Kennedy and Stichometry – Some Methodological Considerations

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In a recent edition of Apeiron, Jay Kennedy published 'Plato's Forms, Pythagorean Mathematics and Stichometry'.[1] In this paper, he asserts that Plato's works have a 12-part structure and that this structure can be interpreted musically, there is evidence for Plato's Pythagoreanism in this musical structure, and ultimately that Plato's philosophy was 'fundamentally Pythagorean'.[2] It is possible to mount many philosophical objections to these theses. Indeed, these run contrary to what a great number of Plato scholars, myself included, believe Plato was doing when he wrote. However, to engage at this level would leave much of Kennedy's thesis unchallenged. In this paper, I examine some methodological issues in Kennedy's stichometry and cast doubt on whether there is evidence to suppose a 12-part structure to Plato's works or any other basic stichometric claim.

I

Kennedy asserts that: 'Passages describing *the divine wisdom and justice of the ideal philosopher* often recur near the centre of the dialogue.'[3] A key question for this assertion, and for the more general notion that the dialogues are divided into twelfths, is how near is near enough to count? The largest difference Kennedy cites is in the case of the *Cratylus*, wherein his passage spans from 47.7% to 51.3% of that work. This means that 2.3% short of the centre counts and so, by a simple symmetry, ought 2.3% beyond the centre, making a spread of 4.6%. This looks extremely gener-

1 J. B. Kennedy 'Plato's Forms, Pythagorean Mathematics, and Stichometry', *Apeiron* 2010, 1–31.
2 Kennedy (2010), 1.
3 Kennedy (2010), 1.

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ous, especially if we consider that if the works are divided into 12, we have 11 significant points (discarding 0/12 and 12/12). With a spread of 4.6% per point, this means that 50.6% of any work is in the catchment area of the significant points. More alarmingly, Kennedy also claims a quarter tone thesis, entailing division into 24, which would give 23 significant points (discarding 0/24 and 24/24) that would mean that all of the work is in the catchment area.[4]

This is possibly slightly unfair, as the *Cratylus* passage Kennedy cites spans the centre of the dialogue (47.7%–51.3%) and could perhaps be narrowed down, although that may well have a cost in terms of important evidence for Kennedy. As a minimum for Kennedy's thesis, taking a passage that does not span the centre of a work, the passage he cites for the *Timaeus* is at 49.4%–49.5%. This would give us a spread of 0.6% doubled by symmetry up to 1.2% or a catchment area of 13.2% for 11 significant points and 27.6% for 23 significant points. Alternatively, there is a passage in the *Symposium*, which Kennedy cites in relation to the Golden Mean with a difference of 0.8%, 1.6% by symmetry, 17.6% of a work at 11 points and 36.8% at 23 points. There is an important requirement for some clear statement of how near is near enough to count and for some argument to support that. A major concern must be that if the bands for evidence around significant points are set this broadly, it is no great surprise that evidence can be found.

II

There is an important need to state how statistically significant these findings are. Kennedy quotes a figure of 0.5% for the accuracy of some of his results.[5] This is fine. However, accuracy is not the same as statistical significance. Results may be very accurate without being statistically significant. So, for example, if I were to claim that Plato uses the word *kai* at each of the one twelfth points of his work, or indeed any randomly chosen points, this would doubtless be very accurate. However, given the abundance of other uses of *kai* in Plato, it would not be statistically significant.

Establishing statistical significance will not be straightforward, as there are several undefined parameters at present. The first of these is the band width for the significant points. The greater the bandwidth, the less statistically significant the findings are likely to be. A further issue will be what subjects are going to count as significant for this study. Kennedy gives us

4 Kennedy (2010), 18 and note 68.
5 Kennedy (2010), 27.

'the divine wisdom and justice of the ideal philosopher'.[6] There is a need to be clear and precise as to just how many further topics are going to be used. It should be clear that the larger the number of topics chosen, the less statistically significant the results are likely to be. Perhaps the most important issue here, and one which is difficult to quantify, is that of how broadly each selected topic is to be construed. If topics are construed broadly, in order to generate instances at or around the supposed significant points, this is very likely to generate many further instances at non-significant points. If this is so, then the statistical significance of instances occurring near significant points will be very low.

