quantity with position, has order, or before and after, in its very notion. In the *Categories*, however, Aristotle does not even list before in place as a meaning of the term "before" (Ch. 12, 14a26–b23), though he does speak of priority in time. If the before and after in time are posterior to the before and after in place, then the former implies the latter. Perhaps this is why Aristotle is content to leave place out of consideration in the *Categories*.

73. In the physical world, what is is the motion; but to be motion is not to be time. Aristotle will now go on to determine what is additional in the notion of time.

74. In this definition, "before and after" must refer to the before and after in motion or in place; to have them refer to the before and after in time would seem to involve circularity.

75. Thus, time, in the physical world, is nothing other than motion, but when we consider the before and after in motion and so number them (by noting that they are two), we recognize time. The recognition of time is nothing other than the recognition of the before and after in motion. So time is something of motion, but to be motion is not to be time.

76. That by which we number is an abstract number, "two," "three," etc., but what we number by these numbers is also called "number," as "a number of horses" or "a number of nows." We might wonder how time can be continuous if it is a number, for numbers are discrete. (Cf. *Categories*, Ch. 6, 4b22–23) When we count the number of feet in a yard, we say there are three feet by noting that we have a beginning, then the end of one foot, which is also the beginning of the next foot, and so on until the end. Thus, we count the continuous in virtue of counting its divisions. The divisions of time which we count are the nows, but in doing so we count the time itself in terms of units. We do not even have to count equal parts of time to do this, so that the time we count in terms of the nows need not be anything more than parts of time, whether equal or unequal.

77. That is, the now is the same for every mobile, but the now is always other insofar as it is now, e.g., 9:00 a.m., later, 9:01 a.m., etc. If time is the number of the motion, and there are many motions, how can the time be one? Just as the divisions of a measuring stick coincide with the divisions of the thing measured, so do the divisions of a motion by which we number other motions coincide with the divisions of the motions which are measured. How is this coincidence possible, though, if the divisions are of the motions and the motions are in different bodies? This is more clearly taken up later, at 223a29–224a17; cf. also Appendix 9, *Time*.

78. It may be as well to note that if time is the number of motion, then it would seem the divisions of time, the "nows," are divisions of motion; but the divisions of motions are the various dispositions of the mobile as it moves, e.g., being here, then here, then here, etc. Bearing this in mind may make the rest of this chapter easier to follow.

79. The now is different insofar as the motion is always other and the division of the motion, which, considered as numbered, is the now, is always different; but insofar as the mobile which the motion and its divisions are in is always the same, the now is always the same.

80. The mobile is one even if it pauses in its motion, but the motion is not one in this case.

81. Cf. 261b27–262b8.

82. Perhaps the thought is that insofar as the now is a division of time, it is only in time, but insofar as the things which are in time are all of them numbered in their duration by time, the number by which we number the nows, and through them time, is also elsewhere.

83. Aristotle said that time is the numbered number (219b5–9) and will say it again very shortly (220b8–9); yet here he argues that because it is a numbering number it is neither fast nor slow. Perhaps we should say that insofar as some motion is numbered by the abstract numbering number, which is clearly neither fast nor slow, that numbered number is neither fast nor slow, but insofar as we compare various motions, including our first motion, among themselves, they are fast or slow.

84. Aristotle seems to assume this as obvious. Einstein would seem to disagree. Cf. Appendix 9, *Time*.

85. The "being of it" seems to indicate its duration, for to endure is nothing other than to continue to be. Here Aristotle uses "τὸ εἶναι" to indicate not essence or nature, as he usually does, but existence or the act of being.

86. If one measures the duration or being of a horse, one is measuring how long it exists; but to measure it, not its being, is to measure its size.

87. The fundamental problem with saying that to be in time is to be when time is may be that the word "when" does not imply any order, while the word "in" does imply order. "When" merely indicates coincidence, not containment. Thus, the difficulty raised here may be akin to that which plagues the view that place is space: a thing is not in space so much as it coincides with it, and the space coincides with the thing as much as the thing with the space.

88. Perhaps the thought is that everything which is in time is somehow contained by time, so that there is a time greater than it, just as there is always a greater number than any given one. But if something exists which is as long as time is, e.g., the universe, then, presuming it exists for all time, is not so much in time as coinciding with time, though the parts of its being or of its duration will be in time. If Aristotle intends to say by this argument that time must be infinite, he is clearly using only a dialectical argument, not a sure proof or demonstration.

89. Time, considered just as such, is the number of motion, and motion removes what is. To understand the production of some particular thing, like a man or a house, we must consider some agent, the parents or the housebuilder. Time, as such, only "causes" flux (222b16–27).

90. Cf. 202a3–5.

91. It does not seem likely that Aristotle means to say that time is a sufficient cause of destruction, but rather that, since time is merely the number of motion, and motion removes what is, time as such is more the cause of destruction. There is time when there is some motion and the possibility, then, of being acted upon, but there is noth-

ing in the nature of time to assure us that the motion or cause will be beneficial to any particular being.

92. Cf. 224b35–225a7.

93. This shows that there is time in all things, but not that there is one time for all things.

94. If time is the number of motion, and number cannot be without the mind, then time cannot be without the mind. But what would really exist of time, outside the mind, would still exist, i.e., motion and its divisions and the mobiles in which they are. The future and the past do not exist, in fact, except in our memory and expectation. Reflection on this leads us to see just how little hold on being the natural world, and we as parts of it, have, and why some philosophers have been led to think that time and motion, and so the entire world of nature, do not really exist. This is, of course, an exaggerated claim. Aristotle's view has the singular merit of showing how time can really be, though in a very imperfect way, and yet in a way that accords with our experience.

95. If there is a natural first, then we would clearly want to use it as our standard measure, as we use the unit of numbers to measure all numbers; if there is not natural first, then we have only a conventional first which we use as if it were first.

96. Cf. Book VIII, Chs. 7–8, 260a20–265a12.

97. Aristotle argues that locomotion is the first of motions and that rotation is the first of locomotions at 260a20-266a5. Note that number presupposes homogeneous units, so that we have a more perfect number to the extent that we have a more homogeneous unit. Thus, though we perceive time by merely seeing one now and then another, and the mind can ignore the differences, we are led on by the numerical nature of time to look for a motion in which the before and after differ only in number, i.e., in being this one and then that one. Uniform rotation would work here because the revolutions differ only in this way. With the failure of Aristotelian cosmology, is there a candidate to replace the uniform motion of the outer sphere as the regular motion which founds time? Or is this really necessary? Cf. Appendix 9, *Time*.

Book V[1]

Chapter 1

Every thing which changes does so either accidentally, as when we say the musical walks, because this thing, to which being musical happens, walks; or else a thing is said to change simply by something of it changing, as things / said [to change] according to the parts (for the body is healed, because the eye or the trunk is, and these are parts of the whole body); there is, however, something which moves neither accidentally nor by some of the parts of it [moving], but by itself moving first. And this latter is what is mobile in virtue of itself; [it is] a different mobile according to a different motion, as, e.g., the alterable, / and among alterations, the healable and the heatable are different.[2] It is similar in the case of movers. For one mover moves [another thing] accidentally, another according to the part, by some one of the parts of this moving [another thing], another in virtue of itself first, as the doctor cures, but the hand hits. 224a21 a25 a30

Now, the first mover is something, [and] what is being moved is something, / moreover, [there is] that in which, the time, and besides these, that from which and that into / which, for every motion is from something and to something. For what is first moved and that to which and from which it is moved are different, e.g., the timber and the hot and the cold. Of these, then, one is that which, one that to which, and one that from which. It is clear, then, that the motion is in the timber, not / in the species. For the species or the place or the amount do not move and are not moved, but the mover [moves] what is moved and to that into which it is moved. For the change is named more from that to which than from that from which. Whence also, destruction is change to non-being. Nevertheless, what is destroyed also changes from being. / And coming to be is to being; nevertheless, it is also from non-being. a35 224b1 b5 b10

What motion is, then, has been said before.[3] The species and the passions and the place, however, into which the moving things are moving, are immobile, e.g., science and heat.[4] Nevertheless, someone might be at a loss as to whether the passions (whiteness is a passion) are motions. For there would be change into motion. / But perhaps not whiteness, but whitening, is a motion. There is also in these [terms of b15

motion] the accidental, and what is according to a part and according to another, and what is primarily and not according to another, e.g., a thing becoming white changes accidentally to being understood (for
224b20 to be understood happens to the color), / to color, because white is a part of color (and to Europe because Athens is a part of Europe), and to white color in virtue of itself.

It is clear, then, how it is moving in virtue of itself, and how accidentally, and how according to something other, and how what is itself
b25 [moving] first [is moving], both in the case of the mover / and of the thing being moved, and that the motion is not in the species, but in the thing moving and in the mobile according to act.

Let accidental change, then, be removed [from consideration]. For it is in all [terms] and always and of all. Change which is not accidental is not in all but in the contraries and what is between [the con-
b30 traries] and in contradiction.[5] / Conviction about this is from induction.

A thing does change from what is between [the contraries]. For the mobile uses the same thing as being contrary in relation to each. For what is between is somehow the ends. Whence, what is between (in relation to the contraries) and the contraries (in relation to the middle) are called somehow contraries, e.g., the middle note is low in
b35 relation to the high and high in relation to the low, and grey is / white in relation to black and black in relation to white.

225a1 Since, however, / every change {μεταβολή} is from something to something (the name can make this clear: for something is "after" {μετά} another, and the name manifests that one thing is before, another after), the thing changing might change in four ways: for it changes either from a subject to a subject, or from a subject to a non-
a5 subject, / or from a non-subject to a subject, or from a non-subject to a non-subject. By "subject," I mean what is made clear by an affirmation.

Whence, from the things said, it is necessary that there be three changes, the one from subject to subject, the one from subject to non-
a10 subject, and the one from non-subject / to subject. For the one from a non-subject to a non-subject is not a change because it is not according to opposition. For here there are neither contraries nor contradiction.

The change, from non-subject to subject, according to contradiction, then, is coming to be; and one is a simple change simply, anoth-
a15 er a certain change of a certain thing, e.g., the change / from non-white to white is a coming to be of the latter, but the one from non-being simply to substance is coming to be simply, according to which change we say there is coming to be simply, and not that there is a cer-

tain coming to be.[6] The change from subject to non-subject is destruction; simply, the one from substance to non-being, a certain one, the change to the opposite negation, just as was / also said in the case of coming to be. a20

If, then, non-being is said in many ways, neither what is [non-being] according to composition or division [of subject and predicate][7] can be moving, nor can what is according to potency, [i.e.], the potential thing which is opposed to being in act simply (for the non-white or the non-good can be accidentally moving, for man may be non-white, / but what is simply a non-this can be moving in no way), a25 for it is impossible that non-being be moving. If this is so, [it is] also [impossible] that coming to be be motion, for it is a non-being that comes to be [something]. For even if it is most true that a non-being comes to be [something] accidentally,[8] nevertheless it is true to say that non-being belongs to what is coming to be simply.[9] And so too resting [is impossible for non-being]. / These unmanageable things a30 happen, then, by non-being moving. And if everything moving is in place, non-being would be somewhere; but it is not in place. Neither, then, is destruction motion. For the contrary to motion is either motion or rest, but destruction is contrary to coming to be.

Since, however, every motion is a certain change, and the changes are / the three mentioned, and of these, the changes accord- a35 ing to coming to be and destruction are / not motions, and these are 225b1 the ones according to contradiction, it is necessary that the change from subject to subject alone be motion. (The "subjects" are either contraries or what is between. For let both privation be put down as a contrary and also things which are made clear by affirmation, [e.g.,] "naked," / "white" and "black.") b5

If, then, the attributes {predicates, categories} are divided as substance, quality, where, when, relation, amount, acting, and suffering,[10] it is necessary that there be three motions: the one of quality, the one of amount, and the one according to place.

Chapter 2

There is not motion according to substance, however, because there is 225a10 no contrary to substance among beings.[11] Neither [is there motion] in relation. For it can be true that, one of the terms changing, the other changes not at all; whence, motion among relations is accidental.[12] Nor [is there motion], of acting and suffering, or of being moved and

225a15 moving, because / there is not motion of motion nor coming to be of coming to be, nor, generally, change of change.

For, first, motion of motion can be in two ways. One, as of some underlying thing {subject}, e.g., a man is moving because he changes from white to black. Is the motion thus either heating or cooling or
a20 changing place or growing / or diminishing? But this is impossible. For change is not a certain one of the underlying {subject} things.[13] Or else motion of motion is the changing of some different underly-
a25 ing thing from a change to a different species [of change], as / man [changes] from sickness to health. But neither is this possible except accidentally. For this very motion is a change from one species to another; so too in coming to be and destruction, except that these latter are changes to opposites in one way, motion is change to opposites in another way. At the same time, then, the man changes from health to sickness and from this same change to another. It is clear, then, that when he falls sick, he will be changed to whatever [the other change is to]; for it can happen that he rests. And, moreover, [the change] will
a30 never be to any chance change; / and the latter change will also be from something to something different; whence, also, the opposite change [to which falling ill changes] will be getting well. But [this can happen] by being accidental, as one changes from remembering to forgetting, because that in which [something] is present, that thing changes sometimes to science, sometimes to ignorance.

a35 Moreover, if there will be change of change and / coming to be of coming to be, the series will go on to infinity. It is necessary, then,
226a1 that the prior change be, if the posterior / will be, as, if simple coming to be was at some time coming to be, the coming to be was also coming to be; whence, what was coming to be simply was not yet, but at some time the coming to be was still coming to be, and this latter again was coming to be at some time; whence, the coming to be was
a5 not yet at that time. Since, however, there is not / some first thing among infinite things, there will not be a first [coming to be]; whence, neither [will there be] a contiguous {successive} [coming to be]. Nothing, then, will be able to come to be or to be moving or to change. Moreover, the contrary motion is of the same thing and, moreover, the rest; and [so too] the coming to be, and the destruction; whence, what was coming to be was being destroyed when what was coming to be was coming to be. For what is coming to be [is
a10 destroyed] neither right away nor later. For / the thing being destroyed [i.e., the very coming to be] must exist. Moreover, matter must be both under what is coming to be and under what is changing. What, then, will it be (just as the soul or the body is what is altering), what will be the thing in this way coming to be motion or coming to be?

And again, what will be that into which they are moving? For there must be some [end] according to a motion from this to that, and this is not motion or coming to be.

At the same time, how / will it be? For learning will not be the coming to be of learning; whence, neither will the coming to be of coming to be [be coming to be], nor a certain one of a certain one. Moreover, if there are three species of motion, it is necessary that both the underlying nature and that into which they are moving be a certain one of these, e.g., that locomotion be altered or be borne. a15

Generally, however, since everything moving is moving in [one of] three ways, either accidentally / or by moving some part or by moving in virtue of itself, change could only be changed accidentally, e.g., if the one getting well [also] runs or learns. But we long ago removed accidental change [from our consideration].[14] a20

Since, however, [motion] is neither of substance nor of relation nor of acting and suffering, it remains that motion is only according to quality and / amount and "where." For in each of these there is contrariety. Let motion according to quality, then, be "alteration." For this common name is attached [to this motion]. I mean by quality not the one in substance (for even the difference is quality),[15] but the passive one, according to which a thing is said to suffer or to be impassible.[16] a25

Motion / according to amount is unnamed in common; in particular, however, it is growth and diminution, the one to perfect magnitude, growth, the one from this, diminution. Motion according to place, both in a common and in a proper way, is unnamed; let it be named in common "locomotion" {bearing, carrying, φορά}. Nevertheless, these things alone are properly said to be borne {φέρεσθαι} when, in things changing place, / their coming to a stand is not from themselves, and they / do not move themselves according to place. a30 a35 226b1

Change in the same species with regard to more and less is alteration. For motion is from a contrary or to a contrary, either simply or in a certain way. For, in the case of the less, this will be said to change in going to the contrary; / in the case of the more, as from the contrary to this same thing. It makes no difference whether it change in some way or simply, except that the contraries must be present in some way; the more and less, however, are more or less of the contrary being present or not. From these [considerations], then, it is clear that these three alone are motions. b5

The immobile, however, is what is wholly unable to be moved, just as sound is invisible, and what is scarcely moved in much time or what begins slowly, which is called unmovable {hard to move}, and what is naturally apt and able to be moving, but is not moving when it is naturally apt and where and how, which, indeed, is the only one b10

226b15 of the immobiles which I say "rests." / For rest is contrary to motion; whence, it would be the privation [of motion] in what is receptive [of motion].

It is apparent from what has been said, then, what motion is and what rest is, and how many changes there are, and what sort of motions there are.

Chapter 3

226b18 After these things, let us say what "together" and "separate" are, and what "touching" is, and what "between" is, and what "in succession" b20 is, / and what "contiguous" {consequent} and "continuous" are, and in what sort of things each of these is naturally apt to be present. I call these things "together" according to place, then, which are in one first place; "separate," which are in a different place; "touching," those of which the ends are together.

"Between" is that which the moving thing is naturally apt to reach before it changes to the extreme, changing continuously accord- b25 ing to / nature. The thing between is one of at least three things: for the contrary is the extreme of a change.[17] What is not at all, or least interrupted, in regard to the thing [through which there is motion] is moving continuously; not [what is not interrupted] in regard to the time (for nothing prevents a thing being interrupted and right away b30 after / the highest note sounding the lowest note), but in regard to the thing in which it is moving. This is apparent in changes according to place and in the other changes. The contrary according to place is what is most distant according to a straight line, for the least line is limited, and the limited is the measure.

b35 "In succession" is that which, being after the beginning / either 227a1 by position or in species or in something else thus determined, / has nothing among things in the same genus between itself and that to which it is in succession. I mean, e.g., a line [is in succession] to a line or lines, or a unit to a unit or units, or a house to a house. But nothing prevents something from being between. For what is "in succes- a5 sion" is in succession to a certain thing / and is after a certain thing. For one is not in succession to two, nor the first day of the month to the second, but the latter to the former. The "contiguous" is what touches, being successive.

a10 Since, however, every change is among opposites, and some opposites are contraries and some are according to contradiction, and

there is nothing towards the middle of a contradiction, it is apparent that what is between will be in among the contraries.

The "continuous" {συνεχές} is what is indeed something contiguous, but I call a thing "continuous" when, in those which touch, the limit of each comes to be one and the same, and, as the name signifies, are held together {συνέχηται}. This is not possible if the extremes are two. This being determined, it is apparent that the continuous is among those things from / which something one is naturally apt to come to be according to contact. And in the way in which the continuous comes to be one at some time, so too the whole will be one, e.g., either by a nail or by glue or by touch or by growing together. 227a15

It is apparent also that what is in succession is first. For it is necessary that what is touching be successive, but not that everything successive be touching. Whence also, what is in succession / is in things prior in account, e.g., in numbers, but touch is not. a20

And if the continuous is, it is necessary that touching is, but if touching, not the continuous. For it is not necessary that the ends of these things be one if they be together; but if they are one, it is necessary that they also be together; whence, growing together is last according to coming to be. For it is necessary that the ends touch if / they will grow together, but not all touching things are naturally apt to grow together. But it is clear that there is not growing together in things in which there is not touching. a25

Whence, if there is a point and a unit, such as some say exist separately, a unit and a point are not able to be the same: for in the latter things touching is present, but in units / succession is present; and of the ones there can be something between, for every line is between points, but of the others this is not necessary, for nothing is between duality and unity. a30

It has been said, then, what "together" and "separate" are, and what "touching" is, and what "between" / and "in succession" are, and what "contiguous" and "continuous" are, and in what sorts of things each of these are present. 227b1

Chapter 4

"One motion" is said in many ways, for we say "one" in many ways. 227b3
It is one in genus, then, according to the shapes {forms} / of the attributes {predicates, categories}; for a locomotion is one in genus with every locomotion, but alteration is different from locomotion in b5

genus. Motion is one in species when, being one in genus, it is also in an indivisible species. For example, there are differences of color, therefore, blackening and whitening are different in species. Every
227b10 whitening, then, will be the same / according to species with every whitening, and every blackening with blackening. Of whitening [there is] no longer [any difference]; whence, whitening is one in species with every whitening. If, however, there are some things which are at the same time both genera and species, it is clear that in a way [the motions in these] will be one in species, but not simply one in species, e.g., learning, if science is a species of belief, but the genus of sciences.

b15 Someone will be at a loss as to whether / a motion is one is species when the same thing changes from the same to the same, e.g., when one point [moves] from this place to that place again and again. If this is so, however, circulation will be the same as being borne in a straight line, and rolling as walking. Or was it not determined that the motion is different should the "that in which" be different in species?
b20 / But the circumference is different in species from the straight line. Thus, then, is motion one in genus and in species.

The motion one in substance and in number is simply one. What such a motion is is clear by dividing. For there are according to number three things about which we speak in regard to motion: that which,
b25 / that in which, and when. I mean that it is necessary that there be something moving, as man or gold, and that this is moving in something, such as in place or passion, and at some time, for everything moves in time. Of these, however, to be one in genus or in species is in the thing in which the mobile is moving, and to be contiguous was in time, but to be simply one motion is [being one] in all these. For
b30 that in which must be one / and indivisible, i.e., a species; and the when, i.e., the time, must be one and must not be interrupted. And what is moving must be one not accidentally, as the white blackens and Coriscus walks (Coriscus and white are one, but accidentally), /
228a1 nor according to something common. For two men may become well at the same time according to the same health, e.g., from inflammation of the eye, but this is not one motion, but one in species.

If what is destroyed can again come to be [and be then] one in number [with what it was before it was destroyed], Socrates' being
a5 altered according to the same alteration in species, / in one time and again in another, would also be one motion [in number]; if not, the motion will be the same [in species], but not one [simply].

There is also a difficulty close to this last: whether health and generally the states and passions in bodies are, in bodies, one in substance. For the things having [them] are clearly things moving and in

flux. If, then, the health / is one and the same from morning to now, a10
why, when one lacking [health] again takes on health, would this health and that health not also be one and the same in number? For the account [of the unity of the states acquired through motions and of the motions] is the same: except they differ this much, that if the motions are two as in number, through this same [fact] it is necessary also that the states [are two]. For the act of what is one in number is one in number. / However, if the state is one, perhaps it would yet not a15
seem to someone that the act is also one. For when the one walking will cease, there is no longer walking, but, walking again, it will be. If, then, the walking is one and the same, one and the same thing could both be destroyed and be many times. These difficulties, then, are outside our / present consideration. a20

Since, however, every motion is continuous, it is necessary that the motion which is simply one also be continuous (if, indeed, all are divisible), and, if continuous, one. For not every motion is continuous with every motion, just as neither is any other chance thing [continuous] with any chance thing, but those of which the extremities are one [are continuous]. Of some things, there are no extremities, of some, there are, but they are different / in species and equivocal. For how a25
could the extremity of a line and of walking touch or come to be one? Motions, then, which are not the same in species or in genus might be contiguous, for a man running might fall sick right away, and, like the torch relay race, the locomotions are contiguous, but not continuous. For the continuous was put down as that of which / the extremities are a30
one; whence, motions are contiguous and in succession by the time being continuous, but they are continuous by the motions being continuous. This is so / when there is one extreme for both [motions]. 228b1
Because of this, it is necessary that a motion which is simply continuous and one is the same in species and is of one thing and is in one time; in one time, indeed, so that there be no immobility in between. For in the time in which it is interrupted, it is necessary that it rest. Motions between which / there is rest are, then, many and not one b5
motion; whence, if some motion is interrupted by standing, it is not one or continuous. It is interrupted, however, if there is time between. In the case of the motion which is not one in species, even if the time is not interrupted, for the time is one, the motion is other in species. For it is necessary that one motion be / also one in species, but it is b10
not necessary that the latter motion be simply one. It has been said, then, what motion which is simply one is.

Moreover, a complete motion is called one, whether it be according to genus or according to species or according to substance, just as in other cases the complete and the whole are related to the one.

228b15 Sometimes, however, even the incomplete is said to be one, if / only it be continuous.

Moreover, in another way besides those said, regular motion is called one. For irregular motion in a way does not seem to be one, but rather regular motion [seems so], e.g., straight line motion. For the irregular is divisible. But they {the unities of the regular and of the irregular} seem to differ as the more and the less. Moving regularly b20 or not is in every motion. For / a thing can alter regularly, and be borne over what is regular, as over a circle or a straight line; and so too in growth and diminution. Sometimes irregularity is difference according to that in which a thing is moving, for it is impossible that a motion which is not over a regular magnitude be regular, e.g., a motion on a bent line, or on a spiral or another magnitude of which / b25 any chance part does not fit with any chance part. Sometimes the difference is not in the "where" nor in the "when" nor in the "that to which," but in the "how." For sometimes it is determined by fastness and slowness. For that of which the speed is the same is regular, that of which it is not, irregular. Whence, speed and slowness are not b30 species or differences of motion, because / they follow upon all [motions], which are different according to species; whence, neither are heaviness and lightness, the motion being to the same thing, as of 229a1 earth in relation to itself, or of fire in relation to itself. / Irregular motion, then, which happens in locomotion on a bent line, is one by being continuous, but less so. What is less always has a mix of the contrary.

If, however, every motion which is one can be regular or not, contiguous motions which are not the same according to species would a5 not be / one and continuous. For how would a motion composed of alteration and locomotion be regular? For they must fit.

Chapter 5

229a7 Moreover, one must determine what sort of motion is contrary to a motion, and about remaining {resting} in the same way. One must first determine whether the motion from the same is contrary to the a10 motion to the same (e.g., the one from health / to the one to health), as coming to be and destruction seem to be; or the one from contraries (e.g., the one from health to the one from sickness); or the one to contraries (e.g., the one to health to the one to sickness); or the one from a contrary to the one to a contrary, (e.g., the one from health to the

one to sickness); or the one from a contrary to a contrary to the one from a contrary to a contrary, (e.g., the one from health to sickness / to the one from sickness to health). For it is necessary that it {the contrariety of motion} be either one or more of these modes. For a thing cannot be opposed otherwise.

However, the motion from a contrary is not contrary to the one to a contrary, e.g., the one from health to the one to sickness. For the motion is one and the same. Nevertheless, to be these is not the same,[18] as changing from health and changing / to sickness are not the same. Nor is the motion from the contrary [contrary] to the one from the contrary. For [moving] from the contrary and to the contrary or what is between happens at the same time. But we will speak about this later.[19]

But changing to a contrary, rather than changing from a contrary, would seem to be the cause of contrariety. For the one is release from contrariety, / the other a seizing [of it]. And each motion is named according to that into which it changes, rather than according to that from which it changes, as healing [is named] from health, falling ill from sickness.

There remains, then, the motion to the contraries and the one to the contraries from the contraries. Perhaps, then, it happens that the motions to contraries are also those from contraries; but perhaps to be these is not the same. I mean the change / to health [is the same, but to be this motion is not the same] with the one from sickness, and the one from health with the one to sickness.

Since, however, change differs from motion (for motion is change from a certain subject to a certain subject),[20] the motion from contrary / to contrary is contrary to the motion from contrary to contrary, e.g., the one from health to sickness to the one from sickness to health.

What sort the contrary motions are seems to be clear from induction also. For falling ill [is contrary] to being healed; and learning to being deceived / (not through oneself), for these motions are to contraries. (For as science, so deception can be gained both through oneself and through another.)[21] And locomotion up [is contrary] to locomotion down (for these are contraries in length); and the one to the right to the one to the left (for these are contraries in width); and the one forward to the one backward (for these also are contraries).

What is only to a contrary, however, is not motion but change, e.g., becoming white but not from a certain thing. And in whatever things there are not contraries, the change from the same is contrary to the change to the same. Whence, coming to be is contrary to destruction, and release to seizing. These are changes, not motions. /

229b15 In any of the contraries in which there is something between, one must somehow put down motions to what is between as being to contraries. For the motion uses what is between as a contrary, in whichever way it be changing, e.g., [the motion] from grey to white is as from black, and from white to gray as to black, but [in motion] from black
b20 to grey the grey is as white. For the middle / in relation to each [term] is somehow called each of the ends, as was also said before.[22] Motion, then, is contrary to motion thus: the one from the contrary to the contrary [is contrary] to the one from the [latter] contrary to the [former] contrary.

Chapter 6

229b23 Since, however, not only motion, but also rest seems to be contrary to
b25 motion, one must determine this. For motion is simply contrary / to motion; but rest is also opposed [to motion], for it is a privation, and a privation is also, in a way, called a contrary. And a certain sort [is contrary] to a certain sort, e.g., [rest] according to place to [motion] according to place. But this is now said simply: for is the motion from this or to this opposed to remaining {resting} there? Since motion is in [between] two subjects, then, it is clear that remaining {resting} /
b30 in this contrary [is contrary] to motion from this contrary, and that remaining in that contrary [is contrary] to the motion from that contrary to this contrary. At the same time, however, these rests are con-
230a1 trary to each other. For it would be strange if motions are / contraries and rests are not opposed. The rests in the contraries are [contrary], e.g., rest in health [is contrary] to rest in sickness. However, [rest in health is contrary] to motion from health to sickness. For it is unreasonable that [it be contrary] to the motion from sickness to health. For the motion to that in which it came to a stand is rather a coming to
a5 rest, / insofar as it happens to come to be at the same time as the motion; it is necessary, however, that the former or the latter [motion be contrary]. For rest in whiteness is not contrary to motion to health. In anything in which there is not a contrary, the change from this is opposed to the change to this, but is not motion, e.g., change from
a10 being [is opposed] to change to being. And / remaining {resting} is not [the contrary] of these, but unchangingness is. And if the subject is a certain thing, the unchangingness in being is contrary to the unchangingness in non-being. If, however, the non-being is not a certain thing, someone might be at a loss as to what unchangingness in being is contrary to, and as to whether this unchangingness is rest. If

the latter is so, however, either not every rest is contrary to motion, or coming to be and / destruction are motion. It is therefore clear that a15
they are not to be called rest, if these are not motions. But unchangingness [in being] is something similar [to rest], but is contrary either to nothing or to unchangingness in non-being or to destruction. For the latter is from unchangingness in being, but coming to be is to unchangingness in being.

Someone might be at a loss, however, as to why there are remainings {rests} and motions according to nature / and beside nature in a20
change according to place, but not in the other changes, e.g., one alteration according to nature and another beside nature. For healing is not more according to nature or beside nature than falling ill, nor whitening than blackening. So too in the case of growth and diminution, for these are not contrary to each other / as one beside nature [is a25
contrary] to nature, nor is growth [contrary] to growth. And in the case of coming to be and destruction the account is the same. For coming to be is not according to nature, destruction beside nature, for becoming old is according to nature. Neither do we see one coming to be according to nature, another beside nature. Or, if what is by violence is beside nature, / is not destruction contrary to destruction, the a30
violent one, as being beside nature, [contrary] to the one according to nature? Are not also, then, some comings to be violent and not fated, to which are contrary the ones according to nature, / and violent 230b1
growths and diminutions, as the fast growths of the pubescent due to indulgence, and grain maturing fast, though not close-packed? And how is it in the case of alteration? Is it not the same way? For some would be violent, some natural, as some men are rid [of fever] not in the days of / crisis, some in the days of crisis; the ones, then, are b5
altered beside nature, the others according to nature. Destructions will, then, be contrary to each other, not to coming to be. And what prevents it being so? For one may also be pleasant, another painful; whence, destruction is not simply contrary to destruction, but insofar as one / of them is this sort, another that sort. b10

Generally, then, motions and rests are contraries in the way said, as motion up to motion down, for these are contrarieties of place. Fire is borne by nature according to upward locomotion, earth according to downward. And the locomotions of these are contraries. Fire, however, [is borne] upward by nature, but downward beside nature. And the motion of this / according to nature is contrary to the motion b15
beside nature. And the remainings {rests} similarly. For remaining {resting} up is contrary to the motion from up downward. That remaining {resting} comes to be beside nature in earth, however, and this motion according to nature; whence, of the same thing, the

remaining {resting} beside nature is contrary to the motion according
230b20 to nature. For the motion / of the same thing is also thus contrary. For the motion upward or the motion downward of these will be, one, according to nature, the other, beside nature. There is a difficulty: whether there is coming to be of every rest which is not eternal, and whether this is coming to a stand. Of remaining {resting} beside nature, then, e.g., of earth up, there would be coming to be. So when it was being borne up by violence, it was coming to a stand. But /
b25 what is coming to a stand always seems to be borne faster, what is by violence in the contrary way. So it will be resting without coming to be resting. Moreover, coming to a stand seems either to be just this, being borne to the [proper] place of the same thing, or else to happen at the same time. And, if remaining {resting} in a certain place is contrary to motion from there, there is a difficulty. For when it is moving
b30 from this and throwing [this] off, / it still seems to have what is being thrown off; whence, if this same rest is contrary to the motion from there to the contrary, contraries will be present at the same time. Or, if it still remains [in some way], does it rest in some way? Generally,
231a1 part of the thing moving is / there, part in that to which it changes. Whence also, motion is more contrary to motion than resting is. It has also been said, about motion and rest, how each is one, and how some are contrary to some.

a5 However,[23] someone will be at a loss about coming to a stand, as to whether there are rests opposite to any motion whatever beside nature. If there will not be, this is strange. For the mobile remains {rests}, but by violence; whence, something will be resting, [though] not always [resting], without coming to be [so]. But it is clear that there will be: for just as something is moving beside nature, some-
a10 thing may rest beside / nature.

Since there are some motions according to nature and some beside nature, as, for fire, motion up is according to nature and motion down beside nature, is the latter motion the contrary, or the motion of earth? For earth is borne down according to nature. Or is it not clear that both [are contraries], but not in the same way, but the motion according to nature [is contrary] as [contrary to] the motion
a15 according to nature of this [thing], but the motion / of fire up is contrary to the motion of fire down as one according to nature to one beside nature. So too in the case of remainings {restings}.

Perhaps, however, motion is opposed to rest in some way. For[24] when it is moving from this and throwing [this] off, it still seems to have what is being thrown off; whence, if this same rest is contrary to the motion from there to the contrary, contraries will be present at the same time.

Endnotes

1. In this book, Aristotle will divide change according to its kinds; in the next book, he will divide it quantitatively.
2. Just as the mobile is defined in reference to the motion, so are the kinds of mobile defined in terms of the kinds of motion.
3. Cf. 201a9–11.
4. They are immobile *per se* or in virtue of themselves, though mobile *per accidens* or accidentally, insofar as they are in something mobile.
5. It is "in the contraries," because it is between, e.g., black and white; "in what is between the contraries," because it is in between, e.g., light and dark grey; and "in the contradictories," because it is in between not-white and white.
6. Because a substance (or a "thing" in the normal English meaning of that word) is a being simply speaking, while a color, e.g., is not a substance or a thing or a being simply speaking, the coming into being of the former is coming to be simply, while the coming to be of the latter is a coming to be only in a qualified sense ("a certain coming to be"). Cf. 190a31–b5.
7. Cf. *Metaphysics*, V, 7, 1017a7.
8. Cf. 191a34–b27.
9. Thus, though being comes from non-being accidentally, it does not move; something must come to be before it can move.
10. Cf. *Categories*, Ch. 4, 1b25–2a10. It is not clear why Aristotle leaves out "being positioned" and "outfitted," which he does include in the list of the ten highest genera in the *Categories*. Perhaps Aristotle just thinks it is obvious that when one puts a shirt on, we have locomotion, not some new sort of motion, and that when one sits down, we have the locomotion of the parts of the body. The other eight categories are more obvious candidates for the genera of motions. Note that motions are not in the genera as species of those genera, but as terminating in the species of those genera. Growth, e.g., is not a species of quantity, but is in the genus quantity because it is the coming to be of an instance of a species of quantity.
11. Cf. *Categories*, Ch. 5, 3b24–32.
12. This brief comment seems to contain a refutation of the position that change of place is merely relative, a position maintained by both Descartes and Einstein. If, in fact, place is nothing but a relation, then change of place amounts to a change in relation presupposing no other change. But a relation is what it is in virtue of some other attribute of the thing which has a relation. For example, if I am taller than my son, this relation "being taller than" depends on our heights, and our heights are not themselves relations. My son becomes taller than me only if I lose height or he gains height, or both – if neither of us changes height, the relation between us cannot change. If place is a purely relative, it cannot change, for relations only change in virtue of the foundation of the relations changing, but it is assumed that there is no such thing in the case of place. On Aristotle's view, though place involves relation (of

the surface which is place to the heaven), it is not merely relation. Perhaps we tend to think relative place makes some sense because we imagine a stable space underlying the related bodies, and unwittingly use this background as place.

13. Motion is the act of the subject which is in potency as such; it is not the subject itself (201a10–11).
14. 224b26–27.
15. Cf. *Metaphysics*, V, 14, 1020a33–b1.
16. Cf. 245b19–248b28; *Categories*, 8, 8b25–10b11.
17. The three are the two extremes and the intermediate.
18. That is, they differ in definition.
19. 229b14–22.
20. 225a34–b5.
21. Aristotle is thinking of learning from a teacher as opposed to discovering things on one's own.
22. Cf. 224b30–35.
23. 231a5–17 seems to be the addition of a commentator.
24. The rest of this paragraph is found in most manuscripts, but is only a repetition of 230b29–231a3.

Book VI[1]

Chapter 1

231a21 If, however, the continuous and what is touching and what is in succession are as determined before,[2] the continuous being that of which the extremes are one, what is touching, that of which [the extremes] are together, and what is in succession, what has nothing of the same kind between, it is impossible that something continuous be [made] a25 from indivisibles, as a line from / points, if, indeed, the line is continuous, but the point indivisible.

For neither are the extremes of points one (for there is not, on the one hand, an extreme, and, on the other, some other part of the indivisible); nor are the extremes together (for there is no extreme of the partless, for the extreme and that of which it is the extreme are different).

a30 Moreover, it is necessary that the points from which the continuous is [made] be either continuous or touching each other. The same 231b1 account, however, applies to all the indivisibles. / They would not be continuous, then, for the reason stated. Everything touches, however, either whole to whole, or part to part, or part to whole. Since, however, the indivisible is partless, it is necessary [for indivisibles] to touch whole to whole; but what is touching whole to whole will not be b5 continuous. For the continuous / has one part and another part, and is divided into things thus different and separated in place.[3]

But, indeed, neither will point be in succession to point, nor now to now, in such a way that the length, or time, is [made] from these. For what is in succession is that of which there is nothing of the same kind between, but between points there is always a line, and between b10 / nows, time.

Moreover, the continuous would be divided into indivisibles, if, indeed, each thing is divided into those from which it is [made]. But nothing continuous was divisible into partless things.[4]

However, no other kind of thing can be between the points and the nows. For if there will be, it is clear that it will be either indivisi- b15 ble or divisible, and if divisible, either into indivisibles / or into things always divisible. This latter, however, is the continuous.

It is apparent, too, that every continuous thing is divisible into

things which are always divisible. For if [it were divisible] into indivisibles, indivisible will be touching indivisible. For the extreme of continuous things is one and touches.[5]

From the same argument, however, magnitude and time and
231b20 motion are composed from indivisibles / and are divided into indivisibles, or not one is. This is clear from the following. For if a magnitude is composed from indivisibles, the motion which is over this will also be from [an] equal [number of] indivisible motions. For example, if ABC is from the indivisibles A, B, C, the motion over which is DEF, according to which [motion] Z is moved over ABC, each part [of the motion] is indivisible.

b25 If, then, motion being present, it is necessary that something be moving, and if something is moving, that motion be present, moving will also be from indivisibles. Z, then, was moving through A, moving with the motion D, through B, with E, and, similarly, through C, with F.

If, then, it is necessary that what is moving from some place to
b30 some place cannot, at the same time, both be moving to and / have moved to where it was moving when it was moving (e.g., when someone walks to Thebes, it is impossible for him to be walking to Thebes
232a1 and to have walked / to Thebes at the same time), and Z was moving through the partless A insofar as the motion D was present; whence, if Z went through after it was going through, A would be divisible; for when Z was going through, it neither was resting nor had it gone through, but was between [these]. But if the mobile is going through
a5 and has gone through at the same time, what is walking, / when it is walking, will have walked there, and will have moved to where it is moving. However, if something is moving over the whole ABC and the motion by which it is moving is DEF, it is never moving but has moved over the partless A. Motion would not be from motions but from moves {starts, jumps}.[6]

And something [will move] by having moved, not by moving. /
a10 For it has gone through A, [though] never going through it. Whence, there will be something which, though never walking, has walked. For it has walked through this, [though] never walking through this.

If, then, it is necessary that everything either is resting or is moving, the mobile rests according to each of [the parts], A, B, and C[7]; whence, there will be something continuously resting and at the same time moving. For it was moving through the whole ABC and it was
a15 resting in whatever part; / whence also in all.[8] And if the indivisibles of DEF are motions, it can happen that, while motion is present, the mobile is not moving but resting; but if they are not motions, motion is not from motions.[9]

However, it is necessary that time be indivisible in the same way as length and motion, and that it be composed from nows which are indivisibles. For / if all magnitudes are divisible, and what has the same speed will go through less in less time, time will also be divisible. If, however, the time in which something is borne through A is divisible, A too will be divisible. 232a20

Chapter 2

Since, however, every magnitude is divisible into magnitudes (for it was shown that it is impossible that something continuous be from indivisibles), and all / magnitude is continuous, it is necessary that the faster be moved a greater [distance] in an equal time, an equal amount in less time, and more in less time, just as some men define "faster." For let that motion according to which A is moved be faster than that according to which B is moved. Since, therefore, the faster is what changes before, in whatever time A has changed from C to D, / e.g., in FG, in this time B will not be yet at D, but will fall short. Whence, in an equal time the faster will go through more. 232a23 a25 a30

But, indeed, even in less time [it will go through] more. For in whatever time A has come to be at D, let B, which is slower, be at E. Since / A has come to be at D in the whole time FG, therefore, it will be at T in a time less than this. And let it be in FK. CT, then, which A has gone through, is greater than CE, but the time FK is less than the whole FG; whence, in less time / it will go through more. 232b1 b5

It is also apparent from the following arguments, however, that the faster will go through the equal in less time. For since the faster goes through the greater in less time than the slower, and, taking it according to itself, it goes through the greater in more time than [it goes through] the lesser, as through LM than through LJ, the time PR in which it goes through / LM is greater than the time PS in which it goes through LJ. Whence, if the time PR is less than X, in which the slower goes through LJ, PS will also be less than X. For it is less than PR, but what is less than the less is itself less; whence, it will be moving an equal [distance] in less time. b10

Moreover, if it is necessary that / everything be moving in an equal or a lesser or a greater time, and what moves in more is slower, and what moves in an equal time is of the same speed, and the faster is neither of the same speed nor slower, the faster would move neither in an equal nor in greater time. It remains, then, that it moves in less; b15

232b20 whence, it is necessary that the faster / go through an equal magnitude in less time.

Since, however, every motion is in time and in every time it is possible to be moved, but everything moving can be moving both faster and slower, in every time a thing could be moving both faster and slower. These things being so, it is necessary that time be continb25 uous. I call "continuous" / what is divisible into things which are always divisible. For, supposing that this is the continuous, it is necessary that time is continuous. For since it was shown that the faster will go through the equal in less time, let that [motion] according to which A moves be faster, that according to which B moves, slower, b30 and let the slower have moved through magnitude CD in time FG. / It is therefore clear that the faster will move through the same magnitude in a time less than this. And let it have moved in FT. Again, since the faster, in the time FT, has gone through the whole CD, the slower will go through less in the same time. Let it, then, have gone through 233a1 / CK. Since, however, B, the slower, has gone through CK in the time FT, the faster will go through it in less time; whence, the time FT will be divided again. This being divided, the magnitude CK will also be a5 divided according to the same argument {ratio}; if, however, / the magnitude, the time as well. And, by taking the slower after the faster and the faster after the slower, and using what was demonstrated, this will always be. For the faster will divide the time, but the slower will a10 divide the length. If, then, / it is always true to convert, and, being converted, a division always comes to be, it is apparent that every time will be continuous.

And at the same time it is clear that every magnitude will be continuous. For the time and the magnitude are divided according to the same and equal divisions. Moreover, from the customary arguments it is manifestly to be said that, if time is continuous, magnitude is as a15 well, if indeed in / half the time the mobile goes through half and, simply, in less time, less. For there will be the same divisions of the time and of the magnitude.

And if either one of these is infinite, the other is also, and as the one is [infinite], the other is also, i.e., if time is infinite with regard to its extremes, so length is infinite with regard to its extremes; but if time is infinite with regard to division, length too is infinite with a20 regard to division; and if in both ways, / magnitude is also infinite in both ways.[10]

Whence also, the argument of Zeno[11] assumes something false: that going through the infinites or touching the infinites each singly a25 cannot happen in a finite time. For both length and time, and / generally, every continuous thing, is called infinite in two ways, either

according to division or with regard to its extremes. In the case of infinites according to amount, then, touching these cannot happen in a finite time, but touching the infinites according to division can happen: for time is itself infinite in this way. Whence, it occurs that the mobile does go through the infinite in an infinite and not in finite [time], / and that it does touch the infinites in infinite, not in finite, a30
[nows].[12]

Neither, then, is it possible to go through the infinite in a finite time, nor to go through the finite in an infinite time, but if the time be infinite, the magnitude will also be infinite; and if the magnitude be infinite, the time will be also. For let the finite magnitude through which be / AB, the infinite time in which, C. Let there be taken some a35
finite / part of the time, CD. In this time, then, it will go through 233b1
something of the magnitude, and let it have gone through BE. (This will either measure that through which, AB, or it will fall short, or it will exceed; for it makes no difference.) For, if the mobile will always go through a magnitude equal to BE in / an equal time, but this mag- b5
nitude measures the whole, the entire time in which it goes through [AB] will be finite. For the magnitude, too, will be divided into equals.[13] Moreover, if it will not go through every magnitude in an infinite time, but it can go through something, e.g., BE, in a finite time, BE will measure the whole, / and the mobile will go through an b10
equal magnitude in an equal time. Whence, the time will also be finite. But that it will not go through BE in an infinite time is apparent, if the time be taken as finite in one direction. For, if it will go through a part in less time, it is necessary that this be finite, the other limit being present. The demonstration is the same / even if the length b15
is infinite but the time is finite.

It is apparent, then, from what was said, that neither line nor surface nor, generally, any one of the continuous things will be indivisible, not only due to what was just now said, but also because it will happen that the indivisible will be divided. For since in every time there is a faster and a slower, / and the faster goes through more in an b20
equal time, it can go through either double or one and a half times the length. (For this can be the ratio of the speeds.) Let the faster, then, have been borne over one and a half in the same time, and let the magnitude over which the faster goes be divided into three indivisibles, AB, BC, and CD, / that of the slower into two, EF and FG. The b25
time too, therefore, will be divided into three indivisibles. For it will go through an equal in an equal time. Let the time, then, be divided into KL, LM, and MN. Again, since the slower has been borne over EFG, the time will also be cut into two parts. So the indivisible will / be divided, and the mobile will go through the partless not in an indi- b30

visible, but in a greater time. It is apparent, then, that not one of the continuous things is partless.

Chapter 3

233b33 It is necessary, however, that what is called a now, not according to something different but in virtue of itself and first[14], is indivisible,
b35 and that / such a thing is present in every time. For there is some
234a1 extreme of the past, / of which, in this direction, there is nothing of the future; and again, there is some extreme of the future, of which, in that direction, there is nothing of the past; which extreme, then, we say is the limit of both. However, should it be shown that this limit is such in virtue of itself and that it is the same, it will be apparent at the
a5 same time that it is indivisible. / It is necessary, then, that the now which is the extreme of both times is the same. For if it is different, one [of these extremes] could not be in succession to the other because the continuous is not from partless things, and if each is separated [from the other], time will be between. For every continuous thing is such that something univocal is between its limits.[15] But
a10 indeed, / if what is between is time, it will be divisible. For it was shown that every time is divisible. Whence, the now would be divisible.

If, however, the now is divisible, there will be something of the past in the future and something of the future in the past. For that according to which time is divided determines the past and the future
a15 time.[16] And, at the same time, / it would not be a now in virtue of itself but according to something different.[17] For the division would not be in virtue of itself. In addition to these [arguments], something of the now will have come to be and something will be in the future, and what is past or future will not always be the same; nor, then, is it the same now, for time is divisible in many ways. Whence, if these things
a20 cannot belong [to the now], it is necessary / that the now in each [of the parts of time, i.e., the past and the future] be the same. But indeed, if the now is the same, it is apparent that it is also indivisible. For if it is divisible, the same things will again happen which also happened before in the argument. It is therefore clear from what has been said that there is something indivisible in time, which we say is the now.

