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MONOCHORD AND HARMONIC CANON: TWO COMMENTS ON PTOL. *HARM.* 2.12 AND 2.13*

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The purpose of this article is to clear up two controversial passages from Ptolemy's *Harmonics*,[1] in chapters 2.12 and 2.13 respectively. As both of them concern his concept of 'harmonic canon' (ἁρμονικὸς κανών), which cannot be understood separately from some fundamentals of his harmonics, I will first briefly refer to the latter.

REASON AND SENSE PERCEPTION IN PTOLEMY'S *HARMONICS*[2]

From the very beginning of his *Harmonics*, Ptolemy identifies the means of assessing harmony, that is, αἴσθησις and λόγος, as 'criteria to judge harmony' (κριτήρια ἁρμονίας, 3.3–4), thus placing them within the frame of the so-called 'criterion of truth' (κριτήριον τῆς ἀληθείας),[3] and proposing them as a way to judge the right linking of sounds, each one in its own way (οὐ κατὰ τὸν αὐτὸν τρόπον, 3.4). Αἴσθησις, 'sense'[4] (ἀκοή, 'hearing', at 3.4), collects sense-data (τὰ φαινόμενα, 5.18), since its concern is matter (ὕλη) and the affections (πάθη) experienced in

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[1] Ptolemy's *Harmonics* is quoted, with no more specification, by number of page and line in Düring's edition: I. Düring, *Die Harmonielehre des Klaudios Ptolemaios* (Gothenburg, 1930). The passages I quote have superscript numbers referring to the corresponding lines.

[2] Cf. the study of this subject in A. Barker, *Scientific Method in Ptolemy's 'Harmonics'* (Cambridge, 2000), 14–32.

[3] In this author's epistemology, the general criterion – compared with a law court's process in his *Iudic.* 3.5–9 – leads from the beings (τὰ ὄντα) or reality judged (τὰ κρινόμενα) to the truth (ἀλήθεια) or purpose of the judgment (τὸ οὗ ἕνεκεν ἡ κρίσις); between them stand the intellect (νοῦς) as judge (τὸ κρῖνον) and its instruments: sense perception (αἴσθησις) collecting data (τὸ δι' οὗ κρίνεται τὸ κρινόμενον) and reason (λόγος) accounting for them (τὸ ᾧ κρίνει τὸ κρῖνον); cf. *Iudic.* 4.15–5.14. On the 'criterion of truth' in general, cf. G. Striker, 'κριτήριον τῆς ἀληθείας', *NAWG* 2 (1974), 49–110; and P. Huby and G. Neal (edd.), *The Criterion of Truth: Essays Written in Honour of George Kerferd Together with a Text and Translation (with Annotations) of Ptolemy's 'On the Kriterion and Hegemonikon'* (Liverpool, 1989). The edition of Ptolemy's *opusculum* on this subject is F. Lammert (ed.), 'Περὶ κριτηρίου καὶ ἡγεμονικοῦ', in E. Boer and F. Lammert (edd.), *Claudii Ptolemaei Opera Quae Exstant Omnia 3.2* (Leipzig, 1961), i–xvi and 1–36 (Ptol. *Iudic.* for short); there is an Italian translation in P. Manuli, 'Claudio Tolomeo: il criterio e il principio', *RSF* (1981), 64–88, and an English one in Huby and Neal (*supra*), 179–230.

[4] Αἴσθησις has the double meaning of 'sense' and 'sensation', generically expressed as 'sense perception', i.e. both the faculty and the act of perceiving.

connection with it (3.4–5); by transmitting these data, *αἴσθησις* triggers the generic criterion's *judicial* activity (see n. 3). As for *λόγος*, 'reason', its mission – we should not forget that the Greek term implies an effective use of words – consists of expressing what has been collected and transmitted by *αἴσθησις* and, since species (*εἶδος*) and cause (*αἴτιον*) are within its competence (3.5), such expression is made by definition and demonstration, which involves explaining causes: this is just the meaning of *λόγος* according to which man was defined as an 'animal endowed with reason' (*ζῷον λόγον ἔχον*), that is, endowed with the capacity of giving explanations by means of words. In harmonics, *λόγος* specifically accounted for musical intervals, since the Pythagoreans (see Barker [n. 2], 54–73) realized that consonant intervals could be described by means of a simple ratio (*λόγος*), 2:1, 3:2, and so on, simpler when more consonant the interval, an expression they later demanded of the melodic intervals constituent of the harmonization (*τὸ ἡρμοσμένον*) – the *melos* ruled by harmonic principles.

Αἴσθησις and *λόγος* are then the means *νοῦς* makes use of to judge and explain the real world (see n. 3), and between them there is no conflict but rather cooperation: the senses indeed get an approximative perception of the beings (3.6), which they transmit to reason (3.7–8); from that perception, the accurate form of the corresponding concept (*ἔννοια*; cf. *Iudic.* 5.21–2) is expressed by reason (3.8), which duly returns it to the senses (3.7–8) as a standard for them. Thus, though preceding in time, the sensation adapts in fact to its intellectual concept, the latter being the model that specifies the former, so sense perception is – this way – subsequent to intellectual perception. All in all, the function of the *λογικὸν κριτήριον* consists of giving the senses guidance on their approximative perception of the beings – the melodic links, in our case – and rendering it accurate: reason must then provide the senses with a procedure (*ἔφοδος*, 5.8–9) to channel them, the senses in turn having the mission of ratifying the models provided by reason.

PTOLEMY'S HARMONIC CANON

'The instrument for such a procedure', says the author at 5.11, 'is called "harmonic canon" [*κανὼν ἁρμονικός*]', and the concern of a harmonist or scholar of harmonics (*ἁρμονικός*, 5.13), he goes on to say, is

> to preserve in every respect the rational hypotheses of the canon, provided that they in no way at all clash with the senses when assessed by the majority …, these hypotheses having been adopted from the data both self-evident and perceived in rough outline through the senses, but having, by the use of reason, revealed the details as accurately as possible. (5.14–19)

In fact, a link between 'reason' (the *λογικὸν κριτήριον*) and 'canon' was not difficult to understand, as the association of 'criterion' with 'canon' was ancient.[5] *Κανών*, originally meaning 'bar' (used to keep something straight),[6] was later understood as 'ruler', a standard of straightness (and could have some units engraved on it and serve as a measuring instrument), whence it took a figurative sense with

[5] By way of example, Epicurus' treatise on criterion had the double title *Περὶ κριτηρίου ἢ Κανών*; cf. D.L. 10.27.16.

