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Princeton, 1967

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FURLEY, D. J.

1967

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TWO STUDIES
IN THE
GREEK ATOMISTS

STUDY I

Indivisible Magnitudes

STUDY II

*Aristotle and Epicurus
on Voluntary Action*

DAVID J. FURLEY

PRINCETON UNIVERSITY PRESS

PRINCETON, NEW JERSEY

1967

PART II

CHAPTER 3

PYTHAGOREAN "ATOMISM"

If the early Pythagoreans were atomists, then they were the first in the field. We should have to examine their atoms and the use they made of them, and turn a critical eye on the claims to originality which have been made for Leucippus and Democritus. We could not help regarding the growth of atomism as something begun by the Pythagoreans.

But I do not believe that the early Pythagoreans were atomists, in any but a trivial sense. There were certain important differences between their ideas and those of Leucippus and Democritus, which make it thoroughly misleading to apply the same name to both. Much of the demolition work on the hypothesis of Pythagorean atomism has already been done by others (particularly W. A. Heidel, Gregory Vlastos, and G. E. L. Owen) to whom I am greatly indebted.*¹ In this chapter and in chapter 5 I shall go over the most important evidence and try to strengthen the case they have made.

It seems certain that the Pythagoreans up to the time of Aristotle held the view that all things are made of number. Aristotle says² they thought that number is the first principle or cause of what exists, in the sense that number constituted both its matter and its properties and dispositions. That is to say, they did not distinguish, as Aristotle did, between material and formal elements; they said that number is the cause of things, and so, in Aristotle's opinion, wished to explain both material and formal properties by deriving them from number.

There are many senses in which this fundamental Pythagorean proposition may be taken. Aristotle himself complains, in a series of objections to those who assert that numbers are the first of things, that

it has never been determined in which of two senses numbers are the causes of substances and of being—whether as boundaries, as

* Please see end of chapter for numbered references.

points are of magnitudes . . . or that harmony is a proportion of numbers and so is man and everything else.^a

What are the alternatives offered by this ungrammatical sentence? Aristotle explains the first one:³

. . . as Eurytus used to determine what was the number of what (e.g., *this* is the number of man, *that* of horse) by representing the shapes of living things by means of pebbles, like the people who bring numbers into the shapes of triangle and square.^b

It is clear that Eurytus' procedure involved finding the number of pebbles with which one could make a sketch of the object in question in such a way as to distinguish it from other objects. In a comment on this passage, the writer called Pseudo-Alexander explains it in these words:

For the sake of argument, suppose the number 250 is the definition of Man, and the number 360 that of Plant; having laid this down, he [sc. Eurytus] used to take two hundred and fifty pebbles, some green, some black, some red, and of all kinds of color in fact. Then he would smear the wall with pitch and make a shaded drawing of a man or a plant; he fixed some of the pebbles in the drawing of the face, some in the hands, and so on, and thus completed the representation of the man with pebbles equal in number to the monads which he said defined man.^c

It is obvious, I think, that if Pseudo-Alexander is anywhere near right about Eurytus' procedure, there is really no question of this being "atomism." If 250 were the number of atoms in a man, it would follow that each atom weighed half a pound or more, and

^a οὐθὲν δὲ διώρισται οὐδὲ ὁποτέρως οἱ ἀριθμοὶ αἰτιοὶ τῶν οὐσιῶν καὶ τοῦ εἶναι, πότερον ὡς ὅροι (οἷον αἱ στιγμαὶ τῶν μεγεθῶν) . . . ἢ ὅτι [ὁ] λόγος ἢ συμφωνία ἀριθμῶν, ὁμοίως δὲ καὶ ἀνθρώπος καὶ τῶν ἄλλων ἕκαστον; (*Metaphysics* N 5, 1092 b 8-15.)

