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Aristotle's argument against the parallel between the Timaeus cosmogony and geometric διαγράμματα (Cael. 279b32 – 280a2)

In Cael. 1.10 Aristotle attacks those who think that the cosmos always exists but set out a cosmogony as if they were οἱ τὰ διαγράμματα γράφοντες, i. e. not because they believe that the cosmos did come to be but merely in order to enhance understanding and for the sake of instruction (Cael. 279b32 – 280a2):

ἣν δέ τινες βοήθειαν ἐπιχειροῦσι φέρειν ἑαυτοῖς τῶν λεγόντων ἄφθαρτον μὲν εἶναι γενόμενον δέ, οὐκ ἔστιν ἀληθής· ὁμοίως γάρ φασι τοῖς τὰ διαγράμματα γράφουσι καὶ σφᾶς εἰρηκέναι περὶ τῆς γενέσεως, οὐχ ὡς γενομένου ποτέ, ἀλλὰ διδασκαλίας χάριν ὡς μᾶλλον γνωριζόντων, ὥσπερ τὸ διάγραμμα γιγνόμενον θεασαμένους.

Commenting on this passage, Simplicius notes that Aristotle argues against Xenocrates and other Platonists who took the Timaeus cosmogony as a fictional account (In Cael. 303.34/35 Heiberg).[1] The Timaeus cosmo-

[1] In De animae procreatione in Timaeo 1013A6 – B4 (= Xenocrates, fr. 68 Heinze) Plutarch attributes this interpretation of the Timaeus cosmogony to Xenocrates and Crantor as well as to those who adopted the views of Xenocrates or Crantor on the creation of the world-soul in the Timaeus: ὁμαλῶς δὲ πάντες οὗτοι χρόνῳ μὲν οἴονται τὴν ψυχὴν μὴ γεγονέναι μηδ' εἶναι γενητήν, πλείονας δὲ δυνάμεις ἔχειν, εἰς ἃς ἀναλύοντα θεωρίας ἕνεκα τὴν οὐσίαν αὐτῆς λόγῳ τὸν Πλάτωνα γιγνομένην ὑποτίθεσθαι καὶ συγκεραννυμένην· τὰ δ' αὐτὰ καὶ περὶ τοῦ κόσμου διανοούμενον ἐπίστασθαι μὲν ἀίδιον ὄντα καὶ ἀγένητον, τὸ δ' ᾧ τρόπῳ συντέτακται καὶ διοικεῖται καταμαθεῖν οὐ ῥᾴδιον ὁρῶντα τοῖς μήτε γένεσιν αὐτοῦ μήτε τῶν γενητικῶν σύνοδον ἐξ ἀρχῆς προϋποθεμένοις ταύτην τὴν ὁδὸν τραπέσθαι. Speusippus also took this view of the Timaeus cosmogony according to a scholium on Cael. 279b 32 – 280a2 in Cod. Paris. Graec. 1853 (E) (= Speusippus, fr. 61b Taran): ὁ Ξενοκράτης καὶ ὁ Σπεύσιππος ἐπιχειροῦντες βοηθῆσαι τῷ Πλάτωνι ἔλεγον ὅτι οὐ γενητὸν τὸν κόσμον ὁ Πλάτων ἐδόξαζεν ἀλλὰ ἀγένητον, χάριν δὲ διδασκαλίας καὶ τοῦ γνωρίσαι καὶ παραστῆσαι αὐτὸ ἀκριβέστερον ἔλεγε τοῦτο γενητόν.

gony, argued the Platonists, does not entail that the cosmos came to be, just as τὰ διαγράμματα of the geometers do not entail that geometric objects come to be. As a geometer constructs a triangle (cf. Euclid's El. 1.1) simply in order to elucidate how a 'platonic' geometric object that always exists is constituted by its component parts (lines or planes respectively), similarly the Platonists set out the Timaeus cosmogony in order to explain how the always existing cosmos is constituted by its elements (Simpl. In Cael. 304.3 – 15 Heiberg):[2]

οὗτοι οὖν γενητὸν καὶ ἄφθαρτον λέγοντες τὸν κόσμον τὴν γένεσιν οὐχ ὡς ἀπὸ χρόνου φασὶ δεῖν ἀκούειν, ἀλλ᾿ ἐξ ὑποθέσεως εἰρημένην διδασκαλίας χάριν τῆς τάξεως τῶν ἐν αὐτῷ προτέρων τε καὶ συνθετωτέρων. ἐπειδὴ γὰρ τῶν ἐν τῷ κόσμῳ τὰ μὲν στοιχεῖά ἐστι, τὰ δὲ ἐκ τῶν στοιχείων, οὐκ ἦν ῥᾴδιον γνῶναι τὴν τούτων διαφοράν, καὶ ὅπως ἐκ τῶν ἁπλουστέρων γίνεται τὰ σύνθετα, τὸν μὴ ἀναλύσαντα τῇ ἐπινοίᾳ τὰ σύνθετα εἰς τὰ ἁπλᾶ καὶ σκοποῦντα, πῶς, εἰ τὰ ἁπλᾶ καθ' αὑτὰ ἦν, ἐξ ἀρχῆς ἀπ' αὐτῶν ἂν ἐγεγόνει τὰ σύνθετα, ὥσπερ ἐπὶ τῶν διαγραμμάτων οἱ μαθηματικοὶ τὴν φύσιν αὐτῶν ζητοῦντες τὰ σύνθετα εἰς τὰ ἁπλᾶ ἀναλύουσι, καὶ ὅπως ἐξ ἐκείνων ἐγένετο ἄν, εἴπερ ἐξ ἀρχῆς ἐγίνετο, σκοποῦσιν, οἷον ὅτι τὸ τρίγωνον ἐκ τριῶν εὐθειῶν κατὰ γωνίας συντιθεμένων, ὁ δὲ κύβος ἐκ τετραγώνων ἓξ κατὰ γωνίας καὶ γραμμὰς ἀλλ' οὐχὶ κατὰ τὰ ἐπίπεδα συντιθεμένων.[3]

[2] That for Simplicius geometric objects are not subject to generation is evident from his rejoinder to Aristotle (In Cael. 305.10 – 12 Heiberg): ἐπὶ δὲ τῶν μαθημάτων, κἂν ἀδύνατον τὸ γένεσιν εἶναι σχημάτων, ἀλλὰ διὰ τὸ συνυπάρχειν ἀεὶ τὰ ἁπλᾶ τοῖς συνθέτοις πρὸς ὑπόθεσιν οὐκ ἔστιν ἀδύνατον ἡ γένεσις.

