Mathematics *vs* Philosophy. An Alleged Fragment of Aristotle in Iamblichus*

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In 1962, Walter Burkert published his *Habilitationsschrift*, now widely known under the title of its English translation, *Lore and Science in Ancient Pythagoreanism*. Since then, *Lore and Science* has remained the most influential book on Pythagoras and Pythagoreanism in contemporary scholarship. There are many reasons for this — one of them is that Burkert solved the problem of Philolaus' fragments. This problem had been the topic of debate for almost a century and a half, during which some scholars leaned towards accepting the authenticity of all the fragments of Philolaus while others persistently rejected them. Burkert challenged the traditional approach to Philolaus' fragments which was based on the exclusive principle that they were either all genuine or all fake, and he convincingly showed that they were, in fact, of both kinds.

In two other important cases, however, when a choice has to be made between exclusive and inclusive principles, Burkert resolutely opts for the first. Thus, he asserts that, when applied to Pythagoras, the formula "not only a 'medicine man' but also a thinker" is too simple and unconvincing.[1] Instead he insists that we have to decide: either Pythagoras was a wonder-worker or a philosopher and scientist. Burkert further argues that Pythagoras as the philosopher and scientist was a retrospective projection by the Academics: Aristotle had never heard of such a figure. Therefore, Burkert postulates that a choice must be made between the Platonic and the Aristotelian traditions, "for only one of them can be historically correct".[2] In fact, neither of these traditions is entirely correct nor entirely unreliable. Each piece of evidence from each author must be assessed individually and according to its value.

Actually, Burkert himself did not just blindly accept the Aristotelian tradition as it had been constituted in earlier scholarship. On the one hand, he disputed Aristotle's authorship of some generally accepted fragments such as, for example, a part of fr. 191 Rose which mentions Pythagoras' mathematical studies.[3] On the other, he detected Aristotelian provenance in some important passages in Iamblichus, which were previously not attributed to Aristotle's pen. This paper deals with one such passage that comes from the third volume of Iamblichus'

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[1] Burkert W. *Lore and Science in Ancient Pythagoreanism*. Cambridge (Mass.) 1972, 209.

[2] Ibid., 81.

[3] "Pythagoras, the son of Mnesarchus, first dedicated himself to the study of mathematical sciences, especially numbers, but later could not refrain from the wonder-working of Pherecydes" (Apollon. *Mirab*. 6). Cf. Burkert. *Lore and Science*, 412.

Pythagorean collection, i.e. from *De communi mathematica scientia* (25, p. 78. 8-18 Festa). Here are the Greek text of the passage and my translation:

> Οἱ δὲ Πυθαγορειοι διατρίψαντες ἐν τοῖς μαθήμασι καὶ τό τε ἀκριβὲς τῶν λογων ἀγαπήσαντες, ὅτι μόνα εἶχεν ἀποδείξεις ὧν μετεχειρίζοντο ἄνθρωποι, καὶ ὁμολογούμενα ὁρῶντες ἐπ’ ἴσον[4] τὰ περὶ τὴν ἁρμονίαν [ὅτι] δι’ ἀριθμῶν καὶ τὰ περὶ τὴν ὄψιν μαθήματα διὰ <δια>γραμμάτων, ὅλως αἴτια τῶν ὄντων ταῦτα ᾠήθησαν εἶναι και τὰς τούτων ἀρχάς· ὥστε τῷ βουλομένῳ θεωρεῖν τὰ ὀντα πῶς ἔχει, εἰς ταῦτα βλεπτέον εἶναι, τοὺς ἀριθμοὺς καὶ τὰ γεωμετρούμενα εἴδη τῶν ὄντων καὶ λόγους, διὰ τὸ δηλοῦσθαι πάντα διὰ τούτων.
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> The Pythagoreans, having devoted themselves to mathematical sciences, and both admiring the accuracy of their reasoning (because they alone among human occupations admitted of proofs), and also seeing a close agreement between the science of harmony by means of numbers and the science of vision by means of figures considered these things (i.e. mathematicals) to be, generally, the causes and principles of existing things. That is why anyone who wishes to study how existing things really are should turn attention to these – to numbers, to geometrical forms of existing things and to ratios, because everything is made clear by them.