^b ὡς Εὐρύτος ἔταττε τίς ἀριθμὸς τίνος, οἷον ὁδὶ μὲν ἀνθρώπου ὁδὶ δὲ ἵππου ὥσπερ οἱ τοὺς ἀριθμοὺς ἄγοντες εἰς τὰ σχήματα τρίγωνον καὶ τετράγωνον, οὕτως ἀφομοίων ταῖς ψήφοις τὰς μορφὰς τῶν φυτῶν. (*Ibid.* 1092 b 10-12.)

^c κείσθω λόγος χάριν ὅρος τοῦ ἀνθρώπου ὁ συν ἀριθμὸς, ὁ δὲ τῆς τοῦ φυτοῦ. τοῦτο θεῖς ἐλάμβανε ψηφίδας διακοσίας πεντήκοντα τὰς μὲν πρασίνους τὰς δὲ μελαίνους, ἄλλας (δὲ) ἐρυθρὰς καὶ ὅλους παντοδαποῖς χρώμασι κεχωρσμένας· εἰτα περιχρίων τὸν τοῖχον ἀσβέστῳ καὶ σκιαγραφῶν ἀνθρώπου καὶ φυτὸν οὕτως ἐπήγγυ τάσδε μὲν τὰς ψηφίδας ἐν τῇ τοῦ προσώπου σκιαγραφίᾳ, τὰς δὲ ἐν τῇ τῶν χειρῶν, ἄλλας δὲ ἐν ἄλλοις, καὶ ἀπετέλει τὴν τοῦ μιμουμένου ἀνθρώπου διὰ ψηφίδων ἰσαριθμῶν ταῖς μονάσιν, ἃς ὀρίζων ἔφασκε τὸν ἀνθρώπου. (*Pseudo-Alexander Metaphysics* 827. 9ff.)

was correspondingly voluminous. This is fantastically implausible. Pseudo-Alexander may of course have invented the number 250 "for the sake of argument," as he says, but the fact still remains that nothing in his description supports the idea that Eurytus was trying to count a man's component atoms. Moreover, this commentator seems to know something about the subject, since he is able to report in a confident tone several details which do not appear elsewhere. There is perhaps no need to labor this point further; the arguments against reading atoms into the story here have been well put by J. E. Raven in his *Pythagoreans and Eleatics*, chapter 8.

What of Aristotle's second alternative—"that harmony is a proportion of numbers, and so is man and everything else"? Tradition credits Pythagoras himself with the discovery that the important musical intervals are expressible as simple numerical ratios. Aristotle means that as the ratio 2:1 defines the octave, so perhaps some other ratio defines man. The octave is a ratio between lengths of string (or some other material); Aristotle indicates later (1092 b 18) that the only way in which he could understand the ratio that defines man is as a ratio between constituent parts or tissues or perhaps of elementary bodies ("e.g., the essence of flesh or bone is number only in this way, three parts of fire and two of earth").

Aristotle hesitates, then, between two interpretations of the theory that number is the cause of all things: either both forms of the theory were advanced and no decision was taken between them or, more likely, his complaint is that the theory as proposed left it ambiguous which interpretation was to be preferred. Both interpretations are incompatible with atomism. The first asserts that the number of a thing is the number of points which can represent its shape; the second, that the defining "number" is a proportion. The first of these is clearly distinguished from atomism; atomism counts the particles right *through* a body, not just the bounding points. How the proportion theory contrasts with atomism will soon be explained further. Obviously, then, Aristotle had never heard of a theory asserting that the "number" of man is to be obtained by counting the indivisible particles in a man. If he knew of this interpretation, he would not have hesitated between two others.

Eurytus belongs to the late fifth or early fourth century B.C.;

there is a century of Pythagoreanism to be accounted for before he arrived on the scene. It may be argued that Aristotle's evidence, as we have considered it so far, does not touch the earliest stages of development, though if this is so, Aristotle is strangely silent about this chronological reservation.