[6] Cf. LSJ s.v. and Striker [n. 3], 61.

the meaning of 'rule'.[7] Ptolemy links up with that tradition to say (5.11–13) that the instrument 'is called "harmonic canon" because of the common attributive [ἁρμονικός] and of its regulating [κανονίζειν] the lack of capacity of the senses to determine truth', followed by his commentator Porphyry (*in Harm.* 22.12–20). As a consequence, Ptolemy's harmonic canon is not a specific instrument[8] but a generic one, to fulfil, on the one hand, the mission of channelling sense perception and leading it to accuracy and, on the other, to submit the rational formulations to endorsement by the senses, thus confirming that such formulations do not contradict sense-data.

Wind or percussion instruments are soon rejected from harmonic research in Ptolemy's treatise (chapter 1.8; cf. 16.32–17.20), so we can state that his canon has to be a chordophone. In fact, a single-stringed canon or monochord (μονόχορδος κανών) is the instrument chosen – as opposed to the ones rejected – to test the ratios of the consonances (see above) faithfully. For our purposes it is enough to know that the monochord consisted of a base with two built-in fixed bridges that a string was stretched over; a mobile bridge or cursor a little bit higher than the fixed ones (18.14, 90.4–5)[9] was shifted under the string to divide it into two segments whose independent sounds produced the required interval when their dividing point was the mathematically appropriate one.[10] However, when the interests of harmonic research demand, the author resorts to different developments of the monochord. For example, to refute (chapter 1.11) the Aristoxenian breaking down of the octave (2:1) into six tones (9:8), a new instrument is proposed, the eight-stringed canon or octachord (ὀκτάχορδος κανών; cf. 37.7, 46.4–5), whose features were similar to the monochord's but with eight strings stretched over the bridges instead of just one, all of them isotone (that is, with equal tone or pitch) and each one provided with its own cursor independent of the other strings. Later (chapter 2.2), we are offered another version of the octachord, based on the helicon (ἑλικών),[11] in which a new transversal bridge, common to all the strings, replaces their eight independent cursors, while its strings, instead of having a fixed position, must now shift along the fixed bridges, according to the required ratios. Again (chapter 3.1), in order to display the two octaves that compose the so-called 'complete system' (τέλειον σύστημα), Ptolemy comes up with a new fifteen-stringed canon (πεντεκαιδεκάχορδος κανών), and, later on (chapter 3.2), with different versions of the octachord.

I do not propose to provide details of these instruments,[12] which would go beyond the purpose of this article, as the important thing to recall here is that all of them are included under the general heading of 'canon': that is, they are all different forms of the harmonic canon, each of them being preferred only accord-

[7] Cf. for example, E. fr. 303.3–5.

[8] However, it has often been identified with the monochord; see, for example, S. Michaelides, *The Music of Ancient Greece: An Encyclopaedia* (London, 1978), s.v. canon; or Barker (n. 2), 23.

[9] There are some textual difficulties in the second testimony.

[10] That is, when the quotient of the lengths of the resultant segments produced the ratio corresponding to that interval. This is Didymus' way of using the canon (see below); the traditional one only took into account the length of just one of the segments, thought of as a fractional part of that of the whole string.

[11] On the helicon and its relationship with the octachord, see M. Bobo de la Peña, 'El helicón y las Musas heliconíades: una cuestión lexicográfica', *Athenæum* 98.1 (2010), 25–43.

[12] A wide study on Ptolemy's instruments can be found in Barker (n. 2), 192–229.

ing to the varying needs of harmonics to channel sense perception and provide the senses with an accurate guide to their perception. After all, as Ptolemy says,

> the canon's task is not to prove by means of just one string in number (or more, albeit in a determined quantity) the ratios of the melodic intervals, but to tune plainly by means of whatever their number may be (isotone, so they present themselves as indistinguishable from a single one), only by the use of reason, precisely what the ablest people in music would tune by ear. (85.11–15)

THE HARMONIC CANON IN CHAPTERS 2.12 AND 2.13

Κανονικοῖς (66.18): monochord and canonic instruments

The first problem I will deal with is raised in chapter 2.12, when the segmentation of the octave according to genus and tone has already been set out and rationally settled: that is, when the mathematical ratios producing the divisions of the octave have already been determined. To carry forth the epistemological programme we revealed above, there is still a need for the senses to approve the proposals of reason, and Ptolemy suggests recourse to the harmonic canon:

> As it remains – in order to prove, through entirely self-evident means, the agreement between reason and sense – to segment also the *harmonic canon*, not only according to just one tone …, but according to simply all the tones and each of the genera used to sing, so that we are shown, as well, the common places of the notes together … (66.6–11)

Now, the author must determine which harmonic canon he will resort to. The first candidate would seem to be the monochord, already used (chapter 1.8) for the sensory verification of the ratios of the consonances; however, the title heading this chapter (2.12), 'About the difficulty of the practical use [δυσχρηστία] of the monochord', betrays his rejection of this instrument, and there is no surprise when passage 66.6–11 continues thus:

> … we will lay out, beforehand, a few short questions *about the defectiveness of just this, the single-stringed canon*, apart from which nothing so far is seen to have been invented for the tunings produced by reason, in melodies in general, to have an easy comparison to discern for the senses. (66.11–15)

Ptolemy then recognizes that 'so far' (μέχρι νῦν, 66.13) nothing – that is, no instrument – except the monochord has been invented for the aim he pursues, and he immediately starts explaining the monochord's defectiveness (ἀτέλεια) in this way:

