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Questions the commonly assumed idea that early Greek philosophy was characterized by a dichotomy between the philosophers, like the Milesian cosmologists, who introduced a philosophy of matter, and the Pythagoreans, who advocated a philosophy of form. Regards the opposition between matter and form, at that stage of the development of ideas, as anachronistic, both too primitive and too modern, which is mostly the result of Aristotle's interpretation of his predecessors. Argues that recent developments in physics, specifically related to new mathematical conceptions of reality (e.g., Einstein's and Heisenberg's notion of fields in space) have cast a shadow of doubt on the absolute distinction between matter and form, a circumstance which calls for a reappraisal of the ancient Pythagorean principles. Ref. 100.

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EARLY PYTHAGOREAN PRINCIPLES: PERAS AND APEIRON

I. Pythagoreans in the History of Philosophy

It is commonly assumed that the Pythagoreans, the Italian school of philosophy, advocated and introduced a philosophy of form or structure in contrast to earlier Ionian philosophy of matter.¹ Presumably by form/structure something like the Aristotelian form-matter distinction is presupposed.

Now judging from the best extant evidence, Aristotle's report in *Metaphysics* A, it appears that (a) the Pythagoreans are thought *different* from the physiologoi by their use of stranger elements: non-sensible, immovable, mathematical objects (989b29-32, cf. 1090a32-5).^{*} However, (b) they *agree* with the physical philosophers that the real is just all that which is perceptible (989b33-990a5). Plato complains that the Pythagoreans are too empirical (*Rep.* 531c).

As for (a), the Pythagoreans seem to speak of another heaven and other bodies, not of the sensible (1090a31-5, cf. 1083b17-19, 990a6-8). The Eleatics somewhat similarly, but more madly (Pythagoreans distinguished from physiologoi (989b29ff, 1053b10-16) but grouped with them against Eleatics (986b8ff)), go beyond senseperception in postulating a higher, unitary and immovable reality (demanded if knowledge is to be possible), but yet, as the Pythagoreans (989b29), transfer the description of that to sensible things (*Cael.* 298b20-5, *GC* 325a2-23). Cf. also Heraclitus' hidden reality (frg. 123).

As for (b), that the real is identical with the perceptible, this is common belief among the Presocratics according to Aristotle (Empedocles, Democritus, Parmenides, Anaxagoras 1009b12-1010a3; cf. *Cael.* 298b22-3 for Eleatics and *DA* 404a27ff for Democritus. Cf. also the general opinion that reality is in motion (*DA* 405a28-9) and Heraclitus' everliving fire which is material but not percepti-

ble to us: exhalation (= soul?) is "very much disembodied" *DA* 405a25-7). This does not appear to be fair as a general comment on the Presocratics, but Aristotle gives us the reason too: the earlier thinkers assert the identity of understanding and perceiving, supposing thinking to be, like perceiving, something bodily and that both are of like by like (*Met.* 1009b12-15, *DA* 427a21-8).² One may feel tempted to take this as no more than Aristotle's interpretation of the Presocratics ("say" = "must say", cf. *GC* 314a8-10). However, even if they did not explicitly say that knowledge is senseperception, they undoubtedly assimilated the former to the latter (cf. also *DA* 410a25-6 and Hicks' note).

II. Two Traditions of Pythagorean Principles

Aristotle's main account (*Met.* A5) of the Pythagoreans contemporary with and before the atomists, after the general doctrine of number/thing likenesses, is two-fold:

(a) the Pythagoreans think that number is the principle (*arche*) both as matter for things and as their modification and states, that the elements of number are the even and the odd (unlimited and limited) and that the One proceeds from both of these and number from the One (986a16-21).

