Ptolemy and Plutarch's *On the Generation of the Soul in the Timaeus*: Three Parallels

Cristian Tolsa

IN THIS PAPER I present three hitherto unnoticed close parallels between the work of the astronomer Claudius Ptolemy and Plutarch's *On the Generation of the Soul in the Timaeus*. The three cases share various characteristics which make a unitary treatment convenient: not only are the three found in Plutarch's commentary, they appear close to one another in the last section of the tract, in which Plutarch summarily exposes various theories about the musical ratios that are used in the construction of the world-soul of the *Timaeus*. Each of the three consists of an analogy between the heavens and musical structures. Furthermore, the three examples are in two works of Ptolemy that are closely related, the *Canobic Inscription* and the *Harmonics*.

My main objective will be to shed light on the sections of these treatises in which Ptolemy combines mathematics and philosophy, frequently ignored given the major interest of historians of mathematics in the purely mathematical developments. I will not claim that Ptolemy was directly influenced by Plutarch; but the number of parallels and their similar context make it plausible that both authors depend on the same source, probably Eudorus of Alexandria.

Ptolemy's *Harmonics* hardly needs an introduction, being a much studied treatise, particularly in regard to the sophisticated epistemology used by Ptolemy in his exploration of the musical ratios.[1] Little is known, however, of the context of its

[1] See for example A. Barker, *Scientific Method in Ptolemy's Harmonics* (Cambridge 2001); D. Creese, *The Monochord in Ancient Greek Science* (Cambridge

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production, its chronology, or its relationship to other works of Ptolemy, as no indications are given in the text or elsewhere in his corpus.

The situation is quite the contrary with the so-called *Canobic Inscription*, much more overlooked in modern scholarship, but with a clearer historical setting. It is primarily an astronomical text, preserved in the manuscript tradition of the *Syntaxis*, purporting to be a transcript of a stele erected by Ptolemy in the tenth year of Antoninus (A.D. 146 or 147).[2] Against scholarly claims that it may have been a late ancient fiction, its authenticity was confirmed by Hamilton, Swerdlow, and Toomer, who discovered that Ptolemy alluded to this work in a passage of the *Syntaxis*.[3] The monumental block, recording the periodicities of the planets (mostly concordant with the *Syntaxis*), was dedicated to a "savior god" (2 θεῷ σωτῆρι), and was set up at Canopus (17 ἀνετέθη ἐν Κανώβῳ), a locality well known in antiquity for its religious festivals and its Serapeion, where

2010) 283–355. Cf. the survey of the whole work in T. Mathiesen, *Apollo's Lyre: Greek Music and Music Theory in Antiquity and the Middle Ages* (Lincoln 1999) 429–496, and the annotated translations of A. Barker, *Greek Musical Writings* II *Harmonic and Acoustic Theory* (Cambridge 1989) 270–391, and M. Raffa, *La scienza armonica di Claudio Tolomeo* (Messina 2002).

[2] l (header) ὡς ἐν τῇ ἐν Κανώβῳ στήλῃ; 17 ι′ ἔτει Ἀντωνίνου. The date is in the Alexandrian calendar, and the equivalence results from the reasonable identification of the emperor as Antoninus Pius, the closest with this name to Ptolemy's astronomical observations in the *Syntaxis*, dated between 127 and 141: see A. Jones, "Ptolemy's *Canobic Inscription* and Heliodorus' Observation Reports," *SCIAMVS* 6 (2005) 53–98, at 53. My section numbers follow this paper, which contains Jones' edition of the text.

[3] N. T. Hamilton, N. M. Swerdlow, and G. J. Toomer, "The Canobic Inscription: Ptolemy's Earliest Work," in J. L. Bergren and B. R. Goldstein (eds.), *From Ancient Omens to Statistical Mechanics* (Copenhagen 1987) 55–73. More recently, Swerdlow has shown the connections between the last section of the inscription and the *Harmonics*: "Ptolemy's *Harmonics* and the 'Tones of the Universe' in the *Canobic Inscription*," in C. Burnett et al. (eds.), *Studies in the History of the Exact Sciences in Honour of David Pingree* (Leiden 2004) 137–180.

incubation took place, according to Strabo (17.1.17).[4] It has therefore been assumed that Ptolemy's dedication was to Serapis, or to the particular version of this god venerated at Canopus, which may have been related to Osiris.[5]

First parallel: the distance of the Sun

The parallels in the inscription are in the last section, which displays a tabular correspondence between the notes of the musical scale and the planetary spheres, what Ptolemy calls "cosmic tones" (14 κοσμικοὶ φθόγγοι). We encounter the first parallel in the prose statements that come before these tables.[6]