> [15]δοκεῖ μὲν γὰρ παρεληλυθέναι τὸ τοιοῦ[16]τον ὄργανον πρὸς χρῆσιν ἅμα χειρουργικὴν καὶ θεωρίαν τῶν ἀποτελε[17]σματικῶν τοῦ ἡρμοσμένου λόγου, ἐπειδὴ τοῖς ἄλλοις οὐκ ἐφαίνετο τῶν [18]εἰρημένων ἑκάτερον ὑπάρχον, ἀλλὰ τοῖς μὲν κανονικοῖς τὸ θεωρηματι[19]κὸν μόνον, λύραις δὲ καὶ κιθάραις καὶ τοῖς ὁμοίοις τὸ χρηστικόν (κἀν [20]τούτοις μὲν μετὰ τοῦ καθήκοντος λόγου συνισταμένων τῶν ἐμμελειῶν, [21]μὴ δεικνυμένου δὲ δι' αὐτῶν, ὁπότε μηδὲ ἐπὶ τῶν αὐλῶν καὶ τῶν [22]συρίγγων τὸ τοιοῦτον ἀκριβοῦται, ἃ μᾶλλον ἂν ἔχοι πρὸς ἀμφοτέρας τὰς [23]ἐνδείξεις τελειότερον,

ὅτι τοῖς μήκεσιν ἀκολούθους λαμβάνει τὰς τῶν [24]φθόγγων διαφοράς)· καταφανείη δ' ἂν πλεῖστον ὅσον τῶν ἄλλων ἐνδέον [25]τῷ τούτοις μὲν τὸ γοῦν ἕτερον ἀκριβῶς ὑπάρχειν, αὐτῷ δὲ μηδέτερον. (66.15–25; text punctuation is mine)

The interpretation of this point is controversial, with two particularly striking questions. First, we have the meanings, not only different but even contradictory, given by scholars to the infinitive παρεληλυθέναι (66.15). Indeed, Wallis, the first editor of the *Harmonics*, interpreted it as *præcelluisse*, 'to stand out',[13] accepted by Ruelle[14] and recently by Raffa,[15] whereas another meaning was, in turn, proposed by Düring,[16] whose interpretation of it as 'ausser Gebrauch gekommen zu sein' ('to fall into disuse') has been accepted by Barker,[17] Solomon[18] and Redondo Reyes.[19] I will come back to this question later.

Secondly, we can see a practically unanimous translation of the articular adjective τοῖς κανονικοῖς (66.18) as 'the scholars of canonic science',[20] with nothing – either here or in any other part of the *Harmonics* – backing such an interpretation; as a result, the segment 66.18–19 (τοῖς μὲν κανονικοῖς τὸ θεωρηματικὸν μόνον, λύραις δὲ καὶ κιθάραις καὶ τοῖς ὁμοίοις τὸ χρηστικόν) gets a forced translation that breaks the correlation between κανονικοῖς and λύραις καὶ κιθάραις κτλ., shown by the particles μέν and δέ, and distorts (cf. n. 20) that of the participle

[13] See J. Wallis (ed. and tr.), *Claudii Ptolemaei Harmonicorum libri tres*, in *Operum Mathematicorum Volumen Tertium* (Oxford, 1699 = Hildesheim and New York, 1972), pref. and 1–152, at 84: *Videtur enim hoc instrumentum* præcelluisse*, utpote tum ad manuale exercitium comparatum, tum ad eorum speculationem quibus harmonici concentus ratio absolvatur*.

[14] Ch.-É. Ruelle, 'Le monochord instrument de musique', *REG* 10 (1897), 309–12, at 310: 'En effet, il semble qu'un instrument de cette nature dût *être excellent*, tout à la fois pour la pratique manuelle (artistique) et pour l'étude théorique des résultats de la raison harmonique.'

[15] M. Raffa, *La scienza armonica di Claudio Tolemeo* (Messina, 2002), 176: 'Da una parte sembra, infatti, che tale strumento *si distingua* per l'utilizzo pratico e contemporaneamente per lo studio dei risultati della ragione applicata alla scienza armonica.'

[16] I. Düring (tr.), *Ptolemaios und Porphyrios über die Musik* (Gothenburg, 1934), 81: 'Dieses Instrument scheint jetzt sowohl in der praktischen Musikübung als für den Nachweis der das Harmonische bewirkenden Relationen *ausser Gebrauch gekommen zu sein*.'

[17] A. Barker (tr.), 'Ptolemy', in *Greek Musical Writings 2: Harmonic and Acoustic Theory* (Cambridge, 1989), 270–391, at 340: 'For this kind of instrument seems *to have passed into disuse*, both for practical performance and for theoretical study of the things that produce the ratio of what is attuned.'

[18] J. Solomon, 'Ptolemy *Harmonics*: translation and commentary', *Mnemosyne* supplement 203 (2000), 93: 'Yet this instrument seems *to have faded from use* for both practical playing and for speculation about the results of realized ratios.'

[19] P. Redondo Reyes, *La Harmónica de Claudio Ptolomeo: edición crítica con introducción, traducción y comentario* (Diss., Murcia, 2002, available on CD), 211: 'Pues parece que tal instrumento *ha caído en desuso* tanto para la ejecución manual como para el estudio teórico de lo que es productor de la razón harmonizada.'

[20] Cf. Ruelle (n. 14), 310: '*Pour les canoniciens*, la seule chose intéressante, c'est la théorie; quand il s'agit des lyres, des cithares et des instruments semblables, c'est la pratique'; Düring (n. 16), 81: 'während es *die Kanoniker* nur für ihre theoretischen Berechnungen verwendeten, für die praktische Musikübung aber Lyren und Kitharen und ähnliche Instrumente'; Barker (n. 17), 340: 'since *the* kanonikoi had as their domain only the study of theorems, and practical usage was involved with *lyrai* and *kitharai*, and similar instruments'; Solomon (n. 18), 93: 'It was only a theoretical instrument *among acousticians*, a practical instrument among lyres, cithara, and the like'; Raffa (n. 15), 176: 'ma *ai "canonici"* interessava solo la parte teorica, mentre nelle lire, cetre e simili interessava solo l'aspetto pratico'; and Redondo Reyes (n. 19), 211: '*a los canonistas* sólo les interesaba la teoría, mientras que a las liras, cítaras y similares, la práctica'.

ὑπάρχον (66.18). Only Raffa[21] seems to be aware of this, though the consequence of his analysing the point is an unnecessary amendment of κανονικοῖς to κανονίοις, which he finally does not take into account in his translation:[22] he is similar to the other scholars in this respect, with perhaps the exception of Wallis,[23] whose 'Canonicis' proves to be unclear with regard to the reference therein.