That nothing is moving in the now is apparent from the follow-
a25 ing. / For if so, something can be moving both faster and slower [in it]. Let, then, the now in which [the thing moves] be N, and in it let

the faster have moved [through] AB. The slower will therefore be moved less than AB in it, e.g., AC. Since, however, the slower has moved [through] AC in the whole now, the faster / will be moved a30
[through] this in less; whence, the now will be divided. But it was indivisible. So there is no moving in the now.

But neither is there resting. For we say that is resting which is naturally apt to be moving, yet is not moving when it is so apt, and where, and how. Whence, since nothing is naturally apt to be moving in the now, it is clear that neither is anything resting [in the now]. Moreover, / if the now is the same in both times, and something / can a35/234b1
be moving in a whole [time], and resting in another whole [time], and a thing moving in a whole time will be moved in whatever [part] of the time in which it is naturally apt to be moving, and the thing resting similarly will rest, it will happen that the same thing will, at once, be resting and moving. For / the same extreme, the now, belongs to b5
both times. Moreover, what is disposed similarly, both itself and its parts, both now and before, we say is resting. But there is not a "before" in the now, whence, neither is there resting. So it is necessary that what is moving is moving in time and what is resting is resting in time.[18]

Chapter 4

It is necessary, however, that every thing which changes be divisible. 234b10
For, since every change is from something to something, and when it is in that to which it changed it is no longer changing, and when it is in that from which it changed, both itself and all its parts, it is not changing (for what is disposed in a similar way, both itself and its parts, is not changing), / it is necessary, then, that something of what b15
is changing be in this and something in the other. For it is not able to be in both or in neither. (By that to which it changes, however, I mean the first [term] according to the change, e.g., [in the change] from white, the grey, not the black. For it is not necessary that the thing changing be in either of the extremes.) / It is apparent, then, that every b20
thing which changes will be divisible.[19]

Motion, however, is divisible in two ways, in one way, by time, in another, according to the motions of the parts of what is moving, e.g., if the whole AC is moving, both AB and BC will be moving.[20] Let, then, the motion of the parts be, of AB, DE, of BC, EF. / It is necessary, b25
then, that the whole DF be the motion of AC. For it will be mov-

ing according to this, since, in fact, each of the parts is moving according to one of these motions. Nothing, however, is moving according to the motion of another. Whence, the whole motion is the motion of the whole magnitude. Moreover, if every motion is of
234b30 something, but the whole / motion DF is not of either part (for each of the two motions is of a part) nor of anything else (for of whatever whole magnitude the whole motion is, the parts of the motion are of the parts of this magnitude; but the parts are of ABC and of nothing else, for there was not one motion of many), the whole motion would
b35 be of the magnitude ABC. Moreover, if there is another / motion of
235a1 the whole, e.g., TI, let there be taken away from it / the motion of either of the parts; these will be equal to DE, EF; for the motion of one thing is one. Whence, if the whole TI will be divided into the motions of the parts, TI will be equal to DF. If, however, it falls short
a5 a certain amount, e.g., KI, this will be the motion of nothing; / for it will be neither of the whole, nor of the parts, because there is one motion of one magnitude, nor of anything else, for a continuous motion is of continuous things. So too, if the parts exceed [the whole] according to the division. Whence, if this is impossible, it is necessary that TI be the same and equal [to DE and EF]. This, then, is the divi-
a10 sion according to the motions of the parts [of the mobile], / and it is necessary that this [division] be in everything divisible.

Another [division of motion] is according to time. For, since every motion is in time, and every time is divisible, and in less the motion is less, it is necessary that every motion be divided according to time.

Since, however, everything moving is moving in something and
a15 at some time, and of everything [moving] there is a motion, / it is necessary that there be the same divisions of the time and of the motion and of the moving and of the thing moving and of that in which the motion is (except that that in which the motion is is not divided in the same way in every case, but the division of place is in virtue of itself, while the division of quality is accidental).[21] For let the time A in
a20 which the mobile is moving be taken, and the motion, / B. If, then, in the entire time it has moved according to the whole motion, in the half, less, and, again, this being divided, less than this, and so always. So too, if the motion is divisible, the time is also divisible. For if the mobile has moved according to the whole motion in the entire time, [then it will move] according to the half in half, and, again, according
a25 to the less in less. / The moving, however, will also be divided in the same way. For let C be the moving. According to the half motion, then, the moving will be less than the whole, and, again, according to the half of the half, and so always. Setting out the moving according

to each of the motions, e.g., according to the motion DC and the motion / CE, one can say that the whole moving will be according to a30
the whole motion, for if the moving be different, there will be more moving according to the same motion, just as we showed also motion to be divisible into the motions of the parts [of the mobile]. For, taking the moving according to each [motion], the whole [moving] will be continuous. So too, however, length too will be shown to be divisible, / and, generally, everything in which change is, though some are a35
divisible accidentally, because what changes is divisible. For one being divided, all will be divided. And / to be finite or infinite will be 235b1
found similarly in all.

However, all [of these] being divided or being infinite followed above all from what changes.[22] For the divisible and the infinite belong directly to what changes: / the case of the divisible, then, was b5
shown before; the case of the infinite will be clear in what follows.

Chapter 5

Since, however, every changing thing changes from something to 235b6
something, it is necessary that what has changed, when it first has changed,[23] be in that to which it has changed. For what changes is displaced or leaves that from which it changes, and either / changing and b10
leaving are the same or leaving follows upon changing. If, however, leaving follows upon changing, having left follows upon having changed. For each is related similarly to each. Since, then, one of the changes is the one according to contradiction, when a thing has changed from non-being to being, it has left / non-being. So it will be b15
in being. For it is necessary that everything either be or not be. It is apparent, then, that, in change according to contradiction, what has changed will be in that to which it has changed. If this is so in this change, however, it will be so also in the others. For the case is similar in the one and in the others.

Moreover, this is also apparent by taking each [kind of change], if, indeed, / it is necessary that what has changed is somewhere or in b20
something. For since it has left that from which it has changed, and it is necessary that it be somewhere, it will be either in that to which or in something else. If, then, what has changed to B is in something else, e.g., in C, it is again changing from C to B. For C was not contiguous to B: the change is continuous. / Whence, what has changed, b25
when it has changed, is changing to that to which it has changed; but

this is impossible. So it is necessary that what has changed be in that to which it has changed. It is apparent, then, that what has come to be, when it has come to be, will be, and what has been destroyed will not
235b30 be. For the claim both was made universally about all change, / and is most clear in change according to contradiction.[24] It is clear, therefore, that what has changed, when it has first changed, is in that [to which it has changed].

It is necessary, however, that the first [part of time] in which what has changed has changed be indivisible. I call "first" what is such not
b35 by some other [part] of itself. For let AC be divisible, / and let it be divided at B. If, then, the mobile has changed in AB or again in BC, it would not have changed first in AC. If, however, it was changing in
236a1 each (for it is necessary / that it has changed or is changing in each), it would also be changing in the whole. But it has changed.[25] The same argument applies even if in one part it is changing and in the other it has changed. For there will be something before the first. So
a5 / that in which it has changed cannot be divisible. It is apparent also, then, that what has been destroyed was destroyed, and what has come to be has come to be, in an indivisible.[26]

However, "first in which it has changed" is said in two ways: in one way, as the first in which the change has finished (for then it is true to say that it has changed); in another way, as the first in which
a10 the mobile began to change. / What is called first according to the end of the change, then, both is present and is. For a change can be finished and there is an end of change, which end, then, was shown to be indivisible through its being a limit. But the first according to the beginning does not exist in any way. For there is no beginning of
a15 motion, nor was the mobile changing / in a first of time.[27] For let the first [part of time in which] be AD. This, then, is not indivisible. For it would happen that the nows are contiguous. Moreover, if the mobile rests in the whole time CA (for let it be supposed to be resting), it also rests in A; whence, if AD is partless, it will be resting and will have
a20 changed. For in / A it rests, but in D it has changed. However, since AD is not partless, it is necessary that it is divisible and that the mobile has changed in any one of the parts of this. For, AD being divided, if the mobile has not changed in either [part], neither has it changed in the whole. If, however, it changes in both, also in the whole; but if it
a25 has changed in either, / not in the whole first. Whence, it is necessary that it has changed in any part. It is apparent, therefore, that there is no first in which it has changed. For the divisions are infinite.

There is not some first part, then, of that which has changed. For, of DE, let DF be the first [part] which has changed. For everything
a30 which changes was shown to be divisible. / Let TI be the time in

which DF has changed. If, then, DF has changed in the whole [time], in half [the time] what has changed will be less and [will have changed] before DF, and, again, something other than this, and something different from that, and so always. Whence, of the thing changing, there will be no first [part] which has changed. / It is apparent a35
from what has been said, then, that there is no first either of what is changing or in the time in which it changes.

The very thing which changes, or according to which it changes, 236b1
however, will not be similar. For there are three things which are spoken of concerning change, the changing thing, that in which it changes, and that into which it changes, e.g., the man, the time, and the white. The / man and the time, then, are divisible, but there is b5
another account of the white. Still, all [such things] are divisible accidentally, for that in which the white or the quality occurs is divisible, but, in whatever is said to be divisible in virtue of itself and not accidentally, / as in magnitudes, there will not be a first. For let the mag- b10
nitude over which be AB, and let the mobile have moved from B to C first. If, therefore, BC will be indivisible, the partless will be contiguous to the partless. If BC is divisible, however, something will be before C, into which the mobile has changed, and again something before that, and so always, because / the division never gives out; b15
whence, there will not be a first into which it has changed; so too in the case of change of amount. For this change, too, is in the continuous. It is apparent, then, that only in one of the motions, in motion according to quality, can there be something indivisible in virtue of itself.[28]

Chapter 6

Since, however, every changing thing changes in time, and something 236b19
/ is said to change in time both as in a first and also as according to a b20
different time (e.g., it changes in the year because it changes in the day), in the first time in which what is changing changes, it is necessary that it be changing in any part of this time.[29] This is clear, then, even from the definition, for we were speaking of the "first" thus.[30] Not only this, but / it is also apparent from the following. For let the b25
first [time] in which what is moving is moving be XR, and let it be divided at K. For every time is divisible. In the time XK, then, it is either moving or not moving, and, so too, again, in KR. If, then, it is moving in neither, it would rest in the whole. / For it is impossible that b30

what is moving not be moving in any parts of this [time]. If it is moving in either part only, however, it would not be moving in the time XR first. For the motion would be according to a different [time]. So it is necessary that it be moving in any part whatever of XR.

This being shown, it is apparent that it is necessary that everything which is moving has moved before. For if a mobile had moved
236b35 in the first time XR through magnitude KL, / what is moving at the same speed and began at the same time will have moved through half
237a1 in half the time. If, however, what / has the same speed has moved through some magnitude in the same time, it is also necessary that the other has moved through the same magnitude; whence, what is moving will have moved. Moreover, if we say a mobile has moved in the whole time XR, or, generally, in any time whatever, by taking the /
a5 extreme now of the time (for this is what determines, and what is between the nows is time), it may be said that it has moved in the other nows similarly. Of the half, however, the division is the extreme; whence, in the half too it will have moved and, generally, in any one of the parts. For the time is always determined by the nows, together
a10 with the cut. If, / then, every time is divisible, and what is between the nows is time, everything which is changing will have changed with respect to infinite things. Moreover, if it is necessary that what is continuously changing, and neither is destroyed nor has paused from change, either is changing or has changed in any [now], but a thing
a15 cannot be changing in the now, / it is necessary that it has changed according to each of the nows. Whence, if the nows are infinite, everything which is changing will have changed with respect to infinite things.

However, not only is it necessary that what is changing has changed, but it is also necessary that what has changed was changing before. For everything that has changed from something to something
a20 has changed in time. / For let it have changed from A to B in the now. In the same now in which it is in A, therefore, it has not changed (for it would be at once in A and in B), for it was shown before that, when it has changed, what has changed is not in that [from which it has
a25 changed]. If, however, it is in another, time will be between. / For the nows were not contiguous. Since, then, it has changed in time, and every time is divisible, in the half there will be another "having changed," and again in the half of that another, and so always; whence, it would be changing before. Moreover, what was said is
a30 more apparent in magnitude, because the magnitude / in which the changing thing changes is continuous. For let there be something having changed from C to D. If CD is indivisible, therefore, the partless will be contiguous to the partless. Since, however, this is impossible,

it is necessary that a magnitude be between and infinitely divisible; whence, a mobile changes to these [intermediates] before. So it is necessary that everything which has changed / was changing before. a35
For the same demonstration is / also in the non-continuous, i.e., in the 237b1
contraries and the contradictory. For we will take the time in which it has changed, and say these things again. Whence, it is necessary that what has changed was changing and that what is changing has changed, and the / "having changed" will be before the changing, and b5
the changing will be before "having changed," and a first will not be taken in any way. The cause of this is that the partless is not contiguous to the partless. For the division is infinite, just as in the case of growing and diminishing lines.[31]

It is apparent, then, / that it is also necessary that what has come b10
to be was coming to be before, and for what is coming to be to have come to be, [i.e.,] in whichever changes are divisible and continuous.[32] Yet, what is coming to be is not always that [which came to be before], but sometimes something else [came to be before], e.g., some one of the parts of that [which is coming to be], like the foundation of the house. So too, in the case of what is being destroyed and what has been destroyed. For / something infinite is directly present in what is b15
coming to be and in what is being destroyed, by their being continuous. And there is neither coming to be without something having come to be, nor having come to be, without something coming to be; and so too in the case of being destroyed and having been destroyed. For the "having been destroyed" will always be before the "being destroyed," and the "being destroyed" before the "having been destroyed." It is apparent, then, that it is necessary both that what has come to be / was coming to be before, and that what is coming to be b20
has come to be before. For every magnitude and every time is always divisible; whence, [a change] would not be in that [time] in which it is as in a first.

Chapter 7

Since, however, everything moving is moving in time, and in more 237b23
time, it moves through a greater magnitude, it is impossible [that something] / be moving through a finite magnitude in an infinite time b25
(not what is always moving over the same magnitude or over some one of the parts of that magnitude, but [what is moving] in the whole time over the whole magnitude).

It is clear, then, that if something be [always] moving with the same speed, it is necessary that it be moving through a finite magnitude in a finite time. For, taking a part [of the magnitude] which will measure the whole, the mobile has moved through the whole in as
237b30 many equal times as there are parts. / Whence, since these same parts are limited both by being each so much and by being all so many, the time too would be finite. For the multiple will be as much as the time of the part multiplied by the multitude of the parts.

But indeed, should the mobile not move with the same speed, this
b35 makes no difference. For let the dimension / AB over which it has
238a1 moved in a infinite time be finite, / and let the infinite time be CD. If, then, it is necessary that it has moved through one thing before another (this is clear, that in the before and after of time it has moved through something different; for always in the greater time it will have moved through something different, whether it be changing with the
a5 same speed / or not with the same speed, and no less whether the motion increase or diminish or remain [constant]), then let there be taken AE, something of the dimension AB, which will measure AB. This, then, came to be in a certain time of the infinite time; for it can-
a10 not be in the infinite, for the whole is in the infinite. And again, / if I take something different, as much as AE, it is necessary [that this be gone through] in a finite time. For the whole is in the infinite. And taking [the magnitude] thus, since no part of the infinite will measure the infinite (for it is impossible that the infinite be made from finite things, whether equal or unequal, because things finite in multitude and magnitude, being determinate in magnitude, will be measured /
a15 by something one, no less whether they be equal or unequal things), and the finite dimension is measured by the amounts AE, the mobile would move through AB in a finite time. So too in the case of coming to rest; whence, it is not possible that something one and the same
a20 is always coming to be or being destroyed.[33] / The same argument, however, also shows that neither what is moving regularly nor what is moving irregularly can be moving or coming to rest through an infinite magnitude in a finite time. For taking some part which will measure the whole time, the mobile will go through, in this time, some amount of the magnitude and not the whole (for in the whole it goes
a25 through the whole), and again in an equal time, / another [amount of the magnitude], and so too in each, whether [the amounts be] equal or unequal to the one taken in the beginning. For this makes no difference, if only each amount be finite. For it is clear that, as the time is done away with, the infinite will not be done away with, the subtraction being finite both in amount and in multitude; whence, the mobile
a30 will not go through the infinite in a finite / time. It makes no differ-

ence whether the magnitude is infinite in either or in both directions. For the argument will be the same.

These things being demonstrated, it is apparent that neither can an infinite thing go through a finite magnitude in a finite time, due to the same cause. For in a part of the time something finite will go through, / and so too in each part; whence, in the whole, something a35
finite [will go through]. Since, however, the finite will not go through the infinite / in a finite time, it is clear that neither does the infinite 238b1
go through the finite [in a finite time]. For if the infinite goes through the finite, it is necessary also that the finite go through the infinite. For it makes no difference which of the two is what is moving. For in both ways, the finite / will go through the infinite. For when the infi- b5
nite A moves, something of it will be over against the finite B, e.g., CD, and again another and another, and so always; whence, it will happen that the infinite has moved through the finite and the finite went through the infinite at the same time. For it is not possible, perhaps, / for the infinite to be moved through the finite otherwise than b10
by the finite going through the infinite, either being borne or measuring; whence, since this is impossible, the infinite would not go through the finite. But indeed, neither will the infinite go through the infinite in a finite time. / For if the infinite, also the finite, for the b15
finite is present in the infinite. Moreover, taking the time, the demonstration will be the same.

Since, however, neither the finite moves through the infinite in a finite time, nor the infinite through the finite, nor the infinite through the infinite, it is apparent that motion will not be infinite in a finite / time. For what difference is there in making the motion or the magni- b20
tude infinite? For it is necessary, if either one [is infinite], that the other be infinite also. For every locomotion is in place.

Chapter 8

Since, however, everything naturally apt [to move] either moves or 238b23
rests when it is naturally apt, and where, and how, it is necessary that what is coming to a stand, when it is coming to a stand, is moving. / For if it is not moving, it will be resting, but it cannot happen that b25
what is resting is coming to rest. This having been demonstrated, it is apparent that it is also necessary that coming to a stand be in time. For what is moving is moving in time, and it was shown that what is coming to a stand is a moving thing; whence, it is necessary to come to a

238b30 stand in time. Moreover, if we say the faster and slower are / in time, and to come to a stand is faster and slower, [this follows]. In that first time in which what is coming to a stand comes to a stand, it is necessary that it be coming to a stand in any part of this. For, the time being divided, if it is coming to a stand in neither of the parts, it is not [doing so] in the whole; whence, what is coming to a stand would not be coming to a stand. If in either, however, it would not be coming to a
b35 stand first in the whole. / For in this part it comes to a stand [not first but] according to something different, just as was said also before in
239a1 the case of what is moving. Just as, however, there is not / a first in which the moving thing is moving, so neither is there [a first] in which what is coming to a stand comes to a stand. For there is not something first either of moving or of coming to a stand. For let AB be that in which first it comes to a stand. This, then, cannot be part-
a5 less. For motion is not in the partless, / because something has moved during it, but what is coming to a stand was shown to be something moving. But indeed, if AB is divisible, the mobile is coming to a stand in any one of the parts of it. For this was shown before, that it is coming to a stand in whatever of the parts of that in which it is first coming to a stand. Since, then, that in which a thing first comes to a stand
a10 is time, and not an indivisible, and every time is / partible to infinity, there will not be a first in which it comes to a stand.

Neither, then, is there a first when the resting thing rested. For, because there is no motion in the indivisible, the mobile did not rest in the partless; but moving is in that in which there is resting. For we said there is resting when what is naturally apt [to move] is not mov-
a15 ing in that in which it is naturally apt to be moving. Moreover, / we also said that something is resting when it is disposed similarly now and before, as if we do not make the judgment by some one thing, but by two at least; whence, that in which it rests will not be partless. If, however, that in which it rests is partible, it would be time, and it will rest in any of the parts of this time. For this will be shown in the same
a20 way as the prior cases; / whence, nothing will be first. The cause of this is that everything rests and is moving in time, and there is not a first time, nor magnitude, nor, generally, any [first] continuous thing. For every one [of these] is partible to infinity.

Since, however, everything moving is moving in time and changes from something to something, it is impossible that the pri-
a25 mary moving thing is then over against something / in that time in which it is moving, [i.e., in the time] in virtue of itself, not in the time in which it is moving due to some part of the time in it.[34] For to rest is to be in the same [disposition] for some time, both the mobile and each of its parts. For we say the mobile rests when it is true to say that

both it and its parts are in the same [disposition] in one and another of the nows. If, however, this is resting, / what is changing cannot be a30
over against something as a whole according to a first time. For every time is divisible; whence, in one and another part of the time it would be true to say that it is in the same [disposition], both it and its parts. For if this is not so, but [it is in the same disposition] in only one of the nows, the mobile will not be over against something for any one time, but [it will be over against something] according to / the limit of a35
the time. In the now, however, it is always over against / something 239b1
remaining; nevertheless, it is not resting. For neither to be moving nor to be resting is in the now, but it is true that in the now the mobile is not moving and is over against something. In time, however, it cannot be over against something resting: for it would happen that what is being borne rests.

Chapter 9

Zeno, however, argues illogically. For, he says, if everything always 239b5
rests or is moving when it is over against an equal [magnitude], and what is being borne is always in a now, the arrow which is borne is immobile. But this is false, for time is not composed from indivisible nows, just as neither is any other magnitude.

However, the arguments of Zeno about motion which give per- b10
plexity to those solving them are four. The first argument is about not moving because what is borne must reach the half before the end, about which argument we decided in the foregoing arguments.[35]

The second argument is the one called "Achilles." It is / this: that b15
the slowest one running will never be left behind by the fastest. For it is necessary that the pursuer go first whence the one fleeing started; whence, it is necessary that the slower always hold some lead. This, however, is the same argument as the one [derived] from cutting [the magnitude] in two; it differs by not dividing into two / the magnitude b20
being taken. The slower not being left behind resulted from the argument, then; the argument comes to be, however, along the same lines as the one derived from cutting in two. For in both not arriving at a limit occurs by somehow dividing the magnitude. But he adds in this argument that not even the fastest one / told of in history [can], in pur- b25
suing, [overtake] the slowest; whence, it is necessary that the solution [of this argument] be the same. Believing, however, that the one holding the lead is not left behind is false. For when he holds the lead, he

is not left behind; but nevertheless, he will be left behind, if it be given
239b30 that he goes through a finite [magnitude]. These, then, are two / arguments.

The third argument, however, is the one mentioned just now, that the arrow which is borne stood still. It happens along with taking time to be composed of nows. For, not granting this, there will not be a syllogism.

The fourth argument is the one about equal bulks moving alongside of equal bulks from opposite sides in the stadium, the ones from
b35 the end / of the stadium, the others from the middle, with the same
240a1 speed, in which / he opines that it happens that the half time is equal to the double time. The illogical argument, however, consists in laying it down that an equal magnitude with the same speed is borne alongside, in one case, the moving and, in the other, the resting, in an
a5 equal time. This is false. For example, let there be / the equal, standing bulks AA; others, BB, starting from their middle, being equal to these [A's] in number and magnitude; others, CC, from the extreme [of the B's, but extending the other way], being equal to these [A's] in number and magnitude, and equal in speed to the B's. It happens,
a10 then, that the first / B and the first C are by the extreme together, moving alongside each other. But it happens that C has gone through alongside all the B's, B, alongside half; whence, the time is half. For each is alongside each for an equal time. It happens, however, that the
a15 B's have gone alongside all the C's. For the first C and the first / B will be together at the contrary extremes, [the C's] coming to be alongside each of the B's in as much time as the A's (so he says), through both coming to be alongside the A's in equal time. This is the argument, then; but it happens along with the falsity mentioned.

Neither, then, according to change in the contradictory will any-
a20 thing / impossible occur for us, e.g., if a thing changes from non-white to white and is in neither, that, then, it will be neither white nor non-white. For, if it is in neither as a whole, that will not stop us from calling it white or not white. For we call something white or not white
a25 not by its being such as a whole, but by most or the most proper / parts [being such]. It is not the same, however, not to be in this and not to be in this as a whole - so too in the case of being, and in the case of non-being and the others according to contradiction. For the mobile will be of necessity in one of the opposites, but as a whole always in neither.[36]

a30 Again, however, in the case of a circle and a sphere and, / generally, among things moving in themselves, [it is argued] that these will happen to rest. For the mobile will be in the same place for some time, both itself and its parts; whence, it will be resting and moving at the

same time. For, first, the parts are not in the same place for any time; and, / further, the whole always changes to something different. For 240b1
the revolution taken from A, and the one from B, and the one from C, and from each of the other marks are not the same, except as musical man and man [are the same], because musical is accidental; / whence, b5
one thing always changes to another, and will never rest. It is the same way in the case of the sphere and in the case of other things moving in themselves.

Chapter 10

These things being demonstrated, we say that the partless cannot be 240b8
moving except accidentally.[37] as by the body / or magnitude in which b10
it is present moving, just as a thing in a ship moves by the locomotion of the ship, or the part by the motion of the whole. I call "partless" the indivisible according to amount. For the motions of the parts are different both according to the parts themselves and according to the motion of the whole. / Someone could see the difference most in a b15
sphere. For there is not the same speed of the parts about the center and [of those] on the outside, and of the whole, as though there is not one motion. Just as we said, then, the partless can be moving thus, as the one sitting in the ship is moving by the going of the ship; in virtue of itself, / however, it cannot. b20

For let the partless be changing from AB to BC, whether from magnitude to magnitude, or from species to species, or according to contradiction. Let the first time in which it changes be D. In the time itself according to which it changes, therefore, it is necessary that it be either in AB, or in BC, or that something of it be in / the latter and b25
something of it is in the other. For everything changing was so disposed. Something of it, then, will not be in each of the two. For it would be partible. But neither would it be in BC. For it will be a thing which has changed; but it is supposed to be changing. It remains, then, that it is in AB in the time according to which it changes. So it will rest. / For to be in the same [disposition] for some time was to b30
rest; whence, the partless cannot be moving, nor, generally, changing. For only thus could there be motion of it, if time were made from nows. For in the now it would always be a thing having moved and changed; / whence, it would never be moving, but always have moved. 241a1
That this is impossible, however, was shown also before. For neither is time made from nows, nor a line from points, nor motion from

241a5 moves. For one who says this does nothing other than make / motion from partless things, just as if time were from nows or length from points.

Moreover, it is apparent from the following [considerations] that neither a point nor any other indivisible can be moving. For it is impossible that anything moving be moved through more than itself before it has moved through either something equal or less. If, then, a10 this is so, it is also apparent that / the point will be moved first through something less or equal. Since, however, it is indivisible, to be moved before through less is impossible; so [it has moved] through something equal to itself; whence, the line will be made from points. For the point, which is always moving through something equal [to itself], will measure the entire line. But if this is impossible, moving the indivisible is impossible.

a15 Moreover, if everything moves in time and nothing moves in the now, and every time is divisible, there would be some lesser time of the moving things, [less] than that in which it moves as much as itself. For the latter will be the time in which it is moving, because everything moves in time; it was shown before, however, that every time is a20 divisible. So if the point / is moving, there will be some time less than that in which it itself was moved. But this is impossible. For in less it is necessary that something less be moving; whence, the indivisible will be divisible into something less, just as time is divisible into time. For the partless and indivisible could be moving in one way only, if it a25 were possible to be moving in the / indivisible now. For to be moving in the now and for something indivisible to be moving are of the same account.[38]

No one change, however, is infinite.[39] For every change was from something to something, both the change in contradiction and the change among contraries; whence, of changes according to contradiction, the affirmation or negation is the limit, e.g., of coming to be, a30 being, of destruction, / non-being, and of those among contraries, the contraries [are the limits]. For these are the ends of the change; whence, also of every alteration. For alteration is from certain contraries. So too [there are ends] of growth and diminution: for the limit 241b1 of growth is / in the perfection of magnitude according to the proper nature; of diminution, however, the removal of this.

Locomotion, however, will not be finite thus. For not all locomotions are among contraries. But since what is impossible to have b5 been cut, in this way, by not being able to be cut (for "impossible" / is said in many ways), what is thus impossible cannot be being cut; nor, generally, can what is impossible to come to be be coming to be, nor can a thing which it is impossible to change be changing to that to

which it is impossible for it to change. If, then, what is borne is changing to a certain thing, it will also be possible to change to that; / whence, motion will not be infinite, nor will a mobile be borne b10
through the infinite. For it is impossible to have gone through this. It is apparent, then, that there is not infinite change so as not to be determined by limits.

But one must look into whether, being one and the same, motion can happen so as to be infinite in time. For if the thing coming to be is not one, perhaps / nothing prevents this, e.g., if after the locomo- b15
tion there be alteration, and after the alteration, growth, and again, coming to be. For thus there will always be a motion in time, but not one motion, because from all these there is not a one. So as to be one, however, a motion cannot be infinite in time; except one: this is / locomotion in a circle.[40]

Endnotes

1. In Book V, Aristotle divided motion according to its kinds; here he goes on to divide it according to its quantity. In this, he first shows that motion (and magnitude and time) is divisible (231a21–233b32), then how motion (and rest) is divided (233b33–239b4), and then exposes some errors about the divisibility of motion (239b5–241b20).

   The fundamental insight of the text is the potential nature of the divisions of a continuum, and so of motion, magnitude, and time. If a continuum is made of points, all possible divisions have already actually been made; if it is not made of points, some of the divisions may still be actual but there will also be some parts which have two extremes and which themselves lie between those extremes; they will therefore be further divisible. That is, we at last must come to a division which is only potential, not actual, at least so long as we assume that the continuum is one thing. Thus, the continuum must have divisions, the first idea of the continuum being what has part outside of part. But these divisions are not actual, according to Aristotle's arguments, but only potential. If the continuum is one thing which has potential divisions, the continuum must be a whole with part outside of part.

2. 226b18 ff.

3. If the continuum were one merely by contact, then there would be an end to its divisions, since every part we come to would also be one by contact, that is, by having its parts actually divided though touching. Since this is not so, the divisions of the continuum are only potential. This potency is the very "part outside of part" which constitutes the continuum; in other words, the "outsidedness" is the potency for division. Thus, the continuum is divisible, not divided.

4. Cf. 200b18–20.

5. Note that here Aristotle argues from one definition of continuous, "that of which the extremes are one," to another, "the infinitely divisible" (200b20; 232b24–215). The position that a line is an infinite, ordered set of points is contradictory to this one, though perhaps sufficient for a mathematician. It is enough for the mathematician that there be a point where he needs it, and that it have a determinate relation to the other points he needs for his proof. But finally the position cannot stand. It considers the points as a kind of material out of which the line is made, and the order as a form. But the points must be distinct from each other if they have order, for order implies distinction. The principle of distinction present here can only be magnitude, for the order is one of position, and position implies magnitude. Thus, magnitude cannot be composed out of points, for the very possibility of a multitude of points, and so of an ordered multitude of points, depends upon magnitude.
6. In chess, the actual motions of the pieces between their squares are of no interest; the players are only interested in where the pieces end up and where they started. The translation "moves" is an attempt to use a word with the same root as "motion" (because the Greek words too share a root), while indicating that the change is sudden and there really is no motion between the terms, but the mobile is now here and then there.
7. Since in A, B, and C it had moved but was never moving, and what is not moving is resting, then it was resting in each of the parts.
8. This argument takes it for granted that there is a difference between motion and rest. If someone denied this, perhaps we could point out that motion would then be a mere name for a collection of rests, which does not seem to be true. Moreover, what appears as motion would simply be an infinite set of rests in intermediate spots. But how could a mobile traverse an infinite series, i.e., how could it get to the end of what has no end? To be at a mid-point C, when going from A to B, would be the same as to be at C when going from B to A; in other words, there would be no order in motion. Finally, since there would be no orderliness in motion, nothing would prevent the mobile from just hopping all over.
9. That motion cannot be composed of non-motions was shown universally for all continua at 231a21–b18; here it is applied to the particular case of motion.
10. Presumably, Aristotle means that if a motion along a straight line is infinite in time, the line is infinite in magnitude, and if the straight line is infinite, the time will be infinite. For nothing would prevent a body from moving forever in a circle, the magnitude of which is finite, as Aristotle indeed holds. Cf. 265a24–27. The circle is itself, though, in a way infinite. Cf. 207a2–8. On the two ways of being infinite, cf. 206b3–33.
11. Zeno argued that there can be no motion, following in the footsteps of his teacher Parmenides (cf. Plato, *Parmenides,* 127a–d). Among his arguments, the most commonly cited is the one which Aristotle refers to here: to move across a room, I must first go half-way, and before that, half of that, etc., so that I can never move across the room because I do not have enough time to go through these infinite steps. Cf. 239b5–240a19.
12. Later, Aristotle will point out a defect in this argument and present a new one. Cf. 263a4–b9.

13. This argument assumes motion of a constant speed. At 237b34–238a19, Aristotle will present an argument without this assumption.

14. Cf. 222a10–24.

15. That is, something of the same name and definition (*Categories*, Ch. 1, 1a6–12); thus, between the points on a line there is always a line, and between the nows there is always time.

16. That is, if the now is the division of the past and the future, and the division belongs to that of which it is the division, and the now is itself divisible and so contains past and future, then part of the past belongs to the future and vice-versa.

17. Cf. 222a10–24.

18. Just as the division of a line is not a line, so the division of time is not time, nor is the division of motion or rest, which is what exists in the now, a motion or a resting.

19. Cf. also 240b20–241a26. The assumption here is that there is a "first" or "next" in motion, e.g., in locomotion, a next place. But is this not contrary to the continuity of motion? For there is no point next to a point, as we saw above (231b6–10), and so no first point which the mobile attains. Perhaps we can explain the sense in which there must be a sort of "first" in motion as follows. Leaving a place is temporally simultaneous with entering another place, but entering is prior to leaving in notion: a mobile leaves insofar as it enters some other place. Even if we just want to leave a room, we have to decide which way to go before we can leave. We can also see that entering is prior to leaving if we consider that the principles of change are material, form, and privation, and that the privation is only negative and so can only be a principle in virtue of what it is a negation of, namely, the form; but form is the term to which motion tends. Since every point is distant from every other (because points cannot be in contact or continuous with each other), there is no point which a point-mobile could enter as it leaves the place it starts from – it would have to disappear from one place and reappear elsewhere. Moreover, since every point is separated from every other by an infinite number of points, there would be no reason for the point-mobile to reappear at any particular place first – it would be no harder to jump from A to B than from A to C. In fact, motion would consist of "moves" or "jumps" to random places without any order at all.

    For a divisible mobile, on the other hand, there is a next place which is equal to it, and the ordered parts of the mobile can account for the ordering of the parts of the motion in going from one place to the next, and then to the next, etc. When the divisible mobile moves, it is only moved as a whole when it attains to such a next place; before that, it has only moved partially, and such a partial motion is in notion posterior to the motion of the whole, for a partial motion is partial because the whole is what it is, and the parts are only potential. Since a point has no parts, there would be no order in the parts of its motion, and it could never undergo a partial movement, but would instead be suddenly and all at once in a place distant from the one it was in. Its "motion" would consist of being here, then there, then there, without any motion between the places and without any order among the places.

    One might object that the motion of a divisible implies the motion of the indivisible, since the limits of the divisible moving thing are themselves indivisible and

move with the divisible. But this motion is only *per accidens* (211a17–23), and what can happen *per accidens* is not necessarily possible *per se*. The motion of a color, for example, is only possible through *per accidens* motion.

20. There is a question here: if everything in motion is divisible, but the parts of the mobile have each their own motion, would there not be an infinite number of motions in every motion? Clearly, the parts of the mobile have to move with the motion of the whole, not with independent motions, but the motion of the whole is itself somehow divided out among the parts, a sign of which is that being side-swiped does not do as much damage as being hit head-on. Cf. 240b13–20.

21. Cf. *Categories*, Ch. 6, 5a38–b10.

22. It is the mobile, the moving thing, which is responsible for the characteristics of motion and time; since motion and time are something of the mobile, the divisibility of the latter, which is in it *per se*, is the cause of the divisibility of the former.

23. The "aspect" of the verb indicates the completion of motion. Compare "I am walking" and "I have walked." The former has a progressive aspect, the latter a perfect or completed aspect. So too with "has moved." This completion may be only imperfect, as when we say, "I have walked for an hour, and I continue to walk now." But even then, we indicate the completion or perfection of a part of the walking, and that the completion is not fully complete is only indicated by the addition of "and I continue to walk now."

24. Because there is no middle in change according to contradiction, it is most clear in this sort of change that what has changed is in that to which it has changed. But note, too, that every change can be considered as a change according to contradiction, for motion from white to black is also from non-black to black.

25. Therefore, this is impossible. Cf. 231b28–232a1.

26. Thus, there is a first moment in which it is true to say of a mobile that "it has changed or moved."

27. There is no first moment of a motion, though there is a moment after which the mobile is in motion.

28. Color, for example, is not divisible in virtue of itself, but only in virtue of the surface it is in.

29. Yet another use of the word "first:" here Aristotle calls "first" the time which exactly contains the motion.

30. Cf. 224a21–30.

31. Cf. 207a33–b13.

32. If coming to be and being destroyed are between contradictories, how can they be continuous? Aristotle here must be taking "being destroyed" and "coming to be" to refer to the process, like heating, which leads to coming to be or being destroyed.

33. In this argument, Aristotle assumes that the magnitude is actually traversed. If the mobile continuously slows down so that, e.g., it crosses half the line in one second, and then the next quarter in another second, and the next eighth in another second,

etc., it will never actually traverse the whole. But any part which is actually traversed will be traversed in a finite time.

34. This apparently means that, during the whole time of a mobile's motion, it is not lined up with some part of the magnitude over which it is moving.

35. 233a21–31.

36. The argument seems to be that motion is between the extremes, but at one extreme the mobile is, e.g., not-white, while at the other it is white. But there is nothing between white and not-white, so that motion cannot exist. Aristotle's answer is that the mobile can change part by part. It seems that this is merely an answer to the objection raised, for Aristotle clearly does not think all alterations take place like this. He is only showing that the argument of his opponent does not follow.

37. Earlier, Aristotle argued that everything which moves in virtue of itself is divisible (234b10–20); here he shows that anything assumed to be indivisible would be immobile, except accidentally.

38. Note that, of these three arguments showing that an indivisible cannot move, the first argues from the distinction between what is moving and what has moved (which is to argue from a distinction found in motion itself), the second is from magnitude, and the third from time. Once again, Aristotle is showing that the divisibility or indivisibility of motion, magnitude, and time go together.

39. Perhaps the two concerns of this chapter, that the indivisible cannot be moving and that no mobile can be moving to infinity are put together because the indivisible is to the finite line along which it would move (if it could) as the finite mobile is to an infinite line (were one to exist). In the first case, there is no way to get going without a sudden change to a new place; in the second, there is no way to finish off the motion. For in the first case there is no first place and in the second there is no last. Can one simply say that the motion of a body (e.g., in inertial motion) is not defined by reference to the last place, which admittedly would not exist, but merely by the "going in a certain direction?" This would seem to imply that becoming does not derive whatever intelligibility it has from being, which is clearly false. For the "going in a certain direction" is at any rate a "going," and this is a becoming which must be understood in reference to a being (in this case, a being in place).

40. This last paragraph foreshadows much of Book VIII.

Book VII[1]

Chapter 1

241b24 It is necessary that everything moving is moved by something. If,
b25 then, it does not have the principle of motion / in itself, it is apparent that it is moved by something different. For the mover will be other.

If, however, [it does have the principle] in itself, let there be taken AB which is not moving by some part of it moving. First, then, assuming that AB is moving by itself because the whole is moving,
b30 and by nothing outside, is / as if, DE moving EZ and itself moving, one should assume DEZ is moving by itself, through not seeing at once which is moved by which, whether DE by EZ or EZ by DE.
242a1 Moreover, what is moving by itself / will at no time pause from moving by means of some different moving thing coming to a stand. It is therefore necessary that, if something moving pauses by something different coming to a stand, the former is moved by something different. This being made apparent, it is necessary that everything moving
a5 is moved by something. / For, since AB was taken as moving, it will be divisible. For everything moving was divisible.[2] Let it be divided, therefore, at C. It is necessary, then, if CB rests, that AB also rests. For if it does not, let it be taken as moving. CB resting, therefore, CA would be moving. So AB is not moving in virtue of itself.[3] But it was
a10 supposed / to be moving in virtue of itself first. It is clear, therefore, that, CB resting, BA would also rest, and the thing which is moving will at some time pause. But if something moving comes to a stand and pauses due to something else resting, the former is moved by something different. It is apparent, then, that everything moving is
a15 moved by something. For everything moving is divisible, / and, the part resting, the whole will also rest.[4]

Since, however, what is moving is moved by something, it is also necessary that everything moving in place be moved by another.[5] And therefore the mover [is moved] by something different, when it itself is also moving, and this again by something different. They will not,
a20 then, go on to infinity, but [the series] will come to a stand / somewhere, and there will be something which will be primarily the cause of moving. For if not, but the movers do go on to infinity, let A, something moved, be moved by B, B by C, C by D; and, then, in this way,

let them go on to infinity. Since, then, the mover and the thing [moved] are moving at the same time, it is clear that / both A and B will be moving at the same time. For A will be moved when B is moving; and B, then, when C, and C when D. The motion of A and B, will therefore be at the same time, and of C, and of each of the remaining ones. We will be able to take each of these, therefore. For even if each is moved by each, the motion of each is no less / one in number, and is not infinite in its extremes, since, indeed, everything moving moves from something to something. For motion happens to be the same either in number, or in genus, or in species. I call that motion same in number, then, which is from the same in number to the same in number in a time same / in number, e.g., from this white, which is one in number, to this black, according to this time, which is one in number. For if [the motion is] according to another time, the motion will no longer be one in number, but in species. That motion is the same in genus which is in the same / attribute {predicate, category}, of substance or of [another] genus,[6] in species, the one from the same in species to the same in species, as from white to black or from good to bad. (These things were also said in the prior discussions.)[7] Let the motion of A, therefore, be taken, and let it be E, and of B, Z, and of CD, / IT, and the time in which A moves, K. The motion of A, then, being determined, the time will be determined and K will not be infinite. But both A and B and each of the remaining ones were moving in the same time. It therefore happens that the motion EZIT, being infinite, is moving in the determined time / K. For in that in which A was moving, all the ones in succession to A, being infinite, were also moving. Whence, they are moving in the same time. For either the motion of A will be equal to that of B, or greater. However, it makes no difference. For in every way an infinite motion happens to be moving in a finite time; and this is impossible.[8]

What was to be shown from the beginning, then, seems to be shown thus, yet it is not shown, because nothing strange happens. For infinite motion can be in a finite time, not the same motion but different motions of many and of infinite moving things, which, indeed, happens in the things [being considered] now.[9] But if it is necessary that what is moving primarily / according to place and bodily motion be touched by or continuous with the mover, as we see this happening in all cases, there will be, indeed, from all a whole, one or continuous.[10] Let what is possible be taken, then, and let the magnitude or the continuous be ABCD and the motion of this, EZIT.

For whether [the mobile be] infinite or finite makes no difference. For either the infinite or the finite will be moved similarly in the finite time K. Either of these, however, is impossible.[11] It is apparent,

then, that what is always [moved] by another will at some time come to a stand and will not go on to infinity, but there will be some thing which will be moved first. Let it make no difference that we have sup-
243a1 posed / something to show this [fact]: for, putting down what can be, nothing strange can have happened.[12]

Chapter 2

243a3 The first mover, however, not as that for the sake of which, but whence is the beginning of motion, is together with what is moving.[13] I say "together" / because nothing is between these. For this is com-
a5 mon in the case of all movers and things moved.

Since, however, there are three motions, the one according to place and the one according to quality and the one according to amount,[14] it is necessary that the things moving are also three. The motion, then, according to place is locomotion, the one according to
a10 quality, alteration, and the one according to amount, growth / and diminution. We should speak first, then, about locomotion; for this is the first of the motions.[15]

243a21 Everything in locomotion, then, is moved either by itself or by something different. If by itself, it is apparent then that, since the mover is present in it, the mover and the moved are together, and nothing is between these.

What is moved by another, however, is moved in [one of] four ways.[16] For the motions [which are derived] from another are four:
a25 pushing, / pulling, carrying, and whirling. For all the others happen to be reduced to these. Of pushing, then, one [sort] is pushing on, the other, pushing off. Pushing on, then, occurs when the mover is not left behind by what is moved; pushing off, when what is pushing off is left behind. Carrying, however, will be in [the other] three motions. For the thing being carried does not move according to itself, but acci-
243b21 dentally.[16] For it is moved / by being in what is moved, or on what is moved, and what is carrying moves either by being pushed or being pulled or being whirled. It is apparent, then, that carrying will be in [the other] three motions.

There is pulling when, either towards itself or towards another, the motion of the one pulling is faster, not being separated from the
b25 motion of the one being pulled. For pulling can be both / towards itself and towards another. And the rest of the pullings will be reduced to these in species, e.g., inspiration and expiration, and spitting, and

whatever [motions] of bodies are assimilative or secretive, and packing, then, and combing. For, of these, one is collection, the other separation. And every motion according to place, then, is collection and separation. Whirling, however, / is composed of pushing and pulling. 244a14
For the mover pulls one part and pushes another. It is apparent, then, that nothing is between the moved and the mover, since the one pushing and the one pulling are together with what is being pulled and what is being pushed. This is also clear from the things determined [before]. For pushing is motion towards another either from itself or / from a20
another, and pulling is from another towards itself or towards another. Moreover, these motions are bringing together and pushing apart.

There is throwing when, the pushing coming to be stronger, the motion [of the air] comes to be faster than the natural motion of the thing being borne; and up to this point the mobile happens to be borne, so long as it {the motion of the air} is stronger than the motion of what is borne.[18] It is apparent, then, that what is moved and the mover are together, and / nothing is between them. a25

But indeed, neither is something between what is being altered and what is altering [it]. This is clear from induction. For in every one it happens that the last one altering and the first one altered are together. For the qualified is altered by being sensible,[19] and sensibles are those by which / bodies differ from each other, e.g., heaviness, 244b16
lightness, hardness, softness, sound, soundless, whiteness, blackness, sweetness, bitterness, wetness, dryness, density, rarity, and the things between these, so too the others falling under the senses, among which are also hotness and coldness, and / smoothness and roughness. b20
For these are passions of what underlies quality. For sensible bodies differ by these or according to having a certain one of these more and less and suffering a certain one of these; for they come to be hot or cold or sweet or bitter or [change] according to some other of the predicates,[20] and the ensouled and unsouled bodies, and / whatever b25
parts of the ensouled are unsouled, do so in the same way. And the senses themselves are altered, for they suffer. For the act {operation, work} of these is a motion [which occurs] through the body suffering something from the sensibles.[21] Whatever things there are according to which the unsouled are altered, then, / the ensouled are also altered 245a16
according to all these; however, whatever things there are according to which the ensouled are altered, the unsouled are not altered according to these, for they are not altered according to the senses, and the unsouled do not notice their being altered. Nothing prevents the ensouled too from not noticing their being altered, when the alteration does not / happen to them according to the senses. If, then, the pas- a20
sions are sensibles, and alteration is through the latter, from these

considerations it is apparent that the one causing suffering and the passion are together, and nothing is between these. For, on the one hand, the air is continuous with this [power], and, on the other hand, the body contacts the air; and the surface with the light, and the light with the sight. So too, the [senses of] hearing and smell [join] with the
245a25 first thing / moving these. In the same way, also, taste and flavor are together. The case of the unsouled and the insensible is similar.

And what is growing and what makes it grow [are together]. For growth is a certain addition; whence, both what is growing and what makes it grow are together. And diminution [is the same]: for the cause of diminution is a certain taking away. It is apparent, then, that
245b16 nothing / is between the extreme mover and the first thing moved.