As an example, Kennedy claims that allusions to the Golden Mean cluster around 61.8% of Plato's works,[7] the value of the Golden Mean itself being 0.618.[8] His lead example is that of the *Republic*. Kennedy comments that there has been a debate on whether the Divided Line was divided by the Golden Mean, and he recognises that there is no explicit reference to the Golden Mean in Plato. He then asserts that discussion of the divided line begins at 61.7% of the *Republic*. Whether there is an allusion to the Golden Mean is doubtful, and there is also a problem of localisation. *Republic* 508b13 (61.7%) does have the good, in proportion to itself. However, this seems a very tenuous allusion to the Golden Mean if it is one, and as Kennedy admits, the discussion of the Divided Line proper begins at 509d6 (62.2%). Kennedy admits the issue of coincidence and also offers examples for the *Parmenides*, *Symposium*, *Phaedrus* and *Philebus*. He quotes *Parmenides* 151b5: '**Parmenides (61.7–61.8)** The one is equal and greater and less than itself ... And if greater and less than equal, it would be of equal measures and more and less than itself ... and in number less and more.' Kennedy believes the content of this passage is similar to Euclid's definition of the Golden Mean and is an allusion to it. I disagree. I do not see the allusion and would argue that the context of the passage would make such an allusion highly unlikely and entirely pointless. The *Symposium* passage at 203e5 merely says that Eros is in the middle of knowledge and ignorance.[9] The *Phaedrus* passage at 259a2 is a reference to noon, the middle of the day. The *Philebus* passage at 45e7 is the Delphic injunction of 'nothing too much'. Leave on one side for a moment the issue of whether these passages do allude to the Golden Mean. If we count these as instances of allusions to the Golden Mean,

6 Kennedy (2010), 10.
7 Kennedy (2010), 22.
8 As Michalis Sialaros has pointed out to me, the Greeks understood the Golden Mean in terms of a ratio, so the transition to a percentage is problematic. Here I quote the figures, which Kennedy uses, without approving the use of such figures.
9 Here I am following Dr. Tad Brennan's analysis at http://leiterreports.typepad.com/blog/2010/06/the-ultimate-esoteric-reading-of-plato.html.

there will be further instances, in huge numbers throughout Plato's works. Note also that even with this broad construal, we have only five purported instances from all of Plato's works. To return to band widths again, Kennedy's Symposium passage is at 61.0%, 0.8% from the Golden Mean point, giving a band width of 1.6%. Given this band width, the breadth of the Golden Mean construal and all the Platonic works to look at, I suspect other locations will throw up five instances. In short, if the Golden Mean is construed this broadly, then the statistical significance of a few instances clustered around 61.8% of the text is going to be very low.

There is then considerable vagueness about what will count as evidence for Kennedy's thesis, which means that it is very hard to give any independent assessment of the statistical significance of his work. We are a very long way from any test of statistical significance. First, the parameters must be defined, and this will not be trivial or non-controversial. Once we have the parameters, we can then conduct a count of all the instances in Plato within those parameters. That, too, would not be trivial as it is hard to see, given the breadth with which Kennedy treats many ideas, how a computer-based count could be done. We would then need to establish distribution patterns and think hard about what the expected distribution patterns should be.[10] We would also need to think about defining appropriate null hypotheses for Kennedy's theses. Null hypotheses give what we would expect to find in the absence of the supposed effect and are critical to many tests of statistical significance. Only when this work is done can we generate any meaningful tests of statistical significance.

There is an important corollary to this vagueness on what counts as a positive instance. This is simply, what is going to count as a contrary instance? If this study wants to claim any scientific/mathematical credibility, this is both critical and non-trivial. One difficulty in giving independent assessment of this thesis is that it is far from clear what a counter instance would consist of, either in terms of position in the text or whether it falls under the breadth of construal of a topic.

III

A further problem in assessing Kennedy's stichometry is that it is not entirely clear which thesis or theses are being advanced. One of them seems to be that:

[10] There are different types of tests of statistical significance, and which are most appropriate depend on the expected distribution pattern of instances.

A) Plato's works are divided into twelfths, and Plato uses certain devices to mark these twelfth points.

But do those devices occur:

(1) at all twelfth points and not elsewhere?
(2) at most twelfth points and not elsewhere?
(3) at all twelfth points and elsewhere?
(4) at most twelfth points and elsewhere?