J. E. Raven asserts that the generation of Philolaüs and Eurytus undertook a "post-Zenonian revision" of Pythagorean theory. Before this revision, the Pythagorean theory of matter was quite different: it was based on the proposition that "all is number," in the sense that everything is defined by the number of "unit-point-atoms" it contains. "When . . . Aristotle speaks of number as . . . 'functioning as the material element in things,' or when as he often does he asserts that the Pythagoreans regarded the universe as consisting of numbers, he means that concrete objects were literally composed of aggregations of unit-point-atoms." ⁴What is the evidence for this early Pythagoreanism?

Paul Tannéry was, I think, the first to attribute a kind of atomism to the Pythagoreans; and he did so in order to provide a target for Zeno's criticisms. "Pour les pythagoriciens, le point est l'unité ayant une position, ou autrement l'unité considérée dans l'espace. Il suit immédiatement de cette définition que le corps géométrique est une pluralité, somme de points. . . . D'ailleurs, à cette époque, aucune distinction ne pouvait encore exister entre un corps géométrique et un corps physique; les pythagoriciens se représentaient donc les corps de la nature comme formés par l'assemblage de points physiques."⁵ Apart from the added bite which this hypothesis gives, so he thought, to Zeno's criticisms, Tannéry produced no more evidence for Pythagorean atomism.

Tannéry's evidence quite failed to support his conclusion, as many scholars have shown—particularly Gregory Vlastos (1953). The definition of a point as a "monad with position" is often mentioned by Aristotle, without being ascribed peculiarly to the Pythagoreans. As a matter of fact, Aristotle regards it as acceptable himself; at least, in his own definition, in *Metaphysics* Δ 6, he makes the point exactly analogous to the monad:

In general, the one is indivisible, either in quantity or in form. Now as to the indivisible in quantity, if it is totally indivisible and

without position, it is called a *monad*, but if it is totally indivisible and *has* position, it is called a *point*.^d

If the mere consenting use of the “monad with position” for a point were enough to make an atomist, then Aristotle might be called an atomist.

However, Aristotle does differ from the Pythagoreans, by his own account. The exact nature of this difference has often been mistaken, I think, because Aristotle’s analogy between the monad and the point is not exact, and it seems that he was not fully aware of the discrepancy. The monad, he says, is totally indivisible *and is also the unit of measure*; the point, on the other hand, is not a unit of measure. He explains this in a discussion of the meaning of “unity” which is of the greatest importance for our present problem.

To be one is to be indivisible, . . . or to be whole and indivisible, but especially to be the first measure of each kind and above all of quantity. . . . Measure is that by which quantity is known, and quantity as such is known by means of a unit or by means of number; but all number is known by means of a unit, so that all quantity as such is known by the unit, and that by which ultimately quantities are known is *ipso facto* a unit; so the unit is the starting point of number as such. Hence in other cases too “measure” means that by which each thing is ultimately known, and the measure of each thing is a unit—in length, breadth, depth, weight, speed. . . . In all these cases, then, the measure and the starting point is one and indivisible, since even in lines they treat one foot as atomic.^e

The unit of measure for number is called a monad; this, he adds, is the most exact of all such units, because the monad is *in every way indivisible*, whereas other units are used by analogy with it. It could

^d πανταχοῦ δὲ τὸ ἐν ἡ τῷ ποσῷ ἢ τῷ εἶδει ἀδιαίρετον. τὸ μὲν οὖν κατὰ τὸ ποσὸν ἀδιαίρετον, τὸ μὲν πάντῃ καὶ ἄθετον λέγεται μονάς, τὸ δὲ πάντῃ καὶ θέσιν ἔχον στιγμῇ. (*Metaphysics* Δ 6, 1016 b 23–26.)