[3] Cf. Proclus, In primum Euclidis elementorum librum commentarii 77.15 – 78.8 Friedlein (= Speusippus fr. 72 Taran): ἤδη δὲ τῶν παλαιῶν οἱ μὲν πάντα θεωρήματα καλεῖν ἠξίωσαν, ὡς οἱ περὶ Σπεύσιππον καὶ Ἀμφίνομον, ἡγούμενοι ταῖς θεωρητικαῖς ἐπιστήμαις οἰκειοτέραν εἶναι τὴν τῶν θεωρημάτων προσηγορίαν ἢ τὴν τῶν προβλημάτων, ἄλλως τε καὶ περὶ ἀϊδίων ποιουμέναις τοὺς λόγους. οὐ γάρ ἐστι γένεσις ἐν τοῖς ἀϊδίοις, ὥστε οὐδὲ τὸ πρόβλημα χώραν ἐπὶ τούτων ἂν ἔχοι, γένεσιν ἐπαγγελλόμενον καὶ ποίησιν τοῦ μήπω πρότερον ὄντος, οἷον ἰσοπλεύρου τριγώνου σύστασιν, ἢ τετραγώνου δοθείσης εὐθείας ἀναγραφήν, ἢ θέσιν εὐθείας πρὸς τῷ δοθέντι σημείῳ. ἄμεινον οὖν φασι λέγειν, ὅτι πάντα ταῦτά ἐστι, τὰς δὲ γενέσεις αὐτῶν οὐ ποιητικῶς ἀλλὰ γνωστικῶς ὁρῶμεν ὡσανεὶ γιγνόμενα λαμβάνοντες τὰ ἀεὶ ὄντα, ὥστε καὶ πάντα θεωρηματικῶς ἐροῦμεν ἀλλ' οὐ προβληματικῶς λαμβάνεσθαι. What is implicit here is Plato's memorable comment on the tension between the nature of geometric objects and the means employed for their investigation: as he explains in Rep. 527a1 – b8, the geometers necessarily rely on constructions in order to obtain knowledge about geometric objects which are, though, exempt from coming to be and passing away (cf. below, n. 30). For a sane discussion of this passage see M. F. Burnyeat, Plato on Why Mathematics is Good for the Soul, in: T. Smiley (ed.), Mathe-

Simplicius' interpretation of the term διάγραμμα as a geometric construction is widely accepted in discussions of Aristotle's objection to Xenocrates and the other Platonists; modern scholars, moreover, tend not to distinguish a geometric construction from the diagram that represents the construction (the lettered diagram is one of the most pervasive features of Greek geometry).[4] On this interpretation οἱ τὰ διαγράμματα γράφοντες are 'those who produce geometric constructions' and thus the Platonists, whose reading of the Timaeus cosmogony Aristotle attacks in Cael. 1.10, likened the Timaeus cosmogony to a geometric construction. The term διάγραμμα, however, is never used in Greek mathematics for a construction or for a diagram.[5] Aristotle uses it either for a geometric proposition or for its proof. He uses, moreover, the cognate verb γράφω not only in the sense 'to draw' but also in the sense 'to prove a geometric proposition'. οἱ τὰ διαγράμματα γράφοντες should, therefore, be understood as 'those who prove geometric propositions' or 'those who carry out geometric proofs'.[6] Thus the Platonists, against whom Aristotle inveighs in Cael. 1.10, likened the Timaeus cosmogony not to a geometric construction but to a geometric proof.

1. The meaning of διάγραμμα and γράφω in Aristotle

That Aristotle does not use the term διάγραμμα for a geometric construction, or for the representation thereof, can be clearly seen from Met. 1051a21 – 30:

> εὑρίσκεται δὲ καὶ τὰ διαγράμματα ἐνεργείᾳ· διαιροῦντες γὰρ εὑρίσκουσιν. εἰ δ᾽ ἦν διῃρημένα, φανερὰ ἂν ἦν· νῦν δ᾽ ἐνυπάρχει δυνάμει … διὰ τί ἐν ἡμικυκλίῳ ὀρθὴ καθόλου; διότι ἐὰν ἴσαι τρεῖς, ἥ τε βάσις δύο καὶ ἡ ἐκ μέσου ἐπισταθεῖσα ὀρθή, ἰδόντι δῆλον τῷ ἐκεῖνο εἰδότι. ὥστε φανερὸν ὅτι τὰ δυνάμει ὄντα εἰς ἐνέργειαν ἀγόμενα εὑρίσκεται.

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matics and Necessity (Oxford 2000), 38 – 41 (in 41 n. 58 Burnyeat relates Rep. 527a1 – b8 to Proclus' report about the views of Menaechmus and Amphinomus on the nature of geometric propositions as well as to Cael. 279b32 – 280a2).

[4] See e. g. S. Leggatt, Aristotle: On the Heavens I and II (Warminster 1995), 209 and J.J. Cleary, Mathematics and Cosmology in Aristotle's Philosophical Development, in: W. Wians (ed.), Aristotle's Philosophical Development: Problems and Prospects (Lanham 1996), 208/209. Neither Leggatt nor Cleary distinguish a geometric construction from the diagram accompanying it.

[5] Cf. R. Netz, The Shaping of Deduction in Greek Mathematics (Oxford 1999), 36.

[6] Commenting on Cael. 279b34, Leggatt (above, n. 4), 211 translates τοῖς τὰ διαγράμματα γράφουσι as 'those who construct geometric figures' but notes that it might also mean 'those who prove their propositions'.

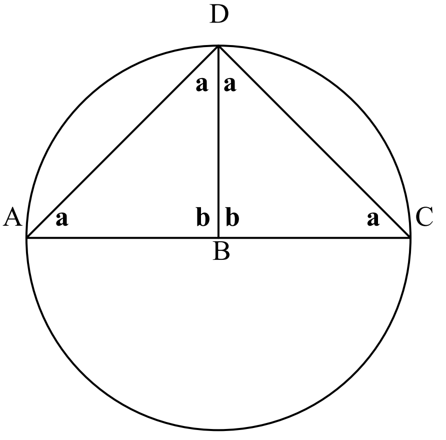

Fig. 1

In Met. 1051a21 – 30 Aristotle illustrates a philosophical point (that actuality is prior to potentiality; see Met. 1051a4/5) with the proof of the proposition that an angle in a semicircle is right.[7] He points out rather cryptically that an angle ADC in a semicircle (Fig. 1) is right because DB = AB = BC, two of these equal segments (AB, BC) make up the base of the semicircle and DB is erected on AC at right angles (διότι ἐὰν ἴσαι τρεῖς, ἥ τε βάσις δύο καὶ ἡ ἐκ μέσου ἐπισταθεῖσα ὀρθή, ἰδόντι δῆλον τῷ ἐκεῖνο εἰδότι): he means that, if in Fig. 1 DB is erected on AC at right angles, then DB = AB = BC[8] so that the triangles DAB, DBC are isosceles and, therefore, the angles **a** are equal;[9] each angle **b**, however, is a right angle because DB is constructed on AC at right angles so that **a** = R/2[10]

[7] This proposition is the first part of Euclid's El. 3.31. Aristotle alludes to a pre-Euclidean proof reconstructed in T. L. Heath, Euclid: The Thirteen Books of the Elements (New York 1956; reprint of the Cambridge ^{2}1926 edition), vol. 2, 63/64; cf. Heath, Mathematics in Aristotle (Oxford 1949), 73/74; J. A. Novac, A Geometrical Syllogism: Posterior Analytics, II, 11, Apeiron 12 (1978), 26 – 33 has argued that Aristotle presupposes the Euclidean proof; see, however, Th. Kouremenos, Aristotle on Syllogistic and Mathematics, Philologus 142 (1998), 232 n. 50.