It should be evident that (3) and (4) are much weaker theses than (1) and (2). It should also be evident that 1 and 2 are non-starters. For example, the claim for speech position can only be that speeches start at some twelfth points but not all (not every twelfth point in Plato has a speech starting there or is included in a longer speech starting at a twelfth point). Clearly, there must be speeches that start at non-significant points as well and so with the other marker devices, which Kennedy proposes, such as 'significant turns in the argument' or 'passages describing the divine wisdom and justice of the ideal philosopher'. It is also important to consider the marker devices individually as well as in a group. So although (3) or (4) might be claimed for a group of these markers, the claim for an individual marker would have to be the rather weaker thesis where these markers occur:

(5) At some twelfth points and elsewhere

Certainly, this is the case for 'passages describing the divine wisdom and justice of the ideal philosopher' occurring near the centre of a work as Kennedy says this happens 'often', and there are passages on this topic elsewhere in Plato. How often is often enough is another ill-defined issue. I would emphasise here that Kennedy's use of the Golden Mean falls into this category as well. References around 61.8% of the text are only claimed in five works. The references are interpreted so broadly that given those criteria, other passages in Plato, not at or near 61.8%, must be taken as referring to the Golden Mean as well.

I seek to clarify the nature of the thesis here for several reasons. The weaker the thesis being proposed, the less statistically significant it is likely to be. In order to avoid version (5), there is a need to use a group of markers as no individual marker picks out all of the twelfth points. This must raise issues on why we use that group of topics or indicators rather than any other group. It is not immediately clear why Plato would want to use these particular markers for twelfth points, and as I argue below, there are issues about circularity and independent justification here. There must also be a concern about how much reliance we can put on an accu-

mulation of evidence from individual markers that accord to (5), when the individual evidence looks distinctly weak.

IV

There are some serious concerns about methodological circularity. If the stichometric thesis is used to determine the data, that data cannot in turn be used to support the stichometric thesis. In relation to the *Phaedrus*, Kennedy claims that: 'If the prologue of the first speech (237a7-b1) is not counted, then the first speech has 6,743 characters, which is close to one twelfth of the dialogue (6,744).'[11] However, no reason is given for not counting the prologue here other than this gives a figure of one twelfth of the dialogue. Evidence like this cannot then be used to support the stichometric thesis on the basis that speech lengths are integer multiples of one twelfth of a work. We need an argument for a general principle that prologues should be ignored or some ad hoc argument as to why this particular prologue should be ignored. A second example of this is speech lengths in the *Symposium*.[12] To get the speech lengths to integer multiples of twelfths, Erxymachus' speech includes the 'hiccups' and the 'repartee' with Aristophanes, whereas with Socrates' speech, the 'banter' at the beginning is excluded.[13] Again, principles and argument are required here. If the stichometric thesis is very strongly established on independent evidence, it might then be possible to clear up some anomalies in this fashion, with due care and with due transparency. This sort of argumentation, however, should not be in the primary evidence, and it casts considerable doubt as to whether lengths and positions of speeches support the stichometric thesis as is claimed.[14]

There is also a more subtle and possibly more problematic form of circularity to consider as well. To return to my initial point in this paper, what is the band width around the supposed significant points going to be? Whatever the answer to that is, the justification should not be 'this is the band width required to make the stichometric thesis work'. There is a need to have an independent means of setting the band width. One can make similar points in relation to several other issues. Which topics are we going to look for around the supposed significant points? How many topics are we going to employ? Again, the justification should not be 'these are the topics which make the stichometric thesis work'. Finally, the

11 Kennedy (2010), 8 note 30.
12 Kennedy (2010), 7 note 26.
13 Kennedy's terms in quotation marks, see Kennedy (2010) 7 note 26.
14 Kennedy (2010), 10.

most problematic issue here may be how broadly those topics are treated. As we have seen in relation to the Golden Mean, it is possible to treat some topics very broadly indeed. How broadly should these topics be treated? Once more, something like 'broadly enough to generate evidence at significant points, not so broadly so as to produce many other instances undermining statistical significance' would lead to circularity.

V

There must be concern that something analogous to the Forer effect operates in relation to this thesis. The Forer effect is the tendency for people to consider groups of statements to be accurate even though the individual statements are vague or meaningless. The effect is often cited in the analysis of horoscopes or psychic cold readings. A psychic may employ a phrase like 'you went through a difficult stage around the time of puberty', something which applies to virtually everyone but is in fact very vague. Such statements are often known as Barnum statements, after the circus owner P.T. Barnum who claimed 'we have something for everyone'. Put a number of Barnum statements together, and the resultant whole seems much more individual and accurate. Forer devised the classic experiment to demonstrate this effect.[15] He gave his students a personality test. Each student was given a character analysis and asked to rate how accurate they thought it was. In fact, they were each given the same analysis, which was actually a series of Barnum statements culled from newspaper astrology columns. The average student assessment of accuracy was 4.26 on a scale of 5, around 85%. This experiment has been repeated many times with similar results.