[4] The dedication of an astronomical inscription was not a novelty in the Greek world: two whitened tablets (λευκώματα) with the title "Astronomy of Eudoxus" are recorded in inventories inscribed by Athenian officials for the temple of Good Fortune on Delos (*I.Délos* 1442.42, 1443.109); Aelian reports that Oenopides of Chios inscribed a bronze tablet with an astronomical period at Olympia, and that Meton of Athens too set up (ἀνέστησε) stelae (*VH* 10.7); Callippus is recorded in the *Parian Marble* to have "set out an astronomy" (ἀστρολογίαν ἐξέθηκεν, *IG* XII.5 444.107). But the closest to Ptolemy's inscription is probably a big fragment of a stele discovered near Lindos on Rhodes recording planetary periods: A. Jones, "The Keskintos Astronomical Inscription: Text and Interpretations," *SCIAMVS* 7 (2006) 3–41.

[5] Jones, *SCIAMVS* 6 (2005) 84, agrees with the identification of the god as Serapis. The region is now submerged and no significant finds have been made, except for a gold foundation plaque of a temple of Osiris from the Ptolemaic period (*OGIS* 60), which was possibly part of the Serapeion described by Strabo: P. G. P. Meyboom, *The Nile Mosaic of Palestrina: Early Evidence of Egyptian Religion in Italy* (Leiden 1995) 333 n.192. See Y. Stolz, "Kanopos oder Menouthis? Zur Identifikation einer Ruinenstätte in der Bucht von Abuqir in Ägypten," *Klio* 90 (2008) 193–207, for a discussion of recently discovered remains of a possible temple enclosure. Plutarch (*De Is. et Os.* 361E), in a passage relating to Osiris, changes the name of the deity to Serapis when referring to the cult of Canopus, and then goes on to tell the story of the identification of the two gods in general and the creation of Serapis by Ptolemy I Soter. Pausanias (2.4.6) explains that on the acropolis of Corinth there were two Serapeia, one of them dedicated to "Serapis in Canopus." Rufinus (*HE* 11.26) mentions rituals involving water at Canopus, typical of Osiris.

[6] This disposition echoes the first part of the inscription, where the astro-

The data recorded here consist of various measurements concerning the configuration of Earth, Sun, and Moon at solar eclipses, as well as the estimated distances of both luminaries from the Earth, expressed in Earth radii. These various parameters are closely related to each other, since Ptolemy calculated the distance of the Sun using the triangles resulting from the configuration of a solar eclipse, once he had calculated the Moon's distance using parallax theory.[7] What is interesting here is that, whereas the distance of the Moon can be established with a reasonable degree of accuracy, the calculation of the distance of the Sun constitutes only a plausible guess, due to Ptolemy's method and the precision of his instruments. The calculation involves division by a number very close to zero, which makes the result unreliable, to the extent that with very similar starting points (variations of only a minute in the measurements) the result in the *Syntaxis* is 1210r (Earth radii), roughly 500r above the 729r recorded in the inscription.[8] Such instability, of which Ptolemy must have been aware, allows the interpretation that he resorted to alternative arguments in order to decide between one value and another. In this sense, Pedersen argues, plausibly, that Ptolemy sticks to 1210r in the *Syntaxis* because this was a number very close to the value calculated by Aristarchus, 1219r.[9]

We seem to encounter a similar situation in the distance reported in the inscription. Our first clue suggesting a non-astronomical argument is that the text explicitly states that the two calculated distances (of Moon and Sun) are the "first squares and cubes" (13 πρώτων κύβων ἅμα καὶ τετραγώνων

nomical tables (4–12) are also preceded by prose statements, in that case establishing basic parameters such as the inclination of the ecliptic and the degrees turned by the heavens in one day (3).

[7] As developed in Ptol. *Alm.* 5.15 (I 422–425 Heiberg). For the mathematical details see O. Pedersen, *A Survey of the Almagest* (New York 1974, rev. ed. 2010) 209–213.

[8] Hamilton et al., in *From Ancient Omens* 70.

[9] Pedersen, *A Survey of the Almagest* 212.

ὅροι). Indeed, the number of Earth radii amounting to the distance of the Moon, 64, is equal to $2^6 = (2^2)^3$, and the value for the Sun, 729, equals $(3^2)^3$. Therefore, both numbers are cubes and squares at the same time, since $(x^2)^3 = (x^3)^2$, and, in addition, it is easy to see that they are the minimum natural numbers that satisfy this condition. Of course, this arithmetical property does not have anything to do with Ptolemy's astronomical methods; it rather looks like recreational mathematics.[10] Now, it is enlightening to observe that the same value for the distance of the Sun is found in a report in Plutarch's *On the Generation of the Soul in the Timaeus*, where, crucially, this arithmetical property is emphasised:[11]

> Many carry over into this context Pythagorean notions too, multiplying by three the distances of the bodies from the middle. This is brought about by placing the unit at the central fire, three at the counter-earth, nine at the earth and 27 at the moon and 81 at Mercury, 243 at Venus and at the sun itself 729, which is at the same time a square and a cubic number; and this is the reason why they sometimes call the sun too a square and a cube.