[8] DB, AB, BC are radii of a circle.

[9] Two of the four angles **a** are base angles of the isosceles triangle DAB and the other two are similarly base angles of the isosceles triangle DBC: the base angles of an isosceles triangle are equal (El. 1.5) and, since the isosceles triangles DAB and DBC are equal by construction and have all their angles equal, the four angles **a** are equal.

[10] The interior angles of a triangle are equal to 2R (El. 1.32). Since the sum of the interior angles of the isosceles triangle DAB or DBC is **b** + 2**a**, it is 2**a** = R, for **b** = R, and thus **a** = R/2. The application of the theorem about the interior angles of a triangle is alluded to in An. Post. 71a19 – 21 (cf. Kouremenos [above, n. 7], 235/236): ὅτι μὲν γὰρ πᾶν τρίγωνον ἔχει δυσὶν ὀρθαῖς ἴσας, προῄδει· ὅτι δὲ τόδε τὸ ἐν τῷ ἡμικυκλίῳ

and, since ADC = 2**a**, ADC is a right angle (the result holds for any angle in the semicircle because all angles in the same segment of a circle are equal; see Euclid El. 3.21). The proof depends on drawing DB in Fig. 1 and, when Aristotle says that the geometers obtain τὰ διαγράμματα they seek by 'dividing' (εὑρίσκεται δὲ καὶ τὰ διαγράμματα ἐνεργείᾳ· διαιροῦντες γὰρ εὑρίσκουσιν), he means that τὰ διαγράμματα are obtained via constructions like drawing DB which divides the triangle ADC in Fig. 1 into two triangles DAB, DBC.[11] The division of the triangle ADC or the perpendicular DB is potential (νῦν δ' ἐνυπάρχει δυνάμει) and thus has to be actualized or drawn by a geometer. It is, however, clearly a means by which the geometers obtain a διάγραμμα, the end of geometric inquiry, and thus this term cannot denote the drawing of the perpendicular DB in Fig. 1.[12]

In Met. 998a25 – 27 τὰ διαγράμματα are geometric propositions from among which Aristotle singles out those he calls the 'elements', i. e. those fundamental διαγράμματα whose proofs are implicit in the proofs of all or most other διαγράμματα (cf. Cat. 14a35 – b2):

καὶ τῶν διαγραμμάτων ταῦτα στοιχεῖα λέγομεν ὧν αἱ ἀποδείξεις ἐνυπάρχουσιν ἐν ταῖς τῶν ἄλλων ἀποδείξεσιν ἢ πάντων ἢ τῶν πλείστων.

τρίγωνόν ἐστιν, ἅμα ἐπαγόμενος ἐγνώρισεν. τῷ ἐκεῖνο εἰδότι in Met. 1051a21 – 30 hints at this step in the proof (ἐκεῖνο is the theorem about the interior angles of a triangle – its proof is sketched a few lines above, in Met. 1051a24 – 26); see W. D. Ross, Aristotle's Metaphysics (Oxford 1924), vol. 2, 271.

[11] See Heath (above, n. 7) 1949, 216/217: "διαιροῦντες,'dividing up', is evidently meant in a non-technical, and even literal sense, and there is no reference to the method of mathematical *analysis*. The dividing up is effected by inserting additional lines, etc. Given a figure in which it is required to prove a certain relation, our ordinary procedure is to join certain points by straight lines, to draw perpendiculars from certain points to certain points, to bisect certain angles, to draw certain circles, and the like, all in the hope that certain relations will then emerge, the use of which will lead to the result desired."

[12] From εἰ δ' ἦν διῃρημένα, φανερὰ ἂν ἦν· νῦν δ' ἐνυπάρχει δυνάμει Ross (above, n. 10), 268/269 concludes that τὰ διαγράμματα are constructions thus foisting on Aristotle a bizarre view: by proving that an angle in a semicircle is right a geometer ultimately seeks to construct something as simple as dropping the perpendicular DB! Ross argues that to make the construction intelligibly is to see the proof but the intelligibility of the construction in a proof of a theorem is not contingent on seeing the proof of this theorem for the simple reason that the knowledge of producing the construction in question is taken for granted (cf. An. Post. 71a19 – 21 quoted above, n. 10). Whereas the subject of φανερὰ ἂν ἦν is clearly τὰ διαγράμματα, the subject and the object of the participles διῃρημένα and διαιροῦντες respectively can only be a particular geometric object on which constructions are carried out (cf. again An. Post. 71a19 – 21). See also below, n. 14.

In Met. 1014a35 – b3 Aristotle rephrases the point he makes in Met. 998a25 – 27 but here τὰ διαγράμματα are undoubtedly proofs of geometric propositions whose elements, like the elements of the proofs in any other science, are assumed to be first figure syllogisms:

παραπλησίως δὲ καὶ τὰ τῶν διαγραμμάτων στοιχεῖα λέγεται, καὶ ὅλως τὰ τῶν ἀποδείξεων· αἱ γὰρ πρῶται ἀποδείξεις καὶ ἐν πλείοσιν ἀποδείξεσιν ἐνυπάρχουσαι, αὗται στοιχεῖα τῶν ἀποδείξεων λέγονται· εἰσὶ δὲ τοιοῦτοι συλλογισμοὶ οἱ πρῶτοι ἐκ τῶν τριῶν δι' ἑνὸς μέσου.[13]

τὰ διαγράμματα are, therefore, proofs of geometric propositions in Met. 1051a21 – 30 too, for they are what the geometers seek to obtain or what answers to the question διὰ τί (e. g. ἐν ἡμικυκλίῳ ὀρθὴ καθόλου).[14] In An. Post. 79a17 – 22 Aristotle (in)famously claims that all or most geometric proofs, i. e. all or most διαγράμματα in the light of Met. 1014a35 – b3, are universal first figure syllogisms (as is also the case with proofs in all other branches of mathematics).[15] It is not, therefore, surprising that in An. Pr. 41b13 – 22 he uses a διάγραμμα to illustrate the need for a universal premise in syllogistic deduction.

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[13] Cf. Meteor. 375b16 – 19: ὅτι δ' οὔτε κύκλον οἷόν τε γενέσθαι τῆς ἴριδος οὔτε μεῖζον ἡμικυκλίου τμῆμα, καὶ περὶ τῶν ἄλλων τῶν συμβαινόντων περὶ αὐτήν, ἐκ τοῦ διαγράμματος ἔσται θεωροῦσι δῆλον. The term διάγραμμα does not refer to the lettered diagram of the geometric configuration Aristotle describes in 375b19 – 29 – it can only refer to the proof, the main part of which is an elaborate synthesis of a locus problem, that follows in 375b29 – 376b22. The diagram of the configuration in question cannot make one understand that the rainbow is not greater than a semicircle: this follows only from the proof which presupposes the diagram but is by no means identical with it.