The concern in relation to Kennedy's thesis is that band widths and topic breadths are construed so broadly and vaguely that they are analogous to Barnum statements. Taken collectively, Kennedy's evidence can look impressive. Is that anything more than something analogous to the Forer effect though? At least we would need to be suspicious of Kennedy's comment that: 'The argument is inductive in form. This means that it gains in strength by accumulating a variety of independent, yet mutually reinforcing kinds of evidence.'[16] If the evidence accumulated is based on vague criteria, the evidence does not mutually reinforce but only gives the illusion of doing so.

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15 B.R. Forer, 'The Fallacy of Personal Validation: A Classroom Demonstration of Gullibility', *Journal of Abnormal and Social Psychology* 44, 1949, 118–123.

16 Kennedy (2010), 1.

VI

Kennedy claims that: 'The effects of a fairly uniform distribution of smaller scribal errors, omissions and interpolations still uncorrected by textual critics would on average compensate for each other.'[17] This looks both highly optimistic and mathematically suspect. One assumption here would be that our texts have roughly equal amounts of omissions or additions. That may not be so. Our texts may have been influenced by one or more manuscripts with more glosses than omissions and vice versa, especially as some copyists may have been inveterate 'glossers' and others inveterate 'omitters' or 'editors'. A surplus of glosses or omissions will not affect the relative text positions if evenly distributed but will affect the absolute length of the text we have. Do we have reason to suppose that additions and omissions are of the same size? I would suggest that glosses may, on average, be larger than omissions. Omissions are typically a word or two; glosses are typically a clause or a sentence.

For argument, let us assume that additions and deletions are equally likely and are of equal size. Now think of this in terms of coin tosses. If we do sets of ten coin tosses, we do not get a 5-5 heads and tails result every time but a distribution from 0-10 to 10-0, with 5-5 more likely but by no means the exclusive result. It is not even the dominant result. This experiment conforms to a Bernoulli distribution and to find the likelihood of a number of heads from a number of tosses,[18] we can use the formula, where x is the number of heads and n the number of tosses:

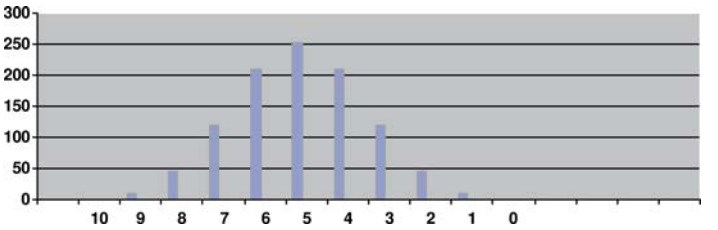
$$\frac{n!}{2^n x!(n-x)!}$$

Putting the figures in and then generating a percentage gives 24.6% for a 5-5 heads and tails result over 10 tosses. For 10 tosses, a 7-3 or 3-7 distribution or worse is more likely than a 5-5 distribution (33.4% to 24.6%).[19] Here is the Bernoulli distribution for 10 tosses, number of heads along the bottom, number of occurrences from 1024 possibilities on the side: (see figure and table next page)

[17] Kennedy (2010), 6.

[18] The Bernoulli distribution approaches the Gaussian (normal or bell shaped) distribution, as the number of trials tends to infinity.

[19] 5-5 = 252 of 1024 possibilities, 7-3 or worse either way = (1 + 10 + 45 + 120) × 2 = 342 of 1024 possibilities.



Score	10-0	9-1	8-2	7-3	6-4	5-5
Occurence	1	10	45	120	210	252
Likelihood	0.09%	0.97%	4.39%	11.72%	20.50%	24.6%
Score and inverse score likelihood	0.18%	1.94%	9.78%	23.44%	41.00%	

Assuming that edits and omissions are equally likely does not ensure that there are the same number of edits and omissions in one text. There will be a spread of results as determined by the Bernoulli distribution. Again, this renders the absolute length figures suspect.