Chapter 3

245b19 Let us consider, from what follows, that all things being altered are
b20 altered by sensibles, and there is alteration / of those things alone which suffer, in virtue of themselves, from the sensibles.[22]

For, of the others, one would most assume alteration to be present in shapes and forms and habits and in the throwing off and the seizing of these.[23] For something of alteration seems to be present [here]; yet alteration is not in these, but these come to be by some-
b25 thing altering, / for they come to be by material becoming dense or becoming rare, or becoming hot or becoming cold; but still, this is not alteration. For we do not call the form [by the same name as] that from which the form of the statue is, nor [by the same name as] that from which is the shape of the pyramid or of the bed, but, denominating,[24] in one case [we call the form] brazen, in another, waxen, in another, wooden. The thing being altered, however, we do so call: for
246a21 we say the bronze is wet or hot or hard, / and not only thus, but [we also call] the wet and the hot bronze, naming the material by the passion in a similar way. Since, then, that from which they (the form and the shape and what comes to be) are, is not named in the same way as the shapes [which come to be] from that, but what is being altered is
a25 named in the same way as the passions, it is apparent that / alteration is in the sensible [qualities] alone.[25] And it would be strange in another way. For saying a man or a house was altered in receiving its end is laughable, [e.g.,] if we should say the perfecting of the house, the coping or the roofing, is alteration, [and that], the house being coped or

roofed, the house is being altered. (It is clear, then, that alteration is not in things coming to be.)

Indeed, neither is it in habits. / For the habits are virtues and 246a30
vices, and every virtue and vice is among / relatives,[26] just as health 246b21
is a certain balance of the hot and the cold, either of things within [the body] or in relation to what contains. So too good and strength are in relation to something. For they are certain dispositions of the best [thing] to the finest [action]. I call the best, however, what saves and
is disposed in regard to nature. Since, then, the virtues / and the vices a25
are among things related to something, and these are not comings to be, nor is there coming to be of these, nor, generally, is there alteration of these, it is apparent that there is no alteration at all in the case of habits. Nor, then, [is there alteration] in the case of virtues and vices of the soul. For virtue is a certain perfection. For each thing is most perfect when it happens upon its proper virtue and is most according
to nature, just as the circle / is most according to nature when it is a30
most a circle. Vice, however, / is the destruction and removal of these. 247a20
The seizing of virtue and the throwing off of vice comes to be, then, when something is altering, yet neither of these is alteration.

It is clear, however, that something is altered [in these cases]. For virtue either is a certain impassivity or is being passive in a certain way, and vice is being passive or a passivity contrary to that of virtue.[27] And as a whole, moral virtue occurs with pleasures and
pains. For it either concerns pleasure / according to act, or through a25
memory, or from hope. If, then, [it concerns pleasure] according to act, the cause is sense; if through memory or from hope, it is from this same sense, for the pleasure is either by remembering such things as we suffered {experienced} or by hoping we will suffer {experience} such things.

But, indeed, neither is there alteration in the thinking part of the soul. For the knowing thing is rather said to be among things related
to something.[28] This is clear: for / no power having been moved, but a30
something being present, something of science has come to be. / For 247b20
we grasp universal science from experience of the particular.[29] Neither, then, is the act {operation, work}[of mind] a coming to be, unless one calls seeing and touching coming to be. For the act {operation, work}[of mind] is of that sort. The seizing of science from the beginning, however, is not a coming to be or an alteration. For the soul, by coming to rest and settling, comes to be understanding and
prudent. Just as, then, when someone / sleeping wakes, or being b25
drunk desists, or being sick gets well, there is not a coming to be of one who understands, though the one in question was not able to use

his science and to act according to it before, so too, being relieved of the tumult, and thought having come to rest and being settled, the power for the use of the science was [then] present. Some such thing, then, comes to be also in the starting of science from the beginning.
247b30 For this is a certain / rest and settling of the tumult. Boys, then, are
248a26 not able to learn nor / to discern by the senses as are their elders. For there is much tumult and motion in the case of boys. One settles and pauses from the tumult sometimes by one's nature, sometimes due to other people. In both of these [cases], however, it happens that some-
248b25 thing is altered, / as happens in regard to act {operation, work} when one awakes or becomes sober. It is apparent, then, that alteration is in the sensibles and in the sensitive part of the soul; in no other part, however, except accidentally.

Chapter 4

248a10 Someone might be at a loss, however, as to whether every motion is comparable with every motion or not.[30] If, then, every one is comparable, and what is of the same speed is what is moving an equal amount in an equal time, some circumference will be equal to a straight line, and greater, then, and lesser.[31] Moreover, some alteration and locomotion will be equal, when in an equal time the one is altered
a15 and the other / enters in [a place]. So a passion will be equal to a length; but this is impossible.

But is it not [true] that it is equally fast when in an equal time it is moved an equal amount, and a passion is not equal to a length, so that alteration is not equal to locomotion nor lesser; whence, not all motions are comparable?

Moreover, how will it happen in the case of the circle and the
a20 straight line? For it is strange if this thing cannot / be moving in a circle and that thing over a straight line similarly, but, right away, either faster or slower, just as if the one were going up, the other going down.

Moreover, it makes no difference to the argument if someone says it is necessary right away for it to be moving faster or slower.[32]
a25 For the circumference will be greater or less / than the straight;
248b1 whence, they can also be equal. For if, in time A, / one mobile went through B, another through C, B would be greater than C. For the faster was spoken of thus. If, therefore, in less time [it goes through] an equal amount, it is faster; whence, there will be some part of A in

which B will go through an equal part of the circle and C will go through C in the whole time A.

But indeed, if they / be comparable, what was already said hap- 248b5
pens, the straight is equal to the circle. But these latter are not comparable. So neither are the motions.

But whatever are not equivocal, all these are comparable. For example, why is it not comparable whether the stylus or the wine or the highest note is sharper? They are not comparable because they are equivocal. But the highest note is comparable to the next note, / because "sharp" signifies the same thing in both. "Fast" is not the b10
same, then, here and there, much less in alteration and locomotion.

Or is this not true in the first place, that if things are not equivocal, they are comparable? For "much" signifies the same thing in water and in air, and they are not comparable. If not, however, "double" is / the same (for it is two in relation to one), and water and air b15
are not comparable [as double and half].

Or does not the same argument apply even in these cases? For "much" is equivocal. But of some things even the accounts are equivocal, e.g., if someone should say that "much" is "so much and more besides," the "so much" is different. And "equal" is equivocal, and "one," if it be said of things, is right away equivocal; / and if this [is b20
equivocal] , so is "two." Since, if the nature were one, why are some comparable, some not?

Or is it because they are in different first recipients? The horse, then, and the dog are comparable as to which is more white, for surface, in which white is first, is the same, and [they are comparable] according to magnitude similarly. But water and voice are not [comparable in this way], for [it is] in something different.[33] / Or is it not b25
clear that we will thus make all things one, / saying that each is in 249a1
something other; and equal and sweet and white will be the same [in themselves] but different in a different thing? Moreover, what is receptive is not a chance thing, but one thing is first receptive of one thing.

But is it not the case that comparable things must not only not be equivocal, but also that they must not be different / either with respect a5
to "that which" or "that in which"? I mean, e.g., as color has division [into kinds]. So according to this [genus] colors are not comparable (i.e., as to whether one is more colored, [i.e.], not according to a certain color, but just as color), but according to white, [they are comparable].[34]

So too in the case of motion, what is of the same speed has moved an equal [magnitude] in an equal time, just this much. If, then, in this time [one part] of the length was altered / and the other entered a10

into [a place], is the alteration then equal to and of same speed as the locomotion? But this would be strange. The cause is that motion has species. Whence, if the things entering into an equal length in an equal time will be equally fast, the straight line and the circumference will be equal. Which, then, is the cause [of the incomparability], that
249a15 locomotion is a genus or that line is a genus? / For the time is always indivisible in species. Rather, the former [two] differ in species together. For locomotion too has species, should that over which it is moving have species. Sometimes, however, that by which [it moves differs], e.g., if feet, [it is] walking, if wings, flying. Or is it not so, but locomotions are other [in species] by the shapes [of the paths]?

Whence, things moving, and undiffering in [kind of] motion,
a20 in an equal time, through the same magnitude, / and a magnitude undiffering in species, are equally fast; whence, one must look to this: what the differences of motion are.

And the argument signifies this, that the genus is not something one, but alongside this hide the many; and there are, among equivocals, some very distant; some having some similarity; some
a25 near either in genus or / by analogy, whence they do not seem to be equivocals, though they are.

When, then, is the species different? Is it when the same [nature] is in another? Or is it not when a different [nature] is in another? And what is the term {definition}? Or is it not that by which we discern that white and sweet are same or other, because they appear in different things, or [also] because they are not the same at all?

Concerning alteration, then, how will one thing be equally fast
a30 with a / different thing? If, then, being healed is being altered, and one thing can be cured faster, another slower, some things can also be
249b1 altered at the same time; whence, the alteration / will be equally fast. For it was altered in an equal time. But what was altered? For equal is not a thing said here [in the genus quality], but as equality is in amount, so is similarity here.[35] But let the equally fast be what is mak-
b5 ing the same change in an equal time. / Which, then, must one compare, the passion or that in which the passion is?

In one case, then, because health is the same, one can grasp that the health is neither more nor less but is present in a similar way. But should the passion be other, as what is becoming white and what is being healed are [both] altered, nothing in these is the same or equal
b10 or similar, insofar as these already make / species of alteration, and are not one, just as neither are the locomotions; whence, one must grasp how many species of alteration there are, and how many of locomotion. If, therefore, the things moving differ in species, that is,

the things of which the motions are[36] in virtue of themselves and not accidentally, the motions also will differ in species; and if in genus, in genus; and if in number, in number.

But, / then, if the alterations are equally fast, [one must ask] 249b15
whether one must look to the passion, if that be the same or similar, or to what is altering, e.g., if so much of this has come to be white and so much of that? Or is it not to both, and the alterations are the same or other by the passion, if it is the same, but equal or unequal, if what is altering is [equal or] unequal?

And one must look into the same thing about coming to be and destruction. / How is coming to be equally fast? [It is equally fast] if b20
in an equal time the same thing and something indivisible [in species comes to be], e.g., man, but not animal. It is faster, however, if in an equal time a different thing [comes to be] (for we do not have some two things in which the difference [lies], like the dissimilarity [for alterations]),[37] or, if substance is number, a greater and lesser number of the same species. But the common thing is unnamed, / and so is b25
each [unnamed] in the way that a passion is "greater" or "more exceeding," an amount "greater."[38]

Chapter 5

Since, however, the mover always moves something and in something 249b27
and up to something (I say, however, "in something" because it is in time, "up to something" because the length is some amount, for the mobile always is moving and has moved at the same time,[39] / whence, b30
there will be some amount which the mobile is moved, and in so much time), if, then, A is the mover, B the moved, the length / C how much 250a1
it has been moved, in so much, the time D, then, in an equal time a power equal to that of A will move the half of B double C, [it will move half of B through] the length C, however, in half of D. For thus will there be proportion.[40]

And if the same power moves the same thing so much / in this a5
time and through the half in half, the half strength will move the half in an equal time through an equal length. For example, let E be half the power of A and Z the half of B. The strength, then, is disposed similarly and according to proportion in relation to the weight; whence, it will move [Z through] an equal length in an equal time. And if / E moves Z in D through C, it is not necessary that E move a10
double Z in an equal time through half of C. If, then, A moves B in D

so much, C, the half of A, E, will not move B [through] something of
a15 C proportional to / the whole C as A to E in the time D nor in some-
thing of D. For, if it chanced, it will not move anything at all. For it
does not follow that if the whole strength moved [it] so much, the half
will move [it] so much nor in any time. For one man would move a
ship, if indeed the strength of the ship haulers and the length which
all moved [the ship] are cut into the number [of movers].[41] Because
250a20 of this, / the argument of Zeno is not true, that any part of the millet
makes a sound. For nothing prevents this from not moving the air
which the whole falling bushel moved in any time. If the millet seed
were by itself it would not move so great a part as it would move as
part of the whole. For when it is in the whole, it is not any one thing,
a25 except in potency. / If, however, there are two [movers] and each of
these moves each [part] so far in so much time, the composed powers
will move what is composed of the weights an equal length and in an
equal time. For this is proportional.

Is it, then, also thus in alteration and growth? For there is
a30 something which causes growth, something which is growing / in so
much time, and the one causes so much growth, the other grows so
much. And so too what causes alteration and what is altered; some-
250b1 thing also is altered so much, / according to more and less, and in so
much time.

In the double time, [it will have] a double [effect], and [if it
has a] double [effect], [it will do so] in a double time; and half in the
half time or, in a half, half, or, [if the power be doubled,] in an equal
time, a double [effect]. If, however, what causes alteration or growth
b5 causes so much growth or alteration in so much time, / it is not also
necessary that [the half] cause a half in the half or in the half, a half,
but it will alter or will grow nothing, if it chanced, just as also in the
case of weight.

Endnotes

1. There are two extant versions of Book VII, ch. 1–3. The differences between them are slight. I have placed my translation of the alternative text after the translation of Book VIII.
2. 234b10–20.
3. Cf. 224a21–30.
4. The argument begins by saying that if a thing ceases from motion because another

does, the first thing must be moved by another. We tend to assume the second thing in question is something which pushes or pulls or otherwise moves the mobile. But the argument proceeds by saying that, since if a part stops, the whole stops, every whole which is in motion must be moved by another (and since all mobiles are divisible wholes, everything in motion is moved by another). Thus, the "other" which, when stopping, stops the first, is not other in every sense, and is not an agent, but is a part of the first, which is a kind of material (195a16–18). What the argument shows is that no mobile is the explanation of its own motion, since the motion depends on the mobile which in turn depends on its parts. Since there is no ultimate part, there is no ultimate explanation in terms of the parts; we must therefore look to another sort of principle to explain the motion, namely an agent. That Aristotle intends to conclude to the existence of an agent is more clear later, when he says, "the first mover, not as that for the sake of which, but whence is the beginning of motion...." (243a3–4), the latter being an abbreviated form of the expression Aristotle usually uses for the agent cause (cf. 194b29–30).

5. The application of the principle that everything moving is moved by another to locomotion is problematic in the case of projectile motion. For a consideration of this, cf. Appendix 10, *A Brief Note on Inertia*.

6. Cf. 242b35 in the Alternative Text.

7. 227b3–228a1.

8. Cf. 238a20–b22.

9. The argument from 238a20–b22 showed that an infinite mobile cannot move in a finite time; it did not show that infinitely many mobiles cannot do so, which is what is required by the argument to this point. Aristotle goes on to resolve the difficulty in the rest of this chapter.

10. That the mover and the mobile have to be "together" or in contact will be argued in the next chapter. Here Aristotle merely says we see this in all cases. We might wonder about cases like magnetism and gravitation. Cf. Appendix 11, *A Note on Contact between the Mover and the Moved*.

11. For the infinite, cf. 238a36–b13; for the finite, 238a32–36. We might also argue, in the case of the finite, that we started with an infinite number of bodies, each of which, however small they might be and whatever ratio their sizes might have to one another, is of some determinate size. The whole composed from them, then, will have to be infinite anyway. But even with regard to the case of the infinite, there is a problem. For the argument at 238a20–b22 showed that an infinite mobile cannot traverse a finite or infinite distance in a finite time. But all that is required for the case under consideration is that the mobile "shift" a little. For Aristotle said himself that the motion of each part is through a finite distance, at 242a29–31. Perhaps the most appropriate response is that a "shifting" motion is posterior to a complete motion (cf. 234b1–20), and so cannot be if the complete motion cannot be. One might more easily refer, though, to the arguments that body cannot be infinite, or to the difficulty that there will be an infinite place bigger than the infinite body, since the body cannot move if it has no place to go.

12. Cf. *Prior Analytics* I, 15, 34a5–33.
13. Here Aristotle supports the premise, used in the previous chapter, that the mover and the mobile are in contact.
14. 225b5–9.
15. Cf. 260a20–261a28; 265b17–266a5.
16. As the rest of the text makes clear, Aristotle is only considering locomotions.
17. 211a12–23.
18. Cf. 215a14–19; 266b27–267a20.
19. In the *Categories*, Aristotle divides the genus "quality" into four sub-genera, the third of which is sensible or affective quality (Ch. 8, 9a28–10a10). In the present text, Aristotle assumes that motion according to quality is in this sub-species only; in the next chapter, he will support that assumption.
20. Note that physical bodies differ not merely by quantitative differences like shape or size, but also by qualitative differences such as heat, weight, dryness, etc. These latter are perceived by the sense of touch, as are most, if not all, of the qualities by which we distinguish the kinds of bodies and in virtue of which they affect each other. Modern chemistry will define its basic bodies by things like atomic weight, but the very arguments for the existence of such a thing as atomic weight are themselves based on tangible qualities like acidity, hardness, the weight of a determinate volume of the element, etc. These are the distinctions which allow us to see that there *are* different kinds of bodies, and from which we begin to give an account of those differences in terms of supposedly more fundamental qualities, some of which are hypothetical to a high degree, like quantum spin or a quark's "strangeness." If we deny the reality of the differences which we first perceive and from which we argue to our modern theories, we have cut ourselves off from the very foundation of our own modern theories.
21. This claim will be qualified in the *On the Soul* II, Ch. 5, 416b32–418a5; Ch. 12, 242a17–24; III, Ch. 7, 431a4–7.
22. Aristotle assumed this in the previous chapter.
23. The four species of quality distinguished in the *Categories* are habit and disposition (8b26–9a13), natural abilities (as we say a man is a "born runner;" cf. 9a14–27), sensible or affective qualities (9a28–10a10), and shapes and figures (10a11–16). Aristotle argues that alteration is only in the third species by rejecting the first and fourth. Perhaps he does not explicitly reject the second because it is obvious that natural abilities are destroyed by destroying the being that has them, not by alteration.
24. Cf. *Categories*, Ch. 1, 1a12–15; Ch. 5, 2a27–34. "Denominating" could also be translated, "naming derivatively."
25. Aristotle has really only argued that alteration is not in the fourth kind of quality; he has not yet addressed the first.
26. Cf. *Categories*, Ch. 8, 8b25–11a38, esp. 11a20–38.

27. As he often does, Aristotle here does not take a determinate position on something not yet settled. His own position is that to be virtuous is not simply to be impassive, as one might think that temperance is being simply unaffected by pleasures and courage being unaffected by fear; rather he holds that to be virtuous is to be affected by the passions in a measured, rational way. He defines virtue as "the habit of the mean" between being overly affected by, e.g., fear and being affected too little. The first would be cowardice, the second, rashness. Cf. *Nicomachean Ethics*, Bk. II, Ch. 6, 1106b36–1107a8.

28. Cf. *Categories*, Ch. 7, 6a36–b6.

29. Cf. *Posterior Analytics* II, 19, 99b32–100b5; *Metaphysics* I, 1, 980a21–981a27; *On the Soul* III, 4–5, 429a10–430a25.

30. Having distinguished the kinds of motion (243a6–10), and having spoken of a series of mobiles and movers (242a15–20 ff.), which later seems to imply some comparability, Aristotle asks whether every motion is comparable to every other; the context will make it clear that by "comparable," he means able to be greater, lesser, or equal.

31. If a rotation can be equal to a motion over a straight line, then the straight line must be equal to the circumference. Aristotle assumes this is impossible. Equality is proven by coincidence of the wholes or by coincidence of parts which are then added or subtracted to something common (cf., e.g., Euclid, *Elements*, Book I, Propositions 8 and 35). But neither the wholes nor any parts of a circle and a straight line can coincide, since they can coincide only in a point and neither is made up of points (cf. 230b21–b18). The various attempts to overcome this dichotomy by means of calculus are not clearly satisfactory. For the purposes of this text, we need not insist upon the point, as the examples of comparing alterations and locomotions seem to be sufficient to show that not every motion is comparable with every other.

32. Someone might try to argue that, though rotation cannot be equal in speed to straight line motion, it can be faster or slower. Aristotle now takes this up.

33. Having suggested that even what seems univocal is not so in different materials, he goes on to suggest that perhaps the name is univocal, but is merely received in different materials; i.e., the only reason things are not univocal is because they are received in different materials. This seems to be a Platonic position, assuming as it does that as we come to more and more universal predicates, we still have a univocal use of the terms, as if justice in the city and in one man are different only in that one is in the great, the other in the small. Cf. Plato, *Republic*, Bk. II, 368c–369a; *Metaphysics*, I, 9, 990b34–991a8; 9929–13. Aristotle goes on to give two objections to this position. It is perhaps important to note that the Greek word for "white" can also mean "clear" or "limpid," whence the examples of voice and water.

34. Thus, in summary, there are three conditions of comparability: first, lack of equivocation; second, sameness of first subject; and third, unity in species. The third may be seen as resulting from the other two, since if the name means the same thing, and the material in which the form named exists is of the same sort, the species would have to be the same, for the material is correlative to the form, as was noted at 249a2–3.

35. Cf. *Categories*, Ch. 6, 6a26–35; Ch. 8, 11a15–19.

36. Given the context, Aristotle seems to mean the genus or species according which the mobile moves, like whiteness or place, not the mobile itself.

37. Perhaps Aristotle is referring to 249b5–7, where he said that there are two things to consider in the comparison of alterations: whether they are of the same species and whether that species is also present to the same degree. While health admits of more and less, "man" or "dog" does not; so in the latter case, that of coming to be, there is only one comparison to be made.

38. Perhaps the thought is that, if substances are numbers, and numbers are collections of units, then all numbers, whether greater or smaller, are of one species. For the accidental combination of units does not seem to be able to make a new sort of thing. But then there will be in this case, as in the case of alteration, two things to compare in coming to be, the substance and the size of the number. What is common and varies, not the being substance but the supposed more and less which is not itself in the genus of quantity, is unnamed, i.e., unnamed in that way in which what so varies is named in quality and amount. The Pythagoreans, and perhaps Plato, thought substances were numbers. Cf. *Metaphysics*, I, 5, 987a17–20; 6, 987b22–25.

39. The mover is a mover in act only so long as there is actually some motion; but whenever there is motion, the mobile both is moving and has already moved some amount. Cf. 236b32–237b9.

40. Note that the rules of proportion which Aristotle gives do not relate power or strength to acceleration but to distance.

41. The ratios which obtain between weights and powers may not hold for all cases. If a certain power moves a certain weight so far, it may not move twice that weight half, or even any distance. Because some ratio may hold for any abstract quantity, it does not follow that it will hold for actual physical bodies. For example, half a given volume of water gives half the weight; but I cannot indefinitely divide the volume and get half the weight of water, because there seems to be a smallest amount of water (cf. 187b13–21). It is only in the abstract world of mathematics that we can be sure our ratios always hold; in the physical world, we must always verify our claims through observation. Because of this, we are forced to continually verify by experiment the applicability of the equations of modern science to new phenomena.

Book VIII

Chapter 1

Is it the case that motion came to be at some time, not being before, 250b11
and is destroyed again, so that nothing is moving, or is it the case that
it neither came to be nor is destroyed, but it always was and always
will be, and is immortal and is in things without pause, being like a
certain life to all things / composed by nature? b15

All those saying something about nature,[1] then, say that motion is, because of the making of the world and because, for all of them, their consideration concerns coming to be and destruction, which cannot be, if motion is not.

But any men who say that worlds and the comings to be and destructions of the worlds are infinite, say motion is always. For it is necessary that the comings to be and destructions / of these worlds are b20
with motion.

Any men who say that the world is one and not always existing make suppositions about motion also according to this account. If, then, it can happen that at some time nothing is moving, it is necessary that this happen in one of two ways. For this is either as Anaxagoras says (for he says that, / all things being together and resting for an infinite time, Mind introduced motion and separated [things]), or as Empedocles says, [that the whole] is moving in part [of time] and again resting in part [of time], moving when friendship makes one from many or strife many from one, but resting in the time between, saying, b25

> Thus insofar as one has learned to be born from many, b30
> And again, one being torn apart, many things are brought about,
> In this they come to be and for them there is no sure life: 251a1
> And in this way alternating forever, they remain in no way;
> In this, they are always immobile according to a circle.[2]

For by the "And in this way alternating," one must suppose him to mean from one [state] to the other. / One must look into how these a5
things are, then. For this is a work preparatory not only to seeing the truth concerning the consideration of nature, but also to the inquiry about the first principle. Let us begin first, however, from the things determined by us before in the *Physics*. We say, then, that motion is

251a10 the act / of the mobile as mobile.[3] So it is necessary that the things able to be moving according to each motion exist. Even apart from the definition of motion, everyone would agree that it is necessary that it is what is moving according to each motion that is able to be moving, e.g., the alterable is altering, the changeable according to place is a15 being borne; / whence, what can be burnt must first be, before it is being burnt, and what can burn before burning.

It is also necessary, then, that these mobiles either come to be (if they at some time do not exist) or are eternal. If, therefore, each of the mobiles came to be, it is necessary, before the change taken, that a20 another change or motion came to be, according to which / what is able to be moved or to move [another] came to be. If, however, beings always existed before, there not being motion, this clearly is, and is understood in a moment to be, unreasonable; not only this, but going into the matter more, [the contrary] happens to be necessary. For if, there being mobiles and motive things, at some time there will be, on the one hand, some first mover, and on the other, something moved / a25 and at some time nothing [moves], but [everything] rests, it is necessary that this [mover or mobile] change first, for there was some cause of the rest. For rest is the privation of motion; whence, before the first change there will be a prior change.

For some things move [others] in one way only, but some [cause] a30 even contrary motions, e.g., fire heats, / but does not cool, but the science of opposites seems to be one.[4] Even in the former case, then, there appears to be something of a similar mode. For the cold heats, in a way, having turned and gone away; just as one who understands willingly errs, when he uses his science in a contrary way.

251b1 But whatever things are able to act and to suffer, then, or to move (and some to be moved) are not [so] able in every way, but [the things which are able to act and to suffer are] things disposed in a certain way and being near to each other. Whence, when the mover approaches, it moves [the other], and the other is moved; [i.e.,] when they are b5 present as were the motive and / the mobile. If, therefore, [a mobile] was not always being moved, it is clear that they were not thus disposed (i.e., as were what is able to be moved and what is able to move), but one of them must have changed. For it is necessary, in things related to something, for this to happen, e.g., if a thing, which was not double, is now double, [it is necessary that] one of the two, if b10 not both, change. So there will be some / change prior to the first.

Besides these arguments, how will the before and after be, if time does not exist, or time, if motion does not exist? If time is the number of motion or is a certain motion,[5] then it is necessary that motion also be eternal if time always exists. But, concerning time, all are

clearly of one mind except one man. / For they say it is ungenerated. b15
And through this Democritus shows that it is impossible that all things come to be. For time is ungenerated. Plato alone, however, generated it. For it came to be together with the heaven. But he said that the heaven came to be.[6] If, then, it is impossible that time either be or / be understood without the now, and the now is a certain middle, b20
being at once a beginning and an end, the beginning of time to be, the end of time having gone by, it is necessary that time is always. For the extreme of the last time taken will be in a certain one of the nows, for there is nothing to take in time / besides the now; whence, since the b25
now is both a beginning and an end, it is necessary that time is always on both sides of this; but indeed, if time is, it is apparent that it is necessary also that motion be, since time is a certain passion of motion.[7]
The argument about motion being indestructible is the same. For, just as in the coming to be / of motion there happens to be some change b30
before the first, thus here after the last. For a thing does not cease being moved and being mobile at the same time, as being burnt and being burnable (for what can be burnt can not be being burnt), nor / motive and moving. And the destructive, then, will need to be 252a1
destroyed when it has destroyed, and the destructive of this again after. For destruction, too, is a certain change. If, then, this is impossible, it is clear that motion is eternal, and it is not true that motion sometimes was and sometimes was not. / For speaking thus seems to a5
be rather akin to a figment.

So too is saying that things are naturally apt to be thus, and that one must think this to be a principle, as Empedocles seems to say, that Love and Strife ruling and moving in turn belongs to things by necessity, and there is resting in the time between. / Perhaps those who a10
make the principle one, like Anaxagoras, would also speak thus.[8]

But indeed, nothing is disordered among things which are by nature and are according to nature. For nature is in all things a cause of order. The infinite, however, has no ratio to the infinite, and every order is a ratio. It is no longer a work of nature for things to be resting for an infinite time, then at some time to have been moved, / when a15
there is no difference of this [time] due to which [it has been moved] now rather than before, nor even some order between these [times]. For either what is by nature is disposed simply, and not thus at one time, otherwise at another, as fire moves up by nature, and not at one time but not at another; or else, in the case of what is not simple, what is by nature has a ratio. Whence, it is better [to speak] as / Empedocles a20
[spoke], and anyone else who said things are so disposed, [saying] that the whole rests in turn and [then] is moving again. For such [a whole] already has a certain order.

But the one saying this must not assert this alone, but must also say the cause of this, and not put down nothing nor deem worthy an
252a25 unreasonable axiom, but bring forth either an induction / or a demonstration. For the things supposed are not the causes [of these alternations], nor was to be friendship or strife [to be] this [sort of alternating thing],[9] but from friendship came gathering, from strife separation. If, however, it is determined that [each acts] in part [of time], one must say in which things this is so, just as that there is something
a30 which gathers men, friendship, and enemies avoid each other. / For this is supposed to be [the case] in the whole also, for it appears to be thus in certain things. But that this is the case through equal times also needed some argument.

Generally, however, thinking this to be a sufficient principle, that something is or comes to be thus always, is not rightly supposed, to
a35 which claim Democritus reduces the causes concerning nature, / [saying] that it also came to be thus before. However, he did not think it
252b1 worthy / to seek the principle of this "always," speaking rightly about some things, but not about all things. For even a triangle has its angles always equal to two right angles, but nevertheless, there is some different cause of this "always." Yet of principles there is not a different cause
b5 of being eternal.[10] / Let so much be said, then, [to show] that there was no time, nor will there be, when motion was not or will not be.

Chapter 2

252b7 The things contrary to this claim are not difficult to resolve. Mostly by looking into the following would there seem to be motion at some time, though it had not been at all [beforehand]. First, because not one
b10 change is eternal, / for every change is naturally apt to be from something to something; whence, it is necessary that the limits of every change are the contraries among which it comes to be; nothing, however, moves to infinity.[11]

Moreover, we see that a thing is able to be moved, [though] neither moving nor having in itself any motion, e.g., in the case of unsouled things, which at some time move, [though] neither a part of
b15 them / nor the whole is moving [before], but resting. It is fitting, however, that they be always or never moving, if motion does not come to be [after] not being.

Such a thing is much more apparent in the case of ensouled things. For sometimes there is no motion in us, but we are still; nev-

ertheless, at some time we move ourselves, and / a beginning of b20
motion came to be in us from ourselves, even if nothing external was moving. For we do not see this in unsouled things similarly, but there is always something different among external things which moves these things, but we say that the animal itself moves itself. Whence, if the ensouled sometimes rests completely, motion can come to be in an immobile thing from the thing itself and not from something external. If, however, / this is able to come to be in an animal, what prevents the b25
same thing happening also according to the whole? For if it comes to be in a small world, it could also come to be in the great; and if in the world, also in the infinite, if, indeed, the infinite can be moving and resting as a whole.[12]

Of these, then, the first thing said is rightly said, that a motion to opposites / is not always one and the same in number. For this is per- b30
haps necessary, if the motion of one and the same thing is able not to be always one and the same. I mean, e.g., [one might consider] whether one and the same sound is of one chord, or is it always different, when a chord is disposed and moved similarly. / But, however b35
this is, nothing prevents a certain motion from being the same / by 253a1
being continuous and eternal. This will be more clear, however, from later things.[13]

That what is not moving [now] be moved [later] is nothing strange, however, should an extrinsic mover sometimes be present, sometimes not. Nevertheless, one must ask how this can be; I mean, so that the same thing is sometimes / moved by the same motive thing, a5
sometimes not. For the one saying this is at a loss about nothing other than why it is not the case that, among beings, some always rest, and the others always move.

The third [objection], however, would seem most of all to present a difficulty, that motion, not being present before, has come to be, which happens among the ensouled. For [an animal], resting before, / after this walks, nothing external having moved, as it seems. But this a10
is false. For we see some of the inborn parts in the animal always moving. Of the motion of this, however, not the animal itself, but, perhaps, its environment is the cause. We say, however, that the animal moves itself not according to every motion, but according to motion / according to place. Nothing, then, prevents many motions a15
coming to be in its body due to its environment (rather, perhaps it is necessary). Of motions, some move the thought or appetite, and that right away moves the whole animal, as happens to those sleeping. For, while no motion of the sensitive part is present, / though some motion a20
is present, animals are again awakened. For these things will be apparent from the following [considerations].[14]

Chapter 3

253a22 The beginning of the consideration, however, which also concerns the difficulty mentioned,[15] is why some things among beings sometimes are moved and sometimes again rest. It is necessary, then, either that
a25 all things always rest, or / that all things are always moving, or that some things are moving and some things rest, and again, of these, either that the ones moving are always moving and the ones resting are always resting, or that all things are naturally apt similarly to be moving and to be resting, or the still remaining and third [case]. For it can be that some among beings are always immobile, and some are
a30 always moving, and / some partake in both; which, indeed, is what must be said by us. For this holds the solution of all the difficulties, and our end of this very business.

[To hold], then, that all things rest, and, putting aside sensation, to seek the reason for this, is a certain weakness of thought.[16] And this is a controversy about something general, but not about a part [of philosophy]; speaking so does not regard natural science alone but all /
253b1 sciences and all opinions, because all use motion.[17] Moreover, just as objections about the principles, in arguments about mathematicals, are not something for the mathematician [to discuss], and so too in other cases, thus neither is there anything for the student of nature in
b5 the objection / now spoken of.[18] For it is a supposition that nature is a principle of motion.[19]

Perhaps, however, saying that all things are moving is false, though less beside the inquiry than the former [opinion]. For in the *Physics*, nature was put down as a principle of rest just as of motion, though motion is similarly natural.[20]

b10 And some say / it is not the case that some beings are moving and some are not, but that all things are moving and always, but this escapes our sense. And though they do not determine what sort of motion they mean, or [whether they mean] all, it is not difficult to contradict them.[21]

For it is not possible that either growing or diminishing be continuous, but there is also [a rest in] a middle. The argument is similar
b15 / to the one about the dripping wearing away a rock and the one about shoots dividing rocks. For it does not follow that if the dripping has extruded or removed so much, [it also removed] half in the half time before: but it is like the hauled ship,[22] and so much dripping [moves]
b20 so much, but the part of this in no time moves so much. / What is removed, then, is divided into many, but not one of these was moved separately, but [all were moved] together. It is apparent, then, that it is

not necessary that something is always {continuously} carried off because diminution is divided to infinity, but at some time a whole is carried off.

So too, however, in any alteration whatever. For it does not follow that, if what is being altered is partible to infinity, / the alteration b25
is too, but it often comes to be all at once, like freezing. Moreover, should something be ill, it is necessary that there be a time in which it will be healed, and that it not be changed in the limit of time. It is necessary, however, to change to health and not to anything else. Whence, saying that altering is continual is very much to dispute with the appearances.[23] / For alteration is among contraries. And a rock b30
comes to be neither harder nor softer.

According to locomotion, however, it would be wondrous if the rock moving down or remaining on the earth escaped notice.[24] Moreover, earth and each of the other elements remain in their proper places by necessity, and they are moved / from these violently. If, b35
then, some are in their proper places, / it is necessary that neither are 254a1
all things [always] moving according to place.[25] Someone would be convinced from these and other such arguments, then, that it is impossible either that all things are moving always or that all things rest always.

But indeed, neither can some things be always resting, others always moving, but nothing sometimes / resting and sometimes moving. a5
One must say that this is impossible in these things, just as in the case of the things spoken of before. For we see the changes mentioned coming to be in the case of the same things.

And in addition to these arguments, [we see] that the one disputing fights against the appearances. For there will not be growth[26]; nor violent motion, if what is resting / before will not be moved against a10
nature.[27] This account, then, removes coming to be and destruction. Perhaps, however, moving seems to everyone to be a certain coming to be and being destroyed. For the mobile comes to be this or in this to which it changes; and that from which it changes, [being] this or there, is destroyed. Whence, it is clear that some things are moving sometimes, and some things rest / sometimes. a15

Deeming it worthy to believe, however, that all things at times rest and at times are moving, is already to be united to the ancient accounts.[28]

One must make a beginning again from the things just now determined, the very thing, indeed, according to which we began before.[29] For either all things rest, or all things are moving, or some among beings rest and some are moving. And if some rest and some / are a20

moving, it is necessary either that all things at times rest and at times are moving; or some always rest and some of these are always moving; [or also] some at times rest and at times are moving.

That, therefore, it is not possible that all things rest has been said before; however, let us say it again now. For even if according to truth
254a25 things are / as some say, that being is infinite and immobile, yet it does not appear so according to sense, but [it appears that] many beings are moving. If, then, opinion is false, or if opinion exists at all, motion also exists, and also if imagination exists; and if at times it seems thus, at times different. For imagination and opinion seem to be
a30 certain motions. / But looking into this, and seeking an argument about that concerning which we are so well off as not to need an argument, is to discern badly the better and the worse, and what is convincing and what is unconvincing, and what is a principle and what is not a principle.

So too, however, it is impossible that all things are moving, or
a35 that some things are always moving and the others always / rest. For
254b1 in regard to all these, one conviction is sufficient: for we see / some things at times moving and at times resting. Whence, it is apparent that it is impossible that all things be resting, or that all things be moving continually, in the same way as that some things are always moving and the others always resting.

It remains, then, to consider whether all things are such as to
b5 move / and to rest, or some are thus, but some always rest and others are always moving. For this latter must be shown by us.

Chapter 4

254b7 Among movers and things moved, then, some move [others] and are moved accidentally, some [do so] in virtue of themselves: [those move or are moved] accidentally which [do so] by being present in the
b10 mover or the thing moved, and things [which do so] / according to their parts; but those [move or are moved] in virtue of themselves which [do so] not by being present in the mover or the thing moved, nor by a certain part of them moving [another] or being moved. Of things [moving and being moved] in virtue of themselves, some are [moving and being moved] by themselves and some by another, and some by nature and some by violence and beside nature.[30]

For a thing which is being moved by itself is moving by nature, /
b15 e.g., each of the animals. For an animal moves itself by itself, but we

say that whatever things have the principle of motion in themselves are moving by nature. Whence, the animal as a whole, by nature, moves itself by itself; nevertheless, its body can be moving both by nature and beside nature. For it makes a difference what sort of motion what is moving / chances [to have] and from what sort of element it is constituted. And of those being moved by another, some are moved by nature, some beside nature, e.g., it is beside nature for the earthy [to move] up and fire down. Moreover, the parts of animals are often moved beside nature, beside the [natural] positions and ways of motion. b20

And it is / most apparent in things moving beside nature that what is moving is moved by something, because of its being clear that such a thing is being moved by another. After things beside nature, among things according to nature, [this is clearest in] things moving themselves, like the animals. For it is not unclear whether they are moved by something, but [rather it is unclear] how one must distinguish the mover and the moved in it. / For it seems the mover and the moved are divided in animals as they are in ships and in things not constituted by nature; so also for everything moving itself. b25 b30

Of the last division mentioned, the remaining one is most doubted. For of things moved by another, we have put down that some / are moving beside nature, and some remain to be opposed [to the former] / because they are by nature. These, like light things and heavy things, are what might provide some difficulty as to what they are moved by. For these are moved into opposite places by violence, but into their proper places, the light, up, the heavy, down, by nature; by what, however, / is not yet apparent, as it is when they are moved beside nature. b35 255a1 a5

For it is impossible to say they are moved by themselves. For this is vital and proper to ensouled things. And they would be able to bring themselves to a stand. I mean, e.g., if a thing is the cause of walking for itself, it is also the cause of not walking. Whence, if it is in its own power for fire to be borne up, it is clear / that to be borne down is also in its own power. It is unreasonable, however, [for them] to be moved by themselves according to one motion alone, if in fact they move themselves. Moreover, how can something continuous and naturally one move itself? For insofar as it is one and continuous, not by touch, a thing is impassible; but insofar as a thing is separated [into parts], one [part] is naturally apt to act, the other to suffer. / So not one of these moves itself, for they are naturally one, nor does any other continuous thing move itself, but it is necessary that in each thing the mover be divided in relation to what is moved, as we see in the case of unsouled things when something among ensouled things moves [them]. a10 a15

But it happens that even these things are always moved by some-
255a20 thing. This would become clear by dividing / the causes. Even in movers one can grasp the things said. For some of these are motive beside their nature (as the lever is not motive of the heavy by nature), and some by nature, as what is hot in act is motive of what is hot in potency. So too, however, in other such things. And what is thus
a25 mobile / by nature is what is in potency such or so much or somewhere, when it has a principle of this sort in itself and not accidentally. For the same thing can be both such and so much, but one is accidental to the other and does not belong in virtue of itself [to the other]. Fire, then, and earth are moved by something: by violence when
a30 beside nature, but by nature / when, being in potency, [they are moved] to their own acts.

Since, however, "in potency" is said in many ways, this is the cause of its not being apparent what such things are moved by, e.g., fire up and earth down. The one learning a science, however, and the one having [it] already and not being in act are in potency in different ways. However, the potential thing always comes to be in act when-
255b1 ever the active / and the passive are together, as the learner comes to be, from being in potency, a different thing in potency. For he who has science, but is not [actually] considering [it], is knowing somehow in potency, but not as [he is] even before learning. When, however, he is thus disposed, he is in act and considers, should nothing prevent him;
b5 or else he will be in the / contradictory [condition] and in ignorance.[31] This is so too in the case of natural things. For the cold is in potency hot, but when it changes, it is fire right away; and it burns, unless something prevents and impedes it. So too in the case of the heavy and the light. For the light comes to be from the heavy, as air from
b10 water, for the air is in potency / first, and it is light right away, and it will be in act right away, unless something prevents it. However, the act of the light is being somewhere and up; it is prevented, however, when it is in the contrary place. And the case is similar in the case of amount and quality. And indeed, it is asked why light and heavy things
b15 are moved to their own place. / The cause is that they are naturally apt to go somewhere, and this is to be light and heavy, the one being determined to what is up, the other to what is down. Light and heavy, however, are in potency in many ways, as was said. For when water is, it is somehow in potency light, and when it is air, it is as yet in poten-
b20 cy, for it can, / being impeded, not be up. But should the thing impeding be removed, it is in act and always comes to be higher. So too, however, what has [a certain] quality changes to being in act. For the one knowing[32] considers right away, unless something prevents him. And the quantified spreads, unless something prevents it. The one

who moves the supporting and preventing thing, / e.g., the one who b25
pulls a pillar out or draws a stone out from a wine-skin in water, in a way moves [another] and in a way does not. For he moves [another] accidentally, as the rebounding ball also was not moved by the wall but by the one throwing. It is clear, therefore, that not one of these things moves itself. / But they have a principle of motion, not of mov- b30
ing [another] nor of acting, but of suffering.

If, then, all moving things are moving either by nature or beside nature and by violence, and all the ones moving by violence and beside nature are moved by something and by another, and again, of the ones moving by nature, the things moving by themselves are moved by something, and also the things not moving by themselves, like light and heavy things / (for [they are moved] either by what 256a1
brought them into being and made them light or heavy, or by the thing releasing what impedes and prevents [their motion]), all moving things would be moved by something.[33]

Chapter 5

This happens in two ways. For either the mover is not [a mover] 256a4
through itself, but through / a different thing which moves the mover, a5
or through itself, and this either first after the extreme [i.e., what is moved] or through many, as the stick moves the rock and is moved by the hand, which is moved by the man, though the man does not move, further, by being moved by another.

We say, then, that both move [others], both the last and the first of the movers, / but more the first. For the latter moves the last but this a10
does not move the first; and also, without the first the last will not move [another], but the former will move [another] without the latter, as the stick will not move [another] without the man moving [it].

If, then, it is necessary that everything moving be moved by something, and either by something moved by / another or not, even a15
if [it is moved] by another moved thing, it is necessary that something be a first mover which is not moved by another; but if this sort of thing is first, it is not necessary that there be another. For it is impossible that the mover and the thing moved by another go on to infinity. For there is nothing first among infinites. If, then, everything moving is moved by something, / and the first mover is moving, but not by a20
another, it is necessary that it be moved by itself.

Moreover, this same argument can go forward thus. For every

mover moves something and by something. For the mover moves either by itself or by another, as the man [moves something] himself
256a25 or with a stick, and the wind itself or / a rock which it pushes knocks something down. It is impossible, however, that that by which a thing moves [another] move [the other] without what is a self-mover. But if it moves by itself, it is not necessary that there be another by which it moves; however, if that by which it moves is a different thing, there is something which will move not by something [else] but by itself, or they will go on to infinity. If, then, something moved moves [another],
a30 it is necessary to come to a stand and not to go on to infinity. / For if the stick moves by being moved by the hand, the hand moves the stick, but if another also moves the hand, this different thing will be what is moving the hand. Whenever, then, a different thing always moves [another] by something, it is necessary that a self-mover be prior. If, then, this [mover] is moving, but there is nothing moving it,
256b1 it is necessary that it move itself. / Whence, according to this argument also, either what is moved is directly moved by a self-mover, or at some time one comes to this sort of thing.[34]

In regard to the things being said, by looking into this matter thus, these same things will happen. For if everything moving is moved by
b5 something moving, / either this belongs to things accidentally, so that it is what is moving that moves [another], though not because it is moving, or not, but [this belongs to movers] in virtue of itself. First, then, if the motion belongs accidentally, it is not necessary that the mover be moving. If this is so, however, it is clear that it can at some
b10 time happen that nothing among beings is moving. For / the accidental is not necessary, but can not be. If, then, we put down what is able to be, nothing impossible, though perhaps what is false, will happen. But it is impossible that motion not exist. For it was shown before that it is necessary that motion always exist.[35]

And this has happened reasonably, for three things are necessary:
b15 the / moved, the mover, and that by which it moves. It is necessary, then, that the moved be moved; it is not necessary, however, for it to move [another]. That by which [the mover] moves, however, both moves [another] and is moved. For this changes at the same time as, and according to the same being as, what is moved. This is clear, however, in the case of those things moving [others] according to place. For it is necessary that they touch each other up to a certain point. /
b20 But what is a mover so as not to be that by which a thing moves [another] is immobile. Since, however, we see the extreme, [i.e.,] what is able to be moved, though it is not a principle of motion, and what is moved, but by another and not by itself, it is reasonable, not to say necessary, for the third also to be, that which moves, being immobile.

Whence also, Anaxagoras / speaks rightly, saying the Mind is impassible and unmixed, since he makes this be the principle of motion. For thus only could it move [another], being immobile, and rule, being unmixed. b25

But indeed, if the mover is moved not accidentally but by necessity, and would not move [another] if it were not moving, it is necessary that the mover, insofar as / it is moving, either be moving so as [to be moving] according to the same species of motion, or else according to a different one. I mean either what is heating is also itself being heated and what is healing being healed and what is bearing being borne, or else what is healing is being borne, but what is bearing is being grown. b30

But it is apparent that this is impossible. For one must speak / of what is divided right up to the indivisible, e.g., if someone teaches [someone] to geometrize about something, he must be being taught to geometrize about this same thing, or if he throws, he must be thrown according to the same manner of throwing. Or else this is not so, but one kind {genus} is from another kind {genus}, e.g., what is bearing is being grown, / but what is causing growth in this is being altered by another, and this thing causing alteration is moved according to a different motion. But it is necessary to come to a stand. For motions are finite [in kind]. Bending back, however, and saying that what is altering [another] is being borne is doing the same thing as if one said right away that what is bearing is being borne and the one teaching is being taught. / For it is clear that everything being moved is also moved by the higher of the movers, and more by the prior among the movers. But indeed, this is certainly impossible. For it happens that the one teaching learns, of which [two, the learner and the teacher,] it is necessary that the one not have science but the other have science. 257a1 a5 a10

Moreover, it is more unreasonable than these [arguments show], / because it happens that everything motive is mobile, if everything moved is moved by something moving. For the mover will be mobile, just as if someone should say everything able to heal [another] and healing [another] is healable, and what is able to build is able to be built, either directly or through many. (I mean [by the latter], e.g., if every motive thing is movable by another, / but is not movable according to the same motion according to which it moves what is proximate, but according to a different motion, e.g., what is able to heal is able to learn). But this [series], being traced back, will come at some time to the same species, as we said before. The one of these is impossible; the other akin to a figment. For it is strange to say that what is able to cause alteration is by necessity able to grow. a15 a20

So it is not necessary that what is moving is always moved by a25

another thing, which latter is also moving. So the series will come to a stand. Whence, either what is first moved will be moved by what is resting, or the same thing will move itself. But indeed, even if one must look into whether the cause of motion and the principle is what
257a30 is moving itself or what is moved by another, / all would put down the former. For what is in virtue of itself is always a cause prior to what is in virtue of some different existing thing. Whence, one must look into this by taking another beginning: if something moves itself, how it moves and in what way.