(b) Other members of the same school say there are ten principles arranged in two columns of cognates: limit/unlimited, odd/even, one/plurality, right/left, male/female, resting/moving, straight/curved, light/darkness, good/bad, square/oblong (986a22-b2). (b) is early Pythagoreanism for the following reasons:

Connection with Alcmaeon and the fact that limit/unlimited and thus, one assumes, the closely related odd/even are not his but special to the Pythagoreans (987a13ff, cf. 990a8-10). Moreover, we may take it that the widest and most comprehensive, that from which the others have a chance of being deducted, limit/unlimited, heading the list is also most basic (thus good/bad belong to limit/unlimited (*EN* 1106b29-30). Cf. also Heidel's ethical argument and Burkert 32-3 n. 25). Also, in Pythagorean cosmogony, which appears to be archaic (air = empty space), this pair is used (1091a12-18). The same cosmogony seems also to point to the originality of male/female (1091a16) and the anyway ancient pair light/darkness (seed) 1091a16, 1092a32) and central fire (*Cael.* 293a19)/air or mist). The same applies to one/plurality (*On Pyth.* frg. 10 Ross, *Phys.* 213b22). With odd/even goes the pair square/oblong, the graphic representation of number being an ancient form of thinking in relatively concrete terms (1092b11-12, *Phys.* 203a10ff). Cf. Burkert 427ff, Heath *Gk. Math* I, 76-84. It cannot of course be proved that the whole decalogue is early, but it seems apriori likely that the number of antitheses was complete (ten) from the start (*On Pyth.* frg. 10 Ross) and there seems no conclusive evidence against. Cf. the rather optimistic view of Guthrie (I 232-3), with the more cautious Vlastos 167-8.

The following characteristics of the two traditions may be noted: (a) is concerned with *ontology* (or numerology/cosmology) and involves certain positions

that seem peculiar to it: 1) the elements of number are even/odd (*On Pyth.* 13 Ross, 986a17-18), 2) the one is generated (986a19-20, 1091a15, *On Pyth.* 13 Ross), 3) use of *peperasmēnon* for limit, 4) good/bad are not principles (1075a36), but effects of a cause (1072b30). (b) is a list of *values* (*On Pyth.* 10 Ross, *EN* 1096b6). In the sequel we shall be mainly dealing with tradition (a).

III. The Nature of the Principles

Now, how are these Pythagorean principles to be conceived? One might think that being the elements of number they would be fairly abstract entities. However, numbers, being identical with things themselves (987b28, 1090a22-3, 32, 990a23), are *not* abstract (see further below), and Aristotle looking through his own spectacles of form/matter concludes that the Pythagorean contrary principles seem to have been ranged under the head of *matter*: "for out of these as immanent parts they say substance is composed and moulded" (986b4-8). By "substance" we are here to understand "individual things" (substance in the sense defined 1017b10-14, cf. 24; 1028b8-16). "Composed" and "moulded" are as concrete as possible in their implications.

However, in contrast to the earlier materialists the two principles of finitude (*peperasmēnon*) and unlimited [and the one] are not certain other natures (*physeis*) like fire, earth, etc., but they are themselves the *substance* (*ousia*) of the things of which they (sc. the one, unlimited) are predicated (987a15-19).³ The point of this obscure saying appears from several restatements of the basic tenet of the Pythagoreans: the one is substance and not a predicate of something else (987b22-3), being and the one are nothing else (in need of a substrate) but themselves substances (1001a4-12, 996a6-8), the problem whether the one itself is a substance or there is an underlying nature (1053b11-13). This appears to imply that finitude and unlimited are thought by Aristotle to be substances in the above mentioned sense of *individual things* (the "ultimate substratum" of 1017b24).⁴ Evidently then Aristotle thinks that the Pythagoreans should be grouped with the materialists (cf. *hypokeimēnon* used of the principle of the first philosophers (984a22, 29), *kai* (986a16) and *kata ton auton* [*tropon* (987a14)]).⁵