Having brought together a number of parallels from different works of Aristotle, in order to show similarities between this passage and characteristic Aristotelian phraseology, Burkert further adduces several arguments in favour of Aristotle’s authorship.[5] First, “the passage cannot have been formulated by Iamblichus himself (following Aristotle *Met*. 985b24ff.) for there is not a slightest hint of the immateriality of the numbers, which was so important to any Platonist”. This seems a strange argument, as if everything Iamblichus says about mathematics has to deal with the immateriality of numbers. Even with all his repetitiveness Iamblichus hardly could have mentioned this topic more often than he did in this work, for example in the preceding chapter 24. Besides, there are many more traces of Platonism in this passage, which relies heavily on the Neopythagorean and Platonic philosophy of Nicomachus of Gerasa (early second century AD), just as the entire *De communi mathematica scientia* does.

Secondly, “since both the preceding material in Iamblichus and that which follows (Arist. fr. 52-53) come from Aristotle, the answer must be that here too we have an independent fragment of Aristotle”. This is an important point that must be looked at in detail. The following chapter of *De communi mathematica scientia* contains indeed two fragments of Aristotle’s *Protrepticus*, which Iamblichus has already used in a slightly modified form in his own *Protrepticus*. Aristotle’s *Protrepticus*, however, does not belong to his writings on the Pythagoreans; though it mentions Pythagoras (fr. 18, 20 Düring), it has nothing to say on the Pythagoreans. The presence of two quotations from Aristotle’s *Protrepticus* in chapter 26 does not by itself increase the possibility that chapter 25 would contain a fragment of Aristotle’s work on the Pythagoreans. Even more problematic is the preceding material in Iamblichus,

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[4] ἐπ’ ἴσον is Vitelli’s emendation of the manuscript’s ἔνισον, elsewhere unattested; cf. Burkert. *Lore and Science*, 448 n. 3.
[5] Ibid., 50 n. 112.

namely, the story about the *acusmatici* and *mathematici* at the beginning of chapter 25. In *Lore and Science* Burkert asserted that this story derives from Aristotle, but recently he has been forced to admit that this cannot be proved.[6] I would suggest that the opposite can be proved: the story about the *acusmatici* and *mathematici* that appears for the first time in the sources of the Imperial period, namely, in Clemens of Alexandria, Porphyry, and Iamblichus, has nothing to do with Aristotle or any other classical writer.[7] Most probably it derives from Nicomachus' biography of Pythagoras. Thus, the passage on the Pythagorean *mathēmata* is sandwiched *not* between two other extracts from Aristotle but between a long extract from Nicomachus' work on Pythagoras and the Pythagoreans and several extracts from Aristotle's *Protrepticus*, which have nothing to do with the Pythagoreans. If anything, this increases the possibility that Iamblichus' reasoning in this passage was influenced by Nicomachus, for which we shall later see abundant evidence.

According to Burkert,[8] Iamblichus made several additions to the passage drawn from Aristotle, which are square-bracketed in *Lore and Science*. The first is τὰ περὶ τὴν ὄψιν μαθήματα διὰ <δια>γραμμάτων. Burkert says that these words are "unclear and factually wrong", so that they cannot come from Aristotle. It has to be mentioned that there are certain inconsistencies in the way Burkert deals with this phrase. His original German version contains only the Greek text of Iamblichus without translation; in the English version this phrase is translated as "the mathematics of optics depending on (dia)grams", but both in his German and in his English comments Burkert regularly interprets τὰ περὶ τὴν ὄψιν μαθήματα as being related to *geometry*, not to optics.[9] As we shall see this leads to some misunderstanding. The second addition of Iamblichus to the Aristotelian text detected by Burkert is τὰ γεωμετρούμενα εἴδη τῶν ὄντων, which in his opinion "sounds like late Platonism". Having deleted these two references to geometry, Burkert concludes: "In the original testimony geometry plays no role, in contrast to that of arithmetic'. As a result, Iamblichus' passage started to look more like the passage in Aristotle's *Metaphysics* 985b24ff. than it did originally.