It is necessary, then, for everything moving to be divisible into things always divisible. For this was shown before in the universal
257b1 arguments / about nature, that everything moving in virtue of itself is continuous.[36] It is impossible, then, for what is moving itself to move itself as a whole.[37] For as a whole it would be borne and bear according to the same locomotion, being one and undivided in species; and
b5 it would be altered and alter, so that it would be teaching / and learning at the same time, and be healing and being healed according to the same health. Moreover, it was determined that it is the mobile that is moved, and this is a thing moved in potency, not in actuality; what is in potency, however, goes into actuality; and motion is the imperfect actuality of the mobile.[38] The mover, however, is already in act, as the
b10 hot heats / and, generally, the thing having the species generates. Whence, the same thing will be hot and not hot in the same way. So too, however, [in the case of] each of those of which it is necessary that the mover have a univocal name.[39] So of the thing moving itself one part moves and one part is moved.

It is apparent from the following, however, that a thing is not a
b15 self-mover in such a way that each part is moved by each part. / For nothing will be the first mover if each part will move each part. For the prior is more a cause of moving than the contiguous {successive}, and will move more so [than the consequent mover]. For something was able to move [another] in two ways, in one way, being itself moved by another, in another, being moved by itself. But the thing
b20 further from what is moved is closer to the / principle than what is between. Moreover, it is not necessary that the mover be moved, unless by itself. So the other moves [the one] in return accidentally. I grant, therefore, that it is able not to move [the one]. So one is being moved, but the mover is immobile. Moreover, it is not necessary that the mover be moved in return, but it is necessary that what moves
b25 [another] be either something immobile or what is / moved by itself, if it is necessary that motion always exist.[40] Moreover, the mover would be moved according to whatever motion it moves {causes}; whence, what is heating would be being heated.

But indeed, neither one nor each of the many parts of the thing which primarily moves itself will move itself. For the whole, if it is moved by itself, will move either by something of itself or / as a whole b30
by the whole. If, then, the whole moves by a certain part moving itself, this part would be the first self-mover. For, being separated, this will move itself, but the whole [will move itself] no longer. If the whole is moved by the whole, however, these parts would move themselves accidentally. Whence, if it is not necessary, let it be taken that they are not being moved / by themselves. So of the whole, one part, 258a1
being immobile, will move, and the other will be moved. For only thus is it possible that something be self-mobile. Moreover, if indeed the whole [of one part] moves itself, one part of it will move, and the other will be moved.[41] So AB will be moved by itself and / by A.[42] a5

Since, however, one thing moves [another], being moved by [yet] another, and another moves [another], being immobile, and one thing moved is a mover, but another moved thing moves nothing, it is necessary that the self-mover be [composed] from an immobile mover, and, again, from something moved, though [the latter is] not of necessity a mover, but [is a mover or not,] whichever of the two chances. For let A be a mover but immobile, and let B be what is moved / by A a10
and also a mover of C, this latter moved by B but not a mover of anything. For even if [the series comes to C] through many things, it will come at some time to C; let it be through one only. The whole ABC, then, moves itself. But if I should remove C, AB will move itself, A moving, B being moved. C, however, will not / move itself, nor will it a15
be moved at all. But indeed, neither will BC move itself without A. For B moves by being moved by another, not by some part of itself. So AB alone moves itself. So it is necessary that a self-mover have an immobile mover and something moved, though [the latter] is not / of a20
necessity a mover of anything [further], either both being touched by each other or one being touched by the other.

If, then, the mover is continuous (for it is necessary that the thing being moved be continuous), each will be touched by the other.[43] It is clear, then, that the whole moves itself, not by something of it being such as itself to move itself, but the whole itself moves itself, being both a thing moved and a mover / by something of it being a mover a25
and something of it being moved. For it does not move [another] as a whole, nor is the whole moved, but A moves [B], and B alone is moved.

There is a difficulty, however: if the mover is continuous yet immobile, and something is removed from A, or from B, the thing moved, will the remainder / of A move, or of B be moved? For if this a30
is so, AB would not be moved by itself primarily. For something being

removed from AB, the remaining AB would still move itself. Nothing
258b1 prevents each / or one of the two, the thing moved, being divided in potency, though undivided in actuality. Should it be divided, however, it is no longer a thing having the same nature. Whence, nothing prevents there being a primarily [self-moving thing] among things divided in potency.[44]

It is apparent, therefore, from these [considerations] that what is
258b5 primarily / a mover is immobile. For either what is moving, but moved by something, comes to a stand right away in the first immobile thing, or in something moving, itself moving itself and causing itself to stand. In both ways it happens that what is the first mover for all moving things is immobile.[45]

Chapter 6

258b10 Since, however, motion must always exist and must not fail, it is necessary that something be eternal, which first thing moves [another], whether it be one or many. And the first mover is immobile. ([Saying], then, that each of the immobile movers is eternal offers nothing in regard to the present argument.)[46]

By looking into [it] thus, however, it is clear that it is necessary
b15 that something be immobile, itself entirely outside / change, both simply and accidentally, yet motive of another.

Should someone wish, let it be possible, in some cases, that a thing exist sometimes and not exist sometimes without coming to be and destruction. For perhaps it is necessary, if something partless at times exists and at times does not exist, that every such thing, with-
b20 out changing, at times / exists and at times does not exist.[47] And of some of the immobile yet motive principles, let even this be possible: at times to exist, at times not to exist. But this is not possible in every case. For it is clear that, in things moving themselves, something is a cause of their at times being and at times not being. For it is neces-
b25 sary that every / self-mover have magnitude, if nothing partless is moving; from the things said, however, there is no [such] necessity in regard to the mover. Of this, then, that some things are coming to be and some are being destroyed, and this continuously, nothing is a cause among things immobile yet not always being[48]; nor, further, are certain ones always [the causes] of certain ones, but others of these
b30 [others]. For of the eternal and continuous [coming to be] / the cause is neither each of these nor all of them. For [the cosmos's] being so

disposed is eternal and by necessity, but all these causes are infinite, and not all are at the same time.[49] It is clear, therefore, that even if some ten thousand principles / among things immobile yet movers, 259a1
and many of the self-movers, are destroyed, and some come to be, and this immobile mover, being immobile, moves this, that one a different thing, nonetheless, there is something which contains [all], and this is beyond each, which thing is the cause of some of them being / and some of them not being, and of continuous change. And this [mover] a5
is the cause of motion for these [movers], but these [movers] are the causes of motion for others. If, then, motion is eternal, the first mover will also be eternal, if it is one; if many, there will be many eternal things.

However, one must think it is one rather than many, and finite rather than infinite [in number]. For, when the same things happen, / one must always rather take finite [principles]. For if it be possible, a10
what is finite and better must rather be present in things which are by nature. And one is sufficient, which, first among immobile things, being eternal, will be the principle of motion for the others.

From this [following consideration] it is also apparent that it is necessary that the first mover be something one and eternal. / For it a15
was shown that it is necessary that motion always exist. However, if it is eternal, it is necessary that it be continuous. For what is eternal is also continuous, but what is in succession is not continuous.[50] But indeed, if it is continuous, it is one. That motion is one, however, which is of one thing moved by one mover. For if different things will move [the mobile], the whole motion is not continuous, / but succes- a20
sive. From these [considerations], then, someone would be convinced that there is some first immobile thing.

And looking again at the principles of movers [this will be clear]. It is apparent, then, that there are some among beings which at times are moved, and at times rest. And through this it has become clear that not all things are moving, nor are all things resting, nor are some things / always resting while the others are always moving. For things a25
which are disposed in both ways and have the potency to be moved and to rest manifest these things.

Since, however, such things are clear to all, we wish to show also the nature of each of the two, that some things are always immobile and some things are always moving. Going forward / towards this, a30
however, and putting down that everything moving is moved by something, and this latter is either immobile or moving, and moving by itself or always by another, we came to grasp that, of things / moving, 259b1
there is a principle, of things moved [by another], what moves itself, but of all things [in motion], the immobile. We manifestly see, how-

ever, such beings which move themselves, like the genus of the ensouled and of animals.

These things, then, suggest the opinion that perhaps motion, not
259b5 being at all [at some time], can have come to be, because of our / seeing this happen in these things. For though they are sometimes immobile, they are moved again, as it seems. One must grasp, then, that they move themselves according to one motion, and according to this motion not properly. For the cause is not from the animal, but other natural motions are present in animals, motions which they do not move {cause} through themselves, like growth, diminution, and res-
b10 piration, according to which / each of the animals is moving, [even when] it is resting and not moving according to a motion from itself. The cause of this is its environment and many of the things which go in, as food goes in. For, digesting, they sleep; [the food] being distributed, however, they awake and move themselves, the first principle being from outside. Whence, they are not always moving continu-
b15 uously by themselves; / for the mover is other, itself moving and changing in relation to each of the self-movers. In all of these things, however, the first mover and cause of its moving itself is moved, though accidentally. For the body changes place, so that what is in the
b20 body / and moves itself by leverage also [changes place].[51]

From which [considerations] one can be convinced that if something is among immobile movers which are themselves moving accidentally, it is impossible that it move [others] according to continuous motion. Whence, if it is necessary that motion exist continuously, there must be some first mover which is immobile even accidentally, if there will be in beings some unceasing and undying motion, as we
b25 said, / and if being is to remain in itself and in the same [disposition]. For, the principle remaining, it is necessary also for the all to remain, being continuous in relation to the principle.

To be moved accidentally by itself and by something different are
b30 not the same, however, for to be moved by something / different is present even among some principles in the heaven, whichever ones are borne according to many locomotions; the other, however, is in destructible things alone.[52]

But indeed, if something is always such, some mover, itself immobile and eternal, it is also necessary that the first thing being
260a1 moved by this be / eternal.[53] This fact is clear also by this, that not otherwise would there be coming to be and destruction and change in others, unless something moved will move [them]. For what is immobile will move according to the same motion in the same way and
a5 according to one motion, / insofar as it is not changing at all in relation to the thing moved. However, what is moved by something

moved, the latter being moved directly by the immobile, [such a mover], through being related to things in different ways, will not be the cause of the same motion, but, through being in contrary places or species, / will yield each of the other things being moved in contrary ways, and at times resting, at times, moving.[54] a10

What we were at a loss about in the beginning[55] has also become apparent, then, from what has been said, [i.e.,] why not all things are moving or resting, or some always moving and the others always resting, but some things at times [move], and at times do not. For the cause of this is now clear, that some / are moved by an eternal immobile thing, whence, they are always moving, but some by a thing moving and changing; whence, necessarily, these also change. The immobile, however, just as was said, as enduring simply and similarly in the same [way], will move according to a motion which is one and simple. a15

Chapter 7

But indeed, by making another beginning [the case] about these things will be more clear.[56] For one must ask whether it can be that some motion is continuous or not, and if it can be, what this motion is and what the first of motions is. For it is clear, if it is necessary that there always be motion and that a certain motion be first and continuous, / that the first mover moves according to this motion, which is necessarily one and the same, and both continuous and first. 260a20 a25

There being three motions, that according to magnitude, that according to passion, and that according to place, which we call "locomotion" {bearing, carrying}, this latter is necessarily the first motion.[57] For it is impossible that growth exist, if alteration be not present / beforehand. For the thing growing grows in a way by what is like, in a way by what is unlike. For the contrary is said to be food for the contrary. All things are added, however, by becoming like to the like. It is necessary, then, that alteration, the change to contraries, exist [if growth exists]. / But indeed, if a thing is altered, there must be something altering and making the hot in act from the hot in potency. It is clear, then, that the mover is not [always] disposed in the same way, but at times it is closer to what is being altered, at times further. These things, however, cannot be without locomotion. / So if it is necessary that motion always be, it is necessary also for locomotion always to be, the first of motions; and, of locomotion, if one is first and another posterior, the first [must always be]. a30 260b1 b5

Moreover, the principle of all passions is density and rarity. For
260b10 even heavy and light and soft and hard and hot / and cold seem to be certain densities and rarities. Condensing and rarifying, however, [seem to be] collection and separation, according to which coming to be and destruction are said of substances. But it is necessary that things being collected and being separated change according to place. And indeed, even the magnitude of a thing growing or diminishing changes according to place.

b15 Moreover, by looking into [it] hence it will be apparent that locomotion is first. For in the case of motion, as in other cases, "first" would be said in many ways. That is called "prior" which, if it is not, the others will not be, though that one can be without the others, and what is [prior] in time, and what is [prior] according to substance.[58]
b20 Whence, since it is necessary that motion / exist continuously, and it would exist continuously either by being continuous or successive, yet more by being continuous, and it is better to be continuous than successive, and we always assume what is better to belong to nature, should it be possible, and it is possible [for motion] to be continuous
b25 (this will be shown later[59]; now, let this be supposed), and / no other motion is able to be continuous except locomotion,[60] it is necessary that locomotion be first. For there is no necessity for what is being borne either to grow or to be altered; nor, then, to come to be or to be destroyed. Not one of these can be, however, if the continuous motion which the first mover moves does not exist.

b30 Moreover, it is first in time. For in eternal things, / moving can only be according to this motion. But in any one thing which can come to be, it is necessary that locomotion be the last of its motions. For first after coming to be are alteration and growth, but locomotion
261a1 is the motion of things already perfected. / But it is necessary that a different thing be moving according to place beforehand, which thing, though it does not come to be, will also be the cause of coming to be for things coming to be, as the begetter is before the begotten, since it would seem that coming to be is the first of motions through this, /
a5 that the thing must have first come to be. And this is so, in any one of the things coming to be; but it is necessary that something different be moving before the things coming to be, itself being and not coming to be, and before this something different. Since, however, it is impossible that coming to be is the first motion, for all moving things would be destructible,[61] it is clear that not one of the successive
a10 motions is beforehand. / (I call "successive," growth, and then alteration, diminution, and destruction. For all these are after coming to be.) Whence, if coming to be is not before locomotion, neither is any one of the other changes.

Generally, it is clear that the thing coming to be is imperfect and is going to a principle; whence, what is later in coming to be is prior in nature. / In all things coming to be, however, locomotion is the last a15
thing present. Whence, some living things, like plants and many kinds {genera} of animals, are, through lacking an organ, wholly immobile, but [locomotion] belongs to the perfected ones. Whence, if locomotion belongs more to things which have received more according to nature, this motion itself would be prior to the others according to / substance, because of those things; and also because, among motions, a20
the thing moving is removed from its substance least in being borne. For according to this motion alone does a mobile change nothing of its being, as the quality of a thing altered and the amount of the thing growing and diminishing [are changed].

This is most clear, however, because the self-mover most properly moves itself according to this same motion, [i.e.,] motion according to place. / Yet we say that this, the self-mover, is the principle of a25
things which are moved and movers and is first among things moved. It is apparent from these [considerations], therefore, that locomotion is the first of motions.

What locomotion is first, however, must now be shown. At the same time, what was put down just now and before, that some / motion can be continuous and eternal, will be apparent by the same a30
inquiry. That, then, not one of the other motions can be continuous, is apparent from these [following considerations]. For all motions and changes are from opposites to opposites, e.g., in coming to be and destruction, the terms are being and non-being; in alteration, / the a35
contrary passions; in growth and diminution, either greatness and smallness or perfection and imperfection of magnitude. Contrary changes, however, are changes / to contraries.[62] It is necessary that a 261b1
thing which, though it existed before, was not always moving according to this [particular] motion, rested before. It is apparent, then, that the thing changing will rest in the contrary [disposition]. So too in changes. For destruction and coming to be are opposed simply, / and b5
a particular one to a particular one. Whence, if it is impossible to change to opposites at the same time, the change will not be continuous, but there will be time between these. For it makes no difference whether changes according to contradiction are contraries or not contraries, if only it be impossible that they be present in the same thing at the same time. For this point / was not used in the argument. Nor b10
[does it matter] if it is not necessary that the mobile rest in the contradiction, nor if the change is not contrary to rest (for perhaps non-being does not rest; but destruction is into non-being), if only time be between. For thus the change is not continuous. For, in the prior argu-

261b15 ments, contrariety was not used, / but [only the fact of] not being able to be together.[63]

One need not be troubled that the same thing will be contrary to many, as motion [is contrary] both to standing and to the motion to the contrary; but this alone is to be grasped, that the contrary motion is somehow opposed both to the motion and to the rest, just as the equal
b20 and the measure [is contrary] both / to the exceeding and to the exceeded, and that opposite motions or changes cannot be present at the same time. Moreover, it would seem to be utterly strange, in the case of coming to be and destruction, if it is necessary that the thing coming to be is destroyed right away and endures for no time. Whence,
b25 from these [considerations], / conviction can come to be in the other cases. For the natural is what is disposed in the same way in all.

Chapter 8

261b27 Let us now say that a certain motion can be infinite, being one and continuous, and that this is motion in a circle. For everything borne is moved either in a circle or on a straight line or on a mixed [one];
b30 whence, / if either of these is not continuous, neither is it possible that the motion composed from both [be continuous].

It is clear, however, that the thing borne on a straight and finite line is not continuously borne, for it turns back, and the thing turning back on a straight line is moving according to contrary motions. For
b35 the contraries, according to place, are upward, downward, / forward, backward, leftward, rightward. For these are the contrarieties of place.
262a1 But what "one and / continuous" motion is has been determined before, that it is the motion of one thing and in one time and in what is undivided according to species. For there were three things: the thing moving, e.g., the man or god, and when, i.e., time, and third, that
a5 in which.[64] This latter is place or passion or species or / magnitude. The contraries differ in species, and are not one; and the differences mentioned [are the contrarieties] of place. A sign that the motion from A to B is contrary to the one from B to A is that they cause each other to come to a stand and cease, if they come to be at the same time. And so too on a circle: as the motion from A towards B [is contrary] to the
a10 motion / from A to C. For they cause [each other] to stand, even if they are continuous and turning back does not come to be, because opposites destroy and prevent each other. But motion to the side is not [contrary] to upward motion.

It is most apparent, however, that it is impossible that motion on a straight line be continuous because it is necessary that a thing turning back come to a stand, not only if it be borne on a straight line, / but even if it be borne on a circle. For to be borne in a circle and a15
according to a circle are not the same. For at times what is moving goes on in a line; at times, however, coming to the same place whence it was urged, it will again turn back. The conviction that it is necessary to come to a stand is not only due to sense but also to argument. The principle is this: for there being three things, / the beginning, the a20
middle, and the end, the middle is both in relation to each, and is one in number, but two in account.[65] Moreover, what is in potency and what is in act are different. Whence, any point of the ones within the ends of the straight line is a middle in potency, but not in act, unless the mobile divides in this point and, coming to a stand, again begins / to move.[66] Thus, however, the middle does come to be a beginning a25
and an end, a beginning of the later motion, and an end of the first motion. I mean, e.g., if what is borne, A,[67] should stand in B and again be borne to C. But whenever it is continuously borne, it is not possible that A either come to be in or come to be away from the point B, but only / that [A] be [there] in the now, in no time (except in the a30
whole time ABC, that of which the now is the division). If someone will put down that it comes to be in and comes to be away from [B], A, being borne, will always stand. For it is impossible / that A come 262b1
to be in and come to be away from B at the same time. So [it does these] in different points of time; so what is in the middle will be time; whence, A would rest in B. So too in the case of the other points, for the same argument applies to all. / But whenever what is borne, A, b5
uses the middle, B, as end and beginning, it is necessary that it stand, because of making [B] two, just as if it were understood [to be two]. But it came to be away from the beginning point A, and when it is finished and stands, it has come to be in C.[68]

Whence also, one must say this to the difficulty. For there is this difficulty: / for if E be equal to F and A be continuously borne from b10
the end [of E] toward C; and at the same time A be in point B, and D be borne from the end F, towards G, regularly and with the same speed as A, [then] D will go to G before A to C. For it is necessary that what pushes on and / departs before goes before. So A does not b15
come to be in and come to be away from B at the same time; whence, it is late. For if [it came to be in and came to be away from B] at the same time, it will not be late; but it will be necessary that it come to a stand.

So one must not put down that when A came to be at B, D at the same time was moving from the end F. For if there will be a coming

262b20 to be of A in B, / there will be also a coming to be away from [B], and not at the same time, but it was [at B] in a cut of time and not in time. Here, then, it is impossible to speak thus about the continuous; but, in the case of what is turning back, it is necessary to speak in this way. For if G be borne to D, and again, having turned back, be borne down-
b25 ward, that to which, the end D, was used as an end / and as a beginning, the one point as two. Whence, it is necessary that G stand. And it does not come to be in D and come to be away from D at the same time. For at the same time, in the same now, it would be and not be there. But indeed, one must not say the old solution: for one cannot
b30 say that G is at D in the cut, though it did not come to be [there] / nor come to be away from [there]. For it is necessary to come to an end in act, not in potency. The points in the middle, then, are in potency, but
263a1 this one is in act, and from below it is an end, / from above a beginning. And so, in the same way, [it is an end and a beginning] of the motions. So it is necessary that what turns back in a straight line stand. So there cannot be continuous, eternal motion on a straight line.

One must counter in the same way those asking about and hold-
a5 ing as worthy / the argument of Zeno: whether one must always go through the half, while these are infinite, and it is impossible to go through the infinite; or, as some ask this same argument in another way, holding it worthy to count, at the same time as the moving, first the half, according to each half coming to be. Whence, if the thing has
a10 gone through the whole, / it happens that an infinite number has been numbered. This, however, is admittedly impossible.

In the first arguments about motion, then, we solved [this difficulty] through time having the infinite in itself.[69] For there is nothing strange if someone goes through the infinite in infinite time. The infi-
a15 nite, however, is present similarly in length and / in time. But while this solution is sufficient to the one asking (for it was asked if infinite things can be gone through or numbered in a finite time), yet with regard to the matter and the truth it is not sufficient. For should someone ask about these same things of time itself (for time has infinite
a20 divisions), leaving aside length and leaving aside / asking whether infinite things can be gone through in a finite time, this solution will no longer be sufficient.

But one must say the truth which we said in the recent arguments. For should someone divide the continuous into two halves, this man
a25 would use one point as two. For he makes it beginning / and end. Both the man who numbers [the parts] and the one who divides [the lines] into halves does this. Dividing in this way, however, neither the line

nor the motion will be continuous. For continuous motion is of the continuous, but infinite halves are present in the continuous, not in actuality but in potency. Should [the mobile] make [them] in actuality, it will not make / continuous motion, but it will stand, which, it is a30
clear, happens in the case of the man who numbers the halves. For it is necessary that he number the one point as / two. For the end of the 263b1
one half will be the beginning of the other, should someone number, not the one continuous line, but the two halves. Whence, one must say, to the one asking whether infinite things can be gone through (either in time or in length), that in a way it is / and in a way it is not b5
[possible]. For it cannot happen, if the things are in actuality, but it can happen, if they are in potency. For the thing which moves continuously has gone through infinite things accidentally, though not simply. For infinite halves happen to be in the line; but the substance and being [of the line] is different [from these halves].

It is also clear that, if someone should not always make that point of time which divides the / before and after[70] be of what is after in the b10
thing, the same thing will be a being and not be a being at the same time, and will not be when it has come to be. The point, then, is common to both (to both the before and the after), and is one and the same in number; in account, however, it is not the same. For it is the end of this, but the beginning of that. In / the thing, however, it is always of b15
the later passion. Let the time in which be ACB, the thing, D. This, in time A, is white, in B, not white. So in C it is white and not white. For in whatever part of A it is true to say it is white, if it was white for this whole time, and in B not white. C, however, is in both. / One must not grant [that it is white] in the whole [AC], but [only in all] except the b20
final now, C. This, however, is already the later time. Even if it was coming to be not white and white was being destroyed in the whole A, it had come to be or was destroyed in C. Whence, it is first true to say that it is white or not white in that now, or else when it has come to be it will not be and when it has been destroyed it will be, or it is necessary / that white and not-white and, generally, being and non- b25
being exist at the same time. If, however, what is, though it was not before, necessarily comes to be and, when it is coming to be, is not, it is not possible that time be divided into indivisible times. For if D were coming to be white in time A, and in a different indivisible / con- b30
secutive time, B, it has come to be and is [white] at the same time, if in A it was coming to be and was not, and in B it is, there must be some coming to be in between: whence, / there must also be a time in 264a1
which it was coming to be. For the same argument will not apply against those saying [times are] not indivisible, but [they can say that]

it has come to be and is in the extreme point of the time in which it was coming to be, nothing of which [point] is contiguous or successive [to the time]. Indivisible times, however, are successive. It is
264a5 apparent that, / if the mobile was coming to be in the whole time, A, there is no time in which it had come to be and was coming to be which is greater than the whole in which it was only coming to be. These, then, and some [other] such [arguments], are those by which someone would be convinced as by proper arguments.

By looking into [the question] logically,[71] however, this same thing will seem to happen also, from the following [considerations].
a10 For everything which is moving / continuously, if nothing pushes it aside, was being borne beforehand to whatever [place] it went to according to locomotion, e.g., if it went to B, it was also being borne to B, and not [moving to B only] when it was near, but right away, as it began to be moved; for why [should one say that it is moving to B] now rather than before? So too in the other cases. That which is being
a15 borne from A to C, then, / when it has come to C, will again come to A, being moved continuously. So when it is borne from A towards C, then is it also borne to A according to the motion from C; whence, it is borne at the same time according to contrary motions. For the motions on a straight line are contraries. And at the same time it also changes from that in which it is not. If this is impossible, then, it is
a20 necessary that it / come to a stand at C. So the motion is not one. For motion distinguished by standing is not one. Moreover, it is apparent more universally about all motion[72] from the following. For if everything moving is moving according to one of the motions mentioned, and rests by one of the opposite rests (for there were not others
a25 besides these), and it is necessary that a thing not / always moving according to this particular motion (I mean motions different in species, and not a motion which is some part of a whole) rest before, according to the opposite rest (for rest is the privation of motion), if, then, motions on a straight line are contraries, and [a thing] cannot be
a30 moving at the same time according to contrary motions, / what is borne from A to C could not be borne at the same time also from C to A. And since it is not borne at the same time, but will [later] be moved according to this same motion, it is necessary that it rest before at C. For this was the rest opposite to the motion from C. It is clear,
264b1 therefore, / from the things said, that the motion will not be continuous. Moreover, this argument is more proper than the ones mentioned: for at the same time not-white is destroyed and white has come to be. If, then, the alteration to white and from white is continuous and
b5 [white] does not remain for some time, / at the same time not-white

was destroyed and white came to be and not-white came to be. For there will be the same time of the three. Moreover, it does not follow that if the time is continuous, so too is the motion, but [only that it is] successive. Yet how would the same extreme belong to contraries, as to whiteness and to blackness?

In revolution the motion will be one and continuous, / for noth- b10
ing impossible happens. For the thing moving from A will be moving at the same time to A according to the same forward direction. For it is moving to what it will come to. But it will not be moved at the same time according to contrary or opposite motions. For not every motion to this [place] is contrary or opposite to the motion from this [place], but the motions on a straight line are contrary / (for in this there are b15
contraries according to place, like those on a diameter, for they are most distant), and the opposite motion is the one according to the same length. Whence, nothing prevents it from moving continuously and being interrupted at no time. For motion in a circle is from the same to the same, motion on a straight line from the same to another. And motion / in a circle is never in the same [points], but motion on b20
a straight line is repeatedly in the same [points]. The motion which comes to be always in different points can be moving continuously; the motion which comes to be repeatedly in the same points cannot. For it is necessary that the mobile be moving at the same time according to opposites. Whence, neither in the semi-circle nor in any other / part of a circle can it be moving continuously. For it is necessary that b25
it be moving repeatedly according to the same things and that it change according to contrary changes. For the limit is not joined to the beginning. However, the motion of a circle does join, and is the only perfect motion.

It is apparent, however, from this division, that neither can the other motions / be continuous. For in every one it happens that the b30
mobile often moves according to the same things, as in alteration, according to the things between, in motion according to amount, according to the middle magnitudes, and in coming to be and destruction similarly. For it makes no difference to make few or many those [middles] through which the change occurs, / nor does putting down 265a1
something between [the extremes] or removing it. For in both ways it happens that the mobile is often moving according to the same things. It is clear, then, from these [considerations] that those students of nature who say that all sensibles are always moving do not speak well.[73] For it is necessary to move / according to some one of these a5
motions, and mostly, according to those men, to alter. For they say that [everything] always flows and is destroyed; moreover, they also

say that coming to be and destruction are alteration. However, just now the argument said, about all motion universally, that a thing can be moving continuously according to no one motion outside of motion in a circle; whence, neither can it be moving continuously
a10 according to / alteration or according to growth. Let so much have been said by us, then, [to show] that no change outside of locomotion in a circle is infinite or continuous.

Chapter 9

265a13 That, however, circulation is the first of locomotions, is clear. For every locomotion, just as we said before, is either in a circle, or on a
a15 / straight line, or mixed. It is necessary, however, that the former are prior to the latter, for the latter is constituted from them. Motion in a circle, however, [is prior] to motion on a straight line. For it is more simple and perfect. For a thing cannot be borne on an infinite straight line. For what is thus infinite does not exist. At the same time, even if it did exist, nothing would move [according to it]. For the impossible
a20 does not come to be, but to go through / the infinite is impossible.[74] But a motion bending back on a finite line is composite and is two motions, and, not bending back, it is imperfect and destructible. And the perfect is by nature and in account and in time prior to the imperfect, and the indestructible to the destructible. Moreover, that which
a25 can be eternal is prior to what cannot be eternal. / Motion in a circle, then, can be eternal, but none of the others, neither locomotion nor another. For the mobile must come to a stand; if, however, there is standing, the motion was destroyed.

It happens reasonably, however, that the motion in a circle is one and continuous while motion on a straight line is not. For the begin-
a30 ning and the end / and the middle of motion on a straight line are determined, and it has all these in itself, so that there is somewhere whence what is moving will begin and somewhere whither it will end, for everything rests in the terms, either whence or whither. [The beginning, middle, and end] of revolution, however, are indeterminate. For why [take] any one rather than another of those on the line? For each is similarly beginning and middle and end; whence, it is
265b1 always / and never in a beginning and in an end. Whence, the sphere somehow moves and rests. For it always occupies the same place. The cause is that all these happen to be in the center, for the center is the

beginning and middle of the magnitude, and the end. Whence, because of this center being outside the / revolution, there is not b5
somewhere where the thing being borne will rest, as having gone through [the path]. For it is always borne about the middle, but not towards an extreme. Because of this, the whole always somehow remains and rests and is moving continuously. It happens, however, conversely: for, because revolution is the measure of motion,[75] it is also necessary that this motion be first / (for everything is measured b10
by what is first); and because it is the first motion, it is the measure of the others. Moreover, regular motion can only be motion in a circle. For things are borne on a straight line irregularly from the beginning and towards the end. For everything, to the extent to which it is borne further away from the [place of] resting, is borne faster. However, only of motion in / a circle are neither the beginning nor the b15
end naturally apt to be in it, but outside.

All who made mention of motion testify that locomotion according to place is the first of motions. For they give the principles of motion for things moving according to such motion. For separation / and collection are motions according to place, and Love and Strife b20
move thus. For the one of these separates, but the other collects. And Anaxagoras says that Mind, the first mover, separates. So too, those who do not speak of any such cause say that moving is due to void.[76] For even / these men say that moving according to place is according b25
to nature. For motion through the void is locomotion and is as in place. They believe that not one of the other motions belongs to the first things, but the other motions are in the things [composed] from these [first] things. For they say composed things grow and are destroyed and are altered by the collecting and separating of the indivisible bodies. / Those who effect coming to be and destruction b30
through density or rarity speak in the same way.[77] For they muster the latter by collection and separation. Moreover, besides these men, the ones making the soul the cause of motion [so testify].[78] For they say that a self-mover is the principle of moving things; an animal, however, and every ensouled thing / moves itself according to motion 266a1
according to place. And we say that only what is moving according to motion according to place is properly moving. Should it rest in the same place, however, while it grows or diminishes or happens to be altering, in some way it is moving, yet we do not say it is moving simply. / It has been said, then, that motion always was and will be for all a5
time, and what the principle of eternal motion is; moreover, what the first motion is, and what motion alone can be eternal, and that the first mover is immobile.

Chapter 10

266a10 Let us now say that it is necessary that the latter be partless and have no magnitude, determining first about the things prior to this.

One of these is that it is not possible that anything finite move [another] for an infinite time. For there are three things: the mover, the moved, third, that in which, the time. These, however, are either all
a15 infinite, / or all finite, or some, as two or one. Let A, then, be the mover, B, the moved, the infinite time through which, C. Let D, then, move E, some part of B; [it will] not [move it], then, in a time equal to C. For the greater is [moved] in more [time]. Whence, the time F is
a20 not infinite. Thus, then, adding to D I shall use up A and [adding] / to E, I shall use up B. However, always removing an equal [amount], I shall not use up the time, for it is infinite. Whence, the entire A will move the whole B in the finite time C. So it is not possible for anything to be moved by the finite through an infinite motion. It is apparent, then, that the finite cannot move [another] for an infinite time.[79]

a25 Generally, it is clear from the following that / there cannot be an infinite power in a finite magnitude. For let the greater power always do the equal in less time, e.g., heating or sweetening or throwing, and, generally, moving. So it is necessary that the thing suffering suffer
a30 something by what is finite but has infinite power, / and more than by another. For the infinite is more. But indeed, the time cannot be nothing. For if the time A is that during which the infinite strength heated or impelled, and a certain finite strength [did so much] in AB, taking
266b1 always a finite [strength] / greater than this, I will come at some time to [the mobile] having been moved in time A. For adding always to the finite, I will exceed everything determinate, and so too, taking away, I will make smaller. So the finite will move [the mobile] in a time
b5 equal to the [time of the] infinite./ But this is impossible. So nothing finite can have infinite power.

Nor, then, can there be a finite [power] in an infinite thing, and even if a greater power can be in a smaller magnitude, a still greater [will be] in a greater. Let, then, AB, that in which [the finite power is],
b10 be infinite. Then BC has some power, which in a certain time / moved [the mobile] D, in time EF. If, then, I take the double of BC, it will move [D] in half the time EF (for let the proportion be this), so that it will move [D] in FG. Always taking [the power] in this way, therefore, I will never go through AB, but I shall always be taking less than the
b15 time given. So the power will be infinite, / for it will exceed every finite power, if, indeed, it is necessary that the time of every finite power be finite. For if so much is done in a certain [time], the greater will move in a determinate time, but in less, according to the converse

of the proportion. Every infinite power, however, just as [every infinite] multitude and magnitude, / is a thing exceeding everything 266b20
determinate. One can also prove this thus. For let us take a certain power, being [in] a finite magnitude, the same in genus as the power in the infinite magnitude, which [finite] power will measure the finite power in the infinite magnitude. / That, then, an infinite power cannot be in a finite magnitude, nor a finite in an infinite, is clear from these b25
[considerations].

First, however, it is well to raise a certain difficulty about things which are borne. For if everything moving is moved by something, how are some things, like things thrown, which do not move themselves, / moved continuously, not being touched by the mover?[80] If the b30
mover at the same time moves something else, like the air, which, being moved, moves [the other], it is similarly impossible that the air be moving, if the first thing does not touch or move [it], but all are moving at the same time and cease when the first mover will cease, / even if the mover, like a magnet, makes what is moved able to move. 267a1
It is necessary, then, to say this, that the first mover makes [the medium] able to move [another], either the air or the water or some other such thing which is naturally apt to move and to be moved. / But it a5
does not cease moving [the other] and being moved at the same time, but [it ceases] being moved when the one moving ceases moving [it], though it is still a mover. Whence also, it moves some other contiguous thing, and the account of this is the same. It ceases, however, when the power for moving [another] always comes to be less in the contiguous thing. At the end, when / it no longer makes what is before a10
it a mover, but only a thing moved, it ceases. It is, however, necessary that these things, the mover and the moved, and the whole motion, cease at the same time. This same motion, [i.e., projectile motion], then, comes to be in what can at times be moved and at times rest, and this motion is not continuous, but appears so. For it is [derived] from beings in succession or touching; for / the mover is not one, but things a15
contiguous to each other [are the movers]. Whence, such motion comes to be in air or water, which motion some men say is mutual replacement. But it is impossible to solve the difficulties raised otherwise than in the way said. Mutual replacement, however, makes all to be moved and to move [another] at the same time, so that it also makes them all cease [at the same time]. Now, however, the thing thrown appears as / something one which is moved continuously. By a20
what [is it moved], then? For not by itself.[81]

Since it is necessary that motion be continuous in beings, and continuous motion is one,[82] it is necessary that the one motion be [the motion] of a certain magnitude (for what is without magnitude is not

moved), both of one [magnitude] and from one [mover] (for [otherwise] it will not be continuous, but one motion will be contiguous to
267a25 and divided from another); if the / mover is one, then, it moves, either being moved or being immobile. If, then, it is a moved thing, it will
267b1 have to follow along and itself change, and at the same time / it will be moved by something [else]; whence, the series will come to a stand and come to being moved by the immobile. For it is not necessary that this latter mover be moved along with [the mobile], but it will always be able to move [another]. For moving [another] in this way is without toil.[83] And this same motion is either alone regular or is most reg-
b5 ular. For the mover does not have any change. / The moved, however, must not change in relation to that mover, so that the motion might be similar [in all its parts]. It is necessary, then, that the mover be either in the middle or in the circle. For these are the principles. But things closer to the mover are moved faster. The motion of the circle, however, is such. So the mover is there.

There is a difficulty, however, about whether something moved /
b10 can move [another] continuously, but not just as what impels again and again, [the motion] being continuous by being successive. For it must [always] push or pull or both, or something different must take over, one after another, just as was said before in the case of things thrown: if the air or the water moves, being divisible, what is moved
b15 is always other. / In both ways it is not possible that the motion be one, but contiguous. Whence, motion alone is continuous according to which the immobile moves. For it is always disposed similarly in itself and is always disposed similarly and continuously in relation to the moved.

These things being determined, it is apparent that it is impossible that the first and immobile mover have some magnitude. For if it has
b20 magnitude, it is necessary that it be either / finite or infinite. On the one hand, it was shown before in the *Physics* that magnitude cannot be infinite[84]; on the other hand, that it is impossible that the finite have an infinite power, and that it is impossible that something be moved by a finite [power] for an infinite time, was shown just now.
b25 Yet the first mover moves an eternal / motion for an infinite time. Therefore, it is apparent that it is indivisible and partless and a thing having no magnitude.[85]

Endnotes

1. For the positions of Aristotle's predecessors in natural philosophy, cf. *Metaphysics*, I, Chs. 3–4, 983b6–985b22; and *The Presocratic Philosophers*, 2nd Ed. G.S. Kirk, J.E. Raven, and M. Schofield (New York: Cambridge University Press, 1983).
2. Empedocles, Fr. 17.
3. 201a10–11; 202a7–8.
4. For example, the doctor knows both health and disease.
5. Aristotle defines time as "the number of motion according to before and after." 219b1–2.
6. Cf. Plato, *Timaeus*, 28b, 38b.
7. One might readily object that a line can have an end point, so that not every point is a mid-point, as Aristotle seems to assume here. We should note that, in the discussion of time, Aristotle argued that time measures rest only by measuring a motion, and it measures a motion by measuring the divisions of a motion (221b7–20; 219a25–b3). But, when a thing moves, there is no first moment of its motion (236a7–27). Thus, if there were a first moment of time, it seems there would be a first in which a thing is moving, which is impossible. The arguments of this chapter seem convincing, and no doubt Aristotle was convinced that they give the most probable position. By the end of this book he has shown the existence of a first, immaterial mover. It seems at least logically possible to look back over the argument from the standpoint of the existence of this immaterial being, and ask whether it would not have the power to supply what is impossible to merely natural causes (which is all Aristotle permits himself to consider in this chapter). If it could, then the infinity of time is not necessary, though it may be the most plausible from the point of view of natural philosophy. The supposition of the "Big Bang" in contemporary cosmology would also be an occasion to wonder whether the arguments of this chapter are demonstrative. For a fuller discussion of the weight of these arguments, cf. St. Thomas' commentary on this passage and his small work, "De Aeternitate Mundi, contra murmurantes" in *Opuscula Philosophica* (Rome: Marietti, 1953), pp. 105–8.
8. The thought seems to be that Empedocles and Anaxagoras just postulate that Love and Strife (for Empedocles) or Mind (for Anaxagoras) act in certain ways, and claim that postulate to be a principle. This is like a "figment," too.
9. That is, the alternate gathering and separation by Love and Strife are not the very definitions of Love and Strife.
10. Because there is nothing before them, first principles must be necessary and eternal; if they were not, there would be a principle on which they depended for existence or truth, and so they would not be first. But whatever are not first principles, even if they be eternal, need some explanation in terms of what is first. Aristotle gives the example of the proposition that the angles of a triangle are equal to two right angles, which, even though eternal, depends upon some other principles for its truth and eternity, e.g., what a triangle is, what a straight line is, etc.

11. 241a26–b20.
12. Aristotle does not believe the universe is infinite or that an infinite thing can move. Cf. 205a8–206a7.
13. 260a20–266a9.
14. It seems Aristotle is referring to 259b3–20.
15. Cf. 253a5–7.
16. In fact, insofar as the argument of Parmenides are founded on the supposition that "being" is said univocally (186a24–b14), it is a result of simple equivocation, a fallacy due partly to a lack of logical training.
17. 254a23–33.
18. Cf. 184b25–185a17; cf. also *Posterior Analytics*, I, 12, 77a36–78a15.
19. 192b8–23.
20. 192b20–23.
21. Probably, Aristotle has Heraclitus in mind. The position that "all things flow" seems to be that all things are always in motion in all ways. Certainly it is true that the arguments which Aristotle goes on to make are more easily understood to contradict this position than the position that all things are always moving in some, though not in all, ways. Cf. *Metaphysics* IV, Ch. 5, 1010a7–15.
22. Cf. 250a12–25.
23. That is, a man must be healing and then healed, and when healed, he is not changing.
24. Given the motion of the earth, this argument loses force. However, if place is immobile, then there seems to be no reason to think that a thing could not rest in place.
25. On the possibility of natural place, cf. Appendix 7, *Place*.
26. If growth never ended, things would always become bigger; this is clearly false.
27. Violent motion is a motion away from natural rest, so if nothing can rest naturally, there would be no violent motion.
28. Especially that of Empedocles, who held that all things rest and then move, and vice-versa.
29. Aristotle is referring to the possible dispositions of things with regard to motion and rest.
30. In this chapter, Aristotle will give an inductive argument to show that everything which is moving is being moved by another. Since the motion of what is moved accidentally is reducible to that of what is moved *per se* ("in virtue of itself"), Aristotle restricts his consideration to what is moved *per se*. He divides these into things moved from without and things moved from within, and into things moved naturally and things moved violently.
31. Does Aristotle mean to imply that there can be a change from potency to act without any agent acting, the change being attributable merely to the presence of the form,

e.g., the consideration of geometry being explained merely by the presence of the habit of geometry in the mind? Aristotle has already argued that heavy and light things do not move themselves (255a5–18), and he concludes that these things are moved, not that they are movers or self-movers (255b30–31). The movers he mentions are the generator and the one that removes impediments to natural motion (255b35–256a2), neither of which act throughout the motion. It seems that he must hold they are moved by something other than themselves even while falling (or rising), given the argument at 241b24–242a15 (in the alternative text, 241b34–242a49), but he does not elucidate on this, perhaps because he simply has no evidence what that mover might be.

32. Aristotle puts knowing in the genus of quality (*Categories*, Ch. 8, 8b29).

33. It is interesting that Aristotle does not take up the question of projectile motion, which modern habits of thought put so much at the forefront of discussions about motion. Projectiles are violently moved, it seems, and yet it is not apparent what moves them, at least after they are launched. Aristotle offers some suggestions at 244a21–25 (in the alternative text, at 243a20–b2) and at 266b27–267a12. Perhaps, because the argument of this chapter is inductive, he does not take up cases where the mover is not apparent, but wishes us to judge what is not manifest (whether there is a cause of motion for projectiles after they are thrown) from what is manifest (the cases he does treat in this chapter). An alternative explanation would be that he is, in this chapter, merely showing how the principle that motion requires a mover applies to certain cases, and is not trying to establish that principle by induction.

34. In the end, Aristotle will conclude that there must be an unmoved mover at the beginning of the series, even if there be a self-mover somewhere along the line. Presumably, he says here there must be a self-mover either because he does not want to postulate the existence or even the possibility of an unmoved mover, or because he wants to consider the nature of a complete series, which would seem to include a self-mover between the unmoved mover and the thing moving by being in motion through another.

35. 251a8–252a5.

36. 234b10–20.

37. 241b24–242a15 (in the alternative text, 241b34–242a49).

38. 201b31–32.

39. Some agents are not "univocal," i.e., they do not share with their effects both the name of the effect and its definition (*Categories*, Ch. 1, 1a6–12), "for man and the sun beget man" (194b13). Without the warming power of the sun, there would be no life on earth, and yet the sun is not alive.

40. 251a8–252a5.

41. 257b3–12.

42. That is, there will be two movers for the same motion, one of which is merely a part of the other.

43. Cf. 202a3–12; 243a3–245b18 (in the alternative text, 243a32–245b2).

44. The mobile will be divisible, because all mobiles are divisible (234b10–20), and therefore the mobile parts of self-movers are divisible. It seems to follow that there cannot be something which is primarily a self-mover. Aristotle's answer is that when self-movers (e.g., animals) are divided, they lose their nature (die), so that there is a primary self-mover even if the mobile part of that self-mover is divisible in thought.

45. Up to here, Aristotle has shown that there is a first mover and that it is *per se* immobile. He will go on to show, in the next chapter, that it is not in motion *per accidens* either.

46. Presumably, Aristotle means that simply positing that each of the immobile movers is eternal is not helpful; this needs to be proven.

47. Aristotle argued earlier that everything in motion is divisible into parts (234b10–20), and that generation and corruption depend on prior motions (251a16–b10). Perhaps this is why he says that partless things cannot come to be or be destroyed. Or he may be thinking of things like animal souls, which do not move *per se*, but only *per accidens*, and so need not be divisible into parts. Moreover, they are forms, not composites of form and material, and so could only be corrupted *per accidens* (cf. 189b30–191b22; *On the Soul* II, Ch. 1, 412a3–b6). Having argued in Ch. 5 that the first mover is not mobile *per se*, he will now argue that it is not even mobile *per accidens*.

48. Since it does not always exist, it can hardly be the cause of eternal motion.

49. If the many movers are not simultaneous in time, they cannot be joint causes of an effect. If they form a series of movers which explains a series of motions, we still have to explain the series of movers in terms of some other mover. This is especially so if we assume, as Aristotle does here, that the series of motions in the universe is eternal and necessary. For if the series of movers which explains this has no explanation, but is merely fortuitous, then the series of motions in the universe is fortuitous as well, contrary to the supposition.

50. Aristotle did not argue in Ch. 1 that there is one eternal motion, but only that motion always exists. The move from saying motion is eternal to saying it is continuous, and so a single motion, seems suspect. Aristotle argued earlier (256a13–257a33) that the series of movers arrives at a self-mover, and then goes on to argue that, even on this supposition, there is a mover prior to the self-mover. He is now in the process of arguing that that prior mover is immobile in every way. If we assume that the eternal mover which accounts for the multitude of generable and corruptible movers is itself a self-mover, then clearly its motion would be one in the sense required by Aristotle's argument. This assumption makes sense if we understand it hypothetically: if the series of movers and mobiles is complete, there will be a self-mover as a first thing in motion; if we assume a less perfect series, we fall back on the previous argument. In neither case do we affect the argument that there must be *at least* one eternal mover.

51. The animal moves itself to get some good which it lacks, like food or shelter, or because it is moved by some other mover, e.g., something in its surroundings. Thus, there is a mover, the good (cf. 243a3–4; in the alternative text, 243a32–33), outside of the animal, which moves it and to which the animal comes into various relations. Though animals are self-movers, they still depend on some external good for their

self-movement; thus, they are not first in every way, even in regard to their own motion. Moreover, they do not move continuously precisely because they seek what they do not have and later do have, and because the mover in them, the soul, is moved accidentally and so comes to have different relations to the thing sought.

52. Aristotle holds that the moon, sun, etc., are moved in spheres and that these lower spheres are also moved in a contrary way by the higher spheres, each sphere being moved by an "intelligence," i.e., an immaterial being (cf. *Metaphysics* XII, 8, 1073a23–1074a17) Thus, the inner spheres are moved accidentally by the outer. In this case, Aristotle implies, there is no impediment to continuous motion, presumably because the mover does not move with the mobile.