^e τὸ ἐν εἶναι τὸ ἀδιαίρετῳ ἐστὶν εἶναι, . . . ἢ καὶ τὸ ὅλῳ καὶ ἀδιαίρετῳ, μάλιστα δὲ τὸ μέτρῳ εἶναι πρώτῳ ἐκάστου γένους καὶ κυριώτατα τοῦ ποσοῦ . . . μέτρον γάρ ἐστιν ὃ τὸ ποσὸν γινώσκεται· γινώσκεται δὲ ἡ ἐν ἡ ἀριθμῷ τὸ ποσὸν ἢ ποσόν, ὃ δὲ ἀριθμὸς ἅπας ἐνί, ὥστε πᾶν τὸ ποσὸν γινώσκεται ἢ ποσὸν τῷ ἐνί, καὶ ὃ πρώτῳ ποσᾷ γινώσκεται, τοῦτο αὐτὸ ἐν· διὸ τὸ ἐν ἀριθμοῦ ἀρχὴ ἢ ἀριθμός. ἐντεῦθεν δὲ καὶ ἐν τοῖς ἄλλοις λέγεται μέτρον ὃ πρώτῳ ἑκάστου γινώσκεται, καὶ τὸ μέτρον ἐκάστου ἐν, ἐν μήκει, ἐν πλάτει, ἐν βάθει, ἐν βάρει, ἐν τάχει . . . ἐν πᾶσι δὲ τούτοις μέτρον καὶ ἀρχὴ ἐν τι καὶ ἀδιαίρετον, ἐπεὶ καὶ ἐν ταῖς γραμμαῖς χρῶνται ὡς ἀτόμῳ τῇ ποδιαίᾳ. (*Ibid.* I 1, 1052 b 16–33.)

hardly be clearer: whereas the monad is the unit of measure for counting number, the *foot* (not the point) is the unit of measure for measuring lines. Aristotle adds that of course the foot is indivisible in a different sense (the text says “with respect to our sense perception”) from the monad, because the foot is a continuous magnitude and everything continuous is divisible.

So the analogy between the point and the monad breaks down. But Aristotle continues to use it, and so it cannot be merely the use of the analogy that he objects to in the Pythagoreans. What he does object to is that they identify the abstract monad, which is the unit of measure in number, with the unit of measure in magnitude:

The Pythagoreans say there is just one kind of number, namely the mathematical kind, only it is not separate but they say sensible substances are made out of it. They make the whole universe out of numbers, but not numbers composed of monads [i.e., monads in the Aristotelian sense, the altogether indivisible units of number] but they lay it down that their monads [i.e., the units of which *their* number is composed] have magnitude.^f

The monad—that is, the abstract unit which is the “starting-point” of number—is altogether indivisible, in Aristotle’s view. So when the Pythagoreans identified the monad with the unit of spatial magnitude, he took it to mean that the unit of spatial magnitude was also altogether indivisible; and this for him constitutes a great objection to their theory:^g

The Pythagorean way in one sense has fewer difficulties than those I have previously mentioned [sc. some theories of the Platonic school], but in another sense it has others peculiar to itself. Not making number *separate* removes many of the impossibilities; but that bodies are composed of numbers, and that this number is the number of mathematics—this is impossible. For (a) it is not true to say that there are indivisible magnitudes. And (b) even if this were the way of it, *monads* at least do not have magnitude, and how can there be a magnitude composed of indivisibles? Yet the number of arithmetic *is* made of monads, and they say that real

^f καὶ οἱ Πυθαγόρειοι δ’ ἓνα [φασὶν εἶναι ἀριθμόν], τὸν μαθηματικόν, πλὴν οὐ κεχωρισμένον ἀλλ’ ἐκ τούτου τὰς αἰσθητὰς οὐσίας συνεστάναι φασὶν· τὸν γὰρ ὅλον οὐρανὸν κατασκευάζουσιν ἐξ ἀριθμῶν, πλὴν οὐ μοναδικῶν, ἀλλὰ τὰς μονάδας ὑπολαμβάνουσιν ἔχειν μέγεθος. (*Ibid.* M 6, 1080 b 16–20.)

things are number—at least, they apply their theories to bodies on the supposition that bodies are made of those numbers.⁸