As far as I know, Burkert's suggestion concerning the authorship of our passage was not accepted in Aristotelian scholarship. The first positive reaction to it came only recently, in 2005, when Myles Burnyeat and Carl Huffman simultaneously supported Burkert's idea and developed it further.[10] They both argued that the passage in question is Aristotle's fragment

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[6] Cf. Burkert. *Lore and Science*, 192ff. and idem, Pythagoreische Retraktationen, in W. Burkert et al., ed., *Fragmentsammlungen philosophischer Texte der Antike*. Göttingen 1998, 314f.: «Daß der exzerpierte Text allerdings ein Werk von Aristoteles war, ist ebenso einleuchtend wie unbeweisbar».
[7] See Zhmud L. *Wissenschaft, Philosophie und Religion im frühen Pythagoreismus*. Berlin 1997, 93ff.
[8] Burkert. *Lore and Science*, 448.
[9] To be sure, "geometrical optics" appears in one footnote, ibid., 448 n. 5.
[10] Burnyeat M. Archytas and Optics, *Science in Context* 18 (2005) 35–53, esp. 38ff.; Huffman C. A. *Archytas of Tarentum: Pythagorean, Philosopher and Mathematician King*, Cambridge 2005, 552ff.

related to the Pythagorean optics.[11] For this they had to remove Burkert's square brackets at least in the first case, since in their view τὰ περὶ τὴν ὄψιν μαθήματα constitutes that very Aristotelian reference to Pythagorean optics, namely, to Archytas' optics according to Burnyeat and to Philolaus' optics according to Huffman. Archytas is indeed the most likely candidate to be the founder of optics, but our passage has no relevance for this, for it does not mention optics and does not derive from Aristotle. Although its author certainly made use of the description of the Pythagoreans in *Metaphysics* A5, which also deals with the relationship of mathematics and philosophy,[12] this only proves that Iamblichus read *Metaphysics* and knew it very well. To be sure, both Burnyeat and Huffman note striking differences between our passage and *Metaphysics* A5, and on this point I completely agree with them (as, of course, on many others):

> According to A5 it was the likeness (ὁμοιώματα) between numbers and things that inspired the generalization from the principles of mathematics to the principles of all the things. The fragment (i.e. Iamblichus' passage – *L.Zh.*) by contrast locates the inspiration in the precision of mathematical *proof*.[13]

Indeed, this emphasis on proof went totally unnoticed by Burkert, though it is both the central point of the passage and one of the decisive points in the debate on its authorship. "The Pythagoreans, admiring the accuracy of mathematical reasoning, because it alone among human activities contains proofs, etc." Is this an Aristotelian idea at all? Was it possible for Aristotle to say that mathematics is the *only* activity that allows proofs?[14] Does not it run against all his emphasis on *apodeixis* in philosophy, including physics and metaphysics? And further: does not this view sound too pessimistic for classical philosophy and even not quite philosophical? Can we really argue that this was not Aristotle's own view, that he just gave an account of the Pythagorean idea? Apart from the fact that an observer does not show any sign of disagree-

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[11] Though Burnyeat says that his "argument does not depend on the attribution" (op. cit., 39f.), in fact it does.

[12] οἱ καλούμενοι Πυθαγόρειοι τῶν μαθημάτων ἁψάμενοι πρῶτοι ταῦτά τε προήγαγον, καὶ ἐντραφέντες ἐν αὐτοῖς τὰς τούτων ἀρχὰς τῶν ὄντων ἀρχὰς ᾠήθησαν εἶναι πάντων. – "The Pythagoreans, as they are called, devoted themselves to mathematics; they were the first to advance this study, and having been brought up in it they thought its principles were the principles of all things" (tr. Ross).

[13] Burnyeat. Op. cit., 39.