Second, in tossing 10 coins, even with a 5-5 result, we may get 5 heads or 4 heads and one tail or vice versa in the first five tosses. Those sequences may also turn up at other points in the 10 tosses. This will not affect the length of the work, but will affect the relative placement within that work, making Kennedy's placement of twelfth points suspect. This assumes, as Kennedy seems to, that glosses and omissions are equally likely at all points in the text. In my experience, glosses in particular tend to come in clusters around interesting or significant passages and are not evenly distributed.

There are two further issues, which Kennedy does not consider here. This is true, but larger numbers do not exclude the possibilities I raise here being significant, it just makes them slightly less likely. These will seriously skew both absolute length and relative position. Second, there is the issue of dislocation of sections of text, which would seriously alter relative lengths. There are then several considerations that will upset relative positions as well as absolute lengths. Trying to compensate for this by increasing band width around the supposed significant points would bring indefensibly large amounts of the text within the catchments areas.

A reply here might be that I have used relatively small numbers in my examples and this tends to exaggerate the problems. This is true. However, larger numbers do not exclude the possibilities, I raise here, to be significant; it just makes them slightly less likely. What is needed here is some quantification. How many errors are we talking about and of what sort of size? What sort of distribution do we expect, and what sort of probabil-

ities of alteration to relative lengths or absolute lengths does that produce? Without that sort of analysis, the assertion that errors will average themselves out carries no weight. How we might carry out such an analysis on errors we have yet to detect may be a significant methodological problem.

The claim that stichometry confirms that our versions of Plato's texts are in good order, when it needs to assume that they are in good order to begin with, also looks distinctly circular. I doubt there is much we can say about the integrity of our versions of Plato, as a whole, as the manuscript traditions they are derived from are quite diverse, and each text has its own difficulties.

VII

Kennedy claims that a further essay will: 'Provide evidence for a fine-grained musical structure between the twelve notes'[20] and in a note adds: 'The so-called 'quartertones' mentioned in the *Republic* at 531a4'.[21] The context for the *Republic* passage is Socrates' discussion of the study of harmony in the education of the guardians. Socrates describes those who try to measure audible concords and sounds against each other and Glaucon replies:

> 'By the gods, they are amusing – they speak of something closely ordered (*puknômata*) and they lay their ears alongside, as if they were trying to catch voices from next door. Some claim to hear a note between, establishing the existence of something smallest, to be used for measurement, while others say these sounds are alike, both using their ears rather than their minds.'[22]

There is no specific mention of quarter tones here. The *puknômata* are things that are closely packed or ordered, such as trees or soldiers. The term is used in relation to music but not specifically for quartertones. Glaucon says 'Some claim to hear a note between (*en mesôi*)'. Assuming the notes are semi-tones, those could be quarter tones if we take *en mesôi* in the sense of precisely in the middle rather than in the slightly looser sense of in between. However, even if there is a reference to quarter tones in this passage, this does not establish that Plato believed that there are quarter tones. All this passage says is that for the purposes of their education, the guardians should think about the nature of harmony rather than conduct a crude empirical investigation. It does not comment on whether quarter notes exist or should be part of a scale. At most, it says that some people believe they can distinguish them.

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20 Kennedy (2010), 18.
21 Kennedy (2010), 18 note 68.
22 Plato, *Republic* 531a.

When Plato does generate a musical scale of his own at *Timaeus* 35b ff., this is a tone and semi-tone scale with no mention of any quarter tones whatsoever. The concluding comment at 36b is that after the division by 9/8 (a tone) and 256/243 (a semi-tone), the mixture from which these were generated was spent, which seems strongly indicative that the division was into semi-tones but nothing further. If Plato had no interest in quarter tones, which is certainly my view of the evidence, then any stichometric structure detected at quarter tone intervals is method induced.

There are some more general concerns about method-induced effects. What is very much needed here is a series of effective control experiments. Kennedy's application of stichometry to the pseudo-Platonic works, although interesting, does not prove a great deal.[23] At most, it shows that in some works that we have grounds to believe were not written by Plato, the method does not induce data. The real problem here is that we do not know which, if any, of the pseudo-Platonica were written by Plato and which, if any, were written by those close enough to Plato to emulate his supposed stichometry. If even one of the pseudo-Platonica, where Kennedy finds stichometry, was in fact written without it, then his method induces data. This also needs some independent scrutiny. It would be important to know what sorts of band widths were applied and what sorts of ideas were looked for near the supposed significant points. It would be interesting, though not conclusive to run these tests on Aristotle. Aristotle would seem to be a good candidate as we have a good deal of his work, and he is roughly contemporaneous with Plato. The key here would be not to look for Pythagorean-related issues in Aristotle but to try the control with issues that Aristotle visits on a similar frequency to the supposed Pythagorean issues in Plato. The critical test, however, surely has to be carried out on Plato's works. This would involve taking a randomised set of locations in Plato and see what results are obtained, then analysing those results in terms of statistical significance to see if Kennedy's data has statistical significance.