The Pythagorean interest in definition is seen as something different (note the transition 987a19-22). The Pythagoreans showed a beginning but superficial interest in definition of essence (987a20-7, cf. 1036b8ff with Alex. in *Met* 512.20 and frg. 13 (p. 138 in Ross)). Aristotle now deals with substance in the sense of essence, the object of definition (cf. 1017b21-3). We seem then to have Aristotle playing around with two sides of his doctrine of substance: first (a) as an individual (*tode ti*), second (now) (b) as an essence (*ti esti*). (a) implies the substance/attribute distinction, whereas (b) concerns a distinction between essential and accidental predication. Cf. (a) primary and (b) secondary substances of the *Categories*. In so far as Aristotle is now suggesting that the Pythagoreans dealt with *secondary substances* he is definitely attributing *abstract* (incorporeal) principles to them. He does not in so many words say that he is still speaking of the

principles, but he is still concerned with the substance (of things), now under the definable aspect (987a20-3). How do we reconcile this very Aristotelian report with the material contrary principles we set out with above?

IV. The Nature of the Unlimited

It may be suggested that there actually was a certain asymmetry between *peras* and *apeiron* in that *only* the latter is fully material (*hyle* 988a24-27). Cf. the Platonic development (987b20ff) of the Pythagorean unlimited from being one to a duality/the great and the small (= material principle, whereas the One is essence). This suggests an asymmetry in the conception of the principles as material.

However, in the *Physics* 203a Aristotle contrasts the Pythagoreans and Plato with all the physicists in that they make the unlimited a principle in the sense of a self-subsistent (material) substance *just as* the One (*peras*) was argued to be a self-subsistent substance (cf. above). So the two principles seem to be on a par.

The unlimited does indeed seem *passive* and *limit* active in the cosmogony: when the one (*monas*) has been constructed immediately the nearest part of the unlimited began to be constrained and limited by the limit (1091a12-18). Similarly, in the *Physics* (213b22-27) we are told that "the void enters into the heaven from the infinite breath (*pneumatōs*, cf. MSS), the heaven being supposed to breathe in the actual void." This idea of a breathing heaven is commented on by Simplicius (*In Phys.* 651.26): "They say that the void enters the cosmos as if it breathed in a sort of breath from that which lies outside," and Stobaeus (*Ecl.* 1, 18, 1c) says that Aristotle in his work on the Pythagoreans writes that the universe from the unlimited draws in time, breath and void (= Arist. frg. 13 Ross). There is here a definite identification of the unlimited with breath and void which seems ancient.⁶ The infinite breath (213b22) is to some extent reminiscent of Anaximenes' cosmic air (frg. 2) and possibly also of Anaximander's fertile infinite (cf. *Phys.* 187a20ff, 203b10-15) and is therefore perhaps best conceived of as a chaotic war-fare of Ionian opposites (hot-cold, dry-wet, etc.). Cf. Plato, *Polit.* 273d: limitless sea of unlikeness and *Phil.* 24a-e, 25de, *Tim.* 52df: irregular solids. Movement belongs to the unlimited because it was thought of as indefinite (*Phys.* 201b19ff), but it is *passive* motion in the sense that it is disorderly, without a goal/limit. However, the unlimited is probably *evil* (*EN* 1106b28, cf. 1072b30) in contrast to Anaximander's infinite and Anaximenes' infinite air that are divine: instead of Ionian material monism we have here *cosmological dualism* leading to/based on anthropological dualism (evil body/supernatural soul). Cf. Orphic dualism and its cosmogonic Night (cf. KRS no 30 and Burkert 37-39). It appears that the cosmos is generated in time (989b31, 990a20-1, 1091a13, 1072b31).

The following conclusion can now be drawn: we are *not* dealing with a form/matter dualism in the Aristotelian sense but with something far more primitive: the primeval unit (with magnitude 1080b21) breathes and imposes

order on the unlimited (1091a15-18). On the other hand, Pythagorean opposites are of another, wider and *more abstract* order than Ionian opposites (cf. *Phys.* 188b30ff) and they are notably *value-laden*. Hence, when Aristotle seems to think, uneasily, that we are still within the confines of materiality, he is not quite right (see below), and when he mentions unlimited only as matter (*hyle* 988a27), he may be interpreting the Pythagoreans in Platonic terms (987b20-27).