[14] Alexander Verlinsky and István Bodnár suggested that the imperfect of the subordinate clause ὅτι μόνα εἶχεν ἀποδείξεις ὧν μετεχειρίζοντο ἄνθρωποι has to be understood in the restrictive temporal sense: it is *only in the past* that mathematics was the only human activity that possessed proofs, not in the present. Grammatically this is possible but such an interpretation would impart to this sentence a historical meaning that is hard to expect from Iamblichus or for that matter from Aristotle. Neither of them believed that deductive proof was found first in *mathēmata* and then taken by philosophy (though this is exactly what happened; see e.g. Zhmud. *Wissenschaft*, 151ff.; Zaicev A. Encore une fois à propos de l'origine de la formalisation du raisonnement chez les Grecs, *Hyperboreus* 9 (2003) 265-273). It is more plausible therefore that the imperfect appeared, instead of the expected praesens, due to *attractio temporis*. See Schwyzer E. *Griechische Grammatik*. 5. Aufl. Bd. 2. München 1988, 279f. – I owe this point to Nina Almazova.

ment with this idea, I do not see why the idea in itself was more possible for the Pythagoreans, or for that matter for any other Pre-Socratic, than it was for Aristotle. This expression of ancient Greek 'scientism', which denies (or at least questions) the existence of a firm proof in any intellectual activity outside of *mathēmata*, is unparalleled in classical sources.

The earliest parallel to this claim that I know of dates to the mid-second century AD and comes unsurprisingly from one of the greatest Greek mathematicians, Ptolemy. In the preface to *Almagest* (p. 6.11-21) when referring to the Aristotelian division of theoretical knowledge into theology, physics, and mathematics, he dwells on their respective subject matter and then asserts:

> ἐξ ὧν διανοηθέντες, ὅτι τὰ μὲν ἄλλα δύο γένη τοῦ θεωρετικοῦ μᾶλλον ἄν τις εἰκασίαν ἢ κατάληψιν ἐπιστημονικὴν εἴποι, τὸ μὲν θεολογικὸν διὰ τὸ παντελῶς ἀφανὲς αὐτοῦ καὶ ἀναπίληπτον, τὸ δὲ φυσικὸν διὰ τὸ τῆς ὕλης ἄστατον καὶ ἄδηλον, ὡς διὰ τοῦτο μηδέποτε ἂν ἐλπίσαι περὶ αὐτῶν ὁμονοῆσαι τοὺς φιλοσοφοῦντας, μόνον δὲ τὸ μαθηματικόν, εἴ τις ἐξεταστικῶς αὐτῷ προσέρχοιτο, βεβαίαν καὶ ἀμετάπιστον τοῖς μεταχειριζομένοις τὴν εἴδησιν παράσχοι ὡς ἂν τῆς ἀποδείξεως δι' ἀναμφισβητήτων ὁδῶν γιγνομένης, ἀριθμητικῆς τε καὶ γεωμετρίας.
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> From all this we concluded, that the first two divisions of theoretical philosophy should rather be called guesswork than knowledge, theology because of its completely invisible and ungraspable nature, physics because of the unstable and unclear nature of the matter; hence there is no hope that philosophers will ever be agreed about them; and that only mathematics can provide sure and unshakable knowledge to its devotees, provided one approaches it rigorously. For its kind of proof proceeds by indisputable methods, namely arithmetic and geometry (tr. G. Toomer).

It is revealing that Ptolemy puts forward this view as his own. He does not seem to rely on any school philosophy, be it Stoic, Peripatetic, Platonic or Sceptical. Even if Ptolemy was not the first scientist to contrast mathematics with the other two parts of philosophy in such a way, he could have easily come to his conviction independently. At any rate, both the reference to philosophers, who are unable to come to agreement on theology and physics, and the reappearance of mathematics as a constituent part of philosophy, point rather to the Imperial than to the Hellenistic period. To be sure, discord (διαφωνία) among philosophers was a popular topic from the fifth century onwards, especially in the Sceptical tradition, but Hellenistic philosophers would not have resorted to mathematics to reach agreement. The attitude of the Hellenistic philosophical schools to mathematics ranged from more or less indifferent to sceptical and even hostile.[15] Even the most scientific among the Stoics, Posidonius, who defended Euclid's geometry against the attacks of the Sceptical Academy and the Epicureans, regarded *mathēmata* only as an auxiliary tool in the service of philosophy, not as an integral part of philosophy.[16] It is the philosopher (φυσικός) who establishes the basic principles and explains the causes, whereas the scientist (μαθηματικός) has to borrow these principles and

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[15] Zmud L. *The Origin of the History of Science in Classical Antiquity.* Berlin 2006, 286ff.
[16] Fr. 90 E.-K.; Kidd I. G. Philosophy and Science in Posidonius, *A&A* 24 (1978) 7–15.

generally to subordinate his research to the results of the philosopher (fr. 18 E-K). What we find in Ptolemy is the opposite attitude to *mathēmata*.