Plutarch commented immediately before this (1028A–B) that, although Plato devised the proportions of the world-soul in the *Timaeus* to be especially appropriate for the soul itself, some interpreters attempted to find them in various ratios perceived in the heavenly bodies. In the passage quoted, Plutarch is referring to certain authors who apparently made use of Pythagorean theory for their explanation of the *Timaeus*, specifically the cosmology featuring a central fire and a counter-Earth, which is attested in the Pythagorean Philolaus

[10] It is dismissively qualified as "sheer numerological nonsense" by Hamilton et al., in *From Ancient Omens* 68.

[11] *An.proc.* 1028B (transl. Cherniss). Any such geometric progression, beginning with 1, has as the 7th term (here corresponding to the Sun) a cube and square, since it will be of the form n^6. This is one of the results of Euclid's proposition *Elem.* 9.8.

of Croton.[12] On the other hand, the triple numbers which they assign to the distances are proportions prescribed in the *Timaeus* (35B–36A).

The fact that Ptolemy uses the same value for the Sun as the interpreters mentioned in this passage, and that in both cases the special property of this number is mentioned, can hardly be a coincidence. Likely enough, Ptolemy knew that the value of 729r was favored as the distance of the Sun on account of its being a tetragonal and a cubic number, and, seeing that his value for the distance of the Moon was also such a number (64r), he opted for 729r in the Sun's case from among the large range of mathematically plausible results of the calculation.[13]

Second parallel: the cosmic scale

The second parallel between the inscription and Plutarch's Timaean commentary is in the section featuring Ptolemy's cosmic tones (14). It might strike a modern reader as strange that here Ptolemy shifts completely away from a physical description of the cosmos, assigning musical notes to his heavenly spheres. Whereas in the treatment of the distances of the Sun and Moon we have seen a true astronomical calculation, even if partly supported through non-astronomical arguments, now Ptolemy devises an imaginative way to conceive the distances of the planets, which were impossible to calculate in his time.

This musical analogy of the heavens is nevertheless not Ptolemy's invention; it in fact constitutes one of the few tenets which can safely be traced back to the early Pythagoreans. Probably the closest we can get to its origin is Aristotle's account, by far our most reliable source, if obscure in this case: large bodies must have produced some sound in their motion,

[12] Philolaus 44A17 D.-K. See C. Huffman, *Philolaus of Croton: Pythagorean and Presocratic* (Cambridge 1993) 238; W. Burkert, *Lore and Science in Ancient Pythagoreanism* (Cambridge [Mass.] 1972) 313.

[13] Hamilton et al., in *From Ancient Omens* 69, show that the result of 729r is attainable with the data of the inscription and Ptolemy's methods, but only with convenient intermediate roundings.

and "their speeds, as measured from their distances, are in the same ratios as musical concordances."[14] For his part, Plato added a crucial contribution to the later history of this analogy, using proportions corresponding to musical intervals in his construction of the soul of the world in the *Timaeus* (36A–D). Turning his intervals into revolving circles, he alluded to the heavenly bodies, but he gave no concrete correspondence between the cosmic spheres and the musical tones. Later writers attempted to complete the picture, for the most part assigning successive notes of a musical scale to the heavenly spheres, with multiple variations in the details both of the scale and of the spheres.[15] Plutarch himself, shortly after his report of the planetary distances, attributes to some people (ἔνιοι) such an assignment, in which, particularly, the Earth is situated at the lowest note of an octave and the following notes are attached to the successive planets up to the sphere of the fixed stars, which receives the eighth note (1028F–1029A).

Against this background, it is remarkable that both Plutarch, in a second version of the cosmic tones which he records shortly after, and Ptolemy, in the *Canobic Inscription*, propose the same and an elsewhere unattested solution. In both, the notes used are not those of a given natural scale as is elsewhere the case, but only the ones which are called "fixed" (ἑστῶτες) in Greek music theory. These are the extreme notes (lowest and highest) of the five tetrachords in Greek theory, amounting to a total of eight different pitches.[16] Plutarch gives an interesting argument for using these notes (1029A, transl. Cherniss):

[14] Arist. *Cael.* 290b21–22 (transl. Stocks). See Burkert, *Lore and Science* 40.