[14] Cf. Heath (above, n. 7) 1949, 216. Aristotle's conclusion in Met. 1051a21 – 30, i.e. ὥστε φανερὸν ὅτι τὰ δυνάμει ὄντα εἰς ἐνέργειαν ἀγόμενα εὑρίσκεται, refers not to potential constructions actualized by a geometer but to potential proofs (διαγράμματα) brought to actuality by a geometer through the actualization of potential constructions. For the potential knowledge of propositions see An. Post. 86a23 – 30: … τῶν προτάσεων τὴν μὲν προτέραν ἔχοντες ἴσμεν πως καὶ τὴν ὑστέραν καὶ ἔχομεν δυνάμει, οἷον εἴ τις οἶδεν ὅτι πᾶν τρίγωνον δυσὶν ὀρθαῖς, οἶδέ πως καὶ τὸ ἰσοσκελὲς ὅτι δύο ὀρθαῖς, δυνάμει, καὶ εἰ μὴ οἶδε τὸ ἰσοσκελὲς ὅτι τρίγωνον· ὁ δὲ ταύτην ἔχων τὴν πρότασιν τὸ καθόλου οὐδαμῶς οἶδεν, οὔτε δυνάμει οὔτ' ἐνεργείᾳ. καὶ ἡ μὲν καθόλου νοητή, ἡ δὲ κατὰ μέρος εἰς αἴσθησιν τελευτᾷ. Having potential knowledge of a proposition means having potentially a proof of this proposition from actually known premises; cf. An. Pr. 67a9 – 14: … εἰ ᾧ τὸ Β, παντὶ τὸ Α ὑπάρχει, τὸ δὲ Β τῷ Γ παντί, τὸ Α παντὶ τῷ Γ ὑπάρξει. εἰ οὖν τις οἶδεν ὅτι τὸ Α, ᾧ τὸ Β, ὑπάρχει παντί, οἶδε καὶ ὅτι τῷ Γ. ἀλλ' οὐδὲν κωλύει ἀγνοεῖν τὸ Γ ὅτι ἔστιν, οἷον εἰ τὸ μὲν Α δύο ὀρθαί, τὸ δ' ἐφ' ᾧ Β τρίγωνον, τὸ δ' ἐφ' ᾧ Γ αἰσθητὸν τρίγωνον. Cf. J. Barnes, Aristotle: Posterior Analytics (Oxford [2]1994), 85/86, on An.Post. 71a17.

[15] I discuss Aristotle's claim in Kouremenos (above, n. 7).

As one expects from the context, in An. Pr. 41b13 – 22 Aristotle does not, and indeed cannot, regard a construction or a diagram thereof as belonging to the διάγραμμα – the latter is conceived as an inference based on a construction which is taken for granted. In the light of An. Post. 79a17 – 22, this inference is implicitly tantamount to a universal first figure syllogism (otherwise Aristotle would not use a διάγραμμα in order to make a point about syllogistic deduction):

μᾶλλον δὲ γίνεται φανερὸν ἐν τοῖς διαγράμμασιν, οἷον ὅτι τοῦ ἰσοσκελοῦς ἴσαι αἱ πρὸς τῇ βάσει. ἔστωσαν εἰς τὸ κέντρον ἠγμέναι αἱ Α Β. εἰ οὖν ἴσην λαμβάνοι τὴν Α Γ γωνίαν τῇ Β Δ μὴ ὅλως ἀξιώσας ἴσας τὰς τῶν ἡμικυκλίων, καὶ πάλιν τὴν Γ τῇ Δ μὴ πᾶσαν προσλαβὼν τὴν τοῦ τμήματος, ἔτι δ' ἀπ' ἴσων οὐσῶν τῶν ὅλων γωνιῶν καὶ ἴσων ἀφῃρημένων ἴσας εἶναι τὰς λοιπὰς τὰς Ε Ζ, τὸ ἐξ ἀρχῆς αἰτήσεται, ἐὰν μὴ λάβῃ ἀπὸ τῶν ἴσων ἴσων ἀφαιρουμένων ἴσα λείπεσθαι.[16]

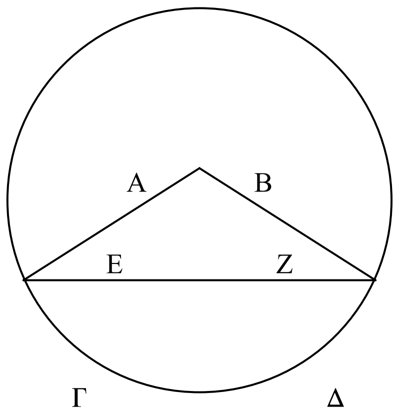

Fig. 2

To show that the base angles E, Z of an isosceles triangle are equal Aristotle assumes that the equal sides of a given isosceles triangle are the

[16] That the base angles of an isosceles triangle are equal is demonstrated by Euclid in El. 1.5. In An. Pr. 41b13 – 22 Aristotle presupposes an evidently pre-Euclidean proof of this proposition; see Heath (above, n. 7) 1956 vol. 1, 252 – 254 and 1949, 23/24. The most striking feature of Aristotle's proof is the use of 'mixed angles', that is 'angles of semicircles' (τὰς τῶν ἡμικυκλίων) between the diameter of a circle and the circumference as well as 'angles of segments' (τὴν τοῦ τμήματος) between chords of a circle and the parts of the circumference bounded by those chords. In Euclid's Elements 'the angle of a semicircle' and the 'angle of a segment' appear only in 3.16 and Def. 3.7 respectively, both remnants of pre-Euclidean Elements; cf. Heath (above, n.7) 1956 vol. 2, on El. Def. 3.7.

radii A, B of a circle (Fig. 2); the cord joining the extremities of A, B is the base of the triangle. The diameters of the circle whose halves are the radii A, B are subtended by the circumferences of the semicircles Γ, Δ respectively and the radii A, B form with the curvilinear segments Γ, Δ the mixed angles ΑΓ, ΒΔ which Aristotle calls 'angles of semicircles'. The letters Γ, Δ are used also for two other mixed angles, called by Aristotle 'angles of segments':[17] these angles are formed at either end of the base of the triangle by the base itself and the segment of the circle it subtends. As it is, E = ΑΓ – Γ and Z = ΒΔ – Δ by construction but, since the 'angles of semicircles' are equal and the 'angles of segments' are also equal, ΑΓ – Γ = ΒΔ – Δ because, if equals are subtracted from equals, the remainders are equal (this is the third Euclidean common notion): therefore, E = Z.