With time this view gained a limited foothold in the Neoplatonic school although it did not become as popular as the traditional Platonic subordination of *mathēmata* to dialectic. Besides Iamblichus, we encounter it in the late sixth-century introductions to philosophy by Elias and David.[17] Explaining why, of the three parts of philosophy, only the middle one is called *mathēmata* (*In Porph. Isag*., p. 28.24f.), Elias says: because only *mathēmata* can provide reliable proofs (τὸ ἀραρὸς τῶν ἀποδείξεων); in *mathēmata* we gain exact knowledge, beyond them we rather guess than know. That is why a philosopher Marinus (Proclus' student and successor) said: "O, if everything were mathematics!".[18] David's arguments are even closer to those of Ptolemy: in physics exact knowledge is impossible because of the unstable nature of the matter, and in theology because divine things are invisible and ungraspable, so that we have guesswork about them rather than exact knowledge.[19]

It is tempting to connect the views of the Neoplatonists with Ptolemy, directly or indirectly, but in spite of all his significance and influence he cannot be made solely responsible for the changing position of *mathēmata vis-a-vis* philosophy in the Imperial period. His older contemporary Nicomachus also testifies to this shift. Unlike Ptolemy, Nicomachus does not use the Aristotelian tripartite division; instead he almost identifies mathematical sciences with philosophy as such.[20] Indeed, philosophy is the desire for wisdom, and wisdom is the knowledge of two forms of being (τὰ τοῦ ὄντος εἴδη), namely, of πλῆθος and μέγεθος, represented by quantity (ποσόν) and magnitude (πηλίκον). Arithmetic deals with absolute quantity, music with relative quantity, geometry with magnitude at rest and astronomy with magnitude in motion (*Intr. arith*. I,2-3). The same subdivision of mathematics is to be found in Iamblichus' *De communi mathematica scientia* (chapter 7) and in Proclus' *Commentary on Euclid's Elements* (chapter 12).[21] What we do not find in Nicomachus, however, is a claim that mathematics has

[17] See Gutas D. Paul the Persian on the Classification of the Parts of Aristotle's Philosophy: A Milestone between Alexandria and Baghdad, *Islam* 60 (1983) 247ff.

[18] ταῦτα γὰρ μανθάνομεν ἀκριβῶς, τὰ δὲ ἄλλα εἰκάζομεν μᾶλλον ἢ μανθάνομεν, διὸ καὶ ὁ φιλόσοφος Μαρῖνος ἔφη 'εἴθε πάντα μαθήματα ἦν'.

[19] *Proleg. phil*., p. 59.23ff.: τὸ φυσιολογικὸν οὐ δύναται λέγεσθαι μαθηματικόν, ἐπειδὴ τοῦτο πάντῃ ἔνυλον ὂν καὶ ἀεὶ ἐν ῥοῇ καὶ ἀπορροῇ ὄν <…>. ἀλλ' οὔτε δὲ τὸ θεολογικὸν δύναται λέγεσθαι μαθηματικόν, ἐπειδὴ τὰ θεῖα ἅτε δὴ ἀόρατα ὄντα καὶ ἀκατάληπτα εἰκασμῷ μᾶλλον γινώσκονται ἤπερ ἀκριβεῖ γνώσει. No less interesting is the second explanation: ἄλλως τε δὲ διὰ τοῦτο αὐτὸ μόνον λέγεται μαθηματικὸν, ἐπειδὴ αὐτὸ διδάσκει ἡμᾶς πῶς δεῖ μανθάνειν τὰ πράγματα· εἰ γὰρ καὶ ἐν τῇ λογικῇ τοῦτο διδάσκει ἡμᾶς ὁ Ἀριστοτέλης, ἀλλ' οὖν ἐκ τοῦ μαθηματικοῦ ἔλαβε τὴν ἀφορμήν.

[20] O'Meara D. *Pythagoras Revived: Mathematics and Philosophy in Late Antiquity*. Oxford 1989, 16.