53. One might think this argument is circular: Aristotle has argued to the eternity and immobility of the first mover from the perpetuity of motion, and here argues in the opposite direction. But here he is arguing that there is some one motion which is perpetual, while earlier he only argued that motion in general is perpetual. He mentioned the unity of the first motion before not to argue to the eternity and immobility of the first mover, but to argue to its unity (259a13–20).

54. Cf. *On Generation and Corruption* II, 10, 336a31–b19.

55. Cf. 253a5–7.

56. Here Aristotle begins to investigate motion caused by the first mover.

57. 225b5–9.

58. Cf. *Categories* 12, 14a26–b3.

59. 261a27–262b8; 264b9–265a12; 265a27–b16.

60. 261a31–b26**.**

61. 259b32–260a19.

62. 229a30–b11.

63. It seems we might go even further: even if the division between the change to A and from A to its opposite B is only a moment, and not a time, the argument is not affected. For the motion to A and to B are opposites and cannot exist together for a time, nor can the divisions of such motions exist together in the moment. That there must be a time between the motions will be argued in the next chapter (261b31–262b8).

64. 227b24–26.

65. That is, it is one point, but, insofar as it is a beginning and also an end, it is "two in account."

66. Points on a line, not at its ends, are not in act but in potency, for a line is not composed of points (231a21–b18), nor are the divisions of motions in act, but in potency (231b18–232a17).

67. Note that in the following argument, "A" is the mobile and the first point on its path and the moment from which the motion begins.

68. In the case of reflex motion along a straight line, the mobile reaches the end and turns

back. But the end point, C, is in act, since the mobile undoubtedly comes to be in C; if so, the mobile rests there. Rest, however, takes time.

69. Cf. 233a21–31.

70. As the context will make clear, Aristotle means the time before and after a new quality or place, etc., comes to be.

71. "Logically" seems to be used by Aristotle as a synonym for "dialectically."

72. That is, not only in the case of locomotion on a straight line.

73. Heraclitus; cf. *Metaphysics* I, 6, 987a32–34.

74. 241a26–b12.

75. 223b18–20.

76. Democritus and Leucippus.

77. Anaximenes.

78. Plato.

79. St. Thomas Aquinas understands the argument as considering the time of the motion in virtue of the parts of the mobile passing a given point. Thus, if an infinite power moves a finite mobile for an infinite time, a part of the mover will move a proportional part of the mobile in a lesser time, since we are considering the mobile as passing a given point. This time must then be finite. But then adding to a mover and the mobile, we will add to the time, but never attain an infinite time. Consequently, the same mover will move the same mobile both in a finite and in an infinite time. Since the absurdity in this argument arises from the finitude of the parts of the mobile, we avoid the difficulty by saying that a motion infinite in time must be of an infinite mobile. But clearly such a mobile could be moved only by an infinitely powerful mover. Thus, only an infinite power could cause an infinite motion.

    The obvious objection to this interpretation is that no mobile is infinite. St. Thomas grants this, but notes that the quantity of a motion can be measured either by the parts of the mobile or by the parts of the magnitude over which the motion occurs. The former, he says, is the more fundamental measure, since that quantity belongs *per se* to the mobile. (Cf. 234b10–20, 235b1–5, and the notes thereon.) If a finite mobile, then, moves for an infinite time, it will do so accidentally. Whence, since the *per se* is always prior to the *per accidens* (cf. 257a30–31), what causes the infinite motion of a finite mobile could cause the motion of an infinite mobile, were such a thing not impossible on other grounds. Thus, the cause of a motion which endures forever would necessarily have infinite power.

80. It seems Aristotle is here concerned not so much with what the mover is as with whether it is one or many, and whether a motion caused by many movers acting successively is one or many. For a discussion of projectile motion, cf. Appendix 10, *A Brief Note on Inertia.*

81. Cf. 215a14–19; 244a21–25.

82. 259a13–20; 260a20–26.

83. When we move something, it moves us in return, and so lifting weights, e.g., tires us out because the weights weigh down on us. This happens because we are susceptible to being moved by the weights; an immobile mover would not have this problem, and so would never tire out. Cf. 202a3–12.

84. 204b1–206a8.

85. The general study of mobile being ends in the proof that there are immobile, immaterial beings. With this claim, Aristotle leaves natural philosophy (198a27–29) and establishes the existence of a science beyond it, a science he calls "theology" or "first philosophy," and later Aristotelians often call "metaphysics."

    That such immaterial beings exist is not obvious, but needs proof. If such things did not exist, there is no study of metaphysics, as Aristotle says: "If, then, there were no other substance, beyond those composed by nature, physics would be first science. But if there is a certain immobile substance, this will be prior and first philosophy" (*Metaphysics* VI, 1, 1026a27–30). We might think that we need no such proof on the grounds that the words "being," "thing," etc., do not obviously include material in their notion. But this does not prove that immaterial things are really possible; it might be that we are simply too unintelligent to see the implicit contradictions in the notion of "immaterial being," just as we cannot see, without argument, the contradiction in the notion "greatest prime number." In fact, we only know that things are possible because we have experience of them or because we can argue to them from things we do experience. If we do not have experience of immaterial beings, then it is only by argument that we can know they are even possible, let alone necessary, and, as Aristotle says, "to seek what a thing is without knowing that it is, is to seek nothing" (*Posterior Analytics* II, 8, 26–27), and "to seek without this (what a thing is), is to do nothing" (*Metaphysics* VI, 1, 1025b28–30). Aristotle also argues that the intellect is immaterial; this is another entryway into metaphysics; cf. *On the Soul* III, 4, 429a18–27; 5, 430a17–19.

Book VII[1]
Chapters 1–3, Alternative Text

Chapter 1

241b35 It is necessary that everything moving is moved by something. / For
b35 if it does not have the principle of motion in itself, it is apparent that it is moved by something different. For the mover will be other.

If, however, [it does have the principle] in itself, let there be taken AB which is not moving in virtue of itself, and not by some part
b40 of it moving. First, then, assuming that AB is moving by itself / because the whole is moving, and by nothing outside, is as if, KL moving LM and itself moving, one should not affirm that KM is moving by something [else] due to it not being apparent which [part] is the mover and which is the moved.

Next, what is not moving by something [else] does not necessar-
242a35 ily / pause by another thing resting; but if something moving rests by something other having paused, it is necessary that it is being moved by something. This being taken as given, everything moving will be moved by something. For, since AB was taken as moving, it is neces-
a40 sary that it be divisible. / For everything moving is divisible. Let it be divided, therefore, at C. CB not moving, then, AB will not be moving. For if it be moving, it is clear that AC would be moving, while CB is resting; whence, it {AB} is not moving in virtue of itself and first.[2] But it was supposed to be moving in virtue of itself first. It is there-
a45 fore necessary / that, if CB is not moving, BA would be resting. But it was agreed that what rests by something else not moving is being moved by something. Whence, it is necessary that everything moving is moved by something. For the thing moving is always divisible, and, the part not moving, the whole will also rest.

a50 Since, however, what is moving / is moved by something, it is also necessary that, if something be according to motion in place by another moving thing, and again the mover be moved by another moving thing, and that one by a different one, and so always, it is necessary that there be some first mover, and not to go on to infinity.

a55 For let it not be so, but let it become infinite. / Let A, then, be moved by B, B by C, C by D; and always the next by the next. Since,

then, it is supposed that the mover, being in motion, moves, it is necessary that the motion of the one being moved and the motion of the mover come to be at the same time. For the mover moves and the moved is moved at the same time. / It is apparent that the motion of a60
A and of B and of C and of each of the movers and moved things will be at the same time. Let the motion of each be taken; let the motion of A be E, and let the motion of B be Z, and let the motion of CD be IT. For even if each is moved by each, one will still be able / to take a a65
motion which is one in number for each. For every motion is from something to something, and is not infinite in its extremes. I call that motion same in number, then, which comes to be from the same in number to the same in number in a time same in number. For motion is the same in genus, and in species, and in number; in / genus, the 242b35
one in the same category {predicate}, e.g., of substance or of quality; in species, the one from the same in species to the same in species, e.g., from white to black, or from good to bad undiffering in species; in number, the one from a thing one in number to a thing one in number in the same time, e.g., from this white to that black, or from this / place to that, in this time. For if it be in another [time], the motion will b40
no longer be one in number, but in species. We spoke about these things in the prior discussions.[3]

Let the time in which A has been moved according to its motion be taken, and let it be K. The motion of A, then, being limited, the time / will be limited. Since, then, the movers and the things moved b45
are infinite, the motion EZIT, the one [made] from all [the individual motions], will be infinite. For the motion of A and of B and of the others can be equal, or the motions of the others can be greater; whence, whether they be equal or they be greater, in both ways the whole is infinite; for we are assuming / what is possible. Since A and each of b50
the others is moved at the same time, the whole motion will be in the same time as the motion of A. But the motion of A is in a limited time. Whence the infinite would be [moved] in a limited time; but this is impossible.

What was to be shown from the beginning, then, seems to be shown thus, yet it is not demonstrated, / because nothing impossible b55
was shown. For infinite motion can be in a finite time, not of one but of many, which, indeed, happens in these things. For each is moved according to its own motion, but it is not impossible that many things be moving at the same time.

But if it is necessary that what is moving [another] primarily according to place and bodily motion / be touched by or continuous b60
with the moved, as we see this happening in all cases, it is necessary that the things being moved and the movers be continuous with or

touching each other, so that there will be something one from all. Whether this be limited or infinite makes no difference with regard to
242b65 the things now [being discussed]. For in every way / the motion will be infinite, being of infinite things, if [the motions] can be either equal or greater than each other. For let us take what is possible as being. If, therefore, the thing [made] from ABCD is either limited or infinite, it will be moved according to the motion EZIT in the time K,
b70 which is limited, it happens that in / a limited time, whether it {ABCD} be limited or infinite, it goes through an infinite. But it is impossible in both ways.

Whence it is necessary to come to a stand and for there to be some first mover and moved. For it makes no difference that the
243a30 impossibility happens from a supposition. / For the supposition taken is possible, but a possible thing being posited, nothing impossible can come to be in addition because of it.

Chapter 2

243a32 The first mover, however, not as that for the sake of which, but whence is the beginning of motion, is together with what is moving. I
a35 say "together" because nothing is between them. For this / is common in the case of all things moved and movers.

Since, however, there are three motions, the one according to place and the one according to quality and the one according to amount, it is necessary that the movers are also three, the one carrying,[4] the one altering, and the one causing growth or diminution. Let
a40 us first speak, then, about locomotion {being borne; carrying}; for / this is the first of the motions.

243a11 Everything in locomotion, then, is moved either by itself or by something different. In the case of things which are moved by themselves, then, it is apparent that in these the moved and the mover are
a15 together. For the first mover is present in these, so that / nothing is between them.

But whatever things are moved by another come to be in four ways, for there are four species of locomotion due to another: pulling, pushing, carrying, and whirling. For all motions according to place are reduced to these.

For pushing on is a certain pushing in which what moves something away from itself pushes while following along; but pushing off
a20 [is a pushing] / in which, having moved, it does not follow along; and

throwing [is a pushing] in which it makes a motion from itself stronger / than the locomotion according to nature, and it is borne for 243b1
as long as the [former] motion has sway. Again, pulling apart and bringing together are pushing off and pulling; for pulling apart is pushing off (for the pushing off is either away from itself or away from another); while bringing together is pulling (for pulling is either towards itself or towards another); / whence also whatever are species b5
of these, like packing and combing, for the one is bringing together, the other pulling apart. Similarly too in the cases of the other collections and separations, for they will all be pulling apart or bringing together, except whatever ones are in coming to be and destruction.

At the same time, it is apparent that collection and separation are b10
not some other genus of motion. For all are divided into some one of the aforementioned. Moreover, inhaling is pulling, exhaling is pushing. Similarly also, spitting and whatever other secretive or assimilative motions are throughout the body; for some are pulling and / some are pushing. The other [motions] according to place must also be b15
reduced, for they all fall into these four. Again, of these, carrying and whirling [are reduced] to pulling and pushing. For carrying is according to some of these three ways. For the thing carried is moved accidentally, because it is in a thing moved / or on something moved, b20
while the thing which carries [it] carries either / a thing pulled or 244a1
pushed or whirled. Whence, carrying is common to all three. Whirling, on the other hand, is composed of pulling and pushing. For it is necessary for the thing which whirls [another] to pull part and to push part. For it brings one part away from itself and one part towards itself. Whence, if what pushes and / what pulls are together with what a5
is pushed and what is pulled, it is apparent that nothing is between the moved and the mover according to place.

Indeed, this is also clear from the definitions. For pushing is motion towards another, either from itself or from another, while pulling is from another, either towards itself or towards another, when the motion / of the one pulling be faster than the continuous things are a10
separated from each other. For thus is the one thing pulled. (Perhaps there might seem to be some pulling in another way as well. For wood does not pull fire thus. But it makes no difference whether the thing pulling pulls while moving or remaining. For sometimes it pulls where it is, sometimes where it was.) It is impossible, however, / to a15
move, without touching, either from itself towards another or from another towards itself; / whence, it is apparent that there is nothing 244b1
between what is being moved according to place and what is moving [it].

But indeed, neither [is something between] what is being altered

and what is altering [it]. This is clear from induction. For in every one
244b5 it happens that the last one altering and / the first one altered are together. For our supposition is that the thing suffering is being altered according to the qualities called passive.[5] For every body differs from body by sensible [qualities], either by [having] more or fewer of them or by having them more and less. But indeed, the thing being altered is altered by the things said. For these are the passions of the underlying quality. For we say that a thing being heated or sweetened or condensed or dried or whitened is being altered, speaking in the same way about the unsouled and the ensouled, and again,
b10 of the ensouled ones, about the non-sensitive / parts and the senses themselves. For the senses too are somehow altered.[6] For sense according to act is a motion through the body, the sense suffering something. Therefore, according to whatever the unsouled are altered, so too are the ensouled, but according to whatever the ensouled [are altered], not according to all these are the unsouled [altered]. For they
b15 are not altered / according to the senses, but what suffers, in one case,
245a1 does not notice it, while in the other, it does. / For nothing prevents even an ensouled thing not noticing, when the alteration does not come to be according to the senses. If, therefore, the thing being altered is altered by sensible, in every such case it is apparent that the
a5 last thing altering and / the first thing being altered are together; for the air is continuous with the one, and the body with the air; again, color [is continuous] with light, and light with sight. Both hearing and smell [take place] in the same way. For the first mover, in the direction of the thing being moved, is the air. And so too in the case of
a10 taste. For the flavor is together with the taste. / And so too in the case of unsouled and insensible things. Thus, nothing is between what is being altered and what is altering [it].

Nor in the case of what is growing and what makes it grow [is there something in between]. For the first thing which makes something grow causes growth by being attached, so that the whole comes to be one thing. And again what makes a thing diminish causes diminution by removal of some one of the things belonging to the one
a15 being diminished. / It is therefore necessary that the thing causing growth and the thing causing diminution be continuous [with the thing being moved]; but there is nothing between continuous things. It is apparent, then, that nothing is between the thing being moved and
245b1 / the first mover, the extreme in the direction of the thing being moved.

Chapter 3

Let us consider, from what follows, that all things being altered are 245b3
altered by sensibles, and there is alteration of those things alone
which / are said to suffer, in virtue of themselves, from the sensibles. b5

For, of the others, one would most assume alteration to be present in shapes and forms and habits[7] and in the seizing and the throwing off of these; but it is in neither. For when the thing being shaped or arranged is perfected, / we do not say that it is that from which [it b10
is made] (e.g., that the statue is bronze or the pyramid is wax or the bed is wood), but, denominating, [we call] the one brazen, the other, waxen, the other, wooden. But we do so predicate in the case of the thing which suffered and was altered. For we say the bronze and the wax is wet and hot and hard, / and not only thus, but [we also say] the b15
wet and the hot is bronze, naming the material equivocally from the passion.[8] / Whence, if that which comes to be, in which the shape is, 246a1
is not spoken of according to the shape or the form, but it is spoken of according to the passion and the alterations, it is apparent that their comings to be would not be alterations.

Moreover, to speak thus would seem strange, [i.e., to say that] / a a5
man or a house or anything else which has come to be has been altered; but perhaps for each thing to come to be something is necessarily being altered, e.g., the material becoming dense or rare or hot or cold; still, the thing coming to be is not being altered, nor is the coming to be of these alteration.

Indeed, neither are habits, either of the body or of the soul, alter- a10
ations. For virtues and vices are among habits. For neither virtue nor vice is an alteration; but virtue is a certain perfection (for each thing is said to be perfect when it takes on its own virtue {excellence}, for then it is most / according to nature, just as a circle is perfect when it a15
comes to be most or when it is best), while vice is the destruction and removal of this. Therefore, just as we do not call the perfecting of the house an alteration (for it would be strange if the coping or roofing is an alteration, or if in being coped or roofed the house / is not perfect- a20
ed but altered), in the same way also in the case of the virtues / and 246b1
vices and the things having or seizing [them]. For the ones are perfections and the others losses, so that they are not alterations.

Moreover, we also say that all the virtues are somehow among the relatives.[9] For those of the body, like health / and well-being, we put b5
down to the mixing and balance of the hot and the cold, either of the things within the body relative to each other or relative to what contains. So too good and strength and the other virtues and vices. For each is somehow among the relatives, and disposes the one having [it]

246b10 well or badly with regard to its proper passions, / proper being those due to which one is naturally apt to come to be or be destroyed. Since, therefore, relatives are not themselves alterations, nor is there alteration of these, nor comings to be, nor, generally, any change of them at all, it is apparent that neither habits nor the throwing off of habits nor the seizing of habits are alterations. But perhaps for them to come
b15 to be or / be destroyed it is necessary that some things be altered, just as also in the case of the species and the form, like the hot and the cold or the dry and the wet, or the things in which these happen to be first. For each vice and virtue is spoken of with regard to those through which the thing having them is naturally apt to be altered.
b20 For virtue makes a thing either impassive or / passive in a certain way, and vice [makes it] passive or a passive in a contrary way.

247a1 Similarly / also in the case of the habits of the soul. For all these also are somehow among relatives, and the virtues are perfections, the vices losses [of the virtues]. Moreover, the virtue disposes well relative to the proper passions, the vice badly. Whence, neither are these
a5 / alterations. Nor, then, are the throwing off and seizing of these. But it is necessary for these to come to be due to the altering of some sensitive part. But the latter will be altered by sensibles. For every moral virtue concerns bodily pleasures and pains, while these are in action
a10 or in remembering or in hoping. The ones / in action, then, are according to sensation, so that they are moved by something sensible, while the ones in memory and hope are from the same [sense]. For either those who remember are pleased by whatever it was they suffered, or those who hope [are pleased] by whatever they look forward to. Whence, it is necessary that every such pleasure comes to be from
a15 sensibles. But since, pleasure and pain / coming to be present, vice and virtue come to be present, for they concern these, while pleasures and pains are alterations of what is sensitive, it is apparent that it is necessary for something to be altered for these to be thrown off and seized. Whence, the coming to be of these is with alteration, but they are not alterations.

247b1 But indeed, neither are the habits of the intellectual part alterations, nor is the coming to be of these. For rather, for the most part, do we say that the one who knows is somehow among relatives. Moreover, it is also apparent that there is no coming to be of them. For
b5 what knows in potency comes to be a knower, not by having / been moved in any way, but by another thing being present. For when a particular occurs, somehow the universal is known in the particular. Again, there is no coming to be of the use and of the act [of intellectual knowing], unless someone should think that the there is coming to be of seeing and touch; for the use and the act is similar to these.

The / first seizing of science, however, is not a coming to be or b10
an alteration. For it is by thought coming to rest and standing that we are said to have knowledge and to be prudent, but there is no coming to be of resting. For, generally, as was said before, there is no coming to be of changes.[10]

Moreover, just as when someone stops being drunk or sleeping or being sick, [and goes] into their opposites, / we do not say that a b15
knower has again come to be (even if it was impossible [for him] to use his knowledge before), so neither [do we so speak] when one first seizes a habit. For it is by the soul settling from its natural tumult that it comes to be a prudent and knowing thing. Whence, also, boys are not able to learn nor / to discern according to the senses as are their 248a1
elders. For there is much tumult and motion. One settles and comes to rest with regard to some things by one's own nature, with regard to others, due to other people; in both cases, things within the body are being altered, just as / in the case of use and act, when one becomes a5
sober or awakes.

It is therefore apparent from what has been said that being altered and alteration are in the sensibles and in the sensitive part of the soul, but in no other thing, except accidentally.

Endnotes

1. There are two extant versions of Book VII, Chs. 1–3. I have translated as the primary text the text which Ross publishes as the Alternate Text in his edition, simply on the grounds that it seems somewhat more clear.
2. Cf. 224a21–30.
3. 227b3–228a1.
4. Aristotle uses the common word for "carrying" for every locomotion. Cf. 226a32–b1.
5. That is, according to the third species of quality named in the *Categories*, Ch. 8, 9a28–10a10.
6. Cf. *On the Soul* II, 5–6, 416b32–418a6.
7. Cf. *Categories*, Ch. 8, 8b25–10a26. Aristotle omits the second species of quality, natural aptitudes or powers, perhaps because these can only change through a change in the subject's nature, and so are clearly not within the range of alteration.
8. Cf. *Categories*, Ch. 5, 2a19–34.
9. That is, their highest genus is "relative," or they are in the category "relative" (cf. *Categories*, Ch. 7, 6b1–2).
10. Cf. 225b13–226a23.

Appendix 1

Method in Aristotelian and Modern Natural Philosophy

The first chapter of the *Physics* gives us an outline of the appropriate method to use in natural philosophy.

Before coming to Aristotle's text, however, it would be well to discuss the very word "method," which is likely to cause some misgivings for those who have read the *Physics* and the other works of natural philosophy by Aristotle and are also familiar with the meaning given to that word in modern philosophy. One of Descartes' most influential works, e.g., is called the "Discourse on Method." But for Descartes, a "method" is a universal procedure which of itself, when well employed, gives the desired results. It is in the Introduction to that work that Descartes makes his astounding claim that all men are equally intelligent, and that his only advantage lies in having used proper method – once everyone has learned the method, anyone will be able to know as much as those considered most brilliant.[1] What I mean to signify by the word "method" is by no means so mechanical. It is through and through suffused with the working of living reason, and its success will depend on very real differences in experience and intelligence.

Perhaps a good beginning for us would be to look a little at the etymology of the word. "Method" is derived from the Greek "μέθοδος," which itself comes from two words, "μετά" and "ὁδός," "over" and "road." To use a method is to be on the way to something, whether a practical result, as when we use the methods of the carpenter to build a desk, or a speculative result, as when we use the "experimental method" to look into the secrets of the natural world. In either case, we use something determinate, but that determinate road we follow is not so determinate as Descartes would wish. There may be many ways to attain one's goal, some no doubt better than others, and there are, e.g., experimental geniuses who see the ways more clearly and more quickly than others. In analytic geometry, everything depends on drawing the right lines, but there are no rules for intuiting which lines should be drawn. In carpentry too, there are many different instruments for the same work and many ways to work the wood, and there is no perfectly determinate way to work this wood into the particular desk I want. Method, then, can only take us so far; it gives us general but not particular guidance.

In the first chapter of the *Physics*, Aristotle gives us two such basic guidelines. First, we should try to see natural things in terms of their "principles, causes, and elements." This is to say that we should try to see why things are as they are. But the way he puts his reason for this fairly obvious claim is illuminating: "For we think we know each thing when we know the first causes and first principles and have reached the elements." In saying that we must *reach* the elements, he implies that we cannot start with them, nor, presumably, with the "principles and causes." And yet he goes on to say that, "It is clear, then, that in natural science as well one must try to determine first what concerns the principles." Should we do this first or not? The contradiction is very superficial, for in saying we must try to determine first what concerns the principles, he is again implying that there is something in our minds before the principles, since the latter must be determined by something else; that is, the principles of the thing may not be the principles of our knowledge of the thing.

What is that "something else" which we must first know? It must be what is intrinsically tied to the principles, because what is not so tied could not lead us to knowledge of the principles. But what is intrinsically tied to a principle is whatever it is a principle of. Thus, implicit in Aristotle's text is another claim which everyone would grant, namely, that we must start with the things about which we wish to know the principles. For example, the principles of water are hydrogen and oxygen, but I must argue to that fact from something I already know: what the name "water" refers to, that the stuff so named can be experimented upon in a certain way, that such an experiment produces two "gases" with such and such properties, that the names "hydrogen" and "oxygen" may be used to denote these gases, etc. In general, the chemist does not start with perfect knowledge of the periodic table; that table is itself the result of years of research, starting with Lavoisier and coming to a triumphant conclusion in the work of Mendeleev. The usual approach used in current textbooks of chemistry, starting with the periodic table as an *a priori* premise, would look odd indeed to either Aristotle or Lavoisier, or even, one suspects, to Mendeleev. That distressing sense which beginning chemistry students feel, of having been left out of the secret, is perfectly natural given what Aristotle is here advocating. For we can only move to what we do not know from what we do know, and no one starts with the knowledge that there are so many elements, that they have these certain properties, and that they are to be arranged *thus*. It is even a matter for argument, i.e., it is not perfectly obvious, that there are such things as elements.

Thus, there must be something about which we are inquiring, and that thing must be better known to us than its principles. The subject of the present work, the thing about which we are inquiring, is mobile being, i.e., what is capable of physical change. In order to understand this sort of being, we have to find its principles.

One might take the words "better known" in more that one way, but here, as the context makes clear, Aristotle is concerned with the fact that we first know

confused wholes, and only later come to clear knowledge of the parts included in that confused whole. He argues this in three ways.

First, he takes the sensible whole: the things which we sense are wholes, e.g., I sense the tree or the man. Only later do I look more closely and so distinguish the parts of these wholes, the branches from the trunk, the greenery from the branches, the leaves from the flowers, the fruit from the metacarp, etc. I knew the parts already, in some way, since I cannot sense the tree without sensing the leaves and branches, etc., but only indistinctly, i.e., without clearly distinguishing them from each other. In this, I am moving from a confused sensation of the whole to a more distinct sensation of the parts. This example is an example of an integral whole which is sensed.

Next Aristotle turns to a kind of intelligible or rational whole. First I know what a circle is in a vague and confused way. As a child, I can point out a circle from among a group of figures without necessarily being able to tell you just what the distinguishing characteristics are. Later, I am able to give something like a definition, by saying that the circle is the one which has a curved edge. I may not even, at first, notice that a circle must be the same shape all around, and so I may not distinguish a circle from an oval. Later I will see this distinction as well, and then I can define the circle, saying something like, "a circle is a flat shape which is the same all around." Here, in Aristotle's words, I have "divided [what is named by the word 'circle'] into the single parts [of its definition, namely, 'flat,' 'shape,' and 'same all around']." I have moved from a confused knowledge of the intelligible whole "circle" to a distinct knowledge of the parts implicitly contained in that whole.

Finally, Aristotle uses a sign drawn from the way children speak. At first, children refer to all men as "fathers," and even refer to adult male animals this way, e.g., "There's a daddy bear." Later, having distinguished being an adult male from an adult male with offspring, they use the name daddy or father for the latter. Earlier, they had confused the notions of adult male and of male parent under a single name; now they distinguish them.

Using three examples, then, he establishes that the confused whole is more known, and this in support of his claim that the universal is more known. For "the universal is a certain whole. For the universal embraces many things within it as parts." Thus, the universal "figure" contains as "parts" the species "circle" and "triangle," and the universal "animal" contains as parts the species "man" and "horse." The universal is a whole which contains the species in confusion, i.e., with fusion of their natures into one whole. What makes a triangle different from a circle is not included in the notion of figure, but both triangle and circle are in the genus "figure" confusedly.

(It should be apparent from this that Aristotle does not think of the universal as a class, since a class does contain the things it contains in all their distinctions. The class of all men, e.g., includes every man in his very distinction

from other men, while the species name, "man," does not. This is why the latter can be predicated of every individual and the former cannot.)

If we grant that Aristotle has shown that we should start with the universal, we still should ask, "Where do we go from here?" It is important to note that Aristotle never suggests that we can simply deduce the less universal from the more universal. We obviously cannot, e.g., deduce the nature of a bee from the nature of body or animal. What we can do is see what principles are implied by the universal nature under consideration, or what properties it must have. For example, in the seventh chapter of the first book, Aristotle shows that, given what change is, there must be three principles of change, matter, form, and privation. He does not try to show that, given what change is, there must be these or those kinds of change and they must have such and such properties. Similarly, in the first chapter of the seventh book, he does not try to show that, given what a mover in general is, there are several species of mover, but that, given that there is motion of some kind, there must be a first mover. This, he thinks, follows from the fact that there is motion of any kind; i.e., from the fact that motion in general is of such a nature, it follows that motion requires a mover.

In the *Physics*, then, Aristotle treats those most general aspects of nature, such as change, motion, the continuum, the relation of the mover and the mobile, etc., and the principles and properties of these aspects. In later works, *On the Heaven*, *On Generation and Corruption*, *Meteorology*, *On the Soul* and the rest of the biological works, he goes on to treat the more particular aspects of nature. Thus, he descends in universality, in each work arguing about the principles and properties which belong to the subject at this or that level of generality. The *Physics* is the first part because it deals with the very most general aspects of mobile being.

As I argued in the *Introduction*, the sort of inquiry represented by modern, experimental science comes after that seen in the *Physics*. There I gave four sorts of priority: common experience is prior to particular experience; common notions are prior to particular notions; natural language is prior to symbolic language; and the simple is prior to the complex. A fuller consideration of the methodology of experimental science would have revealed some further ways in which natural philosophy as found in the *Physics* is prior to experimental science. In particular, we would have seen that the idealized world of modern science is posterior to the world understood in its full concretion as found in Aristotle's natural philosophy, that operational definitions are posterior to definitions of what a thing is, and, most importantly perhaps, utilitarian thought is posterior to speculative thought. For a fuller understanding of Aristotle's method in the *Physics*, it will be useful to contrast it once again, a little more fully, with the method of modern science.

Modern experimental science was born of two tendencies, one which can be traced back to Pythagoras and another which is relatively modern, though it was

not unknown in the ancient world. The first is the desire to understand nature mathematically. Galileo, for example, says,

> Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometic figures without which it is humanly impossible to understand a single word of it; without these, one wanders about in a dark labyrinth.[2]

This motivation is strengthened by the belief that only mathematics produces certainty. Descartes, perhaps the most deliberate mathematizer of all, says, "...among all those who have sought truth in the sciences before now, there was no one but the mathematicians who have been able to find some demonstrations, that is to say, some certain and evident reasons. . . ."[3]

But secondly, there is the desire to produce a useful science. Descartes, known largely for his rationalism, says,

> But, as soon as I had acquired some general notions touching on physics, and, beginning to test them in different particular difficulties, I had noted whence they might lead, and how they were different from the principles accepted up till now, I believed that I could not leave them hidden without gravely sinning against the law which obliges us to procure, as far as we are able, the general good of all men. For they made me see that it is possible to come to knowledge which is very useful for life; and that *in place of this speculative philosophy taught in the schools, one could find a practical one*, by which, knowing the forces and the action of fire, of water, of air, of stars, of the heavens and of all the other bodies which surround us as distinctly as we know the diverse skills of our artisans, we might in the same way use them for all the uses for which they are proper, and so *make ourselves masters and possessors of nature*.[4]

Given, then, that modern physics intends to be thoroughly mathematical and useful, certain consequences follow for its mode of defining. And, as Aristotle says, the nature of a science is explained by the way it defines its fundamental concepts and the way in which it understands the division of its domain.[5]

The physicist Poincaré argued that the mode of definition in modern science is unflinchingly operational:

> When one says that force is the cause of a motion, one is doing metaphysics, and this definition, if one must content oneself with it, will be absolutely sterile. That a definition might serve some purpose, it is necessary that it teaches to *measure* force; moreover, this is sufficient: it is in no way necessary that it teaches us what force is *in itself*, not even whether it is the cause or the effect of motion. [E]ven if this direct intuition [arising from the

> notion of effort, which is familiar to us from infancy] makes us know the true nature of force in itself, it will be insufficient for the founding of Mechanics; it will be, moreover, totally useless. What is important is not to know what force is, it is to know how to measure it.[6]

Eddington holds a similar view:

> It has come to be the accepted practice in introducing new physical quantities that they shall be *defined* by the series of measuring operations and calculations of which they are the result. Those who associate with the result a mental picture of some entity disporting itself in a metaphysical realm of existence do so at their own risk; physics can accept no responsibility for this embellishment. The innovation made by Einstein in his relativity theory was that the physical quantities involved in the measurement of space and time were brought under this rule. The reform was clearly necessary; for the experimenter is called upon to certify the truth of our conclusions about distances and intervals of time, just as much as he is called on to certify the truth of our conclusions about temperatures or magnetic fields. A definition of length which specifies a way of determining lengths observationally is indeed the most urgent requirement of all; for when we come to examine what is actually measured in any kind of experiment, it is nearly always a length or spatial measure – the length of a thread of mercury in a thermometer, the shift of a bright spot on a galvanometer scale, the displacement of a dark line in a spectrogram, etc.[7]

The physicist must content himself with definitions which tell him how to measure the things he studies, for he is concerned with arriving at a definition which will permit him to treat physics mathematically.

To see this more clearly, consider the question, "how would we define 'F' in 'F = ma'?" The word, "force," we can say, means "violence, power, strength, etc." It can be applied to the character of a natural leader, an instrument of political policy, and other things. In the equation, of course, we would be told to take it as "that power which moves bodies faster, slows them down, or changes their direction." Such a phrase, if put into an equation, will not make any sense. We might say (though now this is to go beyond what we normally mean by the word) that we mean "the quantity of that power which moves bodies faster, slows them down, or changes their direction." To get our word to reflect at least approximately what we want in our equation, we have to extend its meaning. Such extensions of meaning are not uncommon, however; the variety of meanings of the word "force" in common speech is enough to prove that. But we can easily see that we have still not gone far enough; we have not managed to get something that we can put into an equation and manipulate the way we manipulate the symbols of our equation. To do this, we are going to have to find something which can be handled like a number and for which a number may be substituted. Since the equations of the physicist concern nothing but the proportions

existing between certain quantities, which proportions are obviously determined by the amounts of the quantities in question, definitions of the terms of equations need contain nothing more than that which determines these amounts; everything else is accidental to that quantity, at least insofar as it enters into the physicists' laws and equations, and so is not to be included in the definition. But what determines these amounts is measurement. The substitute for "F," then, will be a result of measurement, and so will imply a standard measure (e.g., a meter, a gram, or an erg), and standard methods for applying that measure to determine the quantity in question. The means of applying the standard may, of course, be many, for whether I measure weight using an equal arm balance or an electronic balance, I may still use the unit "gram," but the various accepted methods are included in the notion of the measurement. If these two elements, the standard measure and the standard means of applying the standard, are not included in the definition, there is no guarantee that the equation indicates the same thing every time it is used. Thus, what is indicated by "F" will be a result of a measurement performed in a certain way.

For example, we could say that I have to use more power to pick up a boulder than to pick up a pen. This sort of vague statement is not very useful for mathematical physics, as Poincaré says. I could start to define "F" more precisely by claiming that the power needed to lift 25 pounds one foot is half the power needed to lift 50 pounds one foot. I have now defined "F" by including in its notion a certain activity performed upon certain measurable aspects of things, namely, weight and distance, and so I am forced to define "m" (mass) and "s" (distance). Once again, I must define these as results of measurement. "m" might be defined as the measurement resulting from using a particular instrument called a "balance" in a certain way and "s" the result of laying a given metal bar alongside what is to be measured in a certain way. Only if I proceed in this way can I arrive at an "F" which can be put into an equation.

This sort of definition is called "operational" or "experimental" as opposed to a definition which attempts to tell us what a thing is. The definition of force as what can move something is an attempt, however imperfect, to tell us what force is, not how to measure it. Similarly, we might contrast the definition of a "pure substance" (as opposed to a mixture or solution) as "what is not many but only one substance" to the operational definition of a pure substance as "what is not separated into parts differing in kind by the processes of evaporation or filtration or certain other processes." This latter definition, though operational, is not in terms of measurement and so does not represent what can be put into an equation. When we wish to formulate physics in mathematical terms, however, we will need definitions which are not merely operational but also give rise to quantitative measurements. (We may, of course, go on to define different substances in terms of measurements of density, etc., as we do in modern chemistry.)

Because the definitions of a mathematical physics are operational, and because they are intended to supply the terms of mathematically expressed phys-

ical laws, they will be the definitions of symbols as opposed to words. For the symbol is able to be manipulated like a thing: added, subtracted, squared, etc.[8] Moreover, the symbol is uniquely suited to gathering into one easily manipulated sign many disparate elements joined together by the physicist in an artistic act in order to express at once complex methods of measurement and a resulting measure-number.

If we look more carefully at the role of experiment, another artistic aspect emerges. When we contrast the experimental sciences to philosophical (or mathematical) studies, we are inclined to think of the latter as involving the analyses of the meanings of words (or symbols). There is some truth to this intuition, since we really do have to scrutinize closely the meanings of words if we are to see what our fundamental, pre-scientific knowledge of the world contains. Still, we ought not to overemphasize this, as if our common language does not express an original contact with the world, a contact which is filled out by speculation, whether experimental or not, about the world as we know it and express it in common speech.

In any case, the contrast we make between experimental and philosophical knowledge, between studies in which we look to particular, repeatable experiences and those in which we analyze what we knew all along, implies that the "experimental" science is one in which the understanding of the terms used does not allow, simply in virtue of the terms, a clear grasp of the connections between the terms. Because of this obscurity in the subject, we are forced to return over and over to experience, to see whether what seems to follow really does follow, to see whether conclusions which follow for the mathematician are verified in the physical world, to see whether the premisses we have assumed to be universal hold in some new situation, etc. The philosophy of nature may safely claim that motion, always, in every case with no possibility of exceptions, implies difference (for to move implies first having one disposition and then a different one), but the physicist must always look again to verify that Charles' Law holds in such and such a particular case. This is so not only in physics and chemistry, where mathematics plays a large role, but also in biology, where it is much less dominant. Since there are non-quantitative terms, e.g., "bee" and "the dance of the bee," between which we can never see a necessary connection just in virtue of what the words mean, or of the things signified by the words, there will be experimental sciences which do not proceed mathematically.

But the usual idea of "experiment" includes not only this constant recourse to experience, but also manipulation of bodies in a determinate, controlled, and repeatable fashion. In experiment, then, we are faced with the intervention of reason in experience, for in controlling experience, we do not sit passively at the spectacle of the world, but disturb the flow of events in accord with our hunches or theories. For, to perform an experiment, we must first have a clue or two about what we ought to look for. We do not simply stuff things into a test tube and shake it; we put particular chemicals in and do this or that to test this or that

hypothesis. Consequently, in the pursuit of knowledge through experiment, we are not only passive but also active, for we select and then manipulate what has been selected. The experiments which the physicist chooses to perform are not determined *a priori* either as to their particular structure nor even as to whether these are the experiments which ought to be performed. The scientist has a hunch and chooses to test it in this or that way. He may have chosen a different way to test it or he may have had a different hunch altogether. In both ways the experiment is not a "given" of the science, but something "given" by the scientist.

The modern physicist, then, is approaching nature through a certain method, that which requires "experiments," i.e., artificially constructed experiences, and experiences susceptible to mathematical analysis, i.e., experiences the elements of which can be measured by some reasonable and repeatable process. The use of "thought experiments" in relativity and quantum theory only underscores the necessity that the experimenter be inventive, even if such "experiments" are not repeatable, or even performable at all in the extra-mental universe which the physicist is investigating. Yet even these "thought-experiments" must be at least in theory performable, repeatable, and of an exactly determinable quantitative nature before they are admitted to the crystal palace of physics.

If we are to come to grips with the physical world in all its diversity and obscurity, i.e., in its particularity, and especially if we are to do so through mathematics, it seems we will have to perform such controlled experiments. We will not come to any insight at all about particular questions such as "What is the ratio of change of pressure to change of volume for a given quantity of gas at a given temperature?," or "Is the velocity of light greater or lesser *in vacuo* than through a body?" without manipulating particular bodies in a way which permits certain measurements to be taken. Mathematical physics is necessarily "experimental."

Thus the experimental scientist intervenes in nature, takes an artistic approach to it, in his attempt to reveal its secrets and attain control over it.

Now, some experiments seem more simply conclusive than others, e.g., those of Pascal with regard to the weight of the air[9] seem more conclusive than the experiments performed in particle accelerators. The former are more proximately tied to our everyday experience and our common notions, which as we have seen, are our most certain starting points, while the latter are conclusive only within the broad context of a set of theories which are presumed to be true. To take another example, the fact that two globes of gold suspended in an evacuated space move very slightly towards each other was thought to confirm Newton's universal law of gravitation, but it is equally compatible with relativity theory. Einstein and Infeld write,

> It is really our whole system of guesses which is to be either proved or disproved by experiment. No one of the assumptions can be isolated for separate testing. In the case of the planets moving around the sun it is found that the system of mechanics works splendidly. Nevertheless, we can well imag-

> ine that another system, based on different assumptions, might work just as well.[10]

Beyond this intervention of mind in the phenomena of physics lies yet another, the idealization of the very entities discussed and of the conditions under which these entities are imagined. When Newton presents his First Law, the Law of Inertia, he lends it support using three examples. We may be surprised to find that not one is an example of inertial motion:

> A hoop, the parts of which, cohering, are perpetually drawn aside from rectilinear motions, does not cease to rotate, except insofar as it is retarded by air. Moreover, the larger bodies of the planets and comets, conserve still longer their motions, both progressive and circular, made in less resistant space.[11]

Each of the examples is an example of curvilinear motion. It is not even possible, if Newton's theory of gravitation is right, to observe an inertial motion. For the observer must himself have mass and so must the observed, and the distance between them must be finite; whence, the mass of the observer must act on the observed. Thus, even if we hypothesize a universe consisting only of these two bodies, there cannot be a body unaffected by the force of gravity, and therefore there can never be an observation of a body in purely inertial motion. Newton is hoping that we will grant that the only reasons the bodies slow down or change direction is some external force. But strictly, inertial motion can only be imagined, never experienced.

Discussing the genesis of the idea of inertia, Einstein and Infeld ask how we would make a pushcart roll further along a road after letting it go. We would oil the wheels and smooth the road.

> And what has been done by the oiling and smoothing? Only this: the external influences have been made smaller. The effect of what is called friction has been diminished, both in the wheels and between the wheels and the road. This is already a theoretical interpretation of the observable evidence, an interpretation which is, in fact, arbitrary. One significant step further and we shall have the right clew [to the understanding of the motions we are concerned with]. Imagine a road perfectly smooth, and wheels with no friction at all. Then there would be nothing to stop the cart, so that it would run forever. This conclusion is reached only by thinking of an idealized experiment, which can never be actually performed, since it is impossible to eliminate all external influences. The idealized experiment shows the clew which really formed the foundation of the mechanics of motion. . . .
>
> We have seen that this law of inertia cannot be derived directly from experiment, but only by speculative thinking consistent with observation. The idealized experiment can never be actually performed, although it leads to a profound understanding of real experiments.[12]

Thus, what is perhaps the most fundamental law of modern physics is itself not a result of simple observation, as we would hope, but incorporates the work of mind in its formulation.[13] This idealization is by no means restricted to this one example: the physicist has recourse to "perfectly rigid bodies," "ideal gases," "point-masses," etc.[14]

Heisenberg also pointed out that the phenomena dealt with in our experiments as well as the theories used to explain them are highly idealized in physics.[15] The reason for this idealization is that, to couch universal laws of physics mathematically, we are forced to abstract from the complexity and materiality of the very subject of our study. Absent this informing of the world with our own intellect, we cannot see in experience the perfect regularity needed for physics, for the world as experienced is too much in flux and variation, while the physicist seeks the stability and homogeneity of mathematical formalism. We are reminded of the Socratic claim that the world is only a shadow, that reality lies elsewhere, in a separate realm of intellect. As Maurice Clavelin puts it, "All of Galilean science rests on the substitution of a more simple ideal world for the too-complex real world."[16]

This idealization, then, is a result of the mathematical imperative: only homogeneous and simplified objects can be dealt with mathematically. We must bear in mind, however, that this idealization is not necessarily a falsification. But it is not falsification on condition that we remember how we got to the ideal state, namely by removing from our consideration variations which are real. If I say, "this lump of copper is perfectly uniform," I am wrong; if I say, "this lump of copper is perfectly uniform so far as I am concerned," i.e., for practical purposes or for the theoretical purposes of the mathematical physicist, I am right. The *caveat* is usually left understood.

One could very easily go further. In Einstein and Infeld's description of the development of the law of inertia, we assume that we may do away with all friction and still have motion. But how are we assured that imagining away friction is not imagining away something which is necessary for the very existence of motion? Could we agree with someone who said that, since water impedes his progress when swimming, he could swim much better without water? The physicist uses as a methodological principle that everything he does not treat in his idealized problem is a mere complication, that it too could be introduced to the problem and dealt with using exactly the same methods.[17] But he is assuming here that what is possible in his abstract symbolic world is possible in the concrete world in which we live.[18] This is not necessarily so. It is possible to the genus "triangle" that it receive the further specification "equilateral," but this is not possible to the less abstract and more concrete species "scalene triangle." Similarly, it is abstractly possible that any magnitude, however small, be divided again, but the elementary particles of physics are not physically divisible.[19] It is mathematically possible to multiply the velocity of a car as much as we please; it is not physically possible, according to relativity, to exceed the speed of light.

Consequently, the idealizations of mathematical science are not necessarily reflective of a real or even of a possible situation.

The tendency of modern physics to treat what is abstractly possible as physically possible is, then, due to the need to rely heavily on the imagination in formulating physical theory. The physicist looks upon the world as an unopenable watch, as Einstein and Infeld say:

> Physical concepts are free creations of the human mind, and are not, however it may seem, uniquely determined by the external world. In our endeavor to understand reality we are somewhat like a man trying to understand the mechanism of a closed watch. He sees the face and the moving hands, even hears its ticking, but he has no way of opening the case. If he is ingenious he may form some picture of a mechanism which could be responsible for all the things he observes, but he may never be quite sure his picture is the only one which could explain his observations. He will never be able to compare his picture with the real mechanism and he cannot even imagine the possibility or meaning of such a comparison. But he certainly believes that, as his knowledge increases, his picture of reality will become simpler and simpler and will explain a wider and wider range of his sensuous impressions. He may also believe in the existence of the ideal limit of knowledge and that it is approached by the human mind. He may call this ideal limit the objective truth.[20]

Looking at the world this way, we must imagine what might be within the watch, or else confine ourselves to a mere recording of facts. But to the extent that we so use our imaginations, we are not dealing with the phenomena, but with pictures in our imaginations. There is a concomitant tendency, then, to treat this image as reality. We are really engaged in a sort of dialectic between imagination and sensation; the latter is the ultimate arbiter of physical theory, but the former invents the case to be put before the judge. The imaginary system of protons, electrons, and neutrons is thought acceptable if it "saves the phenomena," but is not itself and cannot be a phenomenon. Thus, though we should recognize that Aristotelian and modern physics both use terms defined through sensation and both seek to explain sensible appearances, we must not be too syncretic: there is a huge difference between, on the one hand, looking at experience and drawing conclusions from what is found there, and, on the other, looking at experience and inventing "models" to explain it.