In fact, the masculine of κανονικός, -ή, -όν can often be found with that meaning of 'scholar of canonic science' in Porphyry,[24] but only twice elsewhere: once in a certain 'Dionysius the Musician',[25] quoted by Porphyry himself (*in Harm.* 37.17–20), and another in Plutarch (*Moralia* 657B5). Otherwise, the use of the remaining genders of this adjective can also be regularly read in Porphyry's *in Harmonica*,[26] and it is particularly worth examining the following passage:[27]

(1)Κανονικήν γέ τοι καλοῦσι καὶ τὴν ἐπὶ συρίγγων καὶ αὐλῶν καὶ τῶν (2)ἄλλων πραγματείαν, καίτοι τούτων μὴ κανονικῶν ὄντων, ἀλλ' ἐπεὶ αὐ(3)τοῖς οἱ λόγοι καὶ τὰ θεωρήματα ἐφαρμόζουσι, κανονικὰ καὶ ταῦτα προσα(4)γορεύουσι. μᾶλλον οὖν τὸ ὄργανον ἀπὸ τῆς κανονικῆς πραγματείας (5)κανὼν ὠνομάσθη. κανονικὸς δ' ἐστὶ καθόλου ὁ ἁρμονικὸς ὁ περὶ τοῦ (6)ἡρμοσμένου ποιούμενος τοὺς λόγους.

(*in Harm.* 23.1–6)

'Canonic', at least, is what they also call the study in syrinxes, *auloi* and the others, although these are not canonic; however, since they apply ratios and theories to them, they also call them 'canonic'. Thus, it is rather the instrument which got its name of 'canon' from the canonic study, and 'canonic' is, in general, the harmonist who produces the ratios concerning the harmonisation.

[21] M. Raffa, 'Simmetrie sintattiche, asimmetrie semantiche: nota a Ptol *Harm.* 2.12', *GIF* 53 (2001), 107–16. This paper has a good analysis of 66.15–25, which I took into account for mine.

[22] Raffa (n. 21), 116, declines the amendment, owing to the unanimity of κανονικοῖς in the witnesses.

[23] Wallis (n. 13), 84: *Quandoquidem aliis* instrumentis *non videtur utrumque horum competere: sed* Canonicis *quidem, illud solummodo quod ad Speculationem attinet; Lyris autem, Citharisque, & horum similibus, quod spectat ad exercitium*.

[24] See Porph. *in Harm.* 23.5, 23.7, 23.8 (perhaps quoting Ptolemais Cyrenaica, cf. n. 27); also 23.14, 23.18, 37.25, 92.22, 94.25, 153.18, 153.22, 153.25, 154.7, 154.10, 154.20, 154.22, 154.24, 154.27, 155.11, 155.15, 155.23 and 155.26.

[25] We have no reliable data about this writer, except from his authorship of a Περὶ ὁμοιοτήτων (Porph. *in Harm.* 37.15–16).

[26] Porph. *in Harm.* shows the feminine at 22.15, 22.18 (ἔφοδος), 23.1, 23.4, 23.21 (πραγαματεία), 67.4, 67.5 (θεωρία) and also 22.25, 22.26, 22.27 (πραγαματεία) quoting Ptolemais Cyrenaica; the neuter occurs at 23.2, 23.3 (ὄργανα) (perhaps also quoting Ptolemais Cyrenaica, cf. n. 27). Otherwise, the feminine κανονικάς appears also in Ptolemy's *Harmonics* at 91.26 (χρείας).

[27] The authorship of this passage is debated. According to Düring's text, it is Porphyry's, but B. Alexanderson, *Textual Remarks on Ptolemy's* Harmonica *and Porphyry's* Commentary (Gothenburg, 1969), 21, proposes – rightly, in my opinion – to expand Ptolemais' previous quotation, which according to Düring consists of 22.25–30, into 22.25–23.9; otherwise, the relative οἷς in Düring's text – in the linking Οἷς ἐπάγει κατ' ἐρώτησιν πάλιν καὶ ἀπόκρισιν (23.10), to carry on quoting Ptolemais in 23.10–12 – would not make much sense. Barker (n. 17), 340 n. 90, and Redondo Reyes (n. 19), p. 623 n. 571, attribute the passage to Ptolemais without any comments. In any case, the authorship is not essential to my argument, and I quote Düring's edition literally.

This passage seems to be the origin of the meaning nowadays attributed to κανονικοῖς (66.18).[28] Now, whoever its author might be (see n. 27), the important thing is that *here the adjective can be seen to agree with nouns corresponding to the three genders*, and that there is not – neither is there in the rest of Porphyry's *in Harmonica* – an exclusive use with one or another of them: we have the feminine κανονικήν (23.1) and κανονικῆς (23.4) with πραγματείαν and πραγματείας, respectively, alluding to 'canonics', a discipline similar to harmonics; the aforementioned masculine κανονικός (23.5) also appears, showing the scholar of such a discipline; besides these, referring to the instruments (cf. ὄργανον in 23.4) used for this study, we also have κανονικῶν (23.2) and κανονικά (23.3), both neuter, since the second is morphologically such and the pair of them refer to the same thing. There is no objection, then, to the latter use of the adjective, which is the appropriate one in 66.18, as I will try to prove.

In fact, despite such discrepancy of interpretations, the passage 66.15–25 is a very clear text, well structured through the contrastive use of the particles μέν and δέ, which particularly highlight the breaking down of the dative τοῖς ἄλλοις (66.17) into τοῖς κανονικοῖς (66.18), on the one hand, and λύραις καὶ κιθάραις καὶ τοῖς ὁμοίοις (66.19), on the other, whence it proves to be obvious that the referent of τοῖς ἄλλοις must be inclusive of that of the latter. Now, τοῖς ἄλλοις is clearly opposed to the lexical subject of δοκεῖ, τὸ τοιοῦτον ὄργανον (66.15–16), which refers to the monochord from the previous text (μονοχόρδου κανόνος, 66.12–13), whose defectiveness is being dealt with here; therefore, the implied nucleus of τοῖς ἄλλοις cannot but be ὀργάνοις[29] – whose reference includes that of λύραις καὶ κιθάραις κτλ. – and the same must be that of κανονικοῖς, if we respect the syntax. Düring, nevertheless, ignoring this text's structure – perhaps to justify his view of κανονικοῖς – even makes τοῖς ἄλλοις refer to 'die Organiker, die praktischen Musiker', 'the instrumentalists', as opposed to 'die Kanoniker', 'the scholars of canonics';[30] and Barker, Solomon and Redondo Reyes do something similar.[31] However, surprisingly enough, in the sentence containing καταφανείη (66.24), contrasted in turn with that of δοκεῖ – again by means of the particles μέν and δέ – and with an implied subject identical to the latter's (τὸ τοιοῦτον ὄργανον), to which the τῶν ἄλλων from the supplementary participle ὅσον τῶν ἄλλων ἐνδέον (66.24) is symmetrically opposed, nobody imagines for τῶν ἄλλων any referent other than ὀργάνων,[32] which is incongruous, since we would expect it to make the same reference as the one proposed for τοῖς ἄλλοις.