[21] Later it was repeated in a simplified form in the introductions to philosophy by Ammonius, Elias and David (discrete quantity, absolute and related, and continuous quantity, immovable or moving).

the unique quality of providing firm proofs. Before Iamblichus, I have found such a claim only in Ptolemy.

Now I come to the second point, τὰ περὶ τὴν ὄψιν μαθήματα διὰ <δια>γραμμάτων, which was bracketed by Burkert as Iamblichus' addition to Aristotle's fragment and restored by Burnyeat and Huffman as Aristotle's reference to Pythagorean optics. I gave some arguments why this could not be Aristotle. Now, why optics? I was unable to find another text calling optics τὸ περὶ τὴν ὄψιν μάθημα. Furthermore, nothing in Iamblichus suggests that he was interested in optics; when ὄψις appears in *De communi mathematica scientia* it means simply "vision".[22] I think this is what it means in our passage too, so that τὰ περὶ τὴν ὄψιν μαθήματα διὰ <δια>γραμμάτων has to be understood as "the branch of mathematics related to vision and based on diagrams", i.e. astronomy. Following Plato's approving remark that the Pythagoreans call harmonics and astronomy sister sciences (*Resp.* 530c), it became a commonplace to compare harmonics and astronomy as mathematical sciences dealing with visible and audible movement. Iamblichus, however, wanted to incorporate in his comparison two other sciences of the *quadrivium* as well. Again, in this case too we can find in Ptolemy a very close parallel to such a comparison:

> Related to sight, and to the movements in place of the things that are only seen – that is, the heavenly bodies – is astronomy; related to hearing and to the movements in place, once again, of the things that are only heard – that is, sounds – is harmonics. They employ both arithmetic and geometry, as instruments of indisputable authority, to discover the quantity and quality of the primary movements; and they are as it were cousins, born of the sisters, sight and hearing, and brought up by arithmetic and geometry as children most closely related in their stock.[23]

Thus, the most natural meaning of Iamblichus' comparison would be that the Pythagoreans saw a close agreement between harmonics based on numbers, i.e. on arithmetic, and astronomy based on diagrams, i.e. on geometry: καὶ ὁμολογούμενα ὁρῶντες ἐπ' ἴσον τὰ περὶ τὴν ἁρμονίαν [ὅτι] δι' ἀριθμῶν καὶ τὰ περὶ τὴν ὄψιν μαθήματα διὰ <δια>γραμμάτων. This was, then, Iamblichus' second point: an agreement between different branches of *mathēmata* that study different forms of being encouraged the Pythagoreans to consider mathematical objects as the principles of existing things. This is the meaning that two recent translations of *De*

[22] Huffman. *Archytas*, 565.

[23] *Harm.* III,3, tr. A. Barker. – καὶ τῶν κατ' αὐτὰς ἐπιστημῶν αἱ λογικώτατοι, παρὰ μὲν τὴν ὄψιν καὶ τὰς κατὰ τόπον κινήσεις τῶν μόνως ὁρατῶν, τουτέστι τῶν οὐρανίων, ἀστρονομια, παρὰ δὲ τὴν ἀκοὴν καὶ τὰς κατά τόπον πάλιν κινήσεις τῶν μόνως ἀκουστῶν, τουτέστι τῶν ψόφων, ἁρμονική, χρώμενοι μὲν ὀργάνοις ἀναμφισβητήτοις ἀριθμητικῇ τε καὶ γεωμεταρίᾳ πρὸς τε τὸ ποσὸν καὶ τὸ ποιὸν τῶν πρώτων κινήσεων, ἀνεψιαὶ δ' ὥσπερ καὶ αὐταί, γενόμεναι μὲν ἐξ ἀδελφῶν ὄψεως καὶ ἀκοῆς, τεθραμμέναι δὲ ὡς ἐγγυτάτω πρὸς γένους ὑπ' ἀριθμητικῆς τε καὶ γεωμετρίας.

communi mathematica scientia, one Italian and one German, give to this passage.[24] Note that none of them has any place for optics in this passage.