[15] Authors with concrete attested systems of tones of the spheres: Nicomachus (*Ench.* 12), Eratosthenes (fr.15 Powell [Theon Smyrn. 105.15 ff. Hiller]), Cicero (*Resp.* 6.18); see Burkert, *Lore and Science* 352–353, for an overview of their systems. Aristides Quintilianus (3.22) has the only attested correspondence between spheres and whole scales instead of notes.

[16] In ascending order of pitch, the fixed notes are προσλαμβανόμενος, ὑπάτη ὑπατῶν, ὑπάτη μεσῶν, μέση, παραμέση, νήτη συνεμμένων, νήτη διεζευγμένων, νήτη ὑπερβολαίων.

> To those, however, who think these notions not remote from Plato's meaning the following will appear to be closely connected with the musical ratios, that, there being five tetrachords —those of the lowest and the middle and conjunct and disjunct and highest—the planets have been arranged in five intervals.

Plutarch's reasoning is that there exist five tetrachords and that the planets are arranged in the same number of intervals.[17] He further explains that the lowest tetrachord would extend from the Moon to the Sun "and the planets that keep pace with the Sun" (meaning Venus and Mercury),[18] the second from these to Mars, the third from this to Jupiter, and so on. Thus, the five spheres of the planets would be situated at the limits and junctions of these five intervals. At the two extremes of the scale, the sphere of the fixed stars is placed at the highest note of the fifth interval, and the Earth at προσλαμβανόμενος, the lowest note of the system, which is not attached to any tetrachord.[19]

For its part, Ptolemy's cosmic scale (14) is, like Plutarch's, formed with the fixed notes, although it does not exactly coincide with it. The most relevant difference is that the two lowest notes of the system are occupied in the inscription's table by the primary elements arranged in two groups, namely

[17] The same remark is made by 'Lamprias' in *De def. or.* 430A; in *De E* 389E the five tetrachords appear as one of the examples listed by 'Plutarch' as showing the preeminence of the number five.

[18] The assumption that the Sun, Mercury, and Venus orbit together is reasonable from a geocentric point of view, and is in addition supported by *Ti.* 36D5 τάχει δὲ τρεῖς μὲν ὁμοίως.

[19] It is noteworthy that this is not a one-to-one correspondence between fixed notes and spheres, since the lowest note of the fourth tetrachord (παραμέση) is not attached to any sphere: Plutarch uses in fact only seven of the eight fixed notes. This is due to the fact that the five tetrachords are not all conjoined one above the other as would be required in the picture of nested spheres: the fourth tetrachord (disjunct, διεζευγμένων) begins not where the third ends, but one tone above the second tetrachord; see e.g. Nicom. *Ench.* 11, Ptol. *Harm.* 2.5–6. This is nevertheless not a problem in Ptolemy's tones of the spheres, because his version is not based on the tetrachords, but on the single notes.

fire and air corresponding to the second-lowest note (ὑπάτη ὑπατῶν), and water and earth to the lowest (προσλαμβανόμενος); these two spheres are also mentioned in Ptolemy's *Planetary Hypotheses*,[20] a work in which Timaean ratios play no role, which suggests that this was Ptolemy's own addition. Furthermore, while Plutarch puts the Sun together with Venus and Mercury (in ὑπάτη μεσῶν), Ptolemy has the two planets occupy one note (μέση) and the Sun the next one (παραμέση).

However, there is another remarkable coincidence in Ptolemy's scale and Plutarch's account, appearing in relation to what Plutarch says in the following lines. Plutarch expresses a criticism of the system he has just exposed, on the basis that, according to Plato, there should be an extra note above the whole scale. He justifies this assertion by recounting the myth in Plato's *Republic* about the eight Sirens mounted above the heavenly spheres (617B), identifying them with eight of the Muses, whereas a ninth Muse would be occupied with things terrestrial (*An.proc.* 1029C–D). Therefore, to the present scheme of eight fixed notes, one for the Earth and seven for the heavenly spheres, one should add a note to the latter group. It could be significant for discovering the origin of this story that the same identification of the eight Sirens of the *Republic* with eight of the Muses is put into the mouth of Plutarch's teacher

[20] Here Ptolemy did not use any musical tones, but a system of nested solid spheres within which each planet travels. The dimensions of the spheres are calculated with the ratio of maximum and minimum distances derived from the astronomical models of the *Syntaxis*, and with the hypothesis that there are no void spaces between the solid spheres. The lowest sphere of earth and water is assigned a maximum distance of 1r, and the sphere of air and fire is situated above it as far as the radius 33r, the minimum distance of the Moon. See the text in B. R. Goldstein, "The Arabic Version of Ptolemy's Planetary Hypotheses," *TAPS* 57.4 (1967) 3–55, at 7; Pedersen, *A Survey of the Almagest* 393–395. The explanation for these two spheres could be astrological, since, firstly, both pairs of elements appear prominently in the description of the sublunary world in the *Tetrabiblos* (1.2.1), and, secondly, the notes of the cosmic scale are interpreted astrologically in the preserved fragment of *Harmonics* 3.16 (on which see n.24 below).