In this passage, what Aristotle attributes to the Pythagoreans themselves must be carefully distinguished from what he regards as the objectionable consequences of their view.⁷ He certainly saddles them with the proposition that bodies are composed of numbers; and he says in the last clause that they treat the numbers of which bodies are composed as if they were the numbers of arithmetic. His last sentence states, as an afterthought, the explicit grounds on which his objections were made. Pythagorean number was just the ordinary arithmetical number. But (as all his readers know) the units of ordinary arithmetical numbers are the altogether indivisible monads. So the Pythagoreans were trying to compose their bodies out of indivisibles. But (a) there cannot be indivisible *magnitudes*—Aristotle has proved this elsewhere. And (b) *monads* have no magnitude anyway, being totally indivisible; and it is impossible to compose a magnitude from units that are totally indivisible and without magnitude.⁸

This analysis of Aristotle's argument shows, I think, that it was Aristotle himself who brought together the two properties "with magnitude" and "altogether indivisible." He did so because the *Pythagoreans* said that magnitudes are composed of monads, and he knew that monads are altogether indivisible units. I can see no ground here for attributing the almost technical phrase "atomic magnitudes" to the Pythagoreans. J. E. Raven (in *Pythagoreans and Eleatics*, p. 56) disagrees with this view, and adds: "In any case—and this is the important point—whether or not the Pythagoreans had actually spoken of *ἄτομα μεγέθη*, a belief in their existence does follow, as a logically inevitable consequence, from other propositions which they had undoubtedly accepted. If (i) bodies are composed of

⁸ ὁ δὲ τῶν Πυθαγορείων τρόπος τῇ μὲν ἐλάττωσι ἔχει δυσχερείας τῶν πρότερον εἰρημένων, τῇ δὲ ἰδίᾳ ἐτέρας. τὸ μὲν γὰρ μὴ χωριστὸν ποιεῖν τὸν ἀριθμὸν ἀφαιρεῖται πολλὰ τῶν ἀδυνάτων· τὸ δὲ τὰ σώματα ἐξ ἀριθμῶν εἶναι συγκεῖμενα, καὶ τὸν ἀριθμὸν τοῦτον εἶναι μαθηματικόν, ἀδυνάτον ἐστίν. οὔτε γὰρ ἄτομα μεγέθη λέγειν ἀληθές· εἴ θ' ὅτι μάλιστα τοῦτον ἔχει τὸν τρόπον, οὐχ αἱ γε μονάδες μέγεθος ἔχουσιν, μέγεθος δὲ ἐξ ἀδιαίρετον συγκεῖσθαι πῶς δυνατόν; ἀλλὰ μὴν ὁ γ' ἀριθμητικὸς ἀριθμὸς μοναδικὸς ἐστίν· ἐκείνοι δὲ τὸν ἀριθμὸν τὰ ὄντα λέγουσιν· τὰ γοῦν θεωρήματα προσάπτουσι τοῖς σώμασιν ὡς ἐξ ἐκείνων ὄντων τῶν ἀριθμῶν. (*Ibid.* M 8, 1083 b 8–19.)

units, (ii) the unit is indivisible (an axiom common to all Greek mathematics), and (iii) units have size, it is impossible to evade the two conclusions that Aristotle voices, that indivisible magnitudes exist and that units have weight." After the preceding discussion, it will perhaps be clear what has gone astray in this argument. It all depends on the sense of "unit" and the sense of "indivisible." As a matter of fact, Aristotle, or indeed any other Greek, could assent to these propositions, if the unit is the cubic foot, and "indivisible" is taken only in the weak sense in which Aristotle speaks of the foot as indivisible in the passage I have quoted from *Metaphysics* I 1. The assertion of these three propositions does *not* commit anyone to a belief in "atomic magnitudes" in the strong, technical sense—that is, altogether indivisible magnitudes. The thesis of "atomic magnitudes" follows only if the unit in question is altogether indivisible. Aristotle appears to attribute the thesis to the Pythagoreans (in an offhand sort of way, which would be hard to explain if they had asserted it explicitly) *only* because they identified the unit of arithmetic which he regarded as altogether indivisible with the unit of spatial measurement.