One of the arguments that Huffman and Burnyeat brought against Burkert was that for Iamblichus there was no sense in adducing a reference to such a minor branch of mathematics as optics, instead of geometry itself. "It would be strange in the extreme", notes Huffman, "if Iamblichus had rewritten the passage from Aristotle to include references to optics in the way that Burkert suggests".[25] As I have already mentioned, the problem is that Burkert did *not* say that Iamblichus referred to optics. He believed that Iamblichus referred to *geometry* and he repeated this four times on one page.[26] The reference to optics appears only in the English translation of Iamblichus' passage, whose author seems to be Edwin Minar, the translator of Burkert's book.

There is in this sentence also a minor issue concerning διαγράμματα. Both Huffman and Burnyeat approvingly refer to Reviel Netz, who insists that "The word *diagramma* is never used by Greek mathematicians in the sense of diagram".[27] Accordingly they suggest that διαγράμματα in our passage "does not mean diagrams as such, but rather proofs conducted with a diagram".[28] In fact, there are several examples when Greek mathematicians used διάγραμμα in the sense of diagram.[29] More relevant, however, is the fact that Iamblichus was not a mathematician and that he regularly used διαγράμματα for denoting diagrams and geometrical figures, not proofs,[30] as many philosophers did before and after him.[31]

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[24] Giamblico. *Il Numero e il divino. La scienza matematica comune*, trad. F. Romano. Rimini 1995, 157: "Il Pitagorici, dal momento che si occupavano delle matematiche e amavano l'esattezza dei ragionamenti matematici, perché solo questi possiedono capacità apodittiche nelle faccende umane, e vedevano che erano in perfetto accordo tra loro le armonie ottenute con il calcolo numerico e la loro trasposizione visiva nel diagrammi matematici, ritennero che queste fossero in generale le cause degli enti e i loro princìpi; sicché chi vuole vedere come stanno realmente le cose, è a queste cose che deve guardare, cioè ai numeri e alle forme degli enti ridotte a figure geometriche e ai calcoli relativi, perché per mezzo di essi tutto appare chiaro". Iamblichos. *Von der allgemeinen mathematischen Wissenschaft*, übers. von O. Schönberger und E. Knobloch. St. Katharinen 2000, 51: "Die Pythagoreer aber trieben die mathematischen Wissenschaften und hielten die Exaktheit in der Forschung hoch, da nur diese Wissenschaften als einzige menschliche Einrichtung Beweise besassen; und weil sie sahen, dass die mathematischen Wissenschaften hinsichtlich der Harmonie durch Zahlen und hinsichtlich des Anblicks durch Zeichnungen in gleicher Masse übereinstimmten, hielten sie diese überhaupt für die Ursachen und Prinzipien des Seienden. Wer also die Natur des Seienden noetisch erforschen wolle, müsse auf die Zahlen und die geometrischen Gestalten des Seienden und die Proportionen sehen, denn alles werde dadurch erhellt".

[25] Huffman. *Archytas*, 565; Burnyeat. Op. cit., 40.

[26] Burkert. *Lore and Science*, 448.

[27] Netz R. *The Shaping of Deduction in Greek Mathematics*. Cambridge 1999, 36.

[28] Burnyeat. Op. cit,, 40. Cf. Huffman. *Archytas*, 566: "In mathematical writing διάγραμμα regularly means 'theorem' or 'proof' rather than diagram."

[29] Ptol. *Harm*. III,3; Procl. *In Eucl*., 190.23; *Schol. in Eucl. Elem*. I, schol. 121.54, 148.11; *Schol. in Eucl. Phaen*. 25.2; Leontius, *De spaer. construct*. 6.45.

[30] *VP* 22, 179; *In Nic. arithm. intr*., p. 39.16, 57.4, 60.24, 69.25, 70.9.