In this proof, Aristotle points out, one cannot assume only that ΑΓ = ΒΔ , Γ = Δ and ΑΓ – Γ = ΒΔ – Δ. Since the equality of the base angles is true of any isosceles triangles, it cannot be inferred only from what is true of the particular configuration in Fig. 2 without captatio petendi: the equality of the base angles can be shown to hold of any isosceles triangle only if it is assumed that any two angles of semicircles as well as any two angles of segments are equal and that, if equals are subtracted from any equals, the remainders are equal. It is clear, Aristotle concludes from the διάγραμμα, that there must be a universal premise in any syllogism and that, if the conclusion in a syllogism is universal, it must be deduced from terms belonging universally (An. Pr. 41b22 – 26). Given, therefore, his thesis in An. Post. 79a17 – 24 that all or most διαγράμματα are first figure universal syllogisms, the equality of any isosceles triangle's base angles is by implication the conclusion in a syllogism A *a* B, B *a* Γ ├ A *a* Γ where A stands for 'a pair of equal magnitudes', B for 'a pair of magnitudes which are remainders from equals when equals are subtracted' and Γ for 'base angles of isosceles triangles'; B *a* Γ is, moreover, the conclusion of a first figure universal syllogism B *a* Δ, Δ *a* Γ ├ B *a* Γ where the middle term Δ stands for 'remainders from angles of semicircles when angles of segments are subtracted'.[18]

[17] For the lettering of the diagram Aristotle presupposes in An. Pr. 41b13 – 22 see Heath (above, n. 7) 1949, 24.

[18] As I argue in Kouremenos (above, n. 7), 239 n. 74, for Aristotle only the equalities E = ΑΓ – Γ = ΒΔ – Δ = Z admit of syllogistic formalization; these equalities are conclusions from the inspection of Fig. 2 but Aristotle does not think that inferring these conclusions proceeds through middle terms. A *a* B, i. e. 'equal' belongs to all 'remainders from equals when equals are subtracted', translates syllogistically the third Euclidean common notion. B *a* Δ, i. e. 'remainders from equals when equals are sub-

The formalization of a geometric proposition as a syllogistic proposition A *a* Γ, in Aristotle's terms τὸ Α ὑπάρχει παντὶ τῷ Γ, which is deducible via a middle term B is explicit in An. Post. 94a28 – 35. The geometric proposition in question is once again that the angle in a semicircle (Γ) is right (A).[19] Although Aristotle translates syllogistically this geometric proposition as τὸ Α ὑπάρχει τῷ Γ without the quantifier παντὶ (cf. An. Pr. 24a16 – 20) which is required by his thesis in An. Post. 79a17 – 24, the absence of the quantifier can be easily explained.[20] According to An. Post. 73b32 – 74a3 a geometric property belongs to all subjects of a certain kind if shown to hold of an arbitrarily chosen subject of this kind: Aristotle's example is 'having interior angles equal to two right angles' which holds universally of 'triangle' if shown to hold of an arbitrarily chosen triangle. The same must apply to A, i. e. 'being a right angle' and Γ, i. e. 'angle in a semicircle', in An. Post. 94a28 – 35: A holds universally of Γ, i. e. τὸ Α ὑπάρχει παντὶ τῷ Γ or A *a* Γ, if A is shown to hold of a randomly chosen Γ, i. e. if τὸ Α ὑπάρχει τῷ Γ (and if, one must add in the light of An. Pr. 41b22 – 26, A is shown to hold of a randomly chosen Γ from a universal premise A *a* B, where B belongs to the randomly chosen Γ).[21] As it is, by translating a geometric proposition in An. Post. 94a28 – 35 as τὸ Α ὑπάρχει τῷ Γ without the quantifier παντὶ Aristotle simply states the condition for τὸ Α ὑπάρχειν παντὶ τῷ Γ to obtain:

> διὰ τί ὀρθὴ ἡ ἐν ἡμικυκλίῳ; τίνος ὄντος ὀρθή; ἔστω δὴ ὀρθὴ ἐφ' ἧς Α, ἡμίσεια δυοῖν ὀρθαῖν ἐφ' ἧς Β, ἡ ἐν ἡμικυκλίῳ ἐφ' ἧς Γ. τοῦ δὴ τὸ Α τὴν ὀρθὴν ὑπάρχειν τῷ Γ τῇ ἐν τῷ ἡμικυκλίῳ αἴτιον τὸ Β. αὕτη μὲν γὰρ τῇ Α ἴση, ἡ δὲ τὸ Γ τῇ Β· δύο γὰρ ὀρθῶν ἡμίσεια. τοῦ Β οὖν ὄντος ἡμίσεος δύο ὀρθῶν τὸ Α τῷ Γ ὑπάρχει (τοῦτο δ' ἦν τὸ ἐν ἡμικυκλίῳ ὀρθὴν εἶναι). τοῦτο δὲ ταὐτόν ἐστι τῷ τί ἦν εἶναι, τῷ τοῦτο σημαίνειν τὸν λόγον.

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tracted' belongs to all 'remainders from angles of semicircles when angles of segments are subtracted' translates syllogistically a conclusion that follows from the inspection of Fig. 2. Δ *a* Γ, i. e. 'remainders from angles of semicircles when angles of segments are subtracted' belongs to all 'base angles of isosceles triangles', translates syllogistically the equalities E = ΑΓ – Γ and Z = ΒΔ – Δ which are two more conclusions from the inspection of Fig. 2.

[19] In An. Post. 94a28 – 35, however, Aristotle presupposes a different proof of this proposition from the one he alludes to in Met. 1051a21 – 30; for the reconstruction of the proof which is implicit in An. Post. 94a28 – 35 see Heath (above, n. 7) 1949, 72/73.

[20] This absence has been mistakenly viewed as indicative either of careless formalization on Aristotle's part or of the difficulty to express geometric inferences syllogistically; see R. D. McKirahan, Principles and Proofs (Princeton 1992), 152.

[21] For further discussion see Kouremenos (above, n. 7), 238 – 240.

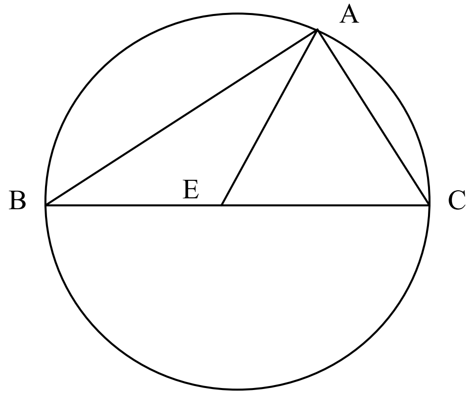

Fig. 3

To show that the angle in a semicircle is a right angle (R) Aristotle considers an angle BAC inscribed in a semicircle and draws AE, E being the center of the diameter BC (Fig. 3). The exterior angle AEC of the triangle ABE is equal to the sum of the triangle's interior angles BAE, ABE (El. 1.32) and, since AE = BE (they are radii of the circle), the angles BAE and ABE are equal (because the triangle is isosceles) so that AEC = 2BAE. In the same manner it follows that the angle AEB is equal to 2EAC. But BAC = BAE + EAC and, moreover, AEC + AEB = 2BAE +2EAC and AEC + AEB = 2R (because of El. 1.13) so that BAE + EAC = R and, therefore, BAC = R. In view of the above, it is the self-evident inference BAC = 2R/2 = R that is explicitly formalized by Aristotle as a first figure universal syllogism A *a* B, B *a* Γ ├ A *a* Γ where A stands for 'right angle', the middle term B for 'half of two right angles' and Γ for 'angle in the semicircle'. Although in An. Post. 94a28 – 35 Aristotle does not characterize the proof of the proposition that the angle in a semicircle is right as a διάγραμμα, this passage bears out the above syllogistic formalization of the geometric proof with which Aristotle illustrates in An. Pr. 41b13 – 22 the need for universal premises in syllogistic deduction. Explicitly characterized as διάγραμμα, the proof in An. Pr. 41b13 – 22 leaves no doubt that the term διάγραμμα means not only 'geometric proposition' but also 'geometric proof' as well as 'geometric proof' (or rather a fragment thereof, not necessarily the most important one from a geometric point of view) 'as a formal deduction', i. e. as a first figure universal syllogism.