If my analysis of Aristotle's evidence is correct, it attributes atomism to the Pythagoreans *only* if their monads were altogether indivisible—that is, only if they used the term "monad" in the strict and precise sense in which it was used by Aristotle. I can see no reason to attribute such precision to them, and I am therefore not convinced that Aristotle's evidence has any tendency to make atomists out of them. On the contrary, I think there are good reasons for saying that they were *not* atomists, and we must now turn to this side of the argument.

It is well known that the Pythagoreans made numbers the elements of more than just concrete physical objects. Aristotle seems to know of statements which attribute number to justice, soul, mind, opportunity, and marriage; and these are only examples.⁹ If concrete objects, though, are made of numbers in the sense that "each such object consisted of a definite number of unit-point atoms,"¹⁰ how would the same numbers add up to justice, or to mind, or marriage? It is an objection that has been made often from Aristotle onward,¹¹ and has never been satisfactorily answered.

Gregory Vlastos writes,¹² "Our best clue to the whole meaning of the theory that 'things are numbers' is surely the Pythagorean discovery of the numerical formulae for the concordant intervals in music which must have been the scientific source of the whole theory. Here there could be no question of number-atomism. Thus the $\frac{1}{2}$ ratio for the octave would only mean that the numbers 1, 2 would be assigned to *any* pair of homogeneous strings the first of which was half the length of the second (cf. Van der Waerden, 'Die Harmonielehre der Pythagoreer,' *Hermes* 78, 1943, 163ff.). It would be absurd to suggest that the numbers 1, 2 could be considered by any mind, no matter how bemused by numerology, the numbers of the 'spatially extended units' composing the strings." It is not so implausible, of course, that 1, 2 should be the numbers of the "spatially extended units" of the strings, if the units may be feet or meters or whatever.¹³ What is fantastic (I agree wholeheartedly with Vlastos) is that these should be the numbers of *atomic* units composing the strings.

It is clear, I think, that the Pythagorean method relied on finding proportions, and not on counting atomic constituents. It is the proportion 2:1 which constitutes the octave, no matter what the units may be. It is still fairly obscure what proportion could determine justice or marriage, but it is very much less difficult to conceive of this than of a group of atoms which might perhaps cease to make up justice and instead make a pyramid or a brick.

The emphasis on proportion is also proved by the Pythagoreans' known interest in *particular* numbers. For an atomist, who believes that things are made of a number of indivisible pieces, there is no special magic about the first few numbers. If one man or brick is larger than another, it simply means that the larger has more atoms than the smaller. Since portions large enough to be *seen* are as a rule obviously divisible, atoms must as a rule be too small to be seen by themselves; hence concrete objects must be composed of rather large numbers of atoms. The Pythagoreans, however, were fascinated by particular numbers, especially the decad. The importance of the decad emerges from many passages, but particularly from the long quotation from a work by Speusippus called "Pythagorean Numbers," preserved in the *Theologoumena Arithmetica*.¹⁴ Speusippus

is said to have used the writings of Philolaüs as his source; his evidence is therefore rather late for the present purpose, but it probably gives a true picture of an original Pythagorean way of thinking. "Ten," he says, "is a perfect number, and rightly and naturally all of us, Greeks and all mankind, end at ten whenever we are counting. . . ." Aristotle confirms¹⁵ that for the Pythagoreans "ten is thought to be something perfect and to embrace in itself the whole nature of number." The reasons for this view of the number ten are set out by Speusippus; they are well known, and need not be repeated here.¹⁶ It is not suggested in any of them that the magic of the number ten derives from or extends to concrete objects made of ten "unit-point-atoms": the reasons have to do with shapes and proportions.