[28] Cf., for example, Barker (n. 17), 340 n. 90, and Redondo Reyes (n. 19), p. 623 n. 571.

[29] So in Wallis (see n. 23); Ruelle (n. 14), 310: 'attendu que *les autres instruments* ne présentent pas évidemment cette double utilité'; and Raffa (n. 15), 176: 'giacché *negli altri strumenti* non si manifestavano entrambe le qualità'; also see Raffa (n. 21), 112.

[30] Düring (n. 16), 24, as against Ruelle's interpretation of the pronoun (cf. n. 29), despite its being right, in my opinion. Cf. Düring (n. 16), 81: 'weil es *den einen* ['die Organiker, also die praktischen Musiker', at 243] für keine dieser beiden Aufgaben hinreichend schien'.

[31] Barker (n. 17), 340: 'while neither of the activities mentioned seemed to be the proper concern of *anyone else*'; Solomon (n. 18), 93: '*To others*, each of these purposes I just mentioned did not seem appropriate'; and Redondo Reyes (n. 19), 211: 'puesto que *para los demás* no existía cada uno de los aspectos mencionados'.

[32] See Wallis (n. 13), 84: *Perspicuum autem est,* instrumentum hoc *præ* aliis *quam plurimum deficiere: quippe quod, illis, eorum saltem alterum accurate competat; huic vero, neutrum*; Ruelle (n. 14), 310: 'Seulement, cet instrument (le monochorde) est plus défectueux que *les autres*. Dans ceux-ci, on rencontre une des (deux) conditions d'exactitude, tandis que dans celui-là, ni l'une ni l'autre condition n'est remplie'; Düring (n. 16), 81: '[Der einsaitige Kanon] dürfte

As for the meanings, τὸ τοιοῦτον ὄργανον alludes, as I have already said, to the monochord. The χειρουργικὴ χρῆσις (66.16) – τὸ χρηστικόν in 66.19 – is the practical use in musical performance; while the θεωρία τῶν ἀποτελεσματικῶν τοῦ ἡρμοσμένου λόγου (66.16–17) – τὸ θεωρηματικόν in 66.18–19 – refers to the use of the instrument for studying theoretically the notes[33] producing the intervals of the harmonization. Otherwise, the value of ὑπάρχω with the dative is the same in the whole passage, that of ὑπάρχον (66.18) with τοῖς ἄλλοις, later implied with τοῖς κανονικοῖς and with λύραις καὶ κιθάραις κτλ., as well as that of ὑπάρχειν (66.25) with τούτοις (66.25), also implied with αὐτῷ (66.25); the meaning of the verb is 'to be at the disposal of', 'to be feasible or allowed for' (cf. LSJ and Bailly s.v.), where the lexeme of the dative specifies at whose disposal the nucleus – that is to say, the subject – of the verb is.

Thus Ptolemy contrasts the monochord with the remainder of the instruments, seeing these as divided into two groups: the canonic ones, solely devoted to harmonic theory (τοῖς κανονικοῖς τὸ θεωρηματικὸν μόνον [*sc.* ὑπάρχον], 66.18–19); and those proper to musical performance (λύραις καὶ κιθάραις καὶ τοῖς ὁμοίοις τὸ χρηστικόν [*sc.* ὑπάρχον], 66.19), regarded as useless for canonic research (66.19–24). In short, the clause of ἐπειδή (66.17) displays instruments other than the monochord as excluded from one or other of the aforementioned roles (τῶν εἰρημένων ἑκάτερον, 66.17–18), either the theoretical one or the performing: that is to say, they were only used for one of them. Consequently, the main clause (the one containing δοκεῖ), as opposed to its subordinate of ἐπειδή, should point out the monochord as available for both roles, which indeed it does – and I take up again the first question I raised – if we accept for παρέρχομαι the meaning of 'to advance' or 'to move forward', strongly suggested by the presence of πρός with the accusative (66.16) showing direction.[34] So we have here an instrument with two functions, but its double functionality is only apparently (cf. δοκεῖ at 66.15) advantageous, as the clause containing καταφανείη (66.24) – contrasted with that

wohl die meisten Mängel gegenüber *den anderen Instrumenten* aufweisen. Erfüllen diese doch wenigstens eine der beiden an sie gestellten Anforderungen (d. h. die Handlichkeit) genau, er aber keine'; Barker (n. 17), 341: 'The degree to which it [the single-stringed *kanōn*] is inferior to *the other instruments* can be seen most plainly in the fact that they can do at any rate one of the two things accurately, while it can do neither'; Solomon (n. 18), 93: 'The monochord would be shown to be more deficient than *the others* since each of them suffices in one aspect but it in neither'; Raffa (n. 15), 176: 'D'altra parte, però, il monocordo sembrerebbe carente molto più che *gli altri strumenti*, in quanto gli altri possiedono perfettamente almeno la seconda possibilità di impiego (cioè quella pratica), mentre esso non possiede fino in fondo nessuna delle due'; and Redondo Reyes (n. 19), 211: 'Pero el canon se revelaría tanto más insuficiente que *los demás* porque éstos al menos establecen con exactitud uno de los aspectos, pero él ninguno'.

[33] The noun φθόγγοι, 'notes', does not, in fact, appear in the text, where we can only read the genitive τῶν ἀποτελεσματικῶν τοῦ ἡρμοσμένου λόγου (66.16–17); however, we can bring τῶν τοῦ ἡρμοσμένου φθόγγων (67.18) here from the closely related context (67.14–20). Hence I propose φθόγγων as an implied nucleus for the genitive in 66.16–17.