If we now turn to the cognate verb γράφω, it does occur at Met. 1078a 14–21 in the sense 'to draw a figure' in a geometric proof.[22] However, it also means 'to prove a geometric proposition', as can be seen from An. Pr. 64b34–65a7 where Aristotle offers a geometric example of circular proof:

ἀλλ' ἐπεὶ τὰ μὲν δι' αὑτῶν πέφυκε γνωρίζεσθαι τὰ δὲ δι' ἄλλων (αἱ μὲν γὰρ ἀρχαὶ δι' αὑτῶν, τὰ δ' ὑπὸ τὰς ἀρχὰς δι' ἄλλων), ὅταν μὴ τὸ δι' αὑτοῦ γνωστὸν δι' αὑτοῦ τις ἐπιχειρῇ δεικνύναι, τότ' αἰτεῖται τὸ ἐξ ἀρχῆς … οἷον εἰ τὸ Α δεικνύοιτο διὰ τοῦ Β, τὸ δὲ Β διὰ τοῦ Γ, τὸ δὲ Γ πεφυκὸς εἴη δείκνυσθαι διὰ τοῦ Α· συμβαίνει γὰρ αὐτὸ δι' αὑτοῦ τὸ Α δεικνύναι τοὺς οὕτω συλλογιζομένους. ὅπερ ποιοῦσιν οἱ τὰς παραλλήλους οἰόμενοι γράφειν· λανθάνουσι γὰρ αὐτοὶ ἑαυτοὺς τοιαῦτα λαμβάνοντες ἃ οὐχ οἷόν τε ἀποδεῖξαι μὴ οὐσῶν τῶν παραλλήλων.

Although Α, Β and Γ are usually term-variables in Aristotle's syllogistic, in An. Pr. 64b34–65a7 they are used as propositional variables[23] and the target of Aristotle's criticism, i. e. οἱ τὰς παραλλήλους οἰόμενοι γράφειν, are charged with carrying out a circular proof $\mathrm{A} \vdash \Gamma \vdash \mathrm{B} \vdash \mathrm{A}$: Aristotle attacks geometers who think that they prove a proposition A about parallels whereas they actually deduce A from A itself without realizing it.[24] Thus in Met. 1078a14–21 the verb γράφω means 'to draw a figure' in a geometric proof but in An. Pr. 64b34–65a7 it means 'to prove a geometric proposition' (through drawn figures).[25] Since, therefore, Aristotle uses the noun διάγραμμα either for a geometric proposition or for the proof of such a proposition, οἱ τὰ διαγράμματα γράφοντες in Cael. 1.10 can only be 'those who prove geometric propositions' or, equivalently, 'those who carry out geometric proofs'. If this is so, in their attempt to show how the Timaeus cosmogony is not at odds with their belief that the cosmos always exists the Platonists Aristotle criticizes in Cael. 1.10 likened the Timaeus cosmogony to a geometric proof.

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22 ὁ δ' αὐτὸς λόγος καὶ περὶ ἁρμονικῆς καὶ ὀπτικῆς· οὐδετέρα γὰρ ᾗ ὄψις ἢ ᾗ φωνὴ θεωρεῖ, ἀλλ' ᾗ γραμμαὶ καὶ ἀριθμοί (οἰκεῖα μέντοι ταῦτα πάθη ἐκείνων), καὶ ἡ μηχανικὴ δὲ ὡσαύτως, ὥστ' εἴ τις θέμενος κεχωρισμένα τῶν συμβεβηκότων σκοπεῖ τι περὶ τούτων ᾗ τοιαῦτα, οὐθὲν διὰ τοῦτο ψεῦδος ψεύσεται, ὥσπερ οὐδ' ὅταν ἐν τῇ γῇ γράφῃ καὶ ποδιαίαν φῇ τὴν μὴ ποδιαίαν· οὐ γὰρ ἐν ταῖς προτάσεσι τὸ ψεῦδος.

23 Cf. Barnes (above, n. 14), 108 on An. Post. 72b38.

24 What proposition Aristotle alludes to is by no means clear; see Heath (above, n. 7) 1949, 27–30.

25 That γράφειν often has logical import is noted by W. Knorr, The Evolution of the Euclidean Elements (Dordrecht 1975), 69–75.

2. Why the Platonists and οἱ τὰ διαγράμματα γράφοντες are incomparable

This is also suggested by Aristotle's argument in Cael. 280a2 – 10 that the Platonists and οἱ τὰ διαγράμματα γράφοντες are incomparable:

Τοῦτο δ' ἐστίν, ὥσπερ λέγομεν, οὐ τὸ αὐτό· ἐν μὲν γὰρ τῇ ποιήσει τῶν διαγραμμάτων πάντων τεθέντων εἶναι ἅμα τὸ αὐτὸ συμβαίνει, ἐν δὲ ταῖς τούτων ἀποδείξεσιν οὐ ταὐτόν, ἀλλ' ἀδύνατον· τὰ γὰρ λαμβανόμενα πρότερον καὶ ὕστερον ὑπεναντία ἐστίν· ἐξ ἀτάκτων γὰρ τεταγμένα γενέσθαι φασίν, ἅμα δὲ ἄτακτον εἶναι καὶ τεταγμένον ἀδύνατον, ἀλλ' ἀνάγκη γένεσιν εἶναι τὴν χωρίζουσαν καὶ χρόνον· ἐν δὲ τοῖς διαγράμμασιν οὐδὲν τῷ χρόνῳ κεχώρισται.

Aristotle argues that the Platonists who adopt the cosmogony in Plato's Timaeus and οἱ τὰ διαγράμματα γράφοντες are incomparable because ἐν τῇ ποιήσει τῶν διαγραμμάτων πάντων τεθέντων εἶναι ἅμα τὸ αὐτὸ συμβαίνει, ἐν δὲ ταῖς τούτων ἀποδείξεσιν οὐ ταὐτόν, ἀλλ' ἀδύνατον (Cael. 280a3 – 5). Aristotle uses the verb ποιεῖν with ἀπόδειξιν or συλλογισμόν as object in the sense 'to carry out a proof' (An. Pr. 28a23, 30a10, 44b26) and what is the case ἐν τῇ ποιήσει τῶν διαγραμμάτων suggests that τὰ διαγράμματα are proofs, for it alludes to the definition of proof in An. Pr. 24b18 – 20:

συλλογισμὸς δέ ἐστι λόγος ἐν ᾧ τεθέντων τινῶν ἕτερόν τι τῶν κειμένων ἐξ ἀνάγκης συμβαίνει τῷ ταῦτα εἶναι.