Of course, not all theories of modern physics are even imaginable. There is no adequate image of the modern theory of light: we are forced to consider light sometimes as a wave and sometimes as a particle. In many cases, the physicist moves beyond even the imagination to the construction of purely symbolic systems. But here we are faced with the same result. For the symbolic system itself comes to be identified with reality, and there is here even less constraint on theory than is the case when the theory is imaginable. We cannot imagine

Reimannian curved space, but we can deal with it symbolically. We are again forced into a dialectic, now of symbol and sense. The theories so formulated are at an even greater remove from "the immediate connection with reality" which is enjoyed by natural language.[21]

These artistic aspects of physics, then, lend it a kind of conformity to the human mind which makes it seem more intelligible to us, as we noted earlier. Kant admirably sums up the role of mind in modern physics in the following words:

> When Galileo experimented with balls of a definite weight on the inclined plane, when Torricelli caused air to sustain a weight which he had calculated beforehand to be equal to that of a definite column of water, or when Stahl, at a later period, converted metals into lime, and reconverted lime into metal, by the addition and subtraction of certain elements; a light broke upon all natural philosophers. They learned that reason only perceives that which it produces after its own design; that it must not be content to follow as it were, in the leading-strings of nature, but must proceed in advance with principles of judgement according to unvarying laws, and compel nature to reply to its own questions. For accidental observations, made according to no preconceived plan, cannot be united under a necessary law. But it is this that reason seeks for and requires. It is only the principles of reason which can give to concordant phenomena the validity of laws, and it is only when experiment is directed by these rational principles that it can have any real utility. Reason must approach nature with the view, indeed, of receiving information from it, not, however in the character of a pupil, who listens to all that his master chooses to tell him, but in that of a judge, who compels the witnesses to reply to those questions which he himself thinks fit to propose. To this single idea must the revolution be ascribed, by which, after groping in the dark for so many centuries, natural science was at length conducted into the path of certain progress.[22]

But, despite Kant's praise, the modern method also has its downside. As Heraclitus said, "Nature loves to hide." In essence, the modern physicists are writing "a likely story," and we do so because nature is not about to reveal herself in all her nakedness. We are like detectives trying to construct a theory to fit the facts; but the detective has an advantage over the physicist, since he has hope of some more direct experience, such as an eyewitness, by which to judge his theory. The physicist will never know if he is entirely right, though he may find out he is entirely wrong. Modern physics, then, is most often unsure of itself.

All this might lead one to think that modern physics is a fairly fanciful undertaking, a result of creative imagination, not a science of the world at all. But it is more reasonable to say that the theories are probable, based on approximate measurements of reality, for the regularities observed by the scientists are real.

Yet even the claim that modern science is probable must not be hastily passed over, for the probability does not primarily reside in the explanatory theories, as is usually supposed, but in their predictive ability. For example, it is widely known that Einstein's theory of relativity overturned the very foundations of Newtonian mechanics, and that, nevertheless, both give approximately the same results when applied to a determinate field of phenomena, namely, what is traveling slowly relative to the speed of light.[23] The physicist's explanation borrows its likelihood from the likeness of the theoretical results to experiment and observation, not from the likeness of the theory to anything, for, as Einstein and Infeld said, we can never open the watch to see what it is really like inside. Only by distinguishing between the theory and the predicted consequences of the theory could we make sense of the claim that Newtonian mechanics is an approximation of relativity theory, for in their principles the two theories are contradictory.

Modern physics, then, attempts to approach the world of nature through an idealization of artistically construed and measured appearances. Symbolic language is well suited to the task of signifying and communicating what is caught in the physicist's net. The strength of this "language" lies in its ability to unite in one "expression" what are naturally not united, e.g., we can symbolize the result of dividing a distance by a time by "v." This, paradoxically, is also its weakness. If the definitions of the symbolic terms of mathematical physics are themselves conglomerations of naturally unrelated measurements, then they are artistic constructs. Faced with the darkness of the natural world, we introduce a little of our own minds in order to make up the difference between the degree of intelligibility required for us to know something and the degree of intelligibility present in nature. This is the idealization which Einstein and Infeld, among others, refer to. The history of physical speculation seems to show that bridging this gap, on the level of the sorts of particular phenomena with which modern science deals, is not possible otherwise than through symbolic construction and the artificial experience called experiment. The symbol is at once our tool for illuminating the darkness and the sign of the presence of that darkness and of its absolute givenness.

The same thing is true of all modern physics. In trying to produce a universal theory of physical reality in mathematical terms and in terms fitted for practical applications, the scientist is forced to measure. In this, he must specify a measure, which involves specifying the conditions under which his measure is a measure. This is the first entry of art into physics. He then goes on to select and perform his experiments and observations, and to interpret them in the light of his theories or guesses, as Einstein called them. The selection and design of experiments to this end is another entry of art into physics, the creative use of the imagination in formulating the guiding theories yet another. Finally, the theories themselves are applicable only to an idealized situation which the physicist hopes his theories reflect. What belongs to experience alone is the reading on the

voltmeter, the string of bubbles in the cloud chamber, the flash of fire in the test tube. The construction of physical theories around these phenomena is the work of mind.

In contrast, the generality and naturalness enjoyed by the evidences of Aristotelian physics allow us to prescind from symbolic and imaginative constructs and instead use natural speech and common experience. As the obscurity of the ultimate nature of the particular phenomena dealt with by the physicist is simply given and cannot be denied, so too is the certainty that change and time exist, that motion implies difference, that shapes only move because they are in bodies, etc. The evidence for the latter is in fact stronger, since the difficulties of, e.g. quantum physics, are not seen except after long study. But if we know that change and time exist, we must have some understanding of them. How else could we use the words correctly and talk about them, disagree about their natures, or even know that we are ignorant about them? The Aristotelian ambition is to lay bare just what this prescientific understanding consists of and implies; this is not to deny the need for more detailed study nor the existence of those less known and less knowable aspects of nature.

This generality of the concerns of the *Physics* also accounts for their non-utilitarian nature. For it is only a particular that can be acted upon: we cannot cook chicken in general, but only this or that one. Whence, the desire for a utilitarian science dictates that we be more concerned with the details of nature than with its more general aspects. And yet the fact that Aristotle's method does not produce useful knowledge, but only understanding, does not make it any less desirable, at least as knowledge. In fact, the denigration of the pursuit of knowledge for its own sake errs in a fundamental way. For one cannot but use the principles which nature supplies; there is no such thing as a utilitarian science not founded upon materials and laws present in nature before the advent of the scientist. The carpenter needs wood, and even the telecommunications engineer relies on light and the laws of physics. The speculative understanding of nature is prior to, and provides the context for, the useful manipulation of nature. And though the great scientists, men like Newton, Einstein, and Heisenberg, used a method which was originally sought at least in part for utilitarian reasons, their own motives seem to have been much more speculative.

The naturally first knowledge of nature is what Aristotle was aiming at in the *Physics*. The modern approach to nature is partly artistic, though, like all arts, it is rooted in a prior knowledge of nature. The two approaches to nature form a whole, one part, the part which by its nature must come first, being the general study of nature as found in the *Physics*, and the other, the more particular sorts of study represented in Aristotle by the later physical works such as *On the Heavens* and *On the Soul*, and in modern science by mathematical physics, chemistry, and biology. One could go on to discuss the relations between Aristotle's approach to these more particular matters and the modern one, but that would carry us beyond what is appropriate to a discussion of the *Physics*.

Endnotes

1 René Descartes, *Discours de la Méthode*, Introduction, ed. by Étienne Gilson (Paris: Librarie Philosophique J. Vrin, 1947), pp. 1–2.

2 Galileo, "The Assayer," in *Discoveries and Opinions of Galileo*, trans. by Stillman Drake (Garden City, New York: Doubleday, 1957), pp. 237–38.

3 Descartes, *op. cit.*, part II, p. 19. Translation my own.

4 Ibid., Part VI, pp. 61–62. Translation my own; emphasis added.

5 *Metaphysics* VI, 1, 1025b3–1026a32.

6 Henri Poincaré, *La Science et l'hypothèse* (Paris: Flammarion, 1968), pp. 118, 124. Emphasis in the original; translation my own.

7 Sir Arthur Eddington, *The Philosophy of Physical Science* (Ann Arbor: The University of Michigan Press, 1958), p. 71. Emphasis in the original.

8 Cf. Introduction, pp. xii–xiv.

9 Cf. Blaise Pascal, "Traité de la pesanteur de la masse de l'air," in *Oeuvres Complétes de Pascal* (Paris: Éditions Gallimard, 1958), pp. 412–71.

10 Albert Einstein and Leopold Infeld, *The Evolution of Physics* (New York: Simon and Schuster, 1942), p. 33.

11 Isaac Newton, *Mathematical Principles of Natural Philosophy*, Axioms or Laws of Motion, Law I. Trans. by Ronald Richard, unpublished. (Also found in *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, Trans. by Andrew Motte, rev. by Florian Cajori, 2 Vols. (Los Angeles: University of California Press, 1934), Vol. I, p. 13.)

12 Albert Einstein and Leopold Infeld, *op. cit*., pp. 7–9.

13 Einstein and Infeld go too far, it seems to me, when they claim that it is only an arbitrary theoretical construct to say the oiling of the wheels, etc., reduces friction, as well as in saying that "physical concepts are free creations of the human mind" (cf. note 20). It seems more reasonable to say that here we simply recognize cause and effect, and that when we idealize, we are idealizing our experience. There are other cases which seem more like arbitrary constructs, e.g., the notion of "strangeness" in quantum physics.

14 For a discussion of the role of idealization in quantum physics, cf. Louis de Broglie, *Matière et lumière* (Paris: Michel, 1938), pp. 307–15. De Broglie implies that the "complementarity" of quantum theories can be understood as the result of the failure of the mind to grasp the object fully in itself, and the consequent need to look at the object from various points of view, all of which are only idealizations of the phenomena. Perhaps something similar should be said about Newtonian, relativistic, and quantum mechanics.

15 Werner Heisenberg, *Physics and Philosophy* (New York: Harper and Row, 1962), p. 200.

16 Maurice Clavelin, *Philosophie Naturelle de Galilée, Essai sur les origines et la formation de la méchanique* (Paris: Librarie Armand Colin, 1968), pp. 379–80. Translation my own.

17 Cf. Galileo, *Two New Sciences*, trans. Stillman Drake (Madison: The University of Wisconsin Press, 1974), pp. 12–13.

18 Cf. 250a9–19.

19 I am assuming here for the sake of argument that such particles have existence the way a horse does. The fact that they are purely theoretical particles adds another twist to the argument.

20 Einstein and Infeld, op. cit. p. 33. Cf. note 13.

21 Cf. Introduction, notes 9, 10, and 11.

22 Immanuel Kant, *Critique of Pure Reason*, 2nd ed., trans. N.K. Smith (London: Macmillan & Co., Ltd, 1933), p. 20.

23 It is often urged that Newton's views are merely an approximation of Einstein's; and as far as the determination of quantities goes this is true enough. But the entire notions of space and time have been significantly altered in going from the one theory to the other. Newton's argument for universal gravitation depends on his second law, which is symbolically expressed as "F=ma," and so his law of gravitation depends on certain views of the measurement of acceleration, and thus of space and time. Einstein's theory is based on an argument that Newton's idea of these measures is unverifiable and therefore inadmissible in physics. Cf. Albert Einstein, *Relativity: The Special and General Theory* (New York: Crown, 1961), pp. 1–37.

Appendix 2

Matter and the Reality of the Physical World

In the beginning of the eighth chapter of Book I of the *Physics*, Aristotle claims that, "the difficulty of the ancients is solved in this way alone." What is that difficulty, and how has Aristotle solved it, and why is his the only possible solution?

The ancients were stymied by a puzzle posed by Parmenides: nothing can come to be, for if something did so, it would come either from being or from non-being. It cannot come from being, because then it would already have been; it cannot come from non-being, because nothing comes from nothing. Consequently, nothing can change. Given that the physical world is the world of nature and change, Parmenides, if not refuted, will have proven that there is no physical world; the physical world, then, belongs to the realm of mere opinion.

Later natural philosophers seem to have taken Parmenides with deep seriousness: Empedocles and Anaxagoras try to save the phenomenon of change without denying Parmenides' fundamental premise that everything either is or is not (a feat Aristotle also claims to have accomplished; cf. 191b26–27), while Democritus seems to have thrown in the towel on this and granted the being of non-being by positing the void (*Metaphysics*, I, 4, 985b7–8).[1]

In Anaxagoras' case, the solution was to say that everything is really present in everything else, and needs only to become apparent through locomotion. Thus, if I drink soup and, as a result, my hair grows, there must be hair in my soup, and when wood burns what really happens is that the hidden smoke and ash particles become apparent. Since everything can (eventually) turn into everything else, everything must originally be in everything else. Empedocles, on the other hand, said that there are four basic elements, earth, air, fire, and water, and that by the combination and separation of these in different proportions, all other things come to be. Democritus said that the world is made of atoms (being) and void (non-being), and that the various combinations of atoms form the things we see around us.

What these views have in common is that they reduce all change to change of place. Everything else is merely appearance. But Democritus was perhaps the more consistent of the three, since he uses non-being as a principle even of change of place, whereas the other two simply assume that *this* change, at any

rate, will not fall victim to Parmenides' argument. And yet why shouldn't it? Does not what changes according to place itself attain something new through that change? And if so, isn't its being in a new place a being which has arisen from non-being? This will be a problem even for Democritus, for he is granting at least that the atoms come into new combinations, and the essential problem will remain for him as well. One might respond, on his behalf, that the motion of the atoms in the void does not involve any new thing, even a new place, since the being in place of the atoms gives them no new quality. But this is simply to say that even locomotion is unreal, for if there is nothing new about a mobile after a change, it cannot have changed.

This reduction of all change to change of place seems somewhat reasonable for at least two reasons. First, we can easily imagine it. But what we can imagine is no criterion for physical reality or even possibility.[2] Secondly, in change of place there really is only a minimal newness at the end. In fact, we often say that something has not changed when it has only changed place. For example, if you put this book on the shelf, you might say you had not changed it, but only put it away.[3] But this finally cannot hold. If there is a change here, there must be something new in the mobile which changes, in Aristotle's terms, there must be a new species or form at the end of the process, or else there is no change or motion at all. If we try to avoid this consequence by saying that the change is only relative, we would be positing that a relation can change with no other change being presupposed, as if my son could become taller than me though neither he nor I changed height. Because relation is only a "being towards another,"[4] it cannot change without that in virtue of which the things are related or "towards each other" being changed.

The solutions of the three thinkers we have been considering are therefore insufficient. So too is any other which ignores the fundamental problem which Parmenides raises – that being cannot come from non-being or from being, regardless of the sort of being we are speaking of.

Aristotle's solution in the *Physics* is to look first at the exact meaning of the expressions, "from being" and "from non-being." When we say that something comes from being or non-being, we mean (or at least should mean, if we are speaking precisely) that it comes from being or non-being just as such, or *per se*, and not accidentally. But in fact it does not; rather, being comes from non-being as well as from being only accidentally.

To clarify: Parmenides says that being cannot come from being because being already is before the change. But when a cup of water is poured onto the ground what comes to be is not what was present already, shape, but a new shape which the water did not have before. If we think that shape, as shape, is the beginning of the change, we will see no change at all, for at the end we have shape still. Thus, shape is only accidentally that from which the change proceeds, for it is not insofar as it has shape that the water changes, but insofar as it has this or that shape which excludes its having the shape it will have at the

end of the change. So too with being. It is not as being that the mobile undergoes change, but as this or that sort of being, a sort which excludes the being which the mobile comes to have at the end of the change.

When the mobile has a sort of being which excludes its also having the being it will later have, it is deprived of the sort of being which is the term of the change. Thus, to have the shape of the glass excludes having the shape of a puddle. Consequently, in Aristotle's terms, the mobile moves from the privation to the form, and this privation is a sort of non-being and is, in the case of physical change at least, the result of having another form to begin with, a form which excludes others and so deprives the matter of them.

What then, of the other horn of Parmenides' dilemma, that being cannot come from non-being? If taken as a *per se* statement, this is as impossible as that being should come from being. If, however, we understand being as coming to be from non-being only *per accidens*, there is no problem. The privation does not constitute a term of the change all by itself, but only in conjunction with the matter, and while it is clearly necessary that the mobile not start with what comes to be in it, the non-presence of the term to which is only something accidental to the term from which.

Thus, the problem of Parmenides is rooted in a failure to make a fundamental logical distinction, that between the *per se* and the *per accidens*. But Aristotle's solution does not say very much; it says only what is necessary for the solution. It does not, remarkably, say what the change is from *per se.* Perhaps this is sufficient because he is only answering an objection, and so only needs to show that the conclusion of Parmenides is not necessary. But still, there must be such a *per se* principle of change, for the *per accidens* can only exist in virtue of the *per se*.[5]

Aristotle twice hints at what this *per se* principle is, once when he says there is another solution in terms of act and potency, and once when he says that, had the nature in question been seen, the difficulty of Parmenides would have been solved.[6] The nature in question is, of course, matter. This was implied when we saw that both the privation and the being at the beginning of the change are *per accidens* principles only. For what these are accidental to is the matter. Moreover, the being which is at the beginning of the change is not even a principle of change, according to the analysis of chapter seven, for it is only something that happens to the matter, and its true significance is that its presence deprives the matter of the term to which the motion tends. The material, then, would seem to be the *per se* principle.

Thus, of the three principles of change[7], two, the matter and the form, are *per se* principles of change, and one, the privation, is only a *per accidens* principle of change; and of the two *per se* principles, one, the form, is not a term from which the change proceeds, and so does not enter into the argument with Parmenides, while the other, the matter, is not so much a term of the change as what endures throughout the change: it is neither that to which nor that from

which the change proceeds, at least if "from which" implies something which is left behind.

The matter is, then, the *per se* principle of change, and not insofar as it is already some being, for then we are back with Parmenides, saying that being comes from being. And though, at the beginning of the change, the matter is deprived of the form which the change will induce, and, at the end of the change, it is deprived of the form it had at the beginning of the change, matter is not the same thing as deprivation.[8] How, then, can matter be understood? It is neither being nor non-being, it seems, for change is from these only *per accidens* but from matter *per se.* But what else is there? And did not Aristotle boast that he had not done away with the claim that everything either is or is not?[9]

Perhaps the first thing to notice is that some "things" are not themselves things so much as they are principles of things. For example, the pronunciation of a word is not itself vocal sound but rather the form of a vocal sound. The sound stands to the pronunciation as matter to form, and what exists is neither the sound without the pronunciation, nor the pronunciation without the sound, but both together. The matter and the form, the sound and the pronunciation, each exist *only* as principles of the concrete, existing word.[10] So too in all other cases: though the material may be a thing, insofar as it is considered *as* material it is not so much a thing as a principle of a thing. A piece of wood is a thing in the normal sense of the word, but insofar as I consider it as the material out of which a table is made, it is only a principle of a thing.

What sort of principle is it? We have seen that it is what underlies the change and is present both at the beginning and at the end of the change, being subject to the form at the end and to the privation at the beginning, but being in itself neither. We can easily see that the matter is that in which the form and privation exist (though, of course, the privation does not exist as such, but is only the absence of the form which comes to be in the matter due to the change). Thus, we see that the matter is that in which the form comes to be, having not been there before. The matter, then, is that which is *capable* of having form, i.e., the matter is, as such, *in potency* to form, or is *able* to have form.

It is, then, from matter, which, insofar as it is material, is what is in potency, that a thing comes to be *per se.* In a way, this is hardly a startling revelation: all we are saying is that the child grows, the man becomes musical, and the body decays. What is somewhat more difficult to see is that, e.g., the potency of the child to grow is a fundamental principle of change.

The temptation to think that potency is merely latent act or reality is strong, because what is fully real or in act is what we can know; other things, such as potential things, are known only by reference to these things. Anaxagoras, e.g., thinks what is in potency in something is really there all along, but in a hidden manner.[11] This obviously fails to do away with the primacy of potency, for the very manifestation of the latent is a move from potency to act, from being able to be manifest to being actually manifest.

Anaxagoras' view, as we saw, seems to consist in reducing all change to change of place, as if change of place itself does not imply the primacy of potency. But how we could hold this is a little hard to conceive: we can hardly hold that, before it moves, a mobile already has its new place, although in a hidden manner. The very place or position or relation which is the new form attained through locomotion is not present in a hidden manner before the motion. The fact that locomotion produces such a slight newness in the mobile grounds the thought that we can do away with the primacy of potency by reducing all motion to change of place. But again, this is to miss the boat entirely, for, if locomotion is real at all, then there must be something new in the mobile at the end of the motion, and if it is unreal, this is certainly no explanation of motion, but rather a denial of it.

Can the phenomenon of change be explained without suggesting the primacy of potency, or is Aristotle right to claim that he has actually discovered the solitary solution to Parmenides' difficulty? It should be fairly clear by this point that Aristotle's claim is justified. For if change is real, there must be something which changes. That which changes must first be deprived of what it later gets, and later have that same thing. It is therefore able to have it, but doesn't have it always. In Aristotle's terms, it is in potency to that form. This potential, material principle is essential for change, because it is that from which the change proceeds. The non-being, from which change also proceeds, only inheres in the matter and so is an accidental principle of change. The being which the matter had before the change, and which gave rise to the privation of the terminal form, is also a principle from which the change proceeds, but not insofar as it is being; rather it is a principle only insofar as it is a principle of the non-being just spoken of.

Thus, the solution of Aristotle is unique. For, in point of fact, if we do not say that being comes from non-being and from being, but only *per accidens*, we will have to say it comes from both or from one of them *per se.* But either is impossible. Therefore, since it is evident that what comes to be does come to be both from what is and from what is not, and that it cannot come from either *per se*, it must come from them *per accidens*. This is what Aristotle has said is the sole solution. The further fact that being comes from matter *per se* and that this is, as matter, potency, is not argued for by Aristotle, nor does he claim it, but it is, I think, sufficiently shown by the foregoing discussion.

The consequence of all this is that we have before us the only real explanation of change. All others either deny it or simply presuppose it. Any physics, then, which does not, explicitly or at least implicitly, acknowledge the primacy of the potency of matter in the explanation of physical change is bound to go wrong, and to constitute, despite what may be appearances to the contrary, philosophical regression.

Since the physical world is the world of nature which we see around us, and since that world is a world of change,[12] we can conclude that the potency of the

matter is one of the most fundamental explanatory principles of the physical world, and that the denial of this potency of matter will inevitably lead to the denial of the reality of the physical world. We have already seen the way that Parmenides makes his denial, that is, by simply denying that there is any newness in the world; another way to deny the physical world would be to postulate the continual creation of the world, this being understood in such a way that the world as it is now is really a different world from the world as it was a second ago, there being no continuous existence of body or matter from one second to the next: God simply makes a new world from one instant to the next, so that there really is no causality or motion in the world, but only this fully real state, then that one, then that one, and so on forever

In either view, the world as we know it is merely an illusion. The real nature of things is wholly hidden from us, for we have no access to it through our first contact with the world in common experience. That experience is of a world of really changing being, including ourselves. If we reject this experience or its implications, we have nowhere to turn for a more stable beginning of philosophy. In fact, the whole history of modern philosophy can be seen as one failed attempt after another to root philosophy in something besides common experience, largely as a result of an overly simplistic understanding of the nature and achievements of modern science. These attempts finally end in the rejection of reason by Nietzsche and the post-modernists.

Endnotes

1 Again, the reader interested in the background of the *Physics* may want to consult *Metaphysics* I, 3–10, 983a24–988a17 and *The Presocratic Philosophers*, 2nd Ed. G.S. Kirk, J.E. Raven, and M. Schofield (Cambridge University Press, New York; 1983).

2 Cf. 208a14–19.

3 261a20–23.

4 Cf. *Categories*, Ch. 7, 8a31–32.

5 Cf. *Metaphysics* V, 8,1017a7–30.

6 191b27–34.

7 189b30–191b22.

8 192a1–6.

9 191b26–27.

10 Clearly, words like "being," "thing," "one," etc., will be used in a new, analogous sense when said of principles which are not beings in the first and normal sense of the word. Cf. 191a7–13.

11 187b2–7.

12 Cf. 192b20–23.

Appendix 3

Principles of Things, Principles of Sciences: The Division of Books One and Two of the *Physics*

Aristotle says, in the last sentence of Book I of the *Physics*, "Let us speak again beginning from another beginning (or 'principle')."[1] What exactly does he have in mind?

One explanation is that offered by St. Thomas Aquinas:

> In the first part, [Aristotle] determines the principles of the subject of this science, that is, the principles of mobile being as such; in the second, [he determines] the principles of the doctrine, in the second book.[2]

To understand this, we have to see that the principles of a thing and of the science of that thing are not the same. For example, the order of procedure determines the science, but not the thing, and a definition is a principle of knowing but not of being, even if the thing defined is a nature and nature is a principle of the thing. A strong example of the difference is found in the principle about contradiction ("the same thing cannot both be and not be at the same time in the same respect"), for nothing is what it is simply because it cannot be something else.

For the most part, the division made by St. Thomas seems like a reasonable one: Book I clearly deals with the principles of mobile things by analyzing them into matter and form, while Book II addresses the sort of definition to be used in natural science[3], and the sorts causes to be used.[4] Thus, St. Thomas says more particularly that, "this second book is divided into two parts: in the first he determines what the consideration of natural science is about; in the second, what causes it demonstrates from."[5]

But the first chapter seems to pose a problem, beginning as it does with what looks like a division of being: "Of things which are, some are by nature and some through other causes."[6] Such a division of things seems to be preparatory not to a discussion of the principles of a science, but to the principles of things. Moreover, the end of this division is the definition of nature,[7] and nature is a principle of things, not of knowing.

A closer look at some of the issues dealt with in Book II will reinforce the

claim that the book as a whole is about the principles of science. First of all, it is clear that the second chapter is about how the physicist, as opposed to the mathematician, will define his subject. He defines with matter, as, for example, he defines the snub nose as a curved nose, while the mathematician defines without matter, leaving the nose out of it and sticking to its curvature in nasal abstraction.[8] The discussion of the four *per se* causes[9] is followed by a consideration of the accidental causes, chance and luck,[10] and is then followed by a consideration of which of these causes the physicist will use[11] (all four *per se* causes, as it turns out – since there is no scientific consideration of what is merely accidental)"[12] all Aristotle can do with the *per accidens* causes is discuss them in general, i.e., speak of what belong *per se* to these sorts of causes). Finally, the famous discussion of whether nature acts for an end establishes something supposed, that final causes are present in nature,[13] and the last chapter deals with the sort of necessity found in things which act for an end.[14] This last is important for the grounding of a science, since some sort of necessity is required for any science, and also, obviously, because if a thing does have final causes among its principles, the student of that science will have to know how to argue from final causes. Moreover, as Aristotle says,[15] earlier philosophers recognized only the absolute necessity of agent and matter in nature; it is reasonable, then, for Aristotle to show that there is another kind of necessity to be found in the science of nature.

Thus, the impression of Book II is that it deals with the principles of the science of nature, while Book I dealt with the principles of the natural thing, showing that those principles are matter and form. Within Book II, the problematic parts are the first chapter and chapters eight and nine, those dealing respectively with what nature is, with whether nature acts for an end, and with the sort of necessity found in things that are for an end. The last two are easier to deal with, since the very position of chapter eight, coming as it does after a discussion which assumes nature acts for an end and claims that one should therefore argue from the end and before the one which shows how one can argue using the end, indicates that it is subsidiary to the discussion of what sort of causes (or middle terms)[16] the natural philosopher should use.

So we are back to the first chapter, but with added reason to think we should understand it to be looking at nature as a principle of knowledge, and not as a principle of things (though certainly not denying that either).

Perhaps we should first note that, while nature is a principle of things, the definition of nature is a principle of knowing. For the definition is not the thing but is a sort of speech which says what a thing is, and which is used as a middle term in a demonstration.[17] Secondly, the consideration of a definition obviously presupposes the consideration of the thing defined. That there be a consideration of nature at all, whether using a formal definition or not, requires that we look to what nature is and so to how it differs from other things.[18] Finally, by the end of the chapter we have come to see that nature is matter and form. But these are

precisely the principles of things which we came to know through Book I. The only difference here is that these principles of things are *considered* in a new way. But a new sort of consideration does not constitute a new sort of principle of things, though it may constitute a new principle of a science, as the consideration of the circle as the genesis of the triangle is the principle of Euclid's *Elements*, while the consideration of it as the limit of a series of inscribed polygons might be a principle of calculus.[19]

Thus, all of Book II can be fittingly understood as a consideration of the principles of the science of nature as opposed to a consideration of the principle of natural things, which was dealt with in Book I.

Endnotes

1 192b4.

2 *In Octo Libros Physicorum Aristotelis Expositio* (Rome: Marietti, 1965), L. I, l. 2, n. 12. Translation my own. Cf. also L. II, l. 1, n.141.

3 193b22–194b15, esp. 194a13–15 and b10–14.

4 198a14–b9.

5 Ibid. Translation my own.

6 192b8–9.

7 192b20–23.

8 Cf. also, *Metaphysics* VI, 1, 1025b3–1026a32. The importance of understanding the mode of defining is highlighted there: "One must not fail to notice how the what it was to be and the account are, for to inquire without this is to do nothing." (1025b28–30)

9 194b16–195b30.

10 195b31–198a13.

11 198a14–b9.

12 *Posterior Analytics*, I, 6, 74b6–12.

13 198b10–199b33.

14 199b34–200b8.

15 198b10–16.

16 Cf. *Posterior Analytics*, I, 71b29–a7.

17 *Posterior Analytics*, II, 1–2, 89b23–90a34.

18 It is particularly appropriate to concentrate on how it differs from art, as Aristotle does at 192b8–32, because, though nature also differs from things which are a result

of violence or chance, nature is closer to art than is violence. Aristotle often uses the principle that "art imitates nature," a principle which, though it may be understood in several ways, always implies a likeness between art and nature.

19 Euclid, *Elements*, Bk. I, Proposition 1. Euclid also treats the circle as the limit of a series of polygons, but he does so only to establish that circles are to each other as the squares on their diameters. Cf. *Elements*, Bk. XII, Proposition 2.

Appendix 4

Chance and the Indeterminacy of Nature

The French mathematician and physicist, Pierre Laplace (1749–1827), said that, were there a mind so powerful as to know all the laws of physics and the positions and velocities of every particle in the universe, that mind could predict the future, no matter how distant.[1] The implication of this view is that the things in nature act necessarily, for if there is real indetermination in nature, our ability, or perhaps even any mind's ability, to predict the future would be severely limited.

It is sometimes thought that this view is compatible with the general principles of the *Physics*: we might think that the apparently indeterminate events of nature are not really so, but are merely the unforeseen results of the accidental combination of necessary causes. This view seems to do away with chance by reducing it to ignorance.

Is this view the same as Aristotle's, or at least compatible with it? I will argue that it is neither, and that the real existence of chance in nature implies radical contingency, something completely opposed by Laplace but perhaps more congenial to contemporary physicists.

Aristotle considers the Laplacian possibility, or something very like it, almost immediately in his treatment of chance[2], only to reject it.[3] There are those, he says, who think that nothing comes to be by luck because "there is some definite cause for everything which we say comes to be by chance or luck."[4] They are assuming, it seems, that those who do believe in luck think that chance events arise for no reason at all, and so their argument betrays their own view that, because there is some sort of cause for every supposed chance event, there is no such thing as chance or luck. The only recourse for those who still wish to speak of chance would be to say that it is only what we call a cause of which we are ignorant.

But Aristotle does not find the position compelling: "For many things both come to be and are by luck and by chance," as he says, "though no one is ignorant of the fact they can be brought back to some cause of coming to be. . . ."[5] When we say a man is lucky because he met the girl of his dreams, we do not thereby affirm, nor seem to ourselves to affirm, that there was simply no cause of the meeting. We recognize that the happy couple met because one wanted to

buy cigars and the other whiskey, and that they arrived at the store at the same time for such and such a reason, etc. In other words, it is simply not the case that those who believe in chance are thinking of events without causes.

Besides, Aristotle affirms several times that chance really does exist.[6] He never actually calls it into question, but seems to consider the universal belief that chance exists as evidence enough that there must be some grounds for the belief. He comes not to bury chance, but to define it. And having defined it, he says that it is truly unpredictable, something beyond human ken: "And saying that luck is something beside reason is right. For reason is of what is always or of what is for the most part, but luck is in things coming to be beyond these. So that, since causes of this sort are indefinite, luck also is indefinite."[7]

This last point, that chance and luck are finally unfathomable, also indicates that the position of Laplace is not even compatible with Aristotelian physics. For the position of Laplace is that chance events are intelligible in themselves in the same way other things are, but we do not have the understanding of them because the laws and arrangements of particles are hidden from us. There is nothing actually unintelligible in nature. Aristotle's view, on the contrary, is that there is real contingency and real unintelligibility in nature. As we saw in Book I,[8] natural things contain a material element which is responsible for change and which can not be known directly, but only in its relation to form. This material element does not lack intelligibility simply because we are ignorant of something pertaining to it, but because it is, in itself, mere potency, and moreover, potency to contradictories, e.g., to white and black, or to hot and cold. For it is difficult to conceive of what can both be and not be a rabbit or a tree.

That the potency of matter gives rise to the contingency of nature is not, however, perfectly apparent. I will try to display the connection, and then to answer some common objections.

Aristotle argues that all natural things are composed of matter and form,[9] arguing from the phenomenon of change. What changes is now like this, then like that, it is here, then there, and so on. We can easily see that in every change there is a mobile or subject of change, something to which it changes, and that it originally lacked that to which it later changes: in Aristotle's terms, the principles of change are matter, form, and privation. The matter, however, cannot receive any form whatsoever, but only those for which it is disposed. Just as the material of a tree cannot immediately become a house, but must first be cut into planks and beams of appropriate sizes, planed and finished, so it cannot become a man, but must go through some process of preparation. For example, it may rot and turn into soil, which feeds a plant which a man eats so as to transform it into his own flesh. The material principle, then, is in potency to many things, but not in any order at all, but first to this thing and then to that thing. The order is determined by the dispositions which are present in the matter. This is the point of Aristotle's example of the seed becoming an animal or plant; namely, that the

seed is a disposed matter, and only certain sorts of things come from matter which is disposed in a particular way.[10]

Matter is not only what underlies and survives change, it is also, in a way, a principle of activity and passivity. For matter is a principle of the being of the natural thing, and so of the natural agent and of the natural patient. Moreover, because the material of the patient needs to be disposed in a particular way, the matter is also a principle of the change insofar as it is the subject of a preexistent form which disposes it to the new form it will receive.

Matter, then, is a principle of contingency in at least two ways. First, insofar as it is a principle of a contingent agent, it is a principle of a contingent action. For if an agent itself need not be, we can hardly say that its action need be. Secondly, insofar as matter is a principle of a contingent patient, it is a principle of a contingent passivity. In short, if both the agent and patient need not be, neither does the action of the agent on the patient need to be.

Looking more closely at the patient also reveals another aspect of the contingency of the action. A contingent effect is one which need not be, just as a necessary effect is one that cannot not be. A contingent effect can be impeded, then, while a necessary one cannot be impeded. What, then, are the conditions of the non-impeding of the contingent effect; or, more simply, on what conditions does the contingent effect depend?

First, the agent and the patient must be of the right kind. The agent must be the right sort of thing, e.g., it must be sharp if it is going to cut wood, and it must have sufficient power to do the job, and it must be present to the patient. If a saw is in the wrong place or too dull, it will not cut the wood.

The patient too must be of the right sort. This means that it must have the ability to take on the effect. You cannot, e.g., teach geometry to a horse. The patient must also lack what the agent is going to cause in it. If the student already knows geometry, you cannot teach it to him again, though you might strengthen his grasp or give him additional geometrical knowledge. In both these cases, the student is actually receiving an effect he did not have before. Finally, a patient may be under the influence of a contrary agent. The student may already be learning history from someone else, so the opportunity to teach geometry is simply not there. Or he may have studied geometry with a bad teacher and now be poorly disposed to learning geometry properly through having already acquired bad intellectual habits. Thus, the patient must have the right matter and be disposed properly with regard to the new reality which the agent is to cause.

Since, however, matter as such is only potential to form,[11] it is, as matter, indeterminate in its dispositions. And since the ultimate matter, the first matter underlying all substances, is not a thing but only a principle of things, denuded of all forms, it has in itself no determination to this or that form which it is capable of. It has, in other words, no form of itself, which form might give it some determination and so some definite dispositions. The matter of merely accidental changes on the other hand, e.g., wood, is already some sort of thing and has,

because of this, certain dispositions which determine what it can become. But the matter of accidental changes is substance, and the matter of substance is the material which includes no such determinations. Since, then, the matter of substance is wholly indeterminate, and is ultimately the matter of all changes insofar as it is the matter of substantial changes and the matter of the material of accidental changes, the indeterminacy of this matter leads to the radical contingency of all natural events.

This position does not amount to saying, however, that there is such a thing as a simply causeless event, for whenever something in fact happens, there is an agent and a patient present which are properly disposed. What I am urging is that they *need not* be present or, if present, properly disposed.

The position of Laplace seems to be that things can only do what they are in fact going to do, so that there is no real contingency in nature. This position implies that all natural beings are really necessary beings, for they cannot be other than they are. But if they can be impeded (and, if we can choose to catch a thrown rock or not, the rock *can* be impeded), then they are not necessary. We might be inclined to deny this on the ground that all conditions in the natural world are given, so that any one natural thing is already placed within a constellation of causes and is therefore fated to be moved and disposed in determinate ways. But each one of these causes can be impeded, and so the constellation does not produce its results with perfect determination.

For example, if we say that ball A is moving at a certain speed and ball B is on a collision course with it at a certain speed, we might think we can then predict with certainty that ball A will be moved by ball B in a perfectly predictable manner. But if the balls are not necessary beings, and their dispositions (in terms of speed, hardness, etc.) are not necessary, the result does not follow necessarily. What we tend to do is postulate that the possible impediments do not, in fact, arise, so that ball A *is* hit by ball B at a certain time, speed, etc. This is simply to say that if they hit, they hit. At each moment of the approach, we assume that no impediment has arisen, and so, positing all along that there is no impediment, of course we think that no impediment arises. We may certainly imagine away all the impediments by positing an abstract world in which such impediments are absent, but this is not the concrete world in which we live.

It seems that we might defend the determinist's view by saying that, because the balls cannot be impeded given the very concrete circumstances which we find in the world, their actions and passions are necessary. This is to say that things must be a certain way, must be necessary, because they cannot be impeded. It is more reasonable, though, to say that what is necessary is what cannot be otherwise, and therefore cannot be impeded, than to say that what cannot be impeded is what is necessary. For the possibility or impossibility of impediments is a result of the contingency or necessity of the things we are considering, not vice-versa.

Moreover, even if we were to grant that the world is a constellation of caus-

es given at any moment, and that all natural events follow necessarily from that constellation, this would finally be no explanation of things as they occur. For to say that what is happening now is a result of what happened before is just to reduce this inexplicable situation to that inexplicable situation. Why did this ball hit that ball? Because this one was moving in this way and that one in that way. Why were they moving thus? Because this one had been hit in this way and that one in that way. This sort of explanation really would only give us a sort of natural history.

We might also think that the very notion of a cause includes necessity. For a cause is relative to its effect, and so one cannot be without the other. Yet the burden of proof is actually on the one who wishes to say that all causes are necessary. If free will is real, then it is a non-necessary cause. And even in nature, we see that things happen, at least in many cases, only for the most part. If we plant a number of seeds, some sprout and some do not. The *prima facie* evidence is that nature is contingent. Furthermore, if we accept the analysis of elementary particles given by quantum physics, then we have a theory which seems once again to imply contingency in nature. Perhaps the reason we are tempted to think that every cause is a necessary cause is that we think of the causes acting: a cause which is actually causing will certainly have an effect, but that which can be a cause need not be causing all the time. This is why Aristotle says that,

> Actual and potential causes differ this much: the ones in act and particular are and are not at the same time as that of which they are the causes, as this one who is curing with this one who is being cured and this one who is building with this which is being built. But the ones in potency are not always so. For the house builder and the house are not destroyed at the same time.[12]

Put baldly, it is hard to see how we can confuse potency (or "ability") and act; we often seem to do so when confronted by particular cases, though. For example, because a line can be divided at any point, we might be tempted to think that it has been divided at every point, so that a line would be made up of points.

Aristotle's insistence that chance and luck are real and are not reducible to ignorance, then, seems to imply contingency in nature and this contingency seems to be rooted in the potency of matter. Without such potency, there would be no change, and if, *per impossibile*, there were motion, the natural world would be like a complex machine, fully determinate at every moment of its existence.

Endnotes

1 Pierre-Simon Laplace, *Théorie Analytique des probabilités* (Paris, 1812), Intro-duction. Translation my own. Cf. also *Dictionary of Scientific Biography*, ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970), Vol. 15, p. 285.

2 195b36–196a7.

3 196a11–15; 196b15; 197a10–18;198a5–9.

4 196a1–3.

5 196a10–14.

6 For example, 196a11–15 and196b15.

7 197a18–21.

8 191a7–15.

9 190b10–11.

10 At 190a31–b5, Aristotle argues that there must be some underlying matter even in simple coming to be (or "substantial change") because animals and plants come from seeds. If determinate disposed matter is required for a certain change to come about, this can only be because what comes before the change has something in common with what comes after; but this is only possible if there is an underlying matter.

11 Cf. Appendix 2, *Matter and the Reality of the Physical World*.

12 195b16–21.

Appendix 5

The Final Cause in Nature

The notion that nature acts for an end is one of the more controverted claims in the *Physics*. On the surface, at least, this is an odd fact, for no one would deny that a lion chases an antelope in order to catch and eat it if it were not for some philosophical presupposition which militates against common sense. Aristotle seems to be pointing to the obviousness of the claim that nature acts for an end at 199a20–30.

There are, however, several influences which might produce such a prejudice. Some people are keen to deny the presence of final causes in nature because they think that the position assumes the existence of God, which they either reject or at least rightly refuse to use as a premise in philosophy until it has been proven. But, in fact, even the modern biologists constantly invoke the final cause, as a cursory review of their writings in natural history will attest, though they will still deny that nature acts for an end when the question is put to them bluntly.

The predominance of mathematical physics as the paradigmatic science also disposes us to deny finality in nature, for mathematics cannot capture the notion of the good. Geometers never argue from final cause, saying, e.g., that the triangle in the semi-circle is right-angled because that is good for the triangle. The abstract mode of mathematics removes from consideration what belongs to the things considered in their concretion; in particular, it leaves out the nature of the thing studied. The mathematical formulation of the law of gravity, e.g., leaves out of consideration the nature of the material and only considers it as "mass," which is itself defined in terms of certain quantitative measures. Such a method, while not really *denying* the presence of final cause, does *ignore* final causes, and so often leads to the denial of final causes.

Not only is mathematical science itself unable to take account of final causes, but the nearly universal election of mathematical physics as the avatar of science leads even those who work in less mathematical areas to conceive of their subjects mechanically, after the manner of classical physics. Thus, e.g., Darwinian evolution and Freudian psychology represent attempts not to mathematize their fields, but nevertheless to mechanize them, to understand their respective phenomena to be the epiphenomena of more basic processes,

processes which are hidden from view and which take the form of the machine-like interactions of more fundamental beings or forces.

And yet this mechanistic understanding of the world is not utterly opposed to the notion that things act for an end; for if natural things are like machines in the ordering of their parts according to mechanical causality, then could they not also be like machines in being ordered to an end? For what else is a machine but an artifact for attaining some end?

The sort of finality found in a machine is not, however, the sort which Aristotle sees in nature. The machine has an entirely external finality; its good is not its own, but another's. The good of a watch is my good; I can tell the time with it, which does the watch no intrinsic good at all. The good of the watch is *only* that of an instrument for the attainment of some other being's end, and in this case, as in the case of all things properly called machines, that being is a man to whose benefit the machine is ordered. If there is good of this sort, and only of this sort, in the universe, then all the universe must be ordered to something outside the universe in the way a watch is ordered to a man, i.e., as an instrument for more easily attaining some end belonging to what is outside the universe. In short, this view of the finality of nature implies a God who attains his good by working with the universe as an instrument. It is not this sort of finality which Aristotle advocates; rather he holds that each natural thing works for its own good, its own preservation, reproduction, feeding, pleasure, etc. The antelope tries to get away from the lion in order to preserve its life, while the lion tries to catch the antelope in order to stay alive by feeding. The argument in the *Physics* makes no claim that there is any coöperation between natural things nor does it claim that their competition is somehow balanced to achieve a greater good. If Aristotle thinks that there is also a larger, universal good in addition to the disparate goods of natural beings, he does not argue about it here.

The argument which Aristotle presents on behalf of Empedocles and others like him,[1] on the other hand, starts by noting that natural things do not seem to coöperate for some greater good. Thus, the argument which concludes to the position that nature does not act for an end begins precisely by looking at how different natures relate to each other, not at how one nature causes the motions proper to that nature. Noticing that rain does not seem to fall for the sake of the grain (for it could as easily destroy the grain, if it falls on it when already threshed), it asks why the parts of animals and plants should not be explained in the same way, so that the parts do not come together for the sake of the whole, but just happen to come together? It proceeds from the observation of apparent mindlessness in the relations between separate natures to the positing of mindlessness in the formation of organic wholes.

The position opposed to Aristotle's may take at least two forms. We could say that each event comes about by necessity, but the coincidence of individual events, which produces a good or an apparent good, is only by chance. Or we

could say that every individual event is contingent, but that, given enough time, every possible event will necessarily occur. The first view bases nature's necessity on determination, the second on indetermination.[2] In either case, the good which comes about is not a cause of what comes about, but just happens to come about; things do not act for the sake of an end, though good things do happen. The good which comes about may even be thought to be only apparent. If, e.g., we thought that the teeth and hands and the other parts of the body just happened to come together, we would really be saying that the conglomeration of parts is only accidentally united, and thus would likely deny that there is a "thing" there for which the parts could *be* good. This is somewhat like Bertrand Russell's notion that Mr. Smith is a bundle of events, not a thing at all. As Aristotle asks, what is there to prevent this from being the way things are in nature?

Before looking in more detail at Aristotle's arguments, we should note that he does not even try to show that the results of natural acts are goods. He takes it as apparent that it is good for the swallow to build a nest and for the lion to eat food. While these cases seem sufficiently clear, we could add something by noting that we ourselves are natural beings and we experience the good results of natural acts and the bad results of the failure of nature to act as it usually does. For example, good food, when well-digested, keeps us healthy, but if our digestion is not working properly, we become (in fact, already are) sick. To deny that health is a good or sickness an evil seems to be mere contentiousness.

We also experience ourselves as single, unified beings. We are not mere assemblages or "bundles of events." My left and right hands are both mine and are united in me in a more fundamental way than are the parts of a watch or the soldiers in an army. The watch and the army are united in purpose and are organized in such a way as to attain that purpose, and so are the parts of our bodies. But each part of the watch and each soldier in the army is more one than the watch or the army. The sort of unity the parts of the watch or the individual soldiers have is in fact presupposed to the unity of the watch or the army. And though this more fundamental unity may involve tremendous complexity at the microscopic and sub-microscopic levels, our experience of living is not the experience of something which is one by arrangement, but of being a single thing, a "this something" or substance.

Without arguing about whether there are in fact goods produced by natural actions or about whether natural things are one or not, since these are matters of experience and not of argument, Aristotle asks whether we must say that the goods produced by the natural actions of natural things are produced accidentally or *per se*, i.e., whether they are produced insofar as they are goods.

Aristotle first claims that all things are either by chance or for a purpose. We may wonder why this is a dichotomy. What about necessity? Is this not what at least some of those against whom Aristotle is arguing would hold to be fundamental in nature? Perhaps this objection misses a basic point: the question at

hand is whether nature acts for an end, not whether the things which act for that end must produce it or not. If, e.g., we held that a kitten necessarily opens its eyes after a few days, and that this is good for the kitten, we might still say that the necessary causes at work were ordered to that good. Thus, some sort of necessity may not be opposed to finality. In accordance with this, we might say, to answer the original question, that nature either produces goods *per se* or *per accidens*, i.e., it acts *for* the good or it does not, and if it does not, the good which arises comes about only by chance, i.e., accidentally from the causes. If we held the former view, that nature does act for the good, we would be agreeing that nature acts for an end; if the latter, we would be saying that the good was only accidentally related to the causes. Thus, whether nature acts out of necessity or not is not pertinent to our consideration. The dichotomy, then, is real.

Given this dichotomy, Aristotle first argues[3] that the *action* of nature is not by chance, because natural things always or usually act in the same way. Because chance is an accidental cause, it does not do this, as we saw in the discussion of chance.[4] But the action is *from nature*, since natural things act as they are naturally apt to act. This is, in fact, what allows us to recognize natural actions, that they are the actions which this or that sort of thing is apt to perform. A hawk flies in one way, a fly in another. (This is true even in the case of "second nature," or habit, as we recognize that men with the habit of temperance, e.g., are apt to act according to reason, while those who are licentious are apt to act unreasonably.) Thus, it is not by chance that natural things act the way they do.[5]

But the actions of natural things not only produce a determinate end, but an end which is a *good*, whether the nature "intended" it or not. For example, the natural development of the kitten leads to its being able to see, which is good for it, whatever we say about whether the development is for the sake of seeing. Natural things are therefore naturally apt to act in such as way as to produce a determinate, good term. That the ends produced are goods is, as we saw earlier, very manifest by induction; the growth of our limbs, for example, is a good thing for us, and there is no one who would willingly have his limbs amputated as being of no particular use.