V. The Nature of Number

Matter is the product of the imposition of *peras* on *apeiron*, which is at the same time the production of numbers (1091a12ff), since things are numbers. Aristotle tells us that the Pythagoreans believed that number is the principle both as *matter* for things and as their *modifications* (*pathe*) and *states* (*hexeis*) (986a16-17). This statement has caused unnecessary exegetical alarm,⁷ but the sense must be elucidated by the preceding page and appears to be simply that the world is or *consists of* number (986a3, cf. 990a21-22, 1083b11-12 (but note a hesitation in lines 18-19), 1090a22, 32). True, number is not only a principle as matter but also as modifications or states. Thus the Pythagoreans noticed that the modifications and ratios of the musical scales were expressible in numbers (985b31-32, cf. 1090a24-5).

Aristotle states the issue in slightly other terms, when he says that numbers are the causes of the substance of other things (987b24-5, cf. 990a20). But he complains that it is not made clear in which way numbers are the causes of substances and of being, whether as *boundaries* or as *ratios* of numbers (1092b8-15). The first alternative is illustrated by points being limits of magnitudes and by a reference to Eurytus who did like those who attribute numbers to shapes like triangle and square (i.e. three and four points/units respectively as the minimum for containing the mentioned figures). The second alternative involves analysis of the proportions in which things are blended or made (e.g. bone or flesh). Aristotle complains that in that case number is not substance nor cause of form: the ratio is the substance, whereas number becomes the matter (*hyle*).

Looking back at *Met.* A we note that not only extended bodies are composed of numbers but also "abstract" entities like justice, soul and reason (985b30-1), opinion, opportunity, injustice, separation and mixture (990a22-5) and marriage (1078b21, before the time of Democritus and Socrates). The identification in the case of "abstract" entities like justice is with a certain modification (*toiondi pathos*) of number (985b29), just as several places in the world are associated with the modifications of number (990a26-7), or modifications of numbers are discovered in harmony, in the world, etc. (1090a24-5, cf. 21-22). The modifications and ratios of harmonies are seen in numbers (985b31-32) and numbers and harmonies⁸ are related to modifications and parts of the world (986a3-6). It seems then that the dictum that "things are numbers" may be a handy way of expressing an identification of things and their properties with *proportions* (modifications of numbers). This appears to be the latter alternative mentioned at 1092b8-15, which is probably the older of the two.⁹ In *On Pyth.* frg. 13 (Ross)

it is stressed over and again that it is observed likenesses between things and number that lead to identification (pp. 139 ll. 6-9, 29-32, 140 ll. 12-15), and this applies equally to reciprocal justice and to the heavenly bodies having their distances in a certain ratio. On the other hand, the first way number may be causes (1092b9-13) obviously refers to calculation with pebbles and representing numbers geometrically (cf. 1036b8-13 for the converse method?). It is explicitly and uniquely connected with a named person, Eurytus, a pupil of Philolaus, and may therefore be relatively late. It does not appear to be assumed in the identifications discussed so far.¹⁰