Picking out the articulation of a proof into premises and conclusion, τεθέντων τινῶν ἕτερόν τι τῶν κειμένων ἐξ ἀνάγκης συμβαίνει resembles what is the case ἐν τῇ ποιήσει τῶν διαγραμμάτων, namely that πάντων τεθέντων εἶναι ἅμα τὸ αὐτὸ συμβαίνει. If this verbal parallel is not a mere accident, it can only suggest that ἡ ποίησις τῶν διαγραμμάτων is not producing geometric constructions or drawing their diagrams but carrying out geometric proofs: Aristotle points out that, if all statements in the premises of a geometric proof are assumed to be true at the same time (πάντων τεθέντων εἶναι ἅμα), the conclusion is unaffected (τὸ αὐτὸ συμβαίνει).

That ἡ ποίησις τῶν διαγραμμάτων means 'carrying out geometric proofs' and not 'producing geometric constructions' or 'drawing diagrams' is also suggested by Aristotle's emphatic contrast between ἐν τῇ ποιήσει τῶν διαγραμμάτων and ἐν ταῖς τούτων ἀποδείξεσιν. The ἀποδείξεις in question are evidently certain proofs the Platonists under attack put forth and, if ἡ ποίησις τῶν διαγραμμάτων means ‘producing geometric constructions’ or ‘drawing diagrams’, Aristotle contrasts two incomparable things: it is, therefore, preferable to understand the phrase in question as ‘carrying out geometric proofs’ in order to obtain a plausible contrast between comparable things, namely geometric proofs and platonist proofs. Aristotle argues that, if all statements in the premises of a platonist proof are assumed to be true at the same time, there obtains an absurdity because τὰ λαμβανόμενα πρότερον καὶ ὕστερον ὑπεναντία ἐστίν (Cael. 280a5/6) but the conclusion in a geometric proof is not affected, i. e. there obtains no absurdity, if all statements in its premises are assumed to be true at the same time. Since Aristotle very often uses the participle λαμβανομένη to qualify a statement (πρότασις) qua premise (see e. g. An. Pr. 33b36 – 40, 35a25 – 28), τὰ λαμβανόμενα can be understood as two statements in the premises of the platonist proofs he has in mind, the adverbs πρότερον and ὕστερον distinguishing the first premise from the second. Being contrary (ὑπεναντία), these statements cannot both be true at the same time and thus the absurdity which, as Aristotle thinks, arises from their contrariety drives home the fact that each of the two statements in question cannot be true at the time the other is true.

If in Cael. 280a2 – 10 Aristotle argues that the Platonists he criticizes and οἱ τὰ διαγράμματα γράφοντες are not comparable because geometric proofs and certain proofs the Platonists put forth differ crucially, in their attempt to show that the Timaeus cosmogony is compatible with their belief that the cosmos always exists the Platonists invoked an analogy between the Timaeus cosmogony and geometric proofs, not geometric constructions or their diagrams; as seen above, this is exactly what one expects in view of Aristotle’s usage of the term διάγραμμα outside Cael. 1.10. In Cael. 280a2 – 10 Aristotle clearly assumes that the Platonists must be committed to certain proofs in virtue of their subscribing to the Timaeus cosmogony. His point is that, if the Platonists adopt the Timaeus cosmogony, they cannot hold on to their thesis that the cosmos exists always on account of the analogy they adduce, for the proofs they are committed to differ from geometric proofs in this respect: in the premises of the platonist proofs there are contrary statements which can both be true at the same time only on pain of absurdity but this is not the case with geometric proofs.

3. The platonist proofs Aristotle compares with geometric proofs

The premises of the platonist proofs contain contrary statements, argues Aristotle, because the Platonists assume that what was initially disorderly became orderly (Cael. 280a7: ἐξ ἀτάκτων γὰρ τεταγμένα γενέσθαι φασίν). This is a clear allusion to the disorderly motions of the elements before the order-imposing intervention of the Demiurge (Tim. 30a2 – 6):

βουληθεὶς γὰρ ὁ θεὸς ἀγαθὰ μὲν πάντα, φλαῦρον δὲ μηδὲν εἶναι κατὰ δύναμιν, οὕτω δὴ πᾶν ὅσον ἦν ὁρατὸν παραλαβὼν οὐχ ἡσυχίαν ἄγον ἀλλὰ κινούμενον πλημμελῶς καὶ ἀτάκτως, εἰς τάξιν αὐτὸ ἤγαγεν ἐκ τῆς ἀταξίας, ἡγησάμενος ἐκεῖνο τούτου πάντως ἄμεινον.

Since Aristotle alludes to this passage in order to back up his contention that two statements in the premises of certain proofs the Platonists under attack put forth are contrary, he implicitly assumes that Tim. 30a2 – 6 encapsulates a number of proofs. That a (trivial) explanation of an event like the establishment of cosmic order by the Demiurge in Tim. 30a2 – 6 proceeds for Aristotle through a middle term is evident from An. Post. 95b16 – 23 where the variables A, Γ and Δ range over events (see An. Post. 95b13 – 15):

οἷον τὸ Α γέγονεν, ἐπεὶ τὸ Γ γέγονεν (ὕστερον δὲ τὸ Γ γέγονεν, ἔμπροσθεν δὲ τὸ Α· ἀρχὴ δὲ τὸ Γ διὰ τὸ ἐγγύτερον τοῦ νῦν εἶναι, ὅ ἐστιν ἀρχὴ τοῦ χρόνου). τὸ δὲ Γ γέγονεν, εἰ τὸ Δ γέγονεν. τοῦ δὴ Δ γενομένου ἀνάγκη τὸ Α γεγονέναι. αἴτιον δὲ τὸ Γ· τοῦ γὰρ Δ γενομένου τὸ Γ ἀνάγκη γεγονέναι, τοῦ δὲ Γ γεγονότος ἀνάγκη πρότερον τὸ Α γεγονέναι. οὕτω δὲ λαμβάνοντι τὸ μέσον στήσεταί που εἰς ἄμεσον, ἢ ἀεὶ παρεμπεσεῖται διὰ τὸ ἄπειρον;

Let A = 'the disorderly motion of the elements for a period up to t_0', Γ = ' the desire of the Demiurge at t_0 to make everything good or orderly', Δ = 'the orderly motion of the elements after t_0'. In Tim. 30a2 – 6 Plato claims that event A happened because event Γ happened and that event Γ happened if event Δ happened. Γ is the middle term explaining the connection between the two terms A and Δ – if event Δ happened, event Γ occurred and, if event Γ occurred, event A occurred. Events A and Δ cannot have happened at the same time. If A and Δ stand for the statements 'the elements moved in a disorderly fashion for a period up to t_0' and 'the elements moved in an orderly fashion after t_0' (the action sentences involving the events for which A and Δ are used above), one can remove the reference to t_0 and assume that these statements are true at the same time only on pain of absurdity because the same thing, elemental motion, cannot be both orderly and disorderly (in the same respect) at the same time: as Aristotle notes, the orderly and disorderly state of a subject must be separated by time, for order comes to be from disorder (Cael. 280a7 – 9: ἅμα δὲ ἄτακτον εἶναι καὶ τεταγμένον ἀδύνατον, ἀλλ' ἀνάγκη γένεσιν εἶναι τὴν χωρίζουσαν καὶ χρόνον). By endorsing, therefore, the Timaeus cosmogony and its crucial assumption in Tim. 30a2 – 6 the Platonists Aristotle criticizes in Cael. 1.10 are committed to a number of similar proofs, for the above explanation applies as much to elemental motion in general as to the motion of each element in particular.