Early Pythagorean cosmogony, in so far as it can now be discovered, also seems incompatible with atomism. As I have shown above, the thesis that the Pythagoreans were atomists depends on the assumption that the monad is for them something that has magnitude *and* is altogether indivisible. Yet this monad with magnitude is something created; and when the first of them is created the first action that it performs is to divide into two. At least, this appears to be the case; Aristotle says,¹⁷ "When the one was composed (whether out of planes or surface or seed or elements they cannot describe), at once the nearest part of the Infinite was drawn in and limited by Limit." Elsewhere,¹⁸ he observes that the void enters the cosmos from the Infinite, being in fact breathed in, and separates things off, "on the ground that void is a kind of separation and distinction between adjacent things; and this" (said the Pythagoreans) "happens first in number, for the void distinguishes their natures." Alexander, possibly quoting from Aristotle's lost work *On the Pythagoreans*, reports¹⁹ that the monad first divided to form the dyad, and so on to form the triad, and the other numbers in succession. These witnesses and others who might be quoted leave many gaps in our knowledge, but it seems fairly clear that the number series was not regarded as primitive or elementary by the Pythagoreans: the numbers were somehow generated, in succession, by the imposition of Limit upon the Infinite, and the first limiting agent appears to have been the first Monad. "The first unit," Raven

writes,²⁰ "begins to breathe in and limit the Unlimited, and the first outcome of its activity is, *by its own division and extension*, the generation of the number 2" (the italics are mine). So much for the alleged axiom that the unit is absolutely indivisible.

The number two, for the Pythagoreans, is also the line, and three is the plane and four the solid; hence the generation of the number series is also the generation of solid bodies. This confusion between arithmetic and geometry, as it has often been said, is explained more easily when one remembers the habit of writing numbers by arranging dots or alphas in patterns. This habit is amply described by Cornford and Raven and needs no further elaboration; but the question arises whether this feature of Pythagoreanism itself proves that they were atomists. The answer is clearly no. Three is the triangle in the sense that any triangle presupposes the number three: it has three elements in it. There is nothing in the theory that requires the elements to be atoms.

If all the contrary evidence is ignored and it is still insisted that the Pythagoreans were atomists, then it must be asked how their theory was supposed to account for change in the natural world. We know that there was a cosmogony: the atoms were generated, not original. The original monad was not an atom, since it divided in order to produce two. None of the units first produced were atoms, if they went on dividing, as it seems they did. Eventually, however, these productive units must have died, as it were; they ceased breathing void in and ceased dividing; atoms were finally produced. At this stage it seems that a completely different set of processes must have taken over. If natural change was to be explained at all (and surely that must have been a feature of any cosmology after Anaximander?), it could only be by rearrangement of atoms. It seems to me quite extraordinary that we should hear nothing at all about these features of their philosophy. There is, after all, an enormous quantity of Pythagorean literature: I have never seen any mention of a distinction between monads which are productive and divisible and monads which are atomic, nor any account of natural change which differs from their cosmogony. I find the conclusion inescapable that there were no such distinctions.

One further point should perhaps be cleared away. The dis-

covery of incommensurables is well known to have caused the Pythagoreans some embarrassment: the discoverer is sometimes said to have been drowned in punishment for some indiscreet revelation connected with this subject.²¹ It should be observed that their embarrassment does not entail that they were atomists. Probably the discovery was first made through studying the pentagram, according to the arguments of von Fritz, Junge, and Heller. It was proved that each diagonal was cut by another in a ratio which could not be expressed in whole numbers of any units whatever. But this is true, and equally embarrassing to those who believe that "all is number," whatever the unit may be; it makes no difference whether the unit is atomic or not.

As a matter of fact, the earliest known method of determining proportion, which was probably the method by which incommensurability was first discovered, itself points to the use of varying, non-atomic units. The method is called *ἀνταίρεσις*, or "reciprocal subtraction."²² To determine the proportion between two lengths A and B , of which A is the greater, first subtract B from A as many times as possible, leaving a remainder C . Then subtract C from B in the same way leaving a remainder D . Then subtract D from C . . . until no remainder is left. The first length which can be subtracted thus without leaving any remainder is the unit in terms of which the proportion $A:B$ can be expressed. Clearly the unit will vary according to what these lengths A and B are; and (to clinch the point that these units are not atoms) the units composing A may be different if A is compared not to B but to a different length Z .