[34] Direction is, indeed, the primary value of πρός + acc. (see H.W. Smyth, *Greek Grammar* [Cambridge, MA, 1956], 371 §1676, 385 §1695 3c; see also *TGL*, LSJ and Bailly s.v. πρός). Otherwise, παρέρχομαι with εἰς + acc. meaning 'to advance' can be seen, for instance, in *TGL* s.v. coll. 493–4 ('prodeo, procedo, progredior … et cum εἰς sequente accus.'); substituting πρός for εἰς is just a hypercorrection on the part of the Atticist Ptolemy in a moment when the use of εἰς was expanding (see F. Blass and A. Debrunner [rev. by R.W. Funk], *A Greek Grammar of the New Testament and Other Early Christian Literature* [London and Chicago, 1961], 110 [§ 203]), and such a substitution is quite normal, owing to the sense of direction in both prepositions.

containing δοκεῖ – clearly shows by focussing on the unsuitability of the instrument for the expanded use, which also accounts (γάρ, 66.15) for the monochord's defectiveness. The text 66.15–25 might then be rendered this way:

> It seems, indeed, that such an instrument [the monochord] has moved forward to practical performing use simultaneous with theorization on the notes [cf. n. 33] producing the ratio of the harmonization, since one or other of the aforementioned roles was not seen to be feasible for the other instruments, but only the theoretical role was feasible for the canonic ones, and the practical one for lyres, kitharas and the like (albeit in these the melodic intervals are constituted with the appropriate ratio, but without it being shown by means of them [the instruments], inasmuch as such a thing is not accurate even in *auloi* and syrinxes, perhaps the most suitable for displaying both roles more completely as they obtain the differences between the notes according to length); however, it could be seen how much more deficient such an instrument is than the others in so far as, for the latter [those used only for either theory or musical practice], at least either one role or the other is feasible with accuracy, whereas neither one nor the other is such [feasible with accuracy] for the former [the monochord].

A first reason to reject the monochord was, then, its *hybrid* use: the instrument, having achieved a performing status, had lost its intrinsically theoretical character and, moreover, had an inaccurate – read *inappropriate* – use for both functions. The rest of chapter 2.12 consists, in fact, of a series of specific criticisms on its use in one or other sense, which incidentally strengthens my interpretation of 66.15–25: why, if the instrument had really fallen into disuse,[35] had Ptolemy to devote almost a whole chapter (66.26–67.20) to criticizing its suitability for theory as well as for performance? Indeed, concerning the theoretical aspect, the author complains that neither the string's evenness nor the bridges' positions were examined any more (maybe practical musicians viewed these matters as being of little importance), 'disregarding that for which the canon is by nature' (ἀφέμενοι τοῦ πρὸς ὃ πέφυκεν, 66.31), that is, the rational segmentation of the string; and again that, even though the beam (πῆχυς, 66.33) – that is, the part of the monochord's base where the measures were engraved – had been well segmented, practical imperatives would not allow looking for the positions of the notes accurately, owing to the required speed of execution. Concerning the practical aspect, the monochord occupies – according to Ptolemy – the lowest place among the instruments for performance, since the need to use both hands to produce each single note deprives it of the characteristic effects of other chordophones, whereas it produces additional noises resulting from the friction caused by the quick sliding of the cursor in pursuit of the notes; and we are finally told that 'those who handle such an instrument, aware of its deviations as regards the notes of the harmonisation, never offer it alone to the senses to be assessed, but accompanied either by the *aulos* or the syrinx, so that its faults go unnoticed with their sonorities' (67.17–21).

[35] The same applies, I think, if it was as outstanding as claimed. Raffa defends ([n. 21], 111) his translation of παρελῆλυθέναι as 'si distingua', as a version 'un po' meno forte' of Wallis' *præcelluisse*, by saying that this instrument distinguishes itself because its double use makes it different from the other ones. However, for the meaning that he proposes ('to be different', 'to distinguish oneself'), I think Ptolemy would have preferred διαφέρω to παρέρχομαι (rather 'to stand out', 'to be superior').

Μονόχορδος Κανών at Ptol. Harm. *68.32*

The other point I would like to discuss is in the following chapter 2.13, whose title 'On the improvements Didymus the Musician seemed to make to the canon' should not mislead us about its contents: it does not deal with Didymus, a scholar about whom we have very little information, but once more with the monochord's features, particularly the new way of handling it that Didymus conceived. Furthermore, Ptolemy is not concealing his views on Didymus' suggestions, as his using the verb δοκεῖν (ἔδοξε, 'seemed', that is, 'was supposed') in the title clearly shows: whatever the opinion of other people might be, he himself does not find Didymus' proposals to be *real* improvements to this instrument's defectiveness but, on the contrary, to have led Didymus himself into error. Indeed, Ptolemy starts by describing Didymus' proposals – which in essence consist of taking advantage of both the notes corresponding to each position of the cursor, instead of just one of them – but, after weighing up the pros and cons of such a methodological innovation, he sets out the segmentations that Didymus had conceived and severely criticizes him, since such segmentations do not fit with the sense-data. Nevertheless, the way that Ptolemy continues, with no interruption at all, with the passage 68.32–69.1 is somewhat puzzling:

(32)γέγονεν οὖν αἴτιον ἅπασι τοῦ μὴ δεδοκιμασμένως προσεληλυθέναι (33)τῇ τῶν λόγων ὑποθέσει τῷ μὴ πρότερον ἐπεσκέφθαι τὴν δι᾽ αὐτῶν (34)χρῆσιν, ἀφ᾽ ἧς μόνης ἠδύναντο παραβάλλεσθαι ταῖς τῆς αἰσθήσεως (1)καταλήψεσι.