Is number then extended? Aristotle claims repeatedly that Pythagorean numbers are not truly monadic (i.e. unextended) but have magnitude (1080b15ff, 30-33; 1083b14-17), though he oddly, in view of 986a19 and *On Pyth.* frg. 13 (Ross p. 140 ll. 7-11), confesses ignorance as to how the first unit is constructed (1091a15-17) and even traces that ignorance to the Pythagoreans themselves (1080b20-22). However, Aristotle also complains that their monads in combination cannot either produce bodies or possess weight (*Cael.* 300a15ff, cf. *Met.* 990a8-14), and we are informed by Stobaeus (*Ecl.* I, 308) that Ecphantus (4th cent. if historical) was the first to conceive of bodily numbers. This leaves the possibility that Pythagorean numbers may have been conceived of as *extended* (with magnitude) but *without corporeality*: matter and geometrical structure coincide, in spite of Aristotle's protests (1001b10, *Sens.* 445b11-15). Cf. Melissos' one which is extended (frg. 3) but without body (frg. 9), Plato's elementary geometrical configurations in space (*Timaeus* 53cff), Descartes' matter = extension only (*Princ. Phil.* II 4, Letter to More 1649 *Phil. Letters*, ed. Kenny, 237-45),¹¹ and in modern times, perhaps, Einstein's and Heisenberg's notion of fields in space.¹² Aristotle cannot accept the notion of an extended but incorporeal self-subsistent substance. This accounts for his unsuccessful attempts to fit the Pythagoreans into his own metaphysical framework.

Conclusion

Is it then a philosophy of form we have been considering or is it rather one of matter? The answer is that the question is anachronistic. Put in Aristotelian terms it is both too modern (later in time) and too primitive. Recent developments in physics appear to have transcended the Aristotelian dichotomy and physicists are now concerned with a mathematical conception of reality that might have raised the interest or even enthusiasm of the ancient Pythagoreans.

NOTES

* Page references to Aristotle lacking the title of the work are to the *Metaphysics*.

1. Cf. e.g. Ross, *Aristotle Metaphysics* I 147, 152, 156, Guthrie *HGPh* I, 4 and 467 and *Greek*

Philosophers (UP 1967) ch. II, Kirk and Raven, *Presocratic Philosophers* 216, Hussey, *The Presocratics* 76, 154, Armstrong, *Intr. Anc. Phil.* (UP 1965) p. 8.

2. Theophrastus (*De Sensu* 1ff) takes Parmenides (frg. 16) as assuming the identity of sensation and thought.

3. Philip (50-1): "not constituted of some other thing like fire" is correct, but unclear what is the reference of "they" in "the substance of the things of which they are predicated." Most other translators are rather free here. Thus Ross translates: "not attributes of certain other things." The chosen translation preserves the archaic ambiguity inherent in the statement that the principles are other than ordinary elements (difference in number/level).

4. Heidel's worry (361) that Pythagoreans may not have meant what they said, i.e. the infinite not after all a substance seems incomprehensible (cf. Anaximander's infinite). Contra Guthrie I 241.

5. Ross I 156 claims that Alexander (47.5) cannot be right in suggesting that the Pythagoreans recognized two material causes for the dubious reason that the preceding summary does not refer to any other thinkers recognizing two material causes. However, in context it appears natural to make just that inference. It is at any rate difficult to see a reference to a formal cause at *Met.* 987a13-14 as Ross wants.

6. Alcmaeon identified air and void (see Beare 93f), whereas Empedocles (frg. 100) and Anaxagoras (*Phys.* 213a24-6) distinguished them.

7. See Ross I 147 who wants to import Aristotelian forms here.

8. Note that harmony appears in Aristotle's account both as sensible object and as a numerical ratio.

9. Empedocles (frg. 96) defines bone as a ratio of three elements and the definition of an "abstract" like justice as a ratio stems from a time before Democritus and Socrates (1078b21-3). The parallel treatment of abstracts and concrete entities points to the early 5th cent.

10. Guthrie (I 256ff) seems rather optimistic in his belief that this aspect is early.

11. I see no need to take the void separating numbers (*Phys.* 213b24ff) as creating literal voids. It is rather the even separating the uneven (*Phys.* 203a10-13).

12. A. Einstein: "Felder sind physikalische Zustände des Raumes" (*Das Raum-Äther- und Feld-Problem der Physik in Forum Philosophicum* I, 1930, p. 143). Cf. W. Heisenberg, *Physik und Philosophie*, 1959, p. 91.

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