Next, Aristotle argues from an analogy to art to make the point that the last thing produced by natural action is not a good simply by accident, but is produced by natural action *because it is a good*. "The posterior is to the prior in a similar way in what is according to art and in what is according to nature."[6] We know that the ordered series of steps in art leads to a good, and we also know that the very reason the steps are ordered in the way they are is *because* of the goodness of the last thing produced. Thus, in art, the process does not produce the end accidentally, but *per se*, i.e., the process produces the good as good and not merely as some last thing which may or may not happen to be good. But the processes of nature, like those of art, consist of an ordered series of steps leading to a good. Since the processes are of the same sort, they must have the same

sort of principles, and since that principle in one case is the good as such, so must it be in the other. Therefore, nature acts for a good as such, or "for the sake of something."

Thus, natural things act in the same way always or for the most part, and therefore not by chance, but *per se*. But they produce determinate ends, which at least happen to be goods, when they so act, and this is because they are natural and so apt to act in a certain way. But the determinate ends do not simply happen to be goods, because the good is what explains this sort of ordered series of steps, as the analogy to art shows. Therefore, nature acts for the sake of a good.

Aristotle also notes that things like spiders and ants and such things act so evidently for ends that some people even wonder whether they are intelligent or not. An unbiased inquiry into natural history, one not prejudiced from the beginning by mechanistic assumptions, will confirm the claim that it is obvious that nature acts for an end, at least in animals and plants.[7]

Finally, Aristotle argues that matter is ordered to form, and so, since matter and form are both nature, nature is both an end and is ordered to an end.[8] That matter is ordered to form is clear from what we saw in Book I, namely, that matter is as such just an *ability for* form. If, as in natural changes, the form is a good for the thing which gets it (as I said, this is evident from induction), this will be a perfection of the thing, a perfection to which it is ordered as to an end.

Nature, then, is a principle of motion, and not of just any motions but of determinate ones. For example, the nature of a caterpillar leads it to eat certain sorts of plants, to build its cocoon in a certain way, and to transform itself into a particular sort of butterfly. When Aristotle said that nature is a principle of motion, he clearly intended to speak of such determinate motions: "each of these [natural things] has in itself a principle of motion and standing, some according to place, some according to growth and diminution, and some according to alteration."[9] As we saw above, this is how we recognize that something is natural to a given sort of thing: it always or usually acts this or that way, it is "apt to act" in a certain way. If dogs sometimes barked but usually meowed, we would think meowing was natural and barking an aberration. And since these determinate motions are not accidentally related to the nature nor are the ends achieved accidentally related to the motions, as we saw, the denial of final causality in nature would finally destroy the very notion of nature. For if the ends are only accidentally related to the processes leading towards them, or the natures only accidentally related to the processes to which they give rise, then the natures would not produce determinate terms of motion. This would be contrary to the very idea of nature.

In light of all this, we can see why Aristotle thinks nature acts for an end and why he goes so far as to say that it is "impossible" (not "unlikely" or "unreasonable") that nature not act for an end,[10] and, of those who deny this, that, "the one who speaks thus wholly does away both with the things which are by nature and with nature."[11]

Endnotes

1 198b16–32.

2 Aristotle's view is that necessity in nature is dependent on determination, but not perfect determination. He also will argue that there is a sort of necessity in nature arising from final causes, which he will call hypothetical necessity (199b34–200b8).

3 198b34–199a8.

4 196a33–197a1.

5 The scholastic dictum, "natura determinatur ad unum" ("nature is determined to one"), seems to be indicating the same thing. We could argue for the claim by noting that nature is a principle of motion and rest, so that what is more natural is more a principle. But if it is more a principle, there is less need of other principles: when other principles are necessary, they are necessary to determine a motion. For example, sensation and choice determine the locomotions of animals and men. So when such further principles are not needed, the principle is already determined to one. But such a determinate principle is more natural. Thus, insofar as a thing is natural, it is determined to one.

6 199a18–20.

7 199a20–30.

8 199a30–32.

9 192b13–15.

10 198b34.

11 199b14–26.

Appendix 6

The Definition of Motion

The definition of motion given by Aristotle, "the actuality of what exists in potency, as such, is motion,"[1] is admittedly difficult to understand. Descartes, in a famous passage, says about it "who understands these words?" and dismisses the definition as an example of trying to make more manifest what is already manifest.[2] But while it is clear that motion exists, it is hardly clear what it is, and it is particularly difficult to see how we could ever define it. Aristotle himself says, after discussing what motion is, that it is "difficult to know."[3]

It is remarkable, for instance, that Descartes takes a stab at a definition, but his is clearly circular: "the transference of a part of matter, or of a body, from the vicinity of those which touch it immediately to the vicinity of some others."[4] "Transference," however, is sort of motion and so cannot be used in the definition of motion. Descartes might defend himself by saying that he is merely trying to describe motion in more precise terms. If so, he has failed, for "transference" is no more clear than "motion." Besides, he has, no doubt quite wittingly,[5] limited all motion to locomotion. But it surely cannot simply be accepted as obvious that every motion is locomotion. For example, the magnetization of a piece of iron may be explicable as some sort of locomotion, but it certainly does not look like one; to insist without argument that this is just a hidden case of locomotion is mere dogmatism.

Aristotle makes no such assumption. He deliberately begins his discussion with two distinctions which embrace both locomotion and any other sort of motion there might be.[6] The distinctions correspond to two of the divisions made in the *Metaphysics*[7]: that between act and potency, and that between the categories or predicates of being.

In the first division, "potency" has to be taken in a certain way. I might say that it is obvious that I am able to stand because I am standing, but this sort of potency is compatible with the very act in terms of which it is defined and so is not a member of a division according to which we can divide the genera – a division must yield parts which are opposed to one another, and therefore incompatible. "Potency" here, then, must be taken "with privation."

After making these two divisions, he mentions some bases for relation: quantity, and action and passion, are foundations of relations.[8] For example, double and half are founded on quantity, and mover and moved are founded on

action and passion. This last division does not come into play until later, when Aristotle discusses the relation between the mover and the moved.[9]

Next, he makes a crucial claim: motion is not "beyond the things."[10] I take him to mean that there is (a) no eleventh category called motion, (b) there is no super-category called motion. Finally before giving the definition, he points out that in each category there is a perfect and an imperfect.[11]

These distinctions lead us to see that we must define motion by something which is found within every genus but which does not belong to any one genus exclusively, e.g., being, unity, etc. Our experience of motion is in terms of its ends (to which and from which) and of those possible divisions within it which would serve as terms if the body rested instead of continuing on, i.e., in terms of the ends of parts of the motion (even if these ends are not fully real).[12] One of these ends, that to which, is seen as some kind of being, the other as not-that-being, i.e., as a kind of non-being, and what is between, the motion, is what is called "becoming." Because becoming is defined in terms of being, we should define motion in terms of its ends. But the division between being and non-being is not the right one to make in trying to define motion, since non-being does not imply any intrinsic order to motion or to being; in fact, it may simply be contrary to being in every way, for some non-beings are in fact impossible, like "square-circle." The name "non-being" is therefore too general to be used to name the term from which of motion, because certain non-beings are not what belong to a subject before motion. But if we are going to refine our notion of the term from which, we shall have to do so for the term to which as well, since the beginning and end of motions must be opposites,[13] and, if properly named, will be named as opposites of some sort.

The names at our disposal are few, but rather than take inventory and argue by elimination, perhaps we could begin by noticing that our first notion must be the notion of being, since this is implicit in every notion, even that of non-being.[14] But when we oppose being to non-being we see that there is a distinction among non-beings: some are impossible, and some can be but are not, e.g., a hundred years ago I did not exist but was able to be. To contrast being with what is not but can be, I use the word "actual" and say that what is being in this sense is in act or is *really* existent. Thus, if we say we are able to be learn mathematics, or are in potency to learning mathematics, we are saying that our state is opposed to one in which we "actually" know mathematics, or have mathematics "in act" or "in actuality." I have not added to the first notion of being anything other than its opposition to what is able to be but is not, the "potential." (The "but is not" specifies that the potency is to be taken in its primitive meaning, which includes privation of that act for which the potency is a potency.)

Thus, I can now speak of the terms of motion as "act" and "potency," merely having clarified which non-being I mean to oppose to the being which is at the end of motion. But motion is clearly what is between these two extremes, and thus is what is between potency and act. (There are two things between the

terms: the motion and the rest in an intermediate state; but more on this later.) This "between" is obviously not a spatial "between," since the mobile is itself that in which both the potency and act are to be found; besides, the motion need not be locomotion (or at least we do not want to assume this), though that is the first sort to which we might apply the words "term," "beginning," "between," "start," etc.[15] The mobile in motion is between potency and act in the sense that it has something of the end of the motion in it, but not all, and so is still in potency to that term, but has some act as well.

Because when the mobile is in motion it has something of the final form in it, it is no longer merely in potency; thus, relative to potency with privation, the thing moving is in act. Motion is therefore an act. But it is not only act, or simply fulfilled act, or "perfect" act, but is the act of what can have still more of that in virtue of which it is said to have a certain potency, i.e., it is the act of the potential, taken with privation. For a potency is always understood relative to an act, whether the potency (or "power") be active or passive, and the potency in question here is the potency for a certain act but with the privation of that act. Still, it has an order to that act, as my ability to stand when I am not standing is defined by, and is a reality of a sort in relation to, my act of standing. So when water is warming up, it is in act, and the motion is an act; but motion is not act in the first simple sense of the word, i.e., as it is opposed simply to potency with privation, but involves, in its very whatness, the notion that it is *some* kind of act. Nor is it simply potency, for it also involves in its notion that it is an act with ordering to a further act, and this notion of further ordering is absent from the notion of act as contrasted simply with potency understood with privation.[16]

This is not true of the rest in the intermediate state, for that rest may just as well be followed by a return to the beginning. The tepid is not ordered to the hot any more than to the cold; it is indifferent with regard to them. Consider a locomotion like my walking out a door. The places I leave and attain are equidistant from the center of the earth, so that, in virtue of the elements of which I am composed, I am no more inclined to one room than to the other, so the understanding of this motion, and the application of the definition to this case, can have nothing to do with a consideration of the more "natural" place. If I should stop in the doorway, in the intermediate state, I am no more ordered to the next room than to this. If, on the other hand, I keep moving, and just insofar as I am moving, I do have such an order.

Here it is important to underline that Aristotle is not concerned with any particular nature, which may in fact be ordered to the hot and not to the cold, or to this size or that, nor with which of these passions might be more "real" and "positive." There is no indication that he takes his definition to apply more to generation than to destruction; in fact, just the opposite. And while hot may be more perfect and real than cold, cold is real, not merely privative, and is an act relative to which a hot thing is said to be in potency. In fact, the positive nature of the two terms of motion is the criterion by which Aristotle distinguishes

motion from generation and corruption.[17] Moreover, a particular kind of thing may have a natural tendency to the cold rather than to the hot, e.g., in Aristotle's opinion, water. A general definition of motion, which is what Aristotle is concerned with here in his general discussion of nature, should not exclude those motions which are detrimental to the mobile, or which, though natural to the mobile, are to what is intrinsically less perfect. The definition does not, then, include any notion that the motion is ordered to what either is best for the mobile or best in itself.

In terms of the words in the definition, we might say that the tepid is not the act of the potency with privation, because the potency with privation must be the potency which implies lack of what it is a potency for, while tepidity is not the act of what lacks tepidity, nor is it the act called hot. Tepidity equally lacks both hot and cold. To put the claim positively: in the case of a thing being heated, the potency is for a certain act, being hot, the act of the potency with privation is the motion, and being hot is the act of the potency without privation, or what Aristotle here calls being "in act only."[18]

Again, whenever we speak of a potency, we must specify the act relative to which it is. This act, hot, can be had perfectly or imperfectly, and imperfectly in two ways. It is had perfectly when the mobile is hot, it is had imperfectly when it is tepid or when it is moving through tepid toward hot. When it is simply tepid, the potency to be hot is not the potency of which the act is the act (since that would be the potency to be tepid, for the potency is defined in terms of its act), but when it is moving, the potency (again, with privation) to be hot, not tepid, is the potency of which the act is the act.

The "act" in the definition, then, is determined by a reference to its subject ("of the potential") as is also the definition of the soul.[19] That subject is the potency with privation, and this is what makes the definition refer not to the intermediate rest but to the intermediate motion. And the ordering of potency to act is the ordering not of a nature to its end, or of the imperfect, taken in any way, to the perfect, but precisely of potency (with privation) to act, as one would expect from context.

I think this is the point of the expression, "as such," as it is used in the definition of motion.[20] Here Aristotle says the motion is not the act of the subject of the motion as having a certain act, but of it just as deprived of a certain act. This excludes four things, though Aristotle only takes up the easiest case, that of the subject. The term from which has already been excluded, in a way, by saying motion is an act. But even before the motion, the subject is something, at least in motion taken strictly (i.e., as opposed to generation and corruption of substances, where the material principle is only a potency). Motion is not that subject. Nor is it the act present at the end of the motion, for this is not the act of the potential as such, i.e., as opposed to and excluding act, in other words, as taken with privation. Nor is it the act which is an intermediate rest, since the potency relative to which the intermediate rest (e.g., in tepidity) is an act is not

the potency to the term (hot), but rather the potency to the intermediate itself. Thus it is not the subject, not the term from which, not the term to which, not the intermediate rest, but the act of the potential as such. Here, then, "as such" means "*per se*" or not according to some act which goes along with the potency, like the act of being bronze, even if that other act is in some way necessary for the motion to exist.

If Aristotle had all these alternatives in mind, why does he only mention the subject (bronze, in his example)? Perhaps because the privation which is understood to be of the notion of potency taken strictly was confused by Plato with the subject.[21] This fits with the cave metaphor found in Plato's *Republic*: the wall of the cave on which images of the ideas are cast is a two-dimensional space[22]; the nurse of becoming in the *Timaeus* is three-dimensional space.[23] Moreover, this explains Aristotle's apparently ungracious insistence that to speak of participation as Plato does is "empty speech."[24] If everything positive which we can say about the things around us is only said in virtue of the forms, then there is nothing at all real in the things around us. The only "thing" left to receive the forms is non-being (if it were a being of any sort it would have a positive nature itself and so be whatever it is by yet another participation in yet another form), but what receives may be called "subject" or "matter." Thus, for Plato, it makes sense that matter is non-being or privation, while for Aristotle, deprivation is not what matter is, it is only something which always accompanies matter, because matter is able to be one thing and then another and cannot be all things at once. Possibly, then, Aristotle concentrates on the exclusion of the subject by the phrase "as such" because he is thinking of the error of Plato with regard to the subject.

It is not easy to understand the words of Aristotle's definition of motion, but we should not go as far as Descartes does in claiming that the words are unintelligible. Rather, at this point, we should more readily understand what Aristotle means when he says that motion "is a certain act, but the sort of act we said, difficult to know, but able to be."[25]

Endnotes

1 201a10–11.

2 Descartes, *Regulae ad Directionem Ingenii*, Rule 12, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1966), vol. X, p. 426.

3 201b33; 202a1.

4 *Principes*, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1971), vol. IX-2, p. 76; translation my own. For the Latin ver-

sion, cf. *Principia Philosophiae*, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1964), vol. VIII-1, p. 53.

5 Descartes, *Le Monde*, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1967), vol. XI, pp. 38–40.

6 200b26–28.

7 *Metaphysics* V, 7, 1017a22–30; 1017a35–b9.

8 200b27–32; cf. *Metaphysics* V, 15, 1020b26–30.

9 202a3–b22.

10 200b32–33.

11 201a3–9. There are at least two errors to which this text is apt to give rise. Aristotle speaks about species within a genus, which species are to each other as perfect to imperfect. Thus, since motion is not a species in any genus (for it is found in many genera), this last "division" of things is not a division of things within which motion might be found, but perhaps of things between which motion might be found.

We have also to avoid an error with regard to how we should understand the claim that "there are as many species of motion as of being." Taken at face value, two difficulties arise: (a) it is rejected by Aristotle at 225b5–9; (b) it cannot follow from what was said before, yet Aristotle introduces the claim with the word "whence" (201a3–9). It seems best, then, to read the text as saying that there are as many species of motion as relevant species of being, i.e., divisions of motions are always based on divisions of being, not that every division of being gives rise to a division of motion.

12 Cf. 263a4–b9.

13 188a27–b26.

14 I do not, of course, mean to imply that our first notion of being is a very profound one, and I would specially insist that we do not at first understand the multitude of related meanings which the word has or have a notion applicable to non-material things.

15 This is because locomotion is most closely associated with quantity and all our phantasms, from which we gather the universals, are quantitative. (Cf. *On Memory and Reminiscence,* Ch 1, 449b30–450a7.) Even growth is in a way less apt to be treated quantitatively, for more than one reason, but especially because it more clearly involves the reduction of a potency to act in one body: the correspondent reduction in locomotion is not too difficult to ignore because "where," the genus in which locomotion occurs (226a23–25), is so difficult to recognize as a distinct sort of being; whence Newton's "state of motion." Cf. Appendix 10, *A Note on Inertia."*

16 201b33–35.

17 224b35–225a20.

18 200b26.

19 Cf. *On the Soul* II, 1, 412b4–6.

20 Cf. especially 201a29–b5.

21 Cf. 192a3–4; 215a9–11; 209b6–17.

22 *Republic* VII, 514a–516c.

23 *Timaeus*, 48e–51c.

24 *Metaphysics* I, 9, 992a28.

25 202a1–3.

Appendix 7

Place

Aristotle's *Physics* came under intense attack during the "scientific revolution" of the sixteenth and seventeenth centuries. More particularly, his definitions of motion, of the infinite, of place, and of time were systematically rejected, sometimes with no more argument than a frown provides. Descartes, e.g., merely claims that the words of the definition of motion are unintelligible and leaves the issue there.[1] There may be many reasons for this rejection, but certainly among them is the mathematization of physics. It is this which explains how we might come to imagine that it is obvious, for example, that place is a separate space, and so that place can obviously be void or empty of body. We easily take away in our imaginations sensible qualities such as heat and color, and imagine bare dimensions without color or any other quality. And we can do this while looking at a moving body, so that we imagine there to remain, in the place where there was a body, a space separate from every body. Newton's "absolute space," e.g., would seem to be partly a consequence of this sort of imagination. He describes this space as "absolute, true, and mathematical,"[2] a revealing combination of adjectives.

But is this sort of imagination any criterion for physics at all? Certainly not: the proper criterion of truth in physics is sensation. If we see with our eyes that, in a certain experiment, the needle on a voltmeter goes to such and such a place, we draw one conclusion about the natural world; if not, we draw another. It is sensation which sits in judgment even here. Moreover, many of the theoretical entities of post-Newtonian physics, things such as warped space and probability waves, are not imaginable anyway, but are purely symbolic constructs.[3]

Aristotle's discussion of place deliberately and consistently takes its beginning from sensation. He notes, and this is the most fundamental thing he says about place, the beginning of every other consideration, that place is known through motion.[4] We recognize that a thing is in place, and is not a part in a whole, because we see that the thing is separated by motion from its surroundings.

He notes first that place is known through motion, but things are moved either *per se* or *per accidens*. Only the things which move *per se* are in place *per se*, so we should look more closely at these. The *per se* mobiles are bodies, things with dimensions. The things which belong to bodies, even their parts,

though they have dimensions, are not moved *per se* but only *per accidens*. (In fact, if any parts were moved *per se*, we would be forced to say that every possible part is moved *per se* and is in place *per se,* so that every change of place would really be an infinite number of separate motions and infinite places would be together.) But things with dimensions are in many places, some of which are common, as a man is in a city, and some proper, as coffee is in a cup. Common places depend on proper places, for nothing can be in a common place without being in some proper place, and common places are not equal to the bodies they contain, while proper places are. Aristotle's principal interest is in that place which coincides with the body in some way.

At this point, we can begin to guess at the genus of place. It may be the very dimensions of the body (which can be thought of as its matter),[5] or the shape of the body (which in a way contains the body), or the dimensions which we may imagine underlie the body. There is also a fourth possibility: the inner surface of the containing body. Aristotle points out that the parts of a body are only in place *per se* after the body has been actually divided.[6] If the parts of the body are not actually divided from each other, the parts are not in a place *per se,* but are in a whole; when the parts are divided, then the outer parts form a place for the inner parts. (Again, if we do not say this, every locomotion will be a multitude of motions.) Thus, the division of the parts makes the inner parts to be in a place. But place must be equal to the placed, so that the inner surface of the outer parts seems to be the place of the inner parts. Thus, Aristotle shows that the genus of place is one of four things.

We see that of the four alternatives, two are formal, the shape and the limit of the surrounding body, and that these coincide with each other (for there is no dimension between the outer limit of the surrounded body, its shape, and the inner limit of the surrounding body), and that the other two are material, and also coincide with each other: the dimensions of the body in place and the separate dimensions of the space which is thought to be occupied by the body. The former two are equal to the placed by containing it, while the latter two are equal to it in volume.

Aristotle rejects the views that place is matter or form on the grounds that these are not separable from the placed through locomotion, while place is, and also rejects the view that place is a separate space on the grounds that it would make the parts, and the surfaces and other limits of body, be in place and be moved in just the same way as the whole, while the fact is that these are moved only *per accidens*. Given the prevalence of the view that place is space, it might be good to look at Aristotle's objections, and some others, a little more closely.

The two objections raised by Aristotle in the discussion of place[7] seem to be directed, at least primarily, at a primitive view in which the dimensions of space are somehow tied to the body which contains the placed, as if, e.g., there were dimensions within a cup, separate from those of the air or the water, but

somehow tied to the cup so as to be moved whenever the cup is moved. Thus, the first argument says that if the water in the jar be shifted, infinite places will be together because each part will be in the water the way the water is in the jar, so that we will really have a nesting set of places; the second says that the place itself will be moved in place. (Aristotle goes on to point out that when a whole jar is shifted, the parts of the water in it do not come to be in a new place except insofar as the jar is always their place, and is itself a place by being a part of the place which is the place of the whole heaven.)[8]

We might read the first argument especially as being of more universal import, however. If a body is in place by coinciding with a separate space, how will there be a place equal to the placed if the dimensions of the space are not coterminous with those of the body? If they are, there must be divisions in the space, and these must not depend on the body, since the space is assumed to be separate and impassible. Since the terms of the body might be anywhere, all possible divisions in space must already be actualized, so that there will be an infinite number of places nesting one within the other. This argument does not assume that the dimensions of space are attached to any body. Perhaps we could answer this argument by noting that a division in a magnitude may be either intrinsic, as the end of a table is in the table, or due to something extrinsic, like the divisions made in the surface of a table by the edges of a book which lies upon it. In the latter case, space would not have to contain actually every possible division of itself, for bodies in space could, by their presence, divide the space extrinsically, resulting in a place equal to the placed.

Other arguments in the *Physics*, though, especially some of those in the treatment of void, are clearly aimed at an underlying space which is completely separate from body. In trying to show the difficulty of knowing what place is, Aristotle asks what its genus might be, and seems to suggest that it will be "three-dimensional thing."[9] But a body is also a three-dimensional thing. How, then, would place and body differ? We could not say that body is hard, because the opposite of hard is soft, but space is not soft. Moreover, the definition of "soft" seems to be something like "easily divisible," but space is not "easily divisible." We would probably have meant, rather, that body is impenetrable. But this will give rise to a circular definition. For we would have to ask, "impenetrable to what?" Body would not be impenetrable to space, since space would penetrate body. Nor could we say that body is impenetrable to body, because then body would be in the definition of body.

Could we, on the other hand, say that the dimensions of space are immaterial while those of bodies are material? This seems more plausible, but that, while dimensions contain within their notion a multitude of parts, they can do so only because they also are material. In fact, two things of the same sort do not differ in what they are, but only in which one they are. There must be, then, a principle in them which is not on the side of form, but still enters into them not

as a mere accident or attribute (since these are differentiated by their subjects), i.e., there must be a substantial principle which is material. Consequently, the notion of immaterial dimensions is self-contradictory.

Again, how would the dimensions which are supposed to coincide with the body in space differ from those of the body?[10] For dimensions do not differ except in position. For example, if I imagine a line, one part of it differs from the other part by being elsewhere. Thus, quantity has sometimes been defined as what has part outside of part, the outside indicating the way the parts are different, not by being a different sort of thing, but by being a different one of the same kind of thing. If this is right, then the question arises: when a body coincides with the supposed separate dimensions of the void, how do those dimensions differ? They certainly do not differ by being, in the one case, hot or cold or heavy or light, but in the other not, for these differences depend upon the dimensions and are not presupposed to them. Nor do they differ by being in different subjects, as the dimensions of wood differ from those of the surrounding air. For the difference of subject seems in some way to presuppose the difference in dimensions, as the parts of wood themselves differ by one being here and another there, which implicates already the difference implied by dimensions. Dimensions seem to differ *per se*, by being external to each other. Thus, the dimensions of a wooden cube and those of the separated space would be the same.

Another argument may also be offered, and is at least hinted at by Aristotle. First, one of the most basic facts about place is that things are in it. But bodies would not be in the separated space so much as they would coincide with it. In fact, because coincidence is mutual, the space would be just as much in the body, and in it in the same sense, as the body is in space.

The view that place is space does have two clear attractions: space would be equal to the placed and immobile in obvious ways. We expect things to be like the things we first know, and the equality of space and body and the immobility of space are of the very sorts we find in bodies. The equality of place and the placed is not too hard to deal with. In fact, when we say that place is equal to the placed, we really mean that the place contains the body, the whole body, and nothing but the body. If place, understood as space, could explain the containment of body by place (which, as we have seen, it cannot), it would do so in a straightforward manner. But Aristotle's view, that place is the inner surface of the surrounding body, does explain containment, and explains the equality of the place and the placed in a way even more consistent with what we intend when we speak of this equality.

The immobility of place, though, is harder to explain in Aristotle's view. How, if place is the innermost surface of the containing body, and the surface of a body goes wherever the body goes, can place be immobile? And how, if the outer sphere is not contained by any body, can it be moved according to place? Aristotle says, "When what is within moves and changes in a moving thing, as

a ship in a river, it uses the container more as a jar than as a place. One intends place, however, to be immobile. Whence, the whole river is more the place, because the whole is immobile."[11] There are two questions which arise from this text: first, how is the river immobile, given that it is always flowing; and second, is not the river only a common place for the boat? How is Aristotle's text of any help, if the place must equal the placed?

It is important to note that Aristotle does not say that the banks of the river are the place, but the river. The significance of this is that the river consists of flowing water, and so Aristotle seems to have deliberately chosen an example where the motion of the container is a given. What, then, is a river? It is a body of water which has a determinate path, say from the Great Lakes to the Gulf of St. Lawrence. Though the water always flows out, the river maintains its identity because of its shape and location relative to the whole earth or heaven. In this, it is like a fire, which is one fire though old fuel is consumed and new fuel added, or like a state, which maintains its identity so long as the constitution remains, even though the citizens die and are born over the centuries. We could summarize this by saying that the unity is from the form or order, while the diversity is from the material. Thus, the river is defined not only by the water, which is its matter, but also by its form, which is the order of its parts and the order of the whole to the greater whole which is the earth.[12] That order is an order of position. Because position follows immediately upon dimensions, and place is an accident of a body, i.e., a dimensional thing, the surface of a body can be in a position. So the common place, which is the river, can be immobile formally, or in position. But even the surface of water which is in immediate contact with the ship can have a determinate and immobile position relative to the whole river, despite the fact that the water continues to flow past it. The motion of the water, the surface of which is the immediate place of the ship, is no more destructive of the immobility of that surface, considered as having a determinate, immobile position relative to the whole river, than the motion of the water is destructive of the immobility of the river as a whole.[13]

What of the rotation of the outer sphere? If there is nothing outside something, it cannot be in place or, it seems, moved in place.[14] The idea of rotation, however, does not necessarily imply something outside, but only that the rotating body be going around an axis. While the bodies which we see rotate are contained by others, this is accidental to rotation as such, even if we would not be able to judge that a body is rotating without an external body to judge it by. Thus, the parts of the sphere contain each other, and come to have different positions relative to the axis, which itself is utterly immobile, since the axis of a rotating body cannot itself rotate, and the world as a whole is not going anywhere because there is no place outside to go to. Thus, the distinction we made in looking at the immobility of the river and the surfaces in the water of the river serves here to understand also how the outer sphere could have been thought to rotate.

The immobility of place, then, is a result of the relations of position

between the outer sphere and the surface which contains a body, or between the axis of rotation of the cosmos and the parts of the outer sphere which contain one another. Thus, the immobility of place is primarily the result of the formal element of position relative to the outer sphere.

With the theory of relativity, it seems that relative position becomes even more central to the notion of place. Is it possible that place is *merely* the positional relation between bodies, as Descartes and Einstein thought?[15] There seem to be some telling objections to such a view. First, a relation does not change unless one or both of the things related change in some other way.[16] For example, if one man is twice as heavy as another, the ratio of their weights will not change unless at least one of them changes his weight. If place were *nothing* but a relation, it does not seem things could change place. Secondly, the experience of force seems to militate against the view. If I push a book across a table, I have certainly done something to the book, not to the universe as a whole. And yet the book has changed its position relative to the entire universe. If, then, place is purely relative, it is as true to say that I have moved the universe as to say that I have moved the book. But the one takes significantly more strength than the other. This fundamental experience of action and power is not, it seems to me, something dubious or theoretical; it is a given which I cannot reasonably ignore, except in the context of a purely mathematical model of the universe. Such models are perfectly legitimate if we bear in mind that that is what they are, and use them as such, but they do not give us any grounds to deny or to doubt experiences which we know better than we know any such theories.

There are two other problems which we might want to look at in relation to Aristotle's definition of place. Can we understand the expansion of the universe on his principles?[17] And does his belief in the existence of natural places have to be discarded in the light of the advances of modern science?

The first question is made more difficult by the nature of the space which is expanding. In the contemporary view, space is not what it used to be. It is not a Newtonian absolute, immutable space, perfectly mirrored by (in fact, a reification of) the imaginary mathematical space familiar from studying geometry. Rather, the expansion of the universe is said to be an expansion of space (or space-time) itself, not merely of the distances between galaxies or other celestial objects. Given such expansion, it is hard to see how we can avoid saying it is some sort of physical body, for, like Aristotle's unmusical man becoming a musical man, it is one subject which changes from being deprived of a form to having it, and so is composed of matter and form, as is shown in the first book of the *Physics*.[18] (The supposition that space can be "warped" by a gravitational field would seem to imply the same thing.)

That the universe is expanding might make us think there must be something into which it is expanding, some empty space outside of it, but this is neither necessary nor part of the theory as currently promulgated. For expansion is

defined not in terms of attaining a larger place which is outside the body expanding, though in our experience all expansions are of this sort, but rather in terms of the internal dimensions of the expanding body. So the expansion of the universe does not force us to say that there is a space outside of the universe into which it is expanding.

It seems more difficult to explain the immobility of place, though, if the universe is expanding. Certainly, if we accepted the Newtonian idea of absolute space, and held that the expansion was merely the moving of bodies away from each other in this immobile space, the explanation of immobility would be easy. But on the view that space itself is expanding, it is not so easy. Perhaps all we can say is that place (and time) do not exist in as perfect a manner as Aristotle and Newton assumed, so that the immobility of place (and the simultaneity of time) is somewhat relative. That is, place might be immobile relative to some things but not to everything. Still, if place is not perfectly immobile, then it seems it must be somewhat mobile, and place will change place, an evident absurdity. It might be better to say, then, that the expansion takes its origin from something the physicists call a "singularity," from which the big bang began to boom, and that this origin provides a sort of immobile referent for position. If this is reasonable, then we could have the immobility of the surfaces which materially constitute place in much the same way as Aristotle had it by reference to the outer sphere and, more ultimately, to the axis of rotation of the universe.

Reflection on modern cosmology also makes it harder to accept the notion of natural places. It is well established that bodies tend to other bodies in their vicinity (the theory even claims that they tend to every body, no matter how distant, but this is less firmly established). When the Apollo astronauts jumped around on the moon, they did not fall to the earth (at least, not noticeably!), but to the moon. All this seems to imply that bodies do not fall to where they are best suited to be, but to the predominant gravitational body in their vicinity, even if they will be destroyed by doing so, as, e.g., by falling into the sun. Moreover, according to modern science, bodies fall due to the external "force" of gravity, whether gravity be explained as a curvature of space or as a force in the classical Newtonian sense. There does not seem to be a natural impulse in one or another direction, but rather a violent seizing of bodies by other ones, in whatever direction they may lie.

These phenomena must be balanced against the argument that there is natural motion and natural place. If we grant that inanimate bodies are natural, then they have intrinsic principles of motion, though perhaps only passive ones. In fact, when arguing that everything in motion is moved by another, Aristotle speaks of the natural motions of inanimate bodies as passive, not active.[19] He mentions there as movers only "what brought them into being and made them light or heavy," and an accidental mover, whatever removes impediments to their natural motions, like the man who releases a stone from his hand.[20] Presumably

there must also be a mover to bring into act the motion of the mobile from one place to another. What this more particular mover is, he does not speculate. Perhaps it is "gravity," or something like it.

In any case, we might argue that there cannot be nature without natural motion, and there cannot be any motion without locomotion.[21] But there also cannot be violent motion without natural motion, so that the violent motions which are caused by an extrinsic cause like gravity, supposing that is all it is, actually presuppose natural motions. Therefore natural locomotions must exist, and these cannot be without natural places.

Someone might object that there is neither natural nor violent motion, because there is no natural motion, and violent motion is defined as what is against natural motion; all motions are merely indifferent. The arrangement of bodies in the universe, and their consequent motions, are entirely determined by their previous arrangement. This seems to be the position usually advocated by modern thinkers. Space, they would say, contains no differences which would account for one part of it being more suitable to a body than another. But we have already seen that the view that place is space is beset with difficulties, and, in any case, it seems to be largely a postulate made for the sake of accommodating a mathematical approach to nature.

In any case, this view runs up against a significant obstacle. If every motion depends on locomotion, and some motions, even if not locomotions, are natural, it seems there must be natural locomotions as principles of the other natural motions (which, of course, would imply natural place). If not, the intelligibility of those motions which are clearly natural, like the beating of a heart, would be illusory or else founded directly on a mysterious non-natural principle such as God.[22] The position of the objector would amount to saying that the order of the universe is not natural, is, in fact, merely accidental (and so, ultimately unintelligible). For what could account for the fact (evident to experience) that these materials are ordered and move in a way suited for the use of animate natures which clearly do have natural motions? The explanation of this order would turn out to be chance (which, as we have seen, cannot be the ultimate explanation of anything, since it is merely an accidental cause),[23] or else a supernatural cause which orders things for the use of natural things, a God who places bodies and moves them around so as to allow animals and plants to exist. It seems more reasonable (at least for a natural philosopher or scientist) to hold that the universe has principles of explanation embedded in it than to hold that it is simply unintelligible or at least has no intrinsic intelligibility. Aristotle's view has the advantage of explaining nature in natural terms, neither foregoing explanation altogether by denying any reason at all for the arrangement of bodies in the universe, nor being forced to appeal immediately to a supernatural agent.

Endnotes

1 Descartes, *Regulae ad Directionem Ingenii*, Rule 12, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1966), vol. X, p. 426; *Le Monde*, Ch. 7, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1967), vol. XI, pp. 38–40.

2 Isaac Newton, *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, Trans. by Andrew Motte, rev. by Florian Cajori, 2 Vols. (Los Angeles: University of California Press, 1934), Vol. I, Scholium (to the Definitions), p. 6.

3 Cf. Appendix 1, *Method in Aristotelian and Modern Natural Philosophy*.

4 211a12–14.

5 209b6–16.

6 211a29–34.

7 211b18–23; 23–29.

8 211b25–29; the significance of this will become clear later.

9 209a2–7.

10 Cf. 216a26–b12.

11 212a16–20.

12 *Meteorology*, Bk. II, Ch. 3, 357b27–32.

13 One might be tempted to say place is merely position, doing away with the problem of how the surface of a mobile body can be immobile, but then we would also have to say place does not contain the placed nor is it equal to it.

14 212a31–b22.

15 Cf. Descartes, *Principes*, ed. Adam and Tannery in *Oeuvres de Descartes* (Paris: Librarie Philosophique J. Vrin, 1971), vol. IX-2, p. 76; Einstein, *Relativity: The Special and General Theory* (New York: Crown, 1961), pp. 9–10.

16 The reason for this is that "being related" is nothing more than "being toward" another, and this "being toward" is necessarily rooted in some other quality which inheres in the thing, as, in the example given, quantity. Cf. *Categories*, Ch. 7, 8a31–32.

17 Like all the theories of modern physics, the notion of the expansion of the universe may be revised, depending as it does on a whole constellation of symbolic constructs, any one of which may be revised at any time. Still, the arguments for the theory, based on the red shift of distant galaxies, seem fairly firm as such things go, and here I intend to accept the theory as given and try to see what Aristotle might have made of it. I am also going to ignore the question of whether space can be warped or consist in any sense of more than three dimensions.

18 189b30–191a15.

19 255b29–31.

20 256a1–2.

21 The priority of locomotion is shown by Aristotle at 260a26–261a28.

22 That they are founded indirectly on such a principle is not a problem. Aristotle himself thinks they are founded on God in some way, at least, and I would argue not only, as on a final cause. Cf. 267b25–26; *Metaphysics* XII, 7, 1072b10–14; 10, 1075a11–25; *On the Soul* II, 4, 415a26–b7.

23 Cf. 198a5–13 and Appendix 4, *Chance and the Indeterminacy of Nature*.

Appendix 8

Void

The possibility of empty space is so universally accepted that Aristotle's rejection of it seems almost quixotic to some readers. We have all been taught that there is, beyond the atmosphere, only "empty space," and we are all familiar with syringes and other sorts of pistons in which we can create a space in which there is, apparently, nothing. Originally, however, belief in the void arose from concerns with motion and difference. The Pythagoreans seem to have held that the heaven breathed in the air (apparently thought to be void space) beyond the heaven in order to distinguish points, which they held to be the true substances of things, from each other.[1] Thus, beings are some sorts of unit-points and the empty space or non-being intervening between them caused their differences. In the face of the Eleatic challenge to motion, the atomists posited that void exists between the atoms, thinking, apparently, that they could avoid Parmenides' dilemmas simply by admitting what he flatly denied, that non-being exists as truly as being.[2] Certainly the atomists, and possibly the Pythagoreans, were moved by the same problem which vexed Parmenides, that what is is being, but what is other is then non-being. Since non-being does not exist, it seems difference cannot exist (since if two things are different, one *is not* the other). But if difference cannot exist, neither can motion, since motion presupposes difference between the terms of motion.

To the extent that belief in the void is based on concerns about place, especially on its immobility and equality to the placed, Aristotle has dealt with it in the texts about place and also in some of those about void.[3] He also argues against the void based on motion, natural motion, and the velocities of motions. The last two sorts are clear enough in the text, but we might add a word here about the problems which arise for motion in general and the experimental arguments for the void, a sort of argument Aristotle does not say much about, and most of which were presented long after he died.

It is often thought that, since the medium through which locomotion occurs impedes the motion, and a rarer medium impedes it less, an empty space will impede it not at all, so that the mobile will move even better in a void. But this argument does not follow: one might say, similarly, that a rounder wheel on a flatter surface rolls better, so that a perfectly round wheel on a perfectly flat surface will roll best of all. But in fact it will not roll at all, for there will be no area

of contact between the wheel and the road, so that there will be no friction to cause the wheel to roll – it would just slide. In moving to the limiting condition, we do away with something essential for the phenomenon in the first place. One might just as well say that, since water impedes a swimmer, he could swim even better if there were no water. The point is that, in the case of locomotion, the medium may not be merely an impediment, but a condition of there being any motion at all. In fact, if locomotion is motion (and it seems ludicrous to deny this), then the mobile must start with the privation of some form and then attain some form through the motion.[4] But if the motion is through pure non-being, there is no way to account for this. On Aristotle's view of place, on the other hand, we can say that the mobile comes to be surrounded by another body (or another part of the same one) and that this being touched by the new surface is a really new thing about the mobile. Being touched and touching are physical realities, even when the difference between being touched by this or by that makes no significant difference to the body touched. The mere fact of being touched by a new body or a new part of a body is sufficient to explain the new form necessary for locomotion to be motion.

We might object by saying that the void has dimensions, and so has a here and a there, and so the body coincides with a different part of the dimensions of void; this is what the new "form" is. But we have at least two problems to explain. First, how can non-being have dimensions, or have anything for that matter? It is silly to say nothing has size. If void exists, it has to be something, for non-being does not exist and has no quantity. Because of this problem, perhaps, some thinkers, especially during the late Middle Ages and the early modern period, held that the dimensions of space were really the dimensions of God, who was thought to be omnipresent, infinite, etc.[5] The difficulties with such a view are beyond the scope of this text. Let it be enough to say that even the old pagan Aristotle was able to see that God could have no dimensions.[6]

The second problem is that the view really does not address the difficulty that locomotion will not attain any new form, and so cannot be motion at all. For the coincidence with a new part of the separate dimensions is nothing to the body. It is not being touched by those dimensions, for they are by supposition purely immaterial. There is no way to understand how the body itself, which is, after all, the mobile, comes to have any new form in this view.[7]

The arguments of the experimental sciences are not dealt with by Aristotle, as we noted above. In general, these all depend on assuming that there is a limit to the expansion of a continuous body, or on the assumption that where we cannot measure pressure, there is no body. For example, when we close a syringe tightly, and then, having blocked the hole at the bottom, we pull up on the syringe, we are inclined to think there is empty space in the syringe because nothing could get in to fill up the space. But if there is some small bit of air or other material in the syringe, it might expand, and one would have to give some argument to say that it could not expand to fill the space. If we say that we can-

not measure any pressure there, and therefore there is no body there, we are assuming that our measuring instruments are perfect, which is obviously false. Every attempt to measure pressure, even when the result indicates a lack of pressure, is subject to the qualification that the measurement is approximate to some degree, however small. It seems that all the experimental arguments for the void fall prey to one or both of these objections. Moreover, current views of space, with their claims that space can be "warped" and expand, indicate that space is some sort of body rather than a set of immaterial dimensions.

These objections to the experimental arguments for the void do not, of course, show that the void does not exist, but only that these arguments do not show that it does. To show that the void is impossible would depend on more universal arguments from the natures of matter, motion, body, dimensions, etc., of the sort presented in the text above in this Appendix and in Appendix 7, *Place*.

Endnotes

1 213b22–27.

2 *Metaphysics* I, 4, 985b7–8; cf. Appendix 2, *Matter and the Reality of the Physical World*.

3 Cf. Appendix 8, *Place*.

4 This is one of the main conclusions of Book I. Cf. esp. 189b30–191a22.

5 Cf. Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore: Johns Hopkins University Press, 1957), p. 148; Edward Grant, *Much Ado About Nothing: Theories of Space and Vacuum from the Middle Ages to the Seventeenth Century* (New York: Cambridge University Press, 1981), p. 402, note 263. Cf. also Isaac Newton, *De gravitatione*, in *Unpublished Scientific Papers of Isaac Newton: A Selection from the Portsmouth Collection in the University Library*, ed. A. Rupert Hall and Marie Boas Hall (Cambridge: Cambridge University Press, 1962), p. 104.

6 267b25–26.

7 In this regard, it is significant that Aristotle does not say locomotion is change in the genus quantity, which is where he places place (*Categories*, Ch. 6, 4b20–25), but rather in the genus "where" (226a23–25), which seems to be the attribute a body has by being in place, not place itself. Thus, we say, "Aristotle is in the Lyceum," not that he *is* the Lyceum. The examples of "where" which Aristotle gives in the *Categories* are both like this: "in the Lyceum, in the marketplace." (*Categories*, Ch. 4, 2a1–2; Ch. 9, 11b14). The new form which the mobile attains through locomotion is not itself the place, but the attribute of being in that place.

Appendix 9

Time

The nature of time is one of the more perplexing problems in natural philosophy. Positions on it have ranged from Aristotle's, that it is merely the before and after of motion considered as numerable, to that of Newton, who, through his pupil Samuel Clarke,[1] affirmed that time and space are sorts of properties of God,[2] to Kant's view that time is a form of sensory intuition imposed upon the world by the mind. And despite the divergence of opinion about what time is, all (almost) grant that time exists. Even after having given some troubling arguments to the effect that time does not exist, Aristotle does not bother trying to show that it does exist or even to answer his own objections.[3] St. Augustine seems to speak for all when he says, "What then is time? Provided that no one asks me, I know."[4]

Aristotle's view might be called "natural" as opposed to Newton's "absolute, true, and mathematical time"[5] or Einstein's relativistic and mathematical time. He begins more surely from common experience about the natural world, while the others are bent from the beginning on treating time in a mathematically congenial manner. He begins, e.g., by noting that the parts of time are the past and the future, that these do not really exist *now*, and that we perceive time (his word is stronger: "we *sense* time") in perceiving motion.

The strong emphasis at the beginning of his discussion on the sensory perception of time is significant, not only because it leads to the definition, but because it counteracts a tendency to which we are all subject. We tend to treat whatever we think of as if it were a thing like other things around us, as we tend to think of space as a three-dimensional thing which is immobile the way bodies are, and of material as a kind of thing like wood or air. Our thoughts of time are subject to this same inclination. And we also tend to think time is independent of physical motion because we are aware of the passage of time even in our thoughts and dreams. Newton's idea, then, of a separately existing time, flowing on from eternity to eternity without regard for the motions of any bodies, is a somewhat natural illusion. For it is an illusion; it is nothing else than making a substance out of uniform motion. What else could we think of a time which changes, but is not the change *of* anything?

In any case, it is our experience that in seeing a motion, we see time, just as in seeing color, we see shape. In both cases, we perceive one thing by perceiv-

ing the other, not by some further act or argument. These two cases may be contrasted with the act of counting horses by counting their jockeys. We count the jockeys, and (assuming no riderless horses or horseless riders), we count the horses by comparing them to the jockeys. We do not perceive the horses or their number in this, but we arrive at knowledge of their number through a comparison with the number of jockeys we see. This is not how we perceive time in perceiving motion; rather, we see time when we see motion, as we see shape when we see color. If we did not *see* time in this way, then, in order to perceive time in perceiving motion, we would have to compare time to motion by some further act, as we did with the horses and the jockeys. We can do this in the case of time and motion, too, as when we use this motion as the time of that motion, e.g., when we clock a runner against the second hand on a watch. Here we do not perceive the motion of the runner in perceiving the motion of the second hand, but measure the one by the other through the comparison of the two motions. No such further act of comparison is found, however, when we merely see the runner and perceive time in doing so.

Further, we might wonder how we, and everybody else, knows that every motion is in time, if the perception of motion does not involve the perception of time – surely some argument would be needed, as in the case of the jockeys and their horses. If someone were to claim that all bodies are in place, we would need an argument, for we do not perceive place in perceiving body; but if someone were to claim that all locomotion is in place, we would not expect an argument, because the perception of locomotion involves the perception of place.[6] But there is no such argument needed to understand that all motion is in time; even the most unreflective persons are aware of this.

Moreover, whenever we speak of "a time," such as a day or a year, we must define it in terms of some motion, as if the latter is its very principle. And, though we may think that defining a certain time in terms of this or that motion is defective, as we might think it better to define the second not as a fraction of the earth's rotation on its axis, we still do not forego all reference to motion, as if that reference is in itself questionable; rather, we simply find another motion which we think is a better standard.

Even Newton and Einstein seem to imply that Aristotle is right to say time is something of motion. Newton, as we saw above, makes time a subsisting change, and even says that time "flows equably."[7] Einstein, on the other hand, says that the quantity of time is dependent on the relative motions of bodies.[8] But can the quantity of time be dependent if time itself is not, and can time be dependent on motion if it is not something of the motion?

Aristotle's arguments against the existence of time seem also to provide evidence against the view that time is independent. For if time is something in itself, an independently existing being, but no part of it exists, how can it exist?[9] And if the now (which is the only thing belonging to time which is really existent) is not always the same,[10] then when will it be destroyed? Neither when it

is, for then it is, nor in another now, for the nows are not simultaneous.[11] If we adopt the view that time is independent of motion, these objections seem unanswerable. For it is clear that the parts of time do not exist all at once, but only the now exists. For that the now is always the same is clearly false, so that we have to say the now is always different. But how will a subsistent now corrupt? Or how will a new one arrive? For these could not corrupt or arise in virtue of something else corrupting or arising, if they are subsistent.