Ammonius in one of Plutarch's *Table Talks*, where it is used to explain the number of the Muses.[21]

Such an extra note at the top of the scale of fixed notes is precisely what we find in Ptolemy's system, an elsewhere unattested pitch, named in the inscription μέση ὑπερβολαίων,[22] and corresponding to the fixed stars. That this note coincides with the one that Plutarch had in mind is further suggested by the fact that it stands a tone above the whole scale in Ptolemy's system, the ratio that seems implied in Plutarch's account: as a matter of fact, Plutarch presents this supposed addition of Plato as an analogue of the addition of προσλαμβανόμενος to the higher pitches, significantly using the term προσλαμβάνων, which probably indicates that it should stand, like προσλαμβανόμενος, separated one tone from the scale.[23]

Third parallel: the musical system of the circle of the zodiac

The third parallel is not found in the *Canobic Inscription*, but in the *Harmonics*. This should not be surprising, since both treatises contain a description of the musical structure of the cosmos, in both cases at the end, the first part being devoted to the proper mathematical investigation. Thus, chapters 3.8–13 of the *Harmonics* are dedicated to the exposition of a series of musical structures superimposed upon basic astronomical lore, and so were the three last chapters (3.15–16), if we are to judge from their titles—the only text that has survived from them in the manuscripts. A possible exception is a dislocated fragment

[21] *Quaest.conv.* 746A: Μοῦσαι δ' εἰσὶν ὀκτὼ μὲν αἱ συμπεριπολοῦσαι ταῖς ὀκτὼ σφαίραις, μία δὲ τὸν περὶ γῆν εἴληχε τόπον. See J. Opsomer, "M. Annius Ammonius: A Philosophical Profile," in M. Bonazzi and J. Opsomer (eds.), *The Origins of the Platonic System: Platonisms of the Early Empire and their Philosophical Contexts* (Louvain 2009) 123–186, at 138.

[22] Between *cruces* in Jones' edition; Swerdlow suggested μετὰ ὑπερβολαίων following Vincent: Jones, *SCIAMVS* 6 (2005) 74; Swerdlow, in *Studies Pingree* 176.

[23] *An.proc.* 1029B–C: οἱ δὲ νεώτεροι τὸν προσλαμβανόμενον, τόνῳ διαφέροντα τῆς ὑπάτης, ἐπὶ τὸ βαρὺ τάξαντες […] ὁ δὲ Πλάτων δῆλός ἐστιν ἐπὶ τὸ ὀξὺ προσλαμβάνων.

of the last chapter which Gregoras identified in another part of the text, precisely referring to a cosmic scale which coincides with the arrangement of the *Canobic Inscription*.[24] Therefore, in principle we could suppose that the second parallel occurred in both works of Ptolemy.

Let us now consider the third parallel between Ptolemy and Plutarch. The first two chapters of the astronomical section of the *Harmonics* are devoted to the construction of an analogy between the circle of the zodiac and a musical structure (3.8–9). Here Ptolemy decides not to assign to the zodiac a concrete scale, but to deal with the arcs of the circle as if they were musical pitches, so that, for example, the whole circle in relation to three quarters of the circle would be in the proportion 4:3, that is, a fourth; similarly, half the circle in relation to a quarter of the circle would be in the proportion 2:1, that is, an octave; and so on. Ptolemy develops this analogy at length in these chapters, even providing a diagram at 3.9.

To my knowledge, the only other ancient occurrence of this correspondence between pitches and the circle of the zodiac is found in Plutarch's Timaean commentary. But, unlike Ptolemy, Plutarch does not explain the analogy: he only provides a concrete instance, without further remark, which is probably due to his excerpting from a source. It is placed after his report of the distances of the planets, inserted within a list of several astronomical proportions which, according to Plutarch, geometricians have related to the *Timaeus*:[25]

> When she [the Moon] has traversed six signs of the zodiac, she exhibits the plenilune as an octave in six tones (ἐν ἑξατόνῳ διὰ πασῶν), as if it were a consonance (ὥσπερ τινὰ συμφωνίαν).

[24] The spheres that are mentioned in it are situated at the same notes as in the *Canobic Inscription*; however, there has been a long discussion about the authenticity of the fragment, on which see Barker, *Greek Musical Writings* II 390 n.89, with bibliography. Barker does not pronounce judgment on the issue, and the last authoritative opinion is that of Düring, who defended Ptolemy's authorship in his edition of the text.