[31] See e.g. Pl. *Crat*. 436d, *Phaed*. 73b; Arist. *De caelo* 279b34, 280b1-11, *Met*. 1051a22; Plut. *Marc*. 19.8-9; Galen. *Adhort*. 5.22-5; Simpl. *In De caelo*, 177.16-19, *In Phys*., 304.31-36, 511.16. – I am

Due to all these reasons, claims Iamblichus, the Pythagoreans considered these things (i.e. mathematicals) to be the causes and principles of existing things, τὰ ὄντα. This again resembles Aristotle, but is much less clear than *Metaphysics* A5, where it is said that the Pythagoreans considered the principles of mathematics to be the principles of all the things. The following sentence from Iamblichus shows that τὰ ὄντα in his sense is much closer to Nicomachus than to Aristotle. In Nicomachus the real ὄντα are immaterial, eternal, unchanging etc., and their two forms are quantity and magnitude, which are studied by arithmetic and harmonics as well as by geometry and astronomy, respectively. Without these *mathēmata*, says Nicomachus, "it is not possible to be exact about the forms of being (τὰ τοῦ ὄντος εἴδη) nor to discover the truth in things that are (ἐν τοῖς οὖσι), the knowledge of which is wisdom, not even to philosophize correctly".[32] Since Iamblichus borrowed from Nicomachus the entire classification both of τὰ ὄντα and of the respective sciences which study them (chapter 7), it is only natural for him to say that "anyone who wishes to study how existing things really are has to look at these things, namely at τοὺς ἀριθμοὺς καὶ τὰ γεωμετρούμενα εἴδη τῶν ὄντων καὶ λόγους." In this case τὰ γεωμετρούμενα εἴδη τῶν ὄντων means "the forms of beings studied by geometry", for example, lines, planes, solids etc. Since the term 'geometrical forms' is an obvious counterpart to 'arithmetical numbers' we cannot separate them, taking τὰ γεωμετρούμενα εἴδη τῶν ὄντων for Iamblichus' addition to Aristotle's fragment, as Burkert suggested. The absence of an article before λόγους, noticed by Burkert, is disturbing, but we cannot improve Iamblichus' style by transforming him into Aristotle.[33] Arguments brought by Huffman and Burnyeat to show that τὰ γεωμετρούμενα εἴδη τῶν ὄντων can derive from Aristotle are not compelling: γεωμετρούμενα remains unattested in the classical period, and τὰ γεωμετρούμενα εἴδη τῶν ὄντων is indeed late Platonism.

Recapitulating my arguments, I would state once more that Iamblichus' passage relies as much on Nicomachus and Ptolemy as on Aristotle and therefore cannot be considered as a fragment of Aristotle. Furthermore, its significance lies not in referring to Pythagorean optics, but in repeating the argument about the unique ability of mathematics to produce irrefutable proofs. But unlike Ptolemy, whose attitude to *mathēmata* was quite conscious and consistent,

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thankful to Henry Mendell for helping me to clarify the issue about διάγραμμα in mathematical and philosophical texts.

[32] *Intr. arith*. I,3, tr. C. Huffman. Cf. ibid.: "For these seem to be sister sciences; for they deal with sister subjects, the first two forms of being" (ταῦτα γὰρ τὰ μαθήματα δοκοῦντι ἔμμεναι ἀδελφεά· περὶ γὰρ ἀδελφεὰ τὰ τοῦ ὄντος πρώτιστα δύο εἴδεα τὰν ἀναστροφὰν ἔχει).

[33] Burkert. *Lore and Science*, 448. "λόγους in itself is intrusive after the clearly established dichotomy of arithmetic and geometry" (ibid.), on what Huffman (*Archytas*, 567) replies: "The mention of ratio does not interfere with the dichotomy, since it is a concept that applies to both arithmetic and geometry". It is worth noting also that Iamblichus often pairs εἴδη with λόγους (*De comm. math. sc*., p. 44.8f., 46.15, 55.26f., 64.13, 74.13); see also λόγους without an article (ibid., 14.6, 30.23, 46.15, 56.8).

Iamblichus does not seem to draw any important conclusions from the words he repeats in passing. In a good Platonic fashion Iamblichus identifies mathematical objects as intermediary between immaterial being and the material world, so that for him *mathēmata* are the second best choice, not the first, as they were for Nicomachus.

It would be very interesting to find more parallels to Ptolemy's view, although I doubt that there really was something like ancient Greek 'scientism' as a pronounced philosophical position. And still, this view, even if only occasionally attested, testifies that the Greeks were not as ignorant about the epistemological differences between philosophy and science (in this case represented by *mathēmata*) as they are so often depicted.