But if time and the nows are not subsistent, as Aristotle claims, then there may be a solution. For, on Aristotle's view, time has real existence only in the potency of the mobile, and, absent that mobile and its motion, time will never exist. Time and the now can, as it were, borrow their existence from that of bodies. The bodies exist and are not mere potencies; nevertheless, their potencies and their motions are real. The divisions of their motions, then, are also real, but are nothing other than the dispositions of the body in motion. When we count these dispositions, noting that the body is here and then there, we note what lies between these dispositions, and we perceive time.

Perhaps a comparison to what would happen if we held that motion were subsistent would help here. When a motion is taking place, the beginning and the end of the motion do not actually exist; all that exists of the motion is the division of the part gone by and of the part to come. This is the division of two non-beings and would be so defined. But such a thing could not exist. A division cannot be actual or real unless that of which it is the division is actual or real. But since motion is in a mobile, the divisions of the motion exists in the mobile insofar as the various dispositions which the mobile attains (being here, then there, then there, etc.) exist in the mobile. And, in fact, the division of motion is the only aspect of the motion that ever exists in the mobile at any one moment. What the mobile has in the moment need not be, in itself, simply such a division, though it may be defined as such when we are comparing the parts of the motion, but is something real in the body at this or that moment. It is a disposition, however, which has an intrinsic ordering to a further disposition, leading on to a new disposition.[12]

It is reasonable that Aristotle first presents objections to the existence of time, then, if those objections really amount to objections to the view that time is subsistent, and that view is somewhat natural, even if mistaken. It is also reasonable that he does not respond to these objections, for they do not bear on time as he has defined it.

Having determined that time is something of motion, in particular, its number according to before and after, there are several important problems which Aristotle must face. If time is something of motion, how can things at rest be in time, as they clearly are? This is not so hard to answer, for clearly we can measure rest by comparing it to a motion and its time: as the moving thing attains different places, we note that the resting thing does not, and so we measure the duration of its rest.

We might also wonder whether Aristotle's view implies that time is subjective, for if time is a number, and only a mind can number, does time not then emerge as a product of our own minds? But we know that it is not true that time is *merely* subjective, as if a time which is long for you might be short for me in some very fundamental sense, and it is not too hard to see that Aristotle's view does not make time simply subjective. If there is a number of cows on a hill, I do not make that number what it is by my counting it, though it could not be counted were there no minds available for the job. I count what is there, and the number is determined by what is there to be counted. So too, motion is what it is without my input; when I count off the divisions of the motion, the "nows," I merely note what is there to be noted. The before and after are in the motion regardless of my being around to notice it. Still, there would be no counted number of cows without a mind, and there would be no time, strictly speaking, without a mind. But that which is the foundation of these numbers out there in the world, i.e., the multitude of cows or the motion and its divisions, would nevertheless exist.[13]

Another problem, and one which does not seem to be peculiar to Aristotle's view though it has peculiar facets in that view, is that time seems to be uniform by its very notion: if it went faster and slower, it could only do so by having different rates at different times. But what has a different rate does more or less in the same time. So there would have to be a time which is prior to the time in question. Time, then, must be uniform. And yet, by the same logic, if time were uniform, it would be so by having the same rate at different times. Are we not forced to postulate a time before time in any case?

Or are we wrong to think that uniformity or irregularity must be measured by an exterior standard? For if uniformity (or irregularity) requires an exterior standard, time can neither be regular nor irregular, as we just saw. In fact, if the measure by which we judge uniformity or irregularity, whether of time or of size or of anything else, must be extrinsic to and prior to the measured, then all such judgments are impossible, since we could never judge the measure itself. Looking at the uniformity of the curvature of a circle, e.g., does not seem to require such an extrinsic measure to be or to be understood: we simply note that each part of the edge of the circle has the same shape. We do this, it seems, by moving the parts on top of each other in our imaginations, and, despite the fact that such motion and superposition is imaginary, it does reveal something real in the circle, for the curvature and its regularity are not simply due to our imagination, though they are perceived by it and in it.

Can we say the same sort of things for time or motion? Just as we superpose the parts of the circle, so we can superpose, using memory and imagination, the parts of motion or of time on each other. We understand that, were this part of the motion or time to start together with that other part, they would (or would not) come to the same term together. Since we would be noting two nows, we would note time in this very process, but we would not be presupposing a time

or motion prior to the motion in question. Consequently, we could judge the uniformity of the time or motion without recourse to a prior, really separate time or motion. It would be enough to make such a judgment that we be able to recognize what regular motion is by negating the differences which we see in accelerated motion, and then see that the motion we are considering does or does not match the definition.

Having said all that, it remains that, given current cosmology, it is highly unlikely that there is a first motion which is regular. The expansion of the universe, e.g., does not seem to be uniform, and, even if it is, it does not seem to be necessarily so. But if the first motion is not regular, time itself would have only an imperfect existence, for, being a number, its units must all be alike for it to be perfect, and, being of the first motion rather than of any motion, the regularity of some motion other than the first would not be germane to our discussion. Thus, while the notion of uniform motion or time is not contrary to the notion of a primary motion or time, it does not seem that there are any motions which might be primary and are regular. If so, time is only imperfectly present in the universe.

This last remark leads to another difficulty. On what grounds need we assume any "first" motion? Is this not just an outdated part of Aristotle's cosmology? A consideration of the problem of simultaneity will lead us to see that there are real grounds for the view that there is indeed a first motion.

It may be as well to note that the problem of simultaneity is not peculiar to Aristotle's natural philosophy or cosmology, but is a universal, for the problem presents itself in any view of time. If A and B are simultaneous motions, I cannot just posit that this is so because they are simultaneous with my watch, for example, for then I still have to ask why my watch and A are simultaneous. Nor can I say that they are simultaneous because they are each simultaneous with some universal time, absolute and independent of bodily motion, some ghostly clock, for I still do not know why either one is simultaneous with that universal time. If that universal time "flows equably," its motion and that of the more obvious motions around us must be correlated somehow, and saying "they just are correlated" is hardly satisfactory.

In order for two motions to be simultaneous, their divisions must be simultaneous; that is, if I mark *this* point in *this* motion, it must be simultaneous with *that* point in *that* motion. We could say that the divisions of the motion are simultaneous in the way that the divisions of a ruler are together with the divisions of the thing they measure. But the divisions of the ruler are made to be simultaneous or together with the divisions of what it measures by placing the two alongside each other. In the case of time, we do no such thing; simultaneity is given to us in nature, without our intervention.

We might be tempted to say that motions and their divisions are simultaneous because we sense them at the same time. This seems to be quite close to what Einstein holds, for he insists that those things are simultaneous which are

perceived by the observer at the same time.[14] However, if this is all there is to it, are we not claiming that our perceptions determine the physical world? While Einstein is surely right to insist that we have to take into account the motions and positions of observers in determining the measurements which our symbols represent, it does not follow that to be simultaneous is, in the nature of things, nothing more than our observation of them at the same time. In fact, when discussing simultaneity, Einstein presents the case of two light beams traveling away from the observer, hitting mirrors, and then bouncing back. He defines the simultaneity of the returns of the beams by the observer's seeing of them when they arrive back at the point of origin.[15] But he also seems to assume something not observed, namely, that the light beams are indeed traveling away from him as he sits awaiting their return. Thus, their unobserved travel away is presumed to be simultaneous with the observer's wait. This sort of presumption of simultaneity seems to be inescapable and precludes the assumption, however fruitful it may be for mathematical physics, that we are ourselves the sole principles of simultaneity.

To what shall we turn, then, to explain that simultaneity which we experience as something beyond ourselves? To be in time is to be in a sort of number, namely, the number of motion. So if two motions are simultaneous in time, i.e., are in the same individual time, both are counted by the very same act of counting: their number is not the same merely in kind, as if this counting of this motion is the same kind of counting as that counting of that motion, but by the counting of the one motion *being* the counting of the other. The ten o'clock of this motion is the same individually as the ten o'clock of that motion. And if there is one time for all things, there must be a motion which, when counted, is the counting of all motions.

If we are to go further, we must note that for the counting to be the same counting, the two things counted must be the same or correlated in virtue of what they are. We can count men by counting heads because they go together. The two motions cannot simply be the same; they are by assumption two and not one. But motions can correspond to each other in virtue of what they are by the one causing the other. Thus, if I carry a box, the motion of the box is caused by me, and because the act of the mover is in the moved,[16] the motion of the box is my act, but is in the box. So in counting the divisions of my motion, I count the divisions of the motion of the box and *vice-versa*. In short, since the act of the cause is in the effect, if one motion causes another, the act of the first is in the second. The simultaneity of cause and effect or of mover and moved, then, may be the foundation of the simultaneity of time.

It seems that this is finally the only possible explanation of simultaneity. As we saw above, we cannot merely say that two motions are simultaneous because they are at the same time, for this begs the question, if time is the number of motion. But even those who deny this, as Newton does, are forced to speak of time as a motion, "flowing equably," and why this supposed incorporeal motion

should be simultaneous with this corporeal one is as much a question in his view as in any other. For Einstein, there should be less difficulty in granting that simultaneity is the result of the causality of one motion, since his notion of simultaneity is intimately bound up with the motions of bodies. He might be less keen on the assumption that there is a simultaneity beyond the one experienced by an observer, but he himself seems to implicitly assume this in his own arguments anyway.

For Aristotle, the motion which causes others and the counting of which is the counting of others is the motion of the outer sphere. This motion is uniform, for it cannot be accelerated or decelerated, and it is the cause of all other motions, and so it is the principle of their unity in time. Moreover, since it is the cause of other motions, and the act of the mover is in the moved, the perception of any motion implies, at least in some sense, the perception of this one. When the existence of the outer sphere was denied, two paths were possible. We could deny that time is in any way related to bodies, as Newton does, or we could deny that there is one time for all things, as Einstein does. But it seems true that even Einstein assumes a kind of simultaneity beyond that of merely observed simultaneity, and that time is not an incorporeal something, as Newton thought. Thus, there must be a motion which is causally related to others and so provides the unity of time. The most obvious candidate would seem to be the expansion of the universe. This is found everywhere, and is causal with respect to space, time, and motion. Whether or not this is a reasonable guess is for others to decide; what seems to follow from Aristotle's considerations is that there must be some such motion even if we do not know what it is.

Endnotes

1 Alexandre Koyré, *From the Closed World to the Infinite Universe* (Baltimore: Johns Hopkins University Press, 1957), pp. 300–301, note 3. This work as a whole presents an interesting overview of some of the controversies about space and time involving Descartes, Newton, Leibniz, and other prominent figures of the scientific revolution.

2 Ibid., p. 257.

3 217b32–218a31.

4 Saint Augustine, *Confessions*, trans. Henry Chadwick, (New York: Oxford University Press, 1991), Bk. XI, Ch. 17. The eleventh book of the *Confessions* is a marvelous invitation to reflection about time.

5 Isaac Newton, *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, Trans. by Andrew Motte, rev. by Florian Cajori, 2 Vols. (Los Angeles: University of California Press, 1934), Vol. I, Scholium (to the Definitions), p. 6.

6 211a12–13.

7 Newton, loc. cit.

8 Albert Einstein, *Relativity: The Special and General Theory* (New York: Crown, 1961), p. 118.

9 217b32–218a8.

10 218a–11; 21–30.

11 218a11–21.

12 It is noteworthy that the Latin expression for the division of motion is "momentum." According to modern English usage, momentum is precisely a disposition which a body in locomotion has at a moment and which, in some way, accounts for its continuing on in motion. For a further discussion of the order found in motion, cf. Appendix 6, *The Definition of Motion*.

13 223a16–29.

14 Albert Einstein, *op. cit.*, p. 21–34.

15 Ibid.

16 202b19–22.

Appendix 10

A Brief Note on Inertia

Aristotle offers two or three arguments that everything which is moving is being moved by another.[1] The modern reader will no doubt wonder about the applicability of the arguments to local motion, especially to projectiles. It is a fundamental law of modern physics that a mobile will keep moving in the direction it is moving, or will remain at rest, unless an external force compels it to accelerate (which includes in its general and technical usage both acceleration and deceleration and changes of direction – this general and technical use being, it seems, a consequence of the law itself).

On the other hand, it does not come as too much of a surprise to say that water is only warming up as long as something warms it, or an animal only grows so long as it takes in food and acts on it. It does seem, though, that there is good reason to think that a body can keep changing place with nothing acting on it. For when we throw something, it keeps moving even though we are no longer moving it, and we feel ourselves pushed against the side of a car which turns suddenly, as if our bodies wanted to keep going in the same way but are pushed out of their paths. Besides these everyday experiences, we are inclined to agree with the law of inertia because it so successfully explains the phenomena of the planets, thrown stones, rockets, etc. All of modern physics, in fact, takes the law as a given. It may be somewhat quixotic, then, to tilt against this particular windmill, but the arguments which Aristotle presents, at least the first and third, seem to be perfectly universal, and so it would be worthwhile to look at this question a little more closely.

For the sake of simplicity, we can take the third argument (257b6–11) of Aristotle as representative. If a thing moves, it attains a new form at the end of the motion. That new form, whether it be a new quality, quantity, or "where," cannot come from the body itself, since it was deprived of it before and so could not give that new form to itself. Thus, there must be something which actually has, in some sense, the form to cause it in the mobile, or else motion will be an example of something coming from nothing.

More formally, we might say that nothing is and is not in the same respect at the same time; but a mobile, insofar as it is subject to motion, is in some way not what it will later be. So it cannot already have that new aspect which the

motion will produce in it. If so, then it cannot cause that new aspect to be in itself. Nor can the new aspect be without any cause, because then something would come from nothing. So it must be caused by another.

This argument is as applicable to local motion as it is to any other sort of motion. The only way to avoid the conclusion that locomotion, or at least inertial locomotion, does not need a cause is to posit that something can already have what it does not already have, or else that something can come from nothing, or else that there is in locomotion no new aspect attained. Obviously, the last is the preferred option.

Evidence for this claim might even be offered from Aristotle's own text: "... among motions, the thing moving is removed from its substance least in being borne. For according to this motion alone does a mobile change nothing of its being, as the quality of a thing altered and the amount of the thing growing and diminishing [are changed]."[2] For what does it matter to the ball that it be at first base rather than third? Locomotion, it seems, does not affect the thing moved at all. However, this position can only hold up if we say that to be in the first place is the same as to be in the second place. But then the first place must *be* the second place.

Thus, if locomotion is indeed motion (and it seems one would deny this only to save a pet theory), then the mobile which moves according to place must have something new at the end of its motion which it did not have at the beginning. This new aspect cannot be the new place itself (for the mobile does not become a place when it changes place), but rather a being in place, what Aristotle calls a "where."[3] While in some way it seems true to say that the thing which has changed place has changed not at all, there must be something new about it or there would be no difference at all when it is in one place or in another. This is tantamount to saying it has simply not moved or changed. What is new about being in a new place is perhaps merely being contained by a new container. However we explain this newness, it is a fact that needs explaining, and not a theory which can be explained away.

Nor can we say that the only new aspect of the body which has changed place is its relation to other bodies. For relations can only change if some thing which is not merely relative changes, as my son cannot become taller than me unless either he or I or both of us change in height. Thus, any change in the relations of bodies must be founded on something not purely relational.

It is not possible, then, to hold that what changes place has nothing at all new about it or that it only has a new relation to other bodies. If this is so, then Aristotle's argument seems to follow.

We might also raise some more particular objections to inertial motion, at least as it is usually understood. It is curious, at the least, to speak of a "state" of uniform motion.[4] The very word "state" is derived from a Latin word meaning "standing." How can moving and standing be compatible? The answer would seem to be that uniform motion in a straight line, i.e., inertial motion, is as much

like standing still as anything could be, except uniform rotation. Nevertheless, to say any sort of motion is standing seems peculiar at best.

Further, part of the theory which goes along with the theory of inertia is that a force changes a mobile's "state of motion or rest."[5] But no such change is observed as the effect of the force. The mobile is at rest, and then in motion. The moment which divides the times of the rest from that of the motion is only a limit, and belongs to that which it limits – it is not some third time during which there is acceleration but not motion, whatever that would mean.

Again, if inertial motion is causeless (and it should be noted that the principle of inertia does not even try to explain uniform rectilinear motion, but only says it needs no explanation), what is force the cause of? Suppose a body is at rest, and then a force acts on it to set it moving. Here the force is supposedly the cause of the change from rest to motion. But there is no change from rest to motion, unless we mean by change merely the fact that the mobile is at rest and later in motion. This cannot be, however, a sufficient account of change, for if there were change every time a thing is different now from what it was before, then, since the supposed change between the rest and the motion is itself not always present, there must be a change to it, and a change to that change, etc.

We might object that the change caused by the force is that from one particular speed to another. This takes time, and is a continuous change, for the mobile accelerates through all speeds on its way to its final speed. But motion is from contrary to contrary (188b21–23), and the contrary of rest is motion, not speed, the latter being an attribute of motion. So a change from rest must be to motion, not to a particular speed, except accidentally.[6]

If we agree with Aristotle that everything in motion is being moved by another, then do we not have to face the question, what does move projectiles? It may be that we can never answer this question. It may be that we are like detectives faced with an insoluble crime – we know someone did it, but will never be able to say who. We are so often in this situation that we tend not to notice it; we do not know, perhaps, how a jet engine works, but we know there is some cause. To be ignorant of what the cause is simply is not the same as to be ignorant as to whether there is a cause.

The solution which Aristotle offers in the *Physics*[7] has been much maligned, and yet it is hard to see what else he could have said, given the state of the argument before him and the evidence available to him. If locomotion is motion and so needs a cause, and if the cause must be in contact with the mobile during the motion, what else could he have said except that the air (or other medium) somehow carries the propulsive power of the one who throws the projectile? For he saw nothing else which is in contact with the mobile except the air or water. It seems that Aristotle was thinking of something like a pressure wave, which is caused when the medium is moved into a smaller volume and then expands, thus moving the next part of the air, which itself becomes compressed, though less so, and so on until the air is no longer able to move the next part of the air. He

seems to have thought that the mobile would be carried along by some such disturbance of the medium like a leaf before the wind.

One problem with this view is that one cannot get a rock to move by blowing on it with any force of a magnitude which might be caused by a hand throwing the rock. Moreover, the planets seem to move without any such medium around them. If, though, there is no void, as Aristotle argues, to my mind persuasively, there must be some medium in so-called empty space, or else what we normally call space must itself be something bodily in some sense (as must be the case if it can warp or expand). If either is true, then there may some causality present in the medium, not necessarily of the sort Aristotle imagined, but perhaps sufficient to explain projectile motion.

Endnotes

1 Cf. 241b24–242a15 (in the alternative text, 241b34–242a49); 254b7–256a3; 257b6–11.

2 261a20–23.

3 226a23–26; cf. *Categories,* Ch. 4, 2a1–2.

4 Cf. Isaac Newton, *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, Trans. by Andrew Motte, rev. by Florian Cajori, 2 Vols. (Los Angeles: University of California Press, 1934), Vol. I, First Law, p. 13.

5 Ibid.

6 These "more particular objections" have been taken from Marcus R. Berquist, "Concerning the Third and Fourth Definitions and the First Law in Newton's Principia," in *The Aquinas Review*, Vol. II, No. 1, 1995, pp. 61–67. Several other objections are also presented there.

7 Cf. 244a21–25 (in the alternative text, 243a20–b2); 266b30–267a20.

Appendix 11

A Note on Contact between the Mover and the Moved

The claim that there is always contact between the mover and the moved[1] may seem, like many of the claims made in the *Physics*, to fly in the face of modern science. Magnetism and gravitation, to take two obvious examples, seem to "act at a distance," i.e., to affect bodies which are not in contact with the source of power, as the earth attracts the moon and a magnet attracts iron. In his discussion of this claim, Aristotle does not even mention these cases, and one might object that, given the inductive nature of his argument, this is a fatal flaw.[2] It is probably the case that Aristotle thought exceptional cases like these were to be understood in the light of others, on the principle that we should start with what we know and move to what we do not know. For it is not apparent that there is no medium which establishes contact between the mover and the moved in magnets, for example, but only that we see do not see one. Since, in cases where we have a better grasp on the mode of interactions between bodies, we see that that interaction depends upon contact, we should at least suspect that there is such interaction in the more obscure cases.

One phenomenon which might lead one to think that there is some action through a medium even in the cases of magnetism and gravitation (and in the other cases like them) is that the ability of the source to affect the mobile is affected by distance. Thus, Newton's famous law of gravitation holds that masses attract each other inversely as the squares of the distance. If a body is twice as far from the earth as another equally massive one, the earth pulls on the former with only one quarter the power with which it pulls on the latter. But if the earth acted directly on the mobile, without any use of the medium as a sort of instrument, why would it do this? In other words, if the power of gravity is applied to the mobile directly, then there is no reason for the power to be diminished due to distance; both of our equally massive bodies are being directly affected by the earth, so they should be equally affected. We cannot respond by saying that they are in fact unequally affected; this is precisely the phenomenon to be explained. Only if we could prove that there is really nothing between the mover and the moved would we have an argument which addressed the point

properly. Such a proof would, of course, have to take into account all the objections to the existence of the void.[3]

A more metaphysical argument might also be suggested. The way something acts depends on the way it exists: a sphere rolls, a cube does not; hot water heats, cold water cools; a man acts as a unified, single being, an army acts as an organized whole composed of unified, single beings. Thus, if a thing *is* here or there, it *acts* here or there, not elsewhere, as the proponents of action at a distance would have it.

It might be good to note also that Newton, to whom we so often attribute belief in action at a distance, denies any such thing in a letter to Richard Bentley:

> It is inconceivable, that inanimate brute matter, should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation, in the sense of Epicurus, be essential and inherent in it. And this is one reason why I desired you would not ascribe innate gravity to me. That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of any thing else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers.[4]

Endnotes

1 243a3–245b18.

2 It is only fair to point out that gravitation, as conceived by Newton and Einstein, was unknown to Aristotle; but the case of magnets was well known even at that time. The existence of universal gravitation was established by Newton in a brilliant argument which constitutes the main thread of his masterpiece, the *Principia Mathematica*. For a solid aid to understanding that argument, cf. *Newton's Principia: The Central Argument, Translation, Notes, and Expanded Proofs*, Dana Densmore, trans. and illust. by William H. Donahue (Santa Fe, N.M.: Green Lion Press, 1995.)

3 Cf. 213a12–217b28 and Appendix 8, *Void*.

4 Isaac Newton, quoted in *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and his System of the World*, Trans. by Andrew Motte, rev. by Florian Cajori, 2 Vols. (Los Angeles: University of California Press, 1934), Vol. II, p. 634.

Glossary

This Glossary lists the primary translations of each word considered. In the translation itself, there are places where an alternative is given within curved brackets ("{}"). Such alternative translations are not given here in this glossary.

Accident – συμβεβεκός – This may also be translated "incidental attribute." In modern English, the word "accident" usually means an occurrence which comes about by bad luck; in this translation, and most others of the *Physics*, the word means what just happens to be in something but does not belong to the nature of the thing or follow from that nature. Thus, white or black are "accidents" of men. The etymology of "accident" closely mirrors the Greek etymology of συμβεβεκός – the former originally means (in Latin) "what has fallen together," the latter, "what has run together."

Account – λόγος – This Greek word can be translated in a number of ways. It started out meaning "gathering" and "collecting." The word "syllogism" retains this sense in that the syllogism is a collecting of words (though not just any collecting of words). Λόγος then comes to mean "word," that by which we gather notions, and "speech," a complex of words, and "argument," a particular sort of speech. It is extended to mean "notion," that which a word signifies, and "reason," the power wherein notions reside. It is also used to mean "ratio" (in fact, the Latin "ratio" is probably the closest word to λόγος; but even this Latin word does not capture the first meanings "gathering" and "word or speech," though its cognate "oratio" does capture the latter.) I have translated this word in almost all cases by "account." This carries the notion of gathering to some extent (to take account is to gather up or summarize), of speech (to give an account is to say something), of argument (to give an account is to give a reason), and of notion (the account of a thing is the notion or notions involved in its explanation). It also carries a relation to calculating (a sort of "reasoning") and to ratio, in both cases through the root word "count." Other translations (in certain contexts) might be "notion," "definition," "thought," "argument," "reason," "formula," "statement," "expression."

Act – ἐνεργός – The Greek word ἔργον is cognate with our English word "work" and should sometimes be so translated. Ἐνεργός means "at work" or "operating" (itself derived from the Latin *opus*, "work"). The verbal form I translate as "is in act." For a more complete explanation of these translations, see the Introduction.

Act (v.) – ποιεῖν – This is also translated by "make" or "do" at some points. "Make" is in some ways better than "acting," but the English has not been extended as far as the Greek and this makes it difficult to always translate as "make."

Action – ποίησις – The noun formed from the verb ποιεῖν.

Actuality – ἐντελέχεια – This word was apparently coined by Aristotle to mean whatever stands to another as does the shape of a clay statue, e.g., to the clay of the clay statue. It is what makes something more than mere ability or "potency." For a more complete explanation of my translation, see Introduction.

Affirmation – φάσις, κατάφασις

Alteration – ἀλλοίωσις – Change in quality, as opposed to change in substance (i.e., the thing itself, like man or stone or hydrogen), or change in amount, or change in place.

Amount – ποσόν – This could also be translated "quantity," and usually is in other translations.

Analogy – ἀναλογία – This is the usual Greek word for "proportion," but we do not normally speak of a "proportional word" in English. It is fundamental, however, that when a word is used "analogously," there is a kind of proportion involved. When, e.g., Aristotle says that what underlies substantial change (e.g., dying, which is a change in what a thing is in the most radical sense of "thing") is known by "analogy," he means that we set up a proportion in order to know that "material": we say, "as the clay is to the making of a statue, so is this underlying material to the thing which comes to be, e.g., the corpse." (Cf. I, 7, 191a7–12.) We may then name the underlying "material" because it has a proportion to the "material" of other changes like making statues.

Argument – λόγος – The Greek word has many analogous meanings. One of them is "argument," i.e., a speech in which one statement is thought to be so because others are so. The strictest form, but by no means the only form, of argument is what Aristotle calls ἀπόδειξις, which I have translated by "demonstration." See the note on "account."

Art – τέχνη – The Greek word was used in a broader sense than we now use the word "art." We tend to mean "fine art" when we say "art." But we still do speak of chairs and tables as "artifacts," i.e., things made by art, and if we note this we might be inclined to call manual skills like carpentry and brick-laying "arts." This is the way the word is used in this translation.

At work – ἐνεργεῖν – See the note on "act."

Attribute – κατηγορία

Bad – κακός, φαῦλος

Beginning – ἀρχή – Also translated by "principle," which is derived from the Latin "principio," "beginning." It can be a beginning in thought or in things.

Being – τὸ εἶναι, ὄν

Being moved – κινεῖσθαι – The Greek is a middle or passive infinitive, so it is often translated not by "being moved," but by "moving."

Between – μεταξύ

Borne – φέρεσθαι – Also translated by "carried," which has much the same sense as "borne" but is less easily used of projectiles: it sounds odd to English ears to say a thrown rock is "carried" to its target, but not so odd that it is "borne" to its target. I have often translated this word also by "moved locally." Aristotle apparently had the same difficulty coming up with an appropriate word for anything which is moving with respect to place, and settled on an analogous extension of the common word for "carried" in the absence of any appropriate word. Cf. V, 2, 226a32–b1.

Bulk – ὄγκος – This word is somewhat like our word "mass" but does not have the latter's technical use. "Bulk" has the advantage because it is not apt to remind us of any scientific theories.

By nature – φύσει – The dative of φύσις, "nature." The Greek dative is often used to indicate the means by which something is done. Thus, what is by nature is what arises out of the intrinsic principles of a thing just as what it is. Cf. II, 1, 192b35–193a2.

By violence – βίᾳ – The dative of βία, violence. βίᾳ can be what is against the inclinations of our will, as when we speak of being "forced" to do something, or what is against the inclinations of a nature, as when we speak of a rock being "forced" up. It is thus opposed to what is by nature or to what by desire. In the *Physics* it is usually opposed to what is "by nature." I have not used the word "force" because of its modern technical meaning in physics. That use is itself best understood when it is recognized as having a primitive meaning equivalent to "violence."

Carrying – φέρεσθαι – See the note on "borne."

Category – κατηγορία – Though the Greek word means literally "accusation" or "predicate" (things said about something), the English has come to mean a group. I have translated the word by "predicate' or "attribute" where the reference is not to one of the ten highest univocal names, i.e., the "categories" of the logical work of that name. Cf. *Categories*, 4, 1b25–2a10.

Cause – αἴτιον, αἰτία – Originally the word means the guilty party, the one

responsible. It is then extended to mean any sort of cause. Cf. II, 3, 194b16–195a4.

Certain – ἀκρίβεια – Some have argued that this word and its adverbial cognate should rather be translated "precise" and "precisely." However, it seems to have the sense of "certain" in many passages, the clearest example I know of being *Categories*, Ch. 7, where it is attributed to ἐπιστήμη as opposed to ὑπόληψις (8b9–12).

Chance – αὐτόματον

Change – μεταβολή – This is more general than motion, because, while change in what a thing is most fundamentally, i.e., substantial change, is certainly change, it is not motion. The sorts of motion are change of place, alteration, and growth and diminution. Cf. V, 1, 225b5–9.

Choice – προαίρεσις

Circulation – κυκλοφορία

Circumference – περιφερής, περιφέρεια

Coincidence – σύμπτομα

Cold – ψυχρόν

Collection – σύγκρισις

Come to a stand – ἵστασθαι

Come to be – γίγνεσθαι – "Simple" coming to be is the coming to be of what is simply, i.e., a thing in the radical, unqualified sense of the word. The things of this sort, men, horses, rocks, elements, etc., are "substances," not in the modern chemical sense of the word, but in the sense that they "stand under" (Latin: *sub* + *stant*) other "things," such as sizes or colors or temperatures. (See the notes on "substance" and on "accident.) They are called "beings" in the normal sense of the word. Because other things are beings by inhering in these, in the case of "accidents," their coming to be is not "simple," but qualified, or, as Aristotle usually puts it, it is a coming to be *this*. Cf. 190a31–33.

Commensurable – σύμμετρος – Also translated "commensurate."

Common – κοινός

Complete – τέλειος – Also translated "perfect."

Concave – κοῖλον

Condensation – πύκνωσις

Container – περιέχον

Contiguous – ἐχόμενος

Continuous – συνεχής

Contraction – συναγωγή

Contradiction – ἀντίφασις

Contrariety – ἐναντίωσις

Contrary – ἐναντίος

Convex – κυρτός

Conviction – πίστις

Corruption – φθορά

Cosmos – κόσμος

Defect – ἔλλειψις

Definition – ὁρισμός

Demonstration – ἀπόδειξις

Denominative – παρώνυμος – This may also be translated "derivative." Cf. *Categories*, Ch. 1, 1a12–15.

Density – πύκνωσις, πυκνότης

Destruction – φθορά

Difference – διαφορά

Dimension – διάστασις, διάστημα

Diminution – φθίσις

Direction – πρόσθεσις, διάστασις, επίστασις

Disposition – διάθεσις

Distance – διάστημα, διάστασις

Divisible – διαίρετός, μεριστός

Division – διαίρεσις

Do – ποιεῖν

Doing (n.) – ποίησις

Down – κάτω

Easily divisible – εὐδιαίρετος

Element – στοιχεῖον

Empty – κενόν – Also translated, "void" and "vacuum."

End – τέλος, ἄκρος

Endure – ὑπομένειν

Ensouled – ἔμψυχον – This could also be translated "animate." I prefer the former because it indicates to the English reader the root of the word, "soul," as does "animate" to the reader familiar with Latin. ("Animate" is from the Latin "anima," "soul." Both the Latin and the Greek words originally mean "breath," and are then extended to mean the principle by which the living thing breathes or, even more generally, is alive.) The word "soul" does not carry the connotations for Aristotle which it does for modern readers. We tend to think of it as implying immateriality, immortality, etc., but for Aristotle, it simply means whatever is the principle by which the living thing is alive. Thus, it is a matter for argument whether any soul is capable of existing without a body. Aristotle addresses this question in the *De Anima*: I, 1, 403a3–16; III, 4, 429a18–27; III, 5, 430a17–19; 22–23.

Equal – ἴσος

Equivocal – ὁμώνυμος – An equivocal name is a name used in more than one sense. It is opposed to the "univocal" name, which is used with one meaning. Thus, if I say, "I saw the movie and you saw the movie," the word "saw" is univocal; but if I say, "I saw the lumber and you saw the car," the word "saw" is equivocal. Equivocal words can be so by design, as when we extend the word "see" from physical sight to intellectual understanding. Cf. *Categories*, Ch.1, 1a1–6.

Eternal – ἀΐδιος, τὸ ἀεί

Ether – αἰθήρ

Evil – κακός

Excess – ὑπεροχή

Expansion – διαστολή

Experience – ἐμπειρία – For a more complete discussion of experience, Cf. *Metaphysics,* I, 1, 980a21–981a27.

Extreme – ἔσχατον, ἄκρος

Extremity – ἔσχατον

Fast – ταχύς

Finite – πεπερασμένον

Fire – πῦρ

First philosophy – πρώτης, φιλοσαφία – Often called "metaphysics," though not by Aristotle, or "theology," a name Aristotle does use. This deals with what can be defined without any matter at all (cf. *Metaphysics* VI, 1,1025b3–1026a32), e.g., being, unity, otherness, actuality, potency, etc. It is important to note that the subject of metaphysics, being as such (Cf. *Metaphysics* IV, 1) is only known to be a subject independent of natural philosophy through arguments from natural philosophy. The proof in the *Physics* that the first mover (or "prime mover") is immaterial (*Physics* VIII, 10) and in the *De Anima* (III, 4 and 5) that the intellect of the human soul is immaterial, found Aristotle's claim that the word "being" has an extension beyond the sensible world studied by the naturalist. Thus he says (*Metaphysics* VI, 1) that, if there were nothing beyond the sensible world, natural philosophy would be first philosophy. It is also important that the name "first philosophy" indicates that metaphysics has a kind of priority to natural philosophy, though one cannot study it first. The traditional name, "metaphysics," which literally means "after the physical (or 'natural') things," was perhaps well chosen, in that the study of metaphysics, though it deals with the most general subject, being as such, and with its causes, the first beings, must come after the study of nature. On the other hand, because these subjects are more universal and the causes of them are more universal, the name "first philosophy" and "theology" are also appropriate. Metaphysics emphatically does not mean, for the Aristotelian tradition, what we might mean by it in more current speech, i.e., studies going beyond the methods of modern science to look for more foundational principles even within the natural world, or what is sometimes called "epistemology," or even, God forbid, the study of crystals and palm reading.

Force – βία – This is not to be confused with "force" as used in modern physics, where it has a technical meaning which may be expressed as "what changes the state of motion or rest of a body," or "what produces a field." In Aristotle, the notion is more general, because it includes what causes motion or rest against the choice of a voluntary agent or the desire of an animal, or the nature of anything. More significantly, perhaps, Aristotle understands force to be against natural or appetitive inclination, whereas no such inclinations are considered by modern physics, except perhaps insofar as statistical physical laws may indicate a propensity in one direction or another.

Form – μορφή – This seems to name the term of a change, like the result of turning clay into a statue. It has an obvious parentage in Plato's "ideas" or "forms." What both thinkers are looking at is that within a thing in virtue of which it is what it is and remains stable in its being such. Sometimes it seems to be used synonymously with "species," sometimes it seems not to be so used. Cf. "species."

Friendship – φιλία – This word is used by Empedocles to name one of his two principles (the other is "strife"), which seem to be agent causes.

Genus – γένος – The translation "kind" or even "general name" might be preferable sometimes. I have sometimes translated this by "kind." Where the intention is clearly to speak of the logical genus, not just some kind (which in English seems to include the species), I have used "genus."

Geometry – γεωμετρία

Godlike – θεῖον

Good – ἀγαθόν, κάλλος, καλός

Great – μέγα

Growth – αὔξησις

Habit – ἕξις – Also translated as "state" and as "possession." This is also the word used in the *Categories* for the predicates which indicate that one is wearing something, "is shod," or "is armed," for example. I prefer, following Duane Berquist of Assumption College, to translate this use "outfit."

Hard – σκληρόν

Harmonics – ἁρμονική

Harmony – ἁρμονία

Heavens – οὐρανός

Heavy – βαρύς

Hot – θερμόν

Hypothesis – ὑπόθεσις – Also translated by "supposition." See also "make suppositions."

Ideas – ἰδέαι

Immobile – ἀκίνητος

Immobility – ἀκινησία

Immortal – ἀθάνατος

Impassivity – ἀπάθεια

Imperfect – ἀτελής, ἀτελεύτητος, ἀτέλευτος – Literally, "without end or completion." Also translated "incomplete."

Impossible – ἀδύνατον

Impulse – ὁρμή

In itself – καθ᾽ αὑτό – In Latin, "*per se*," "through itself." This is usually opposed to what is accidental, and would be defined negatively as "what is not due to another thing." This is why it is sometimes translated "essentially." "Essentially" goes too far, however, since some things do not belong to the "essence" or "nature" (in Aristotle's language, the "what") of a thing, but, because they are necessary consequences of what a thing is ("properties"), are nevertheless true of the thing in itself. Sometimes, on the other hand, the opposition is rather to what is through another. (Cf., e.g., 229b6.)

In between – μεταξύ

In vain – μάτην

Inborn – σύμφυτος

Incomplete – ἀτελής – Also translated "imperfect."

Incorruptible – ἀνόλεθρος

Indefinite – ἀόριστος

Indivisible – ἀδιαίρετος, ἄτομος

Induction – ἐπαγωγή – Discussed by Aristotle most completely in *Prior Analytics* II, 23, 68b8–37 and *Posterior Analytics* II, 19, 99b15–100b17.

Infinite – ἄπειρον – Literally, "without limit."

Inquiry – μέθοδος – Etymologically, the word is derived from the notion of "being on the road." It may be fittingly contrasted with ἐπιστήμη, "science," the etymology of which implies coming to a stand (at the end of a road inquiry). "Method" as understood by modern philosophers, e.g., Descartes, is a notion foreign to Aristotle. Aristotle's "method" (for he does have methods) is much less mechanical than the modern rationalists desire. Moreover, there is no general method sufficient to all sciences, as Descartes would have it. Logic is only a general method; each particular discipline has in addition methods appropriate to itself, and there is also a very general "method" by which the human mind ascends from sensation to intellection. Each of these roads, that of the human intellect as such, that of logic, and that of the particular discipline at hand, must be respected in order to come to full understanding.

Interval – διάστημα, ἀπόστασις

Invisible – ἀόρατος

Irregular – ἀνώμαλος

Irregularity – ἀνωμαλία

Irregularly – ἀνωμάλως

Kind – γένος – See genus.

Length – μῆκος

Light (adj. opposed to "heavy") – κοῦφον

Light (n. opposed to "dark") – φῶς

Limit –πέρας

Limited – πεπερασμένον

Line – γραμμή

Locomotion – φορά – Literally, "carrying" or "bearing." Aristotle extends the usual Greek word for carrying to any kind of change of place.

Logical – λογικός – An argument is "logical," in the sense used in this translation, not merely because it follows the rules of logic, but because it does not proceed from the proper principles of the subject under discussion but rather from common opinions, the opinions of the wise, or from logical notions such as genus, species, predicate, subject, etc. The word might also be translated "dialectical."

Luck – τύχη

Magnitude – μέγεθος

Make suppositions – ὑποθέσθαι – See also "hypothesis."

Mathematics – μαθηματική

Material – ὕλη

Measurable – μετρητός

Measure (n) – μέτριον, μέτρον

Measure (v) – μετρεῖν

Middle – μέσον

Mind – νοῦς

Mistake – ἁμαρτία

Mix – μῖγμα, μίξις

Mixture –μῖγμα

Mobile – κινητόν

Motion – κίνησις – See the note on "change."

Motive – κινητικός

Mover – κινοῦν – In the *Physics*, this is usually used of the agent cause of motion, not of the final cause, though in one place Aristotle grants that the expression might refer to the latter sort of cause. Cf. VII, 2, 243a3–4 or 243a32–33.

Moving – κινεῖσθαι– Cf. the note on "being moved."

Multitude – πλῆθος

Name – ὄνομα

Natural – φυσικός

Natural science – φυσική – This includes any study of natural beings. For this reason, I have not translated the word by "physics," which has come to be opposed to chemistry and biology. In Aristotle's usage, the study in question includes these and all other studies of natural beings. The present work is in a way the study of nature par excellence, because it is the first part of such a study, dealing as it does with the most universal aspects of natural or mobile being. See the Introduction.

Nature – φύσις

Necessary – ἀναγκαῖον

Necessity – ἀνάγκη

Negation – ἀπόφασις

Non-being – μὴ ὄν

Now – νῦν

Number – ἀριθμός

One – ἕν

Operation – ἔργον

Opposite – ἀντίθεσις – Also translated "opposition."

Optics – ὀπτική

Order – τάξις

Organ – ὄργανον – Also translated "tool."

Part – μέρος

Partible – μεριστός

Particular – καθ᾽ ἕκαστον – Literally, "according to each thing."

Partless – ἀμερής

Perfect – τέλειος – Also translated "complete."

Perfection – τέλος

Philosophy – φιλοσοφία – This is not so restricted for Aristotle as it is in modern usage. He includes in philosophy the study of any wisdom of any sort. The etymology of the word is, in fact, "love of wisdom." Thus, first philosophy, or metaphysics, is philosophy in a preeminent way, but the study of "physics" (or better, "natural philosophy") is also philosophy.

Place – τόπος – It is worth noting that translators will often translate ποῦ, "where," by "place," as for example in the Oxford translation of the *Categories*. This is at least not literal, and in some cases misleading. "Where" is the name of one of the ten highest genera, and is the "quality" of being in place, not the place itself. Thus, the examples Aristotle gives of this category are not "the Lyceum" and "the market-place," but "in the Lyceum" and "in the market-place," both of which can be said of an individual substance like Socrates or his dog. Locomotion is in the category "where," for a thing comes to be *in* a new place through locomotion, it does not come to *be* a new place. On the other hand, the word χώρα is also sometimes translated by "place," for example, in the Oxford translation of the *Physics* at 209a19 and 210a12. This too is misleading, for Aristotle is at pains to distinguish the two notions, and even considers the possibility that place is space, only to reject it. Cf. IV, 2, 209b6–17; 4, 211b14–29.

Point – σημεῖον, στιγμή

Position – θέσις

Possession – ἕξις – Also translated as "habit" and "state."

Potency – δύναμις – When used in an active sense, I have translated this by "power." This might also be translated, "ability," which would have the advantage of being easily used in both an active and a passive sense. It seems to me that adhering to such a translation would give rise to some confusing expressions.

Power – δύναμις– When used in a passive sense, translated "potency." See previous note.

Predicate – κατηγορία – What is said about something else. In the sentence, "The man is a genius," "genius" is the predicate or what is said of the subject, "man."

Principle – ἀρχή – This might also be translated "beginning." Principles can be in things or in thought. Thus, hydrogen is a principle of water, but the premise, "water can be broken down into hydrogen and oxygen," is a principle of the knowledge that hydrogen is a principle of water. We may go from or to the principles of things in our thinking, but what we start from will be the principle of our thinking in any case.

Prior – πρότερος

Privation – στέρησις

Productive – ποητικόν

Proportion – ἀναλογία – See note on "analogy."

Pulling – ἕλξις

Pushing – ὦσις

Pushing off – ἄπωσις

Pushing on – ἔπωσις

Quality – ποιόν, ποιότης

Rare – μανόν

Rarefaction – μάνωσις

Rarity – μάνωσις, μανότης

Ratio – λόγος – See note on "account."

Reason – λόγος – See note on "account."

Reasonable – εὔλογος

Reasonably – εὐλόγως

Receptive – δεκτικός

Regular – ὁμαλός

Relation – πρός τι

Relative – πρός τι

Rest – ἠρεμία

Revolution – περιφορά, κυκλοφορία

Science – ἐπιστήμη

Seed – σπέρμα

Sensation – αἴσθησις

Sense – αἴσθησις

Sensible –αἰσθητός

Separate – χωρίς

Separation – διάκρισις, χωρισμός, ἀπόκρισις

Shape – σχῆμα

Similar – ὅμοιος

Simply – ἁπλῶς

Slow – βραδύς

Small – μικρόν

Soft – μαλακόν

Solid – στερεόν

Sophistical – ἐπιστικός

Soul –ψυχή – See note on "ensouled," above.

Space – χώρα

Species – εἶδος – See note on "genus," above.

Speech – λόγος – See note on "account," above.

Speed – τάχος

Sphere – σφαῖρα

State – ἕξις – Also translated as "habit" and "possession."

Straight – εὐθύς

Strange – ἄτοπος

Strength – ἰσχύς

Strife – νεῖκος – An agent cause used by Empedocles; the counterpart of his principle "love."

Student of nature – φυσικός – Cf. note on natural science, above.

Subject – ὑποκείμενον

Substance – οὐσία – A substance is what is, simply speaking, like a man or a horse or a tree. The word might be translated "thing." It does not mean substance in the modern, chemical sense of the word, i.e., an element or compound, as opposed to a mixture. The Greek word οὐσία is derived from the feminine participle of εἶναι, "to be." However, its first nominal usage was to indicate property, especially permanent property. In this sense, it is like "substance" when used in the expression, "a man of substance," i.e., a man with great and permanent wealth. Later, the word came to mean "being," in the sense of that in which qualities like color and size inhere and which remains even while they come and go. This extension of the meaning is probably due to seeing that real estate and

other more or less permanent property endures through the generations and through many commercial transactions. The English word "substance" is derived from the Latin "sub" + "stare," and so indicates by its etymology that the thing named "stands under" its attributes. Thus, the temperature of a man inheres in the man: the man "stands under" the temperature. Substances are the fundamental kind of being, and are opposed to "accidents." See the note on "accident."

Subtraction – ἀφαίρεσις

Successive – ἐφεξῆς – Also translated "in succession."

In succession – ἐφεξῆς – Also translated "successive."

Suffer – πάσχειν

Suffering – πάθησις

Supposition – ὑπόθεσις – See also "hypothesis," "make suppositions."

Surface – ἐπίπεδον, ἐπιφάνεια

Tangible – ἁπτός

Term – ὅρος

That for the sake of which – τὸ οὗ ἕνεκα

The "why" – τὸ διὰ τί

The All – τὸ πᾶν

The middle – τὸ μέσον

This something – τόδε τι – Aristotle uses this expression, translated in Latin by "hoc aliquid," to indicate a particular existing substance, this man or this horse, without determining what sort of substance it is. Such a thing is "something," and it is a particular (a "this").

Thought – διάνοια, νόησις

Throwing – ῥίψις

Timber – ξύλον – Aristotle's word for "material," ὕλη, is derived from this word.

Time – χρόνος

Together – ἅμα – Also translated "at once," "simultaneous."

Touch (n) – ἀφή

Touch (v) – ἅπτομαι

Unchangingness – ἀμεταβλησία

Uncuttable – ἄτομος

Underlying – ὑποκείμεμον

Universal – καθόλου

Univocal – συνώνυμος – Cf. note on "equivocal," above.

Unlimited – ἄπειρον

Unmixed – ἀμιγής

Unmixedly – εἰλικρινῶς

Unmovable – ἀκίνητος

Unordered – ἀταξία

Unorganized – ἀρρύθμιστος

Unreasonable – ἄλογος

Unshaped – ἀσχημάτιστος, ἀσχηοσύνη

Unsouled – ἄψυχος – Cf. note on "ensouled," above. This might also be translated, "inanimate."

Up – ἄνω

Vacuum – κενόν – Also translated, "void" and "empty."

Violence – βία

Violent – βίαιος

Void – κενόν – Also translated, "vacuum" and "empty."

Vortex – δίνη

Weight – βάρος – Also translated by "heaviness."

What is capable of sharing – μεταληπτικός

What it is – τό τὶ ἔστι

What it was to be – τό τὶ ἦν εἶναι

When – ποτέ

Where – ποῦ

Whole – ὅλος

Work – ἔργον

World – κόσμος

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