[25] *An.proc.* 1028D (transl. Cherniss, modified).

When there is a full Moon, that is, when the Moon is in direct opposition to the Sun, she has traversed a half circle—six zodiacal signs—from the position of new Moon (when her place on the zodiac coincided with that of the Sun). Since the whole circle of the zodiac in proportion to half the circle makes the ratio of 2:1, the full Moon is said to exhibit an octave. The meaning of the remark "as if it were a consonance" seems to be that in Pythagorean music theory the consonance of an octave does not amount exactly to six tones,[26] whereas in this analogy there are exactly six signs of the zodiac.

Interpretation: the Timaean background and Ptolemy's philosophy

Chronology theoretically would allow that Ptolemy had read Plutarch's work, but the latter's succinct treatment makes it unlikely that Ptolemy developed his theory based upon this text. This is particularly clear in the third analogy, which in Plutarch is not at all explained.[27] However, the closeness of the coincidences and their similar context leads one to suppose that in these three cases Ptolemy used a very similar source, if not the same, as Plutarch.

The Alexandrian Platonist Eudorus (first century B.C.) is cited three times in Plutarch's text, with two of these mentions related to the exegesis of the numerological issues of Plato's *Timaeus*.[28] Because Plutarch acknowledges that he is following Eudorus' explanation in one of those passages,[29] and because of

[26] See e.g. Ptol. *Harm.* 1.9.

[27] That Plutarch did not devise the analogies himself is obvious in the three cases: the third is part of a series of analogies attributed by Plutarch to some thinkers, who apply "geometrical demonstrations" (1028C γεωμετρικῶν […] ἀποδείξεων); the first analogy, as mentioned above, is attributed to "many" (1028B πολλοί); finally, the case of the cosmic scale is not so explicit, but one may argue that it is introduced as just another of the analogies in the series, and that Plutarch's criticism concerning the lacking extra note suggests that the correspondence was not his own invention.

[28] 1013B, 1019E, 1020C, the last two on the numerical construction of the musical intervals of the world-soul.

[29] 1019E: τὸν δὲ τρόπον, ᾧ λαμβάνουσι τὰς εἰρημένας μεσότητας, ἁπλῶς

Eudorus' known Pythagorean tendencies,[30] this thinker has been considered a plausible source of the 'Pythagorean' reports in this text.[31] We can thus point to Eudorus as a plausible source for Ptolemy, as well.

If this is correct, we would have the first concrete identification of a philosophical source for Ptolemy other than Plato or Aristotle. It would then probably be no coincidence that Eudorus had been active in Alexandria, as was Ptolemy.[32] But even if the source (for either Plutarch or Ptolemy) was not Eudorus, from Plutarch's text it is clear that the context was a discussion of various interpretations of the ratios of the Timaean world-soul related to astronomy. Thus, we can affirm that Ptolemy was clearly influenced by this interpretative tradition of the *Timaeus* in these three instances.

As a matter of fact, the analogies related to the Timaean tradition occupy the whole 'philosophical' section of the *Canobic Inscription*, and in the *Harmonics* the influence of the *Timaeus* is not only patent in the parallel exhibited above and in the cosmic scale originally appearing at the end of the treatise, but actually informs the study of musical ratios in both the soul and the heavens presented in 3.4 and developed in the following chapters.[33] Therefore, one could claim that the influence of the *Timaeus* in the philosophical sections of these two works is fundamental. It is significant that in the introduction to this part of the *Harmonics*, Ptolemy uses a characteristic expression of the

καὶ σαφῶς Εὔδωρος ἀποδείκνυσι.

[30] See M. Bonazzi, "Pythagoreanising Aristotle: Eudorus and the Systematisation of Platonism," in M. Schofield (ed.), *Aristotle, Plato and Pythagoreanism in the First Century BC* (Cambridge 2013) 160–186; H. Tarrant, "Eudorus and the Early Platonist Interpretation of the *Categories*," *LThPh* 64 (2008) 583–595.

[31] J. Dillon, *The Middle Platonists* (Ithaca 1977) 116.

[32] A clear presentation of what is known of Eudorus and his historical and philosophical context in M. Hatzimichali, *Potamo of Alexandria and the Emergence of Eclecticism in Late Hellenistic Philosophy* (Cambridge 2011) 52–60.

[33] See Barker, *Greek Musical Writings* II 374 n.37.

Timaeus, "this world" (3.3 ὅδε ὁ κόσμος), appearing as many as six times in this dialogue and nowhere else in Plato, and indeed very rarely outside of Platonic interpreters.[34] This does not mean, of course, that no other Platonic dialogues influenced this text—reminiscences of the discussion of justice in the *Republic* appear for example in 3.5, as we shall see below. There is also a significant proportion of Aristotelian and Stoic theory in the psychology and epistemology that Ptolemy develops in these chapters,[35] but one can safely conclude that the cosmology based on musical ratios that Ptolemy displays at the end of these two treatises has its model in the *Timaeus*.