This point has been interpreted in a number of ways. Early on we find the feminine ἡ αἰτία in the f-class of the textual transmission according to Düring, as a variant of the neuter αἴτιον (68.32), the predicate adjective with γέγονεν unanimously shown by the remaining manuscripts (at least, the editions do not mention other readings). Though not important as regards the interpretation of this passage, such a variant, in my opinion, makes it more difficult to interpret the lexical subject of γέγονεν, which scholars have identified in different syntagms, as can be seen in the diverse versions of the text. Wallis, for example, introduces an unclear *haec* to fulfil this function.[36] Düring, instead, chooses the articular infinitive τῷ μὴ ἐπεσκέφθαι (τῷ μὴ πρότερον ἐπεσκέφθαι τὴν δι᾽ αὐτῶν χρῆσιν, 68.33–4), after proposing the amendment of the article in the dative (τῷ, 68.33) to one in the neuter nominative (τό), so as to justify his option.[37] His amendment is adopted in the translations of Solomon[38] and Redondo Reyes,[39] the latter moreover including

[36] Wallis (n. 13), 87–8: *Hæc ergo erat omnibus communis causa (cur non probe res processerit in rationum hypothesi,) quod non ante consideratum fuerit exercitium (*seu praxis*) secundum illas rationes: quo solo fieri potuisset cum sensuum perceptione comparatio*.

[37] Düring (n. 16), 84: 'Dass man nicht zu einer unbestrittenen Berechnungsgrundlage der harmonischen Verhältnisse gelangte, liegt für alle Forscher in folgendem begründet: man hatte nicht zuerst die praktische Verwertung jener Relationen untersucht, von welcher allein aus sie mit den Wahrnehmungen unserer Sinne verglichen werden können'; see 18 for his proposal to amend the article.

[38] Solomon (n. 18), 96: 'Many have hypothesized such untested ratios, and the cause for this is their not considering beforehand the use to which these interval [*sic*] will be put. Only from such considerations are they able to be compared by our sense perceptions.'

[39] Redondo Reyes (n. 19), 214: 'Así pues, la causa para todos de haberse ocupado con poco rigor de la hipótesis de las razones, fue no considerar antes su utilización, sólo partiendo de la cual podían ser comparadas con las aprehensiones de la percepción.'

it in his own edition of the text.[40] On the other hand, Barker[41] and Raffa[42] seem to identify as subject of *γέγονεν* the articular infinitive *τοῦ μὴ προσεληλυθέναι* (*τοῦ μὴ δεδοκιμασμένως προσεληλυθέναι τῇ τῶν λόγων ὑποθέσει*, 68.32–3), with Didymus as referent for the nucleus of *προσεληλυθέναι* and *ἐπεσκέφθαι* (68.33); although there is no mention of it, these interpretations would demand amending the article in the genitive (*τοῦ*, 68.32) to one in the neuter nominative (*τό*).

However, do we actually need to change a text that seems to be unanimously attested in the manuscripts, at least as far as the aforementioned articles *τοῦ* and *τῷ* are concerned? A careful examination of this passage shows that the relative clause at the end (*ἀφ' ἧς μόνης ἠδύναντο παραβάλλεσθαι ταῖς τῆς αἰσθήσεως καταλήψεσι*, 68.34–69.1) constitutes, in fact, an allusion to the prepositive syntagm *εἰς τὸ τὰς λόγῳ γινομένας ἁρμογὰς ἐν ταῖς δι' ὅλων μελῳδίαις εὐδιάκριτον ἔχειν τὴν πρὸς τὰς αἰσθήσεις παραβολήν* (66.13–15; see also above), where the analysis of the monochord's defectiveness was stated. Indeed, it is easy to see the parallelism between *οἱ λόγοι*, the implied subject of the relative clause here, and *τὰς λόγῳ γινομένας ἁρμογάς*, the nucleus of *ἔχειν* in 66.13–14; and also between *παραβάλλεσθαι ταῖς τῆς αἰσθήσεως καταλήψεσι* (68.34–69.1) here and *ἔχειν τὴν πρὸς τὰς αἰσθήσεις παραβολήν* (66.14–15) there. Furthermore, we should take into account passage 69.1–8, which follows 68.32–69.1:

(1)*καὶ διὰ τοῦτο τοὺς μὲν τῶν συμφωνιῶν λόγους καὶ διὰ* (2)*μιᾶς χορδῆς ἐξετάζεσθαι δυναμένους κατὰ τὸν εἰς δύο μερισμὸν ἐξειλη*(3)*φότες φαίνονται, τοὺς δὲ τῶν ἐμμελειῶν τῇ συνθέσει τοῦ δι' ὅλου συστή*(4)*ματος μόνως ἂν θεωρηθέντας, ὅπερ οὐκ ἐνῆν ἐπὶ μιᾶς χορδῆς ἀκριβῶς* (5)*ἰδεῖν, καὶ πάνυ διεψευσμένως. ἐλεγχθεῖεν γὰρ ἂν ἐναργῶς, εἴ τις κατ'* (6)*αὐτοὺς ποιοῖτο τὰς κατατομὰς ἐπὶ τῶν ἐκτεθειμένων ἡμῖν ἰσοτόνων* (7) *ὀκτὼ χορδῶν, ἱκανῶν οὐσῶν ἤδη τὸν εἱρμὸν τοῦ μέλους ἐπιδεικνύναι* (8)*ταῖς ἀκοαῖς, ἵνα καταμάθωσι τό τε γνήσιον καὶ τὸ μή.*

Ptolemy here says that using a single string – that is, using the monochord – proves to be insufficient for the purpose set out. Indeed, even though this instrument could serve to check the ratios of the consonances, which only requires two notes, easily obtained on a single string (*τοὺς τῶν συμφωνιῶν λόγους καὶ διὰ μιᾶς χορδῆς ἐξετάζεσθαι δυναμένους κατὰ τὸν εἰς δύο μερισμόν*, 69.1–2), it was, on the contrary, insufficient to check the melodic intervals that segment the whole octave, since such checking could only be done when all the intervals were shown together (*τοὺς τῶν ἐμμελειῶν τῇ συνθέσει τοῦ δι' ὅλου συστήματος μόνως ἂν θεωρηθέντας*, 69.3–4), something simply impossible when using a single string (*οὐκ ἐνῆν ἐπὶ μιᾶς χορδῆς ἀκριβῶς ἰδεῖν*, 69.4–5).

Therefore, the text 68.32–69.1 that we were discussing involves, in fact, an inflection point: after first describing Didymus' so-called improvements to the monochord and later criticizing this author's segmentations, Ptolemy picks up the

[40] Ibid., clxi and 78.17.

[41] Barker (n. 17), 344: 'The reason for all these things was his [i.e. Didymus'] failure to embark on the imposition of the ratios with sufficient circumspection, having failed to consider in advance the way in which they are used in practice: only this makes it possible for them to be brought into conformity with the impressions of the senses.'