To sum up this chapter, then, I conclude that the Pythagoreans were no more atomists than Aristotle was. In some contexts, they held that the unit had magnitude; but this, I have argued, does not make them atomists, since they used variable units.

But this chapter has left out of account what has always been the main prop for the structure of Pythagorean atomism—Zeno. We must now turn to the Eleatics.

NOTES TO CHAPTER 3

1. Heidel (1940), Vlastos (1953 and 1959a), Owen (1957-58).
2. *Metaphysics* A5, 986 a 15.
3. Theophrastus (*Metaphysics* 6 a 19) tells us that the authority for attributing this to Eurytus is Archytas.
4. Kirk and Raven (1957), pp. 247-248.
5. Tannéry (1887), pp. 250-251.
6. My analysis of this passage is a little different from the usual one and requires some minor alterations to the punctuation given in Ross's text: see note 8.
7. My analysis may be contrasted with Raven's (1948), pp. 53-57.
8. See note 6. My paraphrase assumes that ἀδιαπέρων in line 15 is taken by Aristotle to be entailed by οὐ . . . μέγεθος ἔχουσιν in the previous line. The mutual entailment of "indivisible" and "without magnitude" is a commonplace for Aristotle.
9. *Metaphysics* A 5, 985 b 26; M 4, 1078 b 21.
10. Kirk and Raven (1957), p. 249.
11. *Metaphysics* A 8, 990 a 22.
12. Vlastos (1953), p. 33.
13. Raven (Kirk and Raven, 1957, p. 247) writes: "the Pythagoreans did indeed assume, even though the assumption was only tacit, that units are spatially extended." The evidence seems to show that Pythagorean units were sometimes but *not always* regarded as spatially extended.
14. Conveniently accessible in DK 44 A 13.
15. *Metaphysics* A 5, 986 a 8.
16. See Kirk and Raven (1957), pp. 229-230.
17. *Metaphysics* N 3, 1091 a 15.
18. *Physics* Δ 6, 213 b 22.
19. *Metaphysics* 512.37.
20. Raven (1948), p. 50.
21. DK 18 A 4.
22. See Junge (1958) for a very clear explanation of this.

CHAPTER 4

THE ELEATIC CONCEPT OF AN
INDIVISIBLE BEING

THE first undoubted assertion of an indivisible being was made by Parmenides. Melissus, his supporter, gave a lead to the Atomists, as has often been observed, when he said: "If there were many things, they would have to be of the same description as I say the One is."¹ How would Melissus describe his "One"? Was its indivisibility the same as that which belonged to Parmenides' "One"?

Parmenides announced his intention of proving that Being is a "single whole" in the opening lines of the "Way of Truth."² He kept his promise later:

Nor is it divisible, since it *is*, all alike; it is not any *more* here, which would prevent it holding together, nor any *less*, but all is full of being. So being is continuous (holds together); for being is next to being.³

If I understand Parmenides' argument correctly, he tried to show first that there could be no coming-to-be or passing-away, and hence that there could be no degrees of being; a thing must either *be* in a total sense, or not be. Then he picked up this conclusion; if it *is* in a total sense, then there can be no differentiation in it at all. There is nothing but total being everywhere.³ Thus a would-be divider can find nothing on which he can get a purchase. Wherever he considers what exists, it is all exactly the same.

Study confidently things distant, as being all similarly present to the mind; for you will not cut off being from its clinging to being,

* Please see end of chapter for numbered references.

^a οὐδὲ διαίρετόν ἐστιν, ἐπεὶ πᾶν ἔστιν ὁμοιον
οὐδέ τι τῇ μᾶλλον, τό κεν εἴργοι μιν συνέχεσθαι,
οὐδέ τι χειρότερον, πᾶν δ' ἐμπλεόν ἐστιν ἐόντος.
τῷ ξυνεχὲς πᾶν ἐστιν· ἐὼν γὰρ ἐόντι πελάζει. (Parmenides B 8, 22-25.)