However, it is important to bear in mind that Ptolemy, contrary to Plutarch and Eudorus, does not present himself as a contributor to the philosophical tradition of the *Timaeus*. Ptolemy actually does not mention the *Timaeus* anywhere in his work, including these three passages; he rather uses this tradition, without any commitment, to build his own material. It is true that he presented himself as a philosopher, most clearly in the preface of the *Syntaxis* where he defined mathematics—his enterprise in that work, as he himself remarks—as an important part of theoretical philosophy,[36] and in many of his treatises we can see how he effectively embedded his mathematics within a broader philosophical frame, with the main influences being Platonism and Aristotelianism.[37] But he sel-

[34] *Ti.* 23A, 29B, 30B, 30D, 48A, 92C. Cf. for example Philo *Op.* 9, *Leg.* 3.99, 101, 127.

[35] E.g. *Harm.* 3.3, 3.5; cf. Barker, *Greek Musical Writings* II 371–372 nn.27, 28, 30; 375 nn.38, 42.

[36] Ptol. *Alm.* 1.1 (I 4–5 Heiberg). See J. Feke, "Ptolemy's Defense of Theoretical Philosophy," *Apeiron* 45 (2012) 61–90. Ptolemy's definition of the philosopher at the end of *Harm.* 3.5 could also be taken as a self-presentation.

[37] He has been labeled a "Platonist empiricist": J. Feke and A. Jones, "Ptolemy," in L. Gerson (ed.), *The Cambridge History of Philosophy in Late Antiquity* I (Cambridge 2010) 197–209.

dom admits these influences,[38] and he is never one-sided: one may argue that, very much like Galen, Ptolemy's philosophical commitment, to which he was chiefly contributing, was his particular science, in his case mathematics.[39]

To illustrate the difference between Ptolemy's and Plutarch's aims, one could adduce a thinner but significant parallel between Plutarch and Ptolemy's *Harmonics*, found in the chapters on the analogies between music and the soul in the latter work and in one of Plutarch's *Platonic Questions*. In 3.5, Ptolemy, without citing Plato, assigns to each part of the three-fold Platonic division of the soul one of the main concords (octave, fifth, and fourth), based on reasonings such as that "the appetitive, which is lowest in order of importance, [should be attached] to the fourth."[40] On the other hand, Plutarch (1007E) clearly identifies his text as an interpretation of Plato's *Republic*, particularly on the passage (443D) about the harmony of the man who attains justice, and, more focused on Plato's narrative, Plutarch does not attach concords to the parts of the soul like Ptolemy, but speculates, with arguments similar to the astonomer's, on the assigment of notes that Plato had in mind—Plato mentions

[38] A well-known case is the mention of Aristotle in the preface of the *Syntaxis*, on which see L. C. Taub, *Ptolemy's Universe: The Natural Philosophical and Ethical Foundations of Ptolemy's Astronomy* (Chicago 1993) 21–24. The only other philosophical sources mentioned in the whole corpus are Plato and again Aristotle, in *Plan.hyp.* 113.31 and 114.15 and 26 Heiberg respectively. Verbal echoes such as the one noted above in the *Harmonics* alluding to the *Timaeus* may also be counted in this category.

[39] For a discussion of the problematic relationship between Galen and the Middle Platonists see R. Chiaradonna, "Galen and Middle Platonism," in C. Gill et al. (eds.), *Galen and the World of Knowledge* (Cambridge 2009) 243–260. See in the same volume P. J. van der Eijk, "'Aristotle! What a thing to say!'" 261–281, and T. Tieleman, "Galen and the Stoics," 282–299. It is also interesting to consider that other kinds of intellectuals, such as the biblical exegete Philo of Alexandria, placed their main study within a broader philosophical frame: Plato's *Timaeus* is especially relevant for Philo, on which see D. T. Runia, *Philo of Alexandria and the Timaeus of Plato* (Leiden 1986).

[40] *Harm.* 3.5 (transl. Barker).

three notes, but again does not specify the concrete correspondence.

A little further in the same chapter of Ptolemy, it becomes evident that he drew on the same Platonic passage as Plutarch, as he alludes to the harmony of the philosopher in connection with justice.[41] But at the same time his aim is a different one. It is illuminating that at the beginning of the chapter he presents a basically Aristotelian division of the soul to build another analogy with the basic concords,[42] which apparently coexists with the Platonic one, neither one being superior to the other.