[42] Raffa (n. 15), 179: 'La causa di tutti questi difetti è stata che egli [i.e. Didimo] non si è accostato all'individuazioni dei rapporti secondo un metodo sperimentale, dato che prima non ha esaminato l'uso che se ne poteva fare nella pratica musicale, l'unica cosa a partire dalla quale avrebbe potuto confrontare i rapporti con i dati della percezione sensoriale.'

thread of his real thinking, which is none other than the monochord's defectiveness complained about in 66.11–15 (see above), in order finally to describe what such defectiveness consists of. Thus, the first part of chapter 2.13 in fact provides us with a new basis to argue in the same direction – that is, the difficulties of using the monochord as harmonic canon to crown the exposition of the ratios corresponding to the diverse genera and tones: Didymus would have proposed a *rational* segmentation of the tetrachord that he had not checked against sense perception, owing to his lack of an adequate means to do so, because of the insufficiency of the monochord for this purpose, even after his own improvements. Furthermore, the inflection point I am referring to at 68.32–69.1 is, in fact, underlined by the particle *οὖν* (68.32) after *γέγονεν*, the one most often used in Ptolemy's *Harmonics* to show, in particular, the transition to a new chapter.[43]

The subject of *γέγονεν*, as the argumentative twist suggests to us, must then be connected with the main matter of these two chapters (the monochord and its weak points), and should not be looked for in the context of the last passage (that is, the one previous to 68.32–69.1) but rather in that of 66.11–15, to which the relative clause 68.34–69.1 refers us back by changing the topic. Moreover, the gender of the predicate adjective *αἴτιον* in 68.32 – testified to by the most reliable manuscripts, according to Düring himself[44] – suggests a neuter noun as subject of *γέγονεν*; and, following our previous discussion, the obvious candidate for such a function seems to be the syntagm *τὸ τοιοῦτον ὄργανον*, by means of which Ptolemy has being referring to the monochord throughout the last chapter, for example at 66.15–16 and 67.17, or – slightly modified (*τὸ ὄργανον τοῦτο*) – at 67.4, and which is, in fact, the main concern of both chapters 2.12 and 2.13.

If the subject I am proposing for *γέγονεν* is accepted, the analysis of 68.32–69.1, now without any need of amendment, proves to be very simple. The dative *ἅπασι* (68.32) and the articular infinitive *τοῦ προσελθεῖν* (68.32–3) are both complements of the predicative *αἴτιον* as an example of the structure *αἴτιόν τινί τινος* 'responsible, with regard to somebody, for something'; in our case, the instrument in question is pointed out as responsible 'with regard to everybody' for '[their] approaching the hypothesis of the ratios without testing it': that is, we are shown the monochord as the *culprit* of everybody's making the mistake described in the infinitive clause. Otherwise, the referent of this 'everybody' (*ἅπασι*) is to be sought in 69.1–8 and put in connection with the implied subject of *φαίνονται* (69.3), which agrees with the participle *ἐξειληφότες* (69.2–3) governed by this verb, the same of *ἐνῆν* (69.4) and *ἐλεγχθεῖεν* (69.5), alluding to the scholars of harmonics, Didymus among them. Eventually, still in 68.32–69.1, the other articular infinitive *τῷ μὴ ἐπεσκέφθαι* (68.33–4), with the relative clause *ἀφ' ἧς … καταλήψεσι* (68.34–69.1), complements the first one (*τοῦ προσελθεῖν*), with a causal value. The translation of 68.32–69.8 could read like this:

Thus, [such an instrument] has become responsible for all [the scholars] approaching the hypothesis of the ratios without testing it, because of [their] not previously examining the practical use of such ratios, the sole basis on which these can be contrasted with what the senses apprehend. And that is why they appear to have achieved the ratios of the

[43] *Οὖν* is used in more than the half of them: 1.2, 1.4, 1.7, 1.8, 1.12, 1.13; 2.2, 2.3, 2.5, 2.6, 2.7, 2.9, 2.15; 3.1, 3.3, 3.4, 3.8, 3.10 and 3.14.

[44] Those of the m-class; see Düring (n. 1), xlvii; also his *stemma codicum* in ibid., xlvi–lxix.

consonances, since these could be examined even by means of a single string by division of it into two parts; instead, as the ratios of the melodic intervals could have been observed only in the composition of the whole system, something that precisely was not in their hands to do accurately on just a single string, they appear to have achieved these as well, [and] quite falsely. They would, indeed, be patently refuted if the segmentations according to them were made on the eight isotone [i.e. with equal tone or pitch] strings we have set out, since these are already enough to show the concatenation of the melody to the ears, so that the latter appreciate which is genuine and which is not so.

The monochord is, then, defective (ἀτελής) or deficient. The reason to reject it for this part of the experimentation does not lie only in its hybrid use, simultaneously theoretical and practical. That use, bemoaned in chapter 2.12, involved not only a lack of accuracy inappropriate to a canonic instrument but also a practical incapacity to produce notes in rapid succession, which is the true cause of its being rejected, as we saw in our commentary on chapter 2.13: the instrument is useless at reproducing the totality of the intervals that segment the octave. For the right sense-verification of their seven corresponding ratios, there would be a need rather of the octachord devised by Ptolemy, whatever its versions (1.11, 2.2), and its use is clearly suggested by his offering to resort to 'the eight isotone strings we have set out' (69.6–7). Certainly, the insufficient number of strings in the monochord makes it impossible for scholars (Didymus included) to examine the practical use of the ratios that they propose, the sole form of verifying their sense perception; they are thus forced, so to speak, to formulate non-tested hypotheses on the segmentation of the octave, as a result of the inadequacy of the monochord as experimental basis, which is decried in 68.32–69.1.

My interpretation of the passage does not, I believe, raise any difficulties, but is, on the contrary, its simplest explanation. It might be advisable, nevertheless, in order to make the text more understandable, to change its punctuation[45] and separate it from the preceding part, thus making a new paragraph from 68.32–69.1 onwards.

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[45] On the problems of Düring's punctuation of Ptolemy's text, cf. M. Bobo de la Peña, 'Algunas consideraciones críticas y exegéticas en torno al texto de la *Harmonía* de C. Tolomeo (I)', *Emerita* 74 (2006), 341–58, at 341–2, n. 2.