4. The platonist analogy between the Timaeus cosmogony and geometric proofs

Unlike the contrary statements A and Δ in the platonist proof, any two statements in the premises of a geometric proof are true at the same time according to Aristotle. Let A in A *a* B, B *a* Γ ├ A *a* Γ stand for 'right angle', the middle term B for 'half of two right angles' and Γ for 'angle in the semicircle': as seen above, these are the values Aristotle assigns to the term-variables A, B, Γ in An. Post. 94a28 – 35 where he formalizes syllogistically the proof that the angle in the semicircle is right. A and B could not be predicated universally of B and Γ if they were predicated of all B and Γ at some times and not at others, in which case A *a* B and B *a* Γ might not be true at the same time.[26] That these statements are true at the same time, however, does not mean that they are true now or at another time. As Aristotle points out in An. Pr. 34b7 – 11, A holds of all B in a universal premise A *a* B not now or at another time but simpliciter (ἁπλῶς).[27] If simpliciter here means that the present 'holds' in a universal premise is timeless, i. e. that the truth of the premise is not relative to a given time,[28] A *a* B and B *a* Γ are timelessly true or, in the light of Aristotle's peculiar construal of timelessness, true at all times:[29] thus they are true at the same time not in the sense that they are true now or at another time but in the sense that, being timelessly true, they are true at any time.

Thus by pointing out against the Platonists that the statements A and Δ cannot both be true at the same time Aristotle in effect points out that these statements cannot both be always true, unlike what is the case with any two statements in a geometric proof. Since for Aristotle this brings out the

[26] See An. Post. 73a28/29: κατὰ παντὸς μὲν οὖν τοῦτο λέγω ὃ ἂν ᾖ μὴ ἐπὶ τινὸς μὲν τινὸς δὲ μή, μηδὲ ποτὲ μὲν ποτὲ δὲ μή …

[27] δεῖ δὲ λαμβάνειν τὸ παντὶ ὑπάρχον μὴ κατὰ χρόνον ὁρίσαντας, οἷον νῦν ἢ ἐν τῷδε τῷ χρόνῳ, ἀλλ' ἁπλῶς· διὰ τοιούτων γὰρ προτάσεων καὶ τοὺς συλλογισμοὺς ποιοῦμεν, ἐπεὶ κατά γε τὸ νῦν λαμβανομένης τῆς προτάσεως οὐκ ἔσται συλλογισμός.

[28] See Barnes (above, n. 14), 112, on An. Post. 73a28.

[29] See R. Sorabji, Time, Creation and the Continuum (London 1983), 125 – 127.

untenability of the analogy by which the Platonists attempted to idiosyncratically square the Timaeus cosmogony with their belief that the cosmos always exists, the platonist analogy can be fleshed out as follows. What is always true of the everlasting cosmos (e. g. that the motions of the elements are orderly) becomes true after a certain time in the Timaeus cosmogony, as if the cosmos did come to be, but in a geometric proof too what is always true of non-sensible and eternal geometric objects becomes true after a certain time, as if these objects were subject to generation. For Plato geometric knowledge is of what is always true (Rep. 527a1 – b8), i. e. about intelligible objects as turns out from Rep. 510d5 – 511a2. From this passage, however, it also turns out that geometric knowledge is obtained via reasoning about sensible instances of the non-sensible geometric objects: what is always true of the non-sensible geometric objects cannot, therefore, but become true of the sensible instances of these objects after a certain time, i. e. after these sensible instances have been produced in a construction or assumed in a proof or after a theorem about them has been demonstrated.[30] Thus in geometry what is always true of everlasting objects appears to become true after a given time, as if these objects were subject to generation, when a geometer attempts to understand the objects under study and their relations or impart this understanding to others. By the lights of the Platonists whom Aristotle criticizes in Cael. 1.10 what is always true of the everlasting cosmos appears to become true after a given

[30] In Rep. 527a1 – b8 Plato claims that geometric knowledge is not of what comes to be at a certain time and passes away (τοῦ ποτέ τι γιγνομένου καὶ ἀπολλυμένου) but of what is always (τοῦ ἀεὶ ὄντος). That geometric knowledge is of what is always can only be a particularization of Plato's thesis in Rep. 477b10/11 (cf. 478a6/7) that knowledge is set over what is (always, as it turns out from 479e7 – 9). Following the construal of what is in Rep. 477b10/11 by G. Fine, Knowledge and Belief in Republic 5 – 7, in: G. Fine (ed.), Plato 1: Metaphysics and Epistemology (Oxford 1999), 217 – 220, I understand what is always in Rep. 527a1 – b8 as what is always true, i. e. as propositions that are always true. What, therefore, comes to be at a certain time and passes away is what becomes true at a certain time and then ceases to be true: it corresponds to the opposite of what is in Rep. 477b10/11, i. e. to what is and is not (true), or to the object of belief (see 478d5 – e6; what comes to be and passes away, τὸ γιγνόμενόν τε καὶ ἀπολλύμενον, is implicitly characterized as the object of belief in 508d6 – 9). In Rep. 527a1 – b8 Plato contrasts geometric constructions like squaring, applying an area and adding with the knowledge of what is always true. In the light, therefore, of Rep. 510d5 – 511a2 what comes to be true and then stops being true can be plausibly understood as propositions which, though always true of abstract geometric objects, come to be true of transient sensible instances of these objects when these instances are produced in a construction or assumed in a proof as well as when a theorem about them is demonstrated.

time in the Timaeus cosmogony, as if the cosmos did come to be, but this is simply an attempt to understand the cosmos or impart this understanding to others. The Platonists' belief that the cosmos always exists is, therefore, compatible with the Timaeus cosmogony. Aristotle objects that the platonist analogy between a cosmogony and a geometric proof does not hold for a very simple reason. When a geometric proof is being carried out, the statements in it apply truly to geometric particulars after certain times, as these objects are constructed and manipulated by the geometer, but any two of them can be safely assumed to describe truly the same abstract and immutable object at any time without any absurdity. A cosmogony, on the other hand, by definition contains statements about the elements of an evolving system and pairs of such statements are unavoidably contrary, which means that they cannot both be true at any time, as if they were statements about the abstract and immutable objects of geometry, without patent absurdity.[31]

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