We have another valuable instance in Ptolemy's *On the Criterion and the Commanding Faculty*: here Ptolemy develops, again without citing any authority, an epistemology concerned with assuring an accurate perception and a sound intellect, and thus apt for a scientist working on applied mathematics.[43] A. A. Long usefully characterized Ptolemy's philosophical stance in this treatise as "optimum agreement," a label which refers to Ptolemy's attempt to combine various philosophical opinions, eliding the differences and generally ignoring controversies,[44] but which could also be extended to denote the agreement be-

[41] See Barker, *Greek Musical Writings* II 377 n.48.

[42] See Barker, *Greek Musical Writings* II 375 n.38. In this case the division reflects also Stoic influence.

[43] Even though Ptolemy does not make reference to any kind of mathematics in the text. Swerdlow, in *Studies Pingree* 180, doubts the authenticity of this text mainly on this ground, but this does not seem enough to contradict the manuscripts' ascription. Ptolemy's style is actually quite recognizable, for example in the use of two non-technical words found in the Greek corpus only in other works of Ptolemy, specifically forms of προσπαραμυθέομαι (*Crit.* 3 and 6, *Harm.* 3.4, *Phas.* 13) and ἐπιπολυπραγμονέω (*Crit.* 13, *Tetr.* 3.6.4).

[44] A. A. Long, "Ptolemy *On the Criterion*: An Epistemology for a Practicing Scientist," in J. Dillon and A. A. Long (eds.), *The Question of "Eclecticism": Studies in Later Greek Philosophy* (Berkeley 1988) 176–207, at 196. As Long remarks, in this Ptolemy differs from Galen, who in his aggressive polemics reveals himself as more interested in philosophy *per se*.

tween his philosophy and his scientific aims.[45] A good example of such a combination is found at the end of this treatise, where Ptolemy draws an analogy between the parts of the soul and the parts of the body, mixing views in the *Timaeus* about the submission to the intellect of the emotional and appetitive parts, as well as their situation in the body, with an Aristotelian account of perception and intellect.[46]

Back to Ptolemy's cosmology: it is interesting to find that the musical analogy is not mentioned in any other of Ptolemy's astronomical works, which he wrote after the *Canobic Inscription* (see n.3 above). In fact, in the second book of the *Planetary Hypotheses*, he depicts an alternative model, featuring nested solid shells (made of aether) containing the epicycles (see n.20). The numbers are here taken from real measures, namely the distances of the Moon and the Sun and the dimension of the epicycles, as calculated in the *Syntaxis*. By contrast with what we have seen in the inscription, Ptolemy now has a physical picture of the cosmos in mind, suitable for building a scale model. In fact, this was one of the purposes of the treatise, as the first words of the preface confirm, where he states that he is writing in order to afford a handy comprehension of the astronomical system "by ourselves and by those who choose to deploy these theories in models."[47]

This physical concept of the cosmos is in the tradition of the cosmology developed in the *Metaphysics*, where Aristotle adopts the model of nested spheres of Eudoxus and Callippus.[48] Ptolemy actually recognizes this Aristotelian pedigree in the text, for he cites Aristotle—even if only to criticize him for supposing that the poles of each sphere are fixed on its superior sphere—

[45] See for example Long, in *The Question of "Eclecticism"* 195–196.

[46] *Crit.* 13–16. See Long, in *The Question of "Eclecticism"* 205.

[47] Ptol. *Plan.hyp.* 70.13–14 Heiberg (my translation): ὑπό τε ἡμῶν αὐτῶν καὶ τῶν εἰς ὀργανοποιίαν ἐκτάσσειν αὐτὰ προαιρουμένων.

[48] *Metaph.* 1073b31–1074a14. See A. Jones, "Ptolemy's Mathematical Models and their Meaning," in M. Kinyon and G. van Brummelen (eds.), *Mathematics and the Historian's Craft* (New York 2005) 27–42, at 33.

but when describing his solid shells he says that they might be conceived as the whorls of Plato (see n.38 for the reference). As Heiberg remarks in a note ad loc., Ptolemy is referring here to the myth of Er recounted at the end of the *Republic* (616D), where the spheres of the universe are represented as eight nested spindle whorls (σφόνδυλος). Here Plato again attributes a musical note to each of the whorls (617B), but Ptolemy does not mention music at all. One could argue that Ptolemy did not need a musical structure anymore, since he had substituted for it a physical model of nested shells. But it is also true that Aristotle had strongly criticized the musical analogy of the heavens,[49] so that by silencing music Ptolemy could be said to have reached a better agreement between Plato and Aristotle.[50]

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Barcelona
ctolsa@gmail.com

[49] Arist. *Cael.* 290b12–14, cf. *De an.* 407b34–35.

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