VIII

How are disputes between Kennedy and experts on Platonic texts going to be resolved? To give an example here, Kennedy claims that:

> 'Finally, the *Timaeus* interrupts a long passage on natural philosophy at the centre of the dialogue with a paragraph of Pythagorean theology. Since justice is sometimes for Plato a kind of harmony, this passage would itself constitute an example of just and divine rule:

[23] Kennedy (2010), 19.

> **Timaeus (49.4–49.5p):** Necessity willingly or unwillingly obeys God, who harmonises everything in the universe according to precise proportions.'[24]

I would claim some expertise in relation to the *Timaeus*.[25] It has never occurred to me before that there is an interruption at this point or that anything Pythagorean is being proposed here. Looking at the passage again, I would flatly deny both suggestions. The passage seems to me to flow perfectly well and I do not see what Pythagorean about this passage.

This is slightly more problematic than may appear at first glance. This passage is at 56c3, 49.4% of the way through the *Timaeus*. The centre is at 56e3, so I would estimate 50.6% of the *Timaeus* to be around 57b3, generating a 1.2% band around the middle of this work. The problem is that as far as I can see, this passage is the only candidate for anything that marks the middle of the *Timaeus*. Indeed, one can broaden that band somewhat and still be left without any plausible candidate. Going backwards, 55c about the use of the dodecahedron and whether there are five worlds might be a candidate, going forwards, 57d sums up the section on the construction of the four elements. Neither though seems important markers for the centre of the *Timaeus*, and if they are not plausible candidates, then we need to go back to 53c and the beginning of the exposition of the geometry of the four elements. Going forwards, we might need to go to 69a, which gives us a summary followed by an indication of a fresh start. This is a remarkable result, as it looks like a nasty counter instance for the stichometric thesis. If any work of Plato shows musical structure, it should be the *Timaeus*, given that it discusses the relation of music to the cosmos, but there seems to be nothing significant to mark the centre of that work.

What I would expect in the *Timaeus*, if the stichometric thesis is correct, is that the major and well sign-posted transitions in that work are at significant points. So the transition from introduction to the works of reason (29d), from the works of reason to the works of necessity (48a), and from the works of necessity to the construction of the human soul/body, and the works of reason combined with intelligence (69a), would all seem to be important and well sign-posted points. However, the first two of these do not come anywhere near the supposed significant points. 29d is roughly halfway between the first and second twelfth points. 48a is approximately 2/3 of the way between the fourth and fifth twelfth points. Recourse to quarter notes is unlikely to be a saviour here, as something as important as these transitions in the *Timaeus* are hardly likely to be relegated to occurring at quarter tones. *Timaeus* 69a does fall reasonably close

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[24] Kennedy (2010), 12.

[25] See, e.g., A.D. Gregory and R. Waterfield, *Plato: Timaeus and Critias*, Oxford: Oxford University Press, 2008, A.D. Gregory *Plato's Philosophy of Science*, London: Duckworth 2000.

to the 8/12th point of 68e2, but it is only to be expected that one point of these three would do so. The key is surely all three, as pivotal moments in the *Timaeus*, should fall on significant points. Aficionados of other Plato works, where there is strong signposting or clear pivotal points, might try this strategy as well to see if they match the twelfth points of those works. This is a critical test. It is one thing to go to the supposed significant points and search for markers, a procedure which will be open to the accusation of confirmation bias.[26] It is another to decide independently on key transitional points in a dialogue and then see if they match the supposed significant points in that work.

A possible escape strategy here is to argue that instead of taking the *Timaeus* on its own, it should be taken as part of the whole with the *Critias* and *Hermocrates*. As the *Critias* is unfinished, and we have no trace of the *Hermocrates*, the claim might then be that without being able to determine the length of the work, we cannot do the stichometry. However, as everyone since antiquity has taken the *Timaeus* as a whole, and there are abundant indications in its text that it should be taken as a whole, this would be a counsel of despair.

IX

Kennedy claims that Plato's philosophy is 'Fundamentally Pythagorean'[27] and that: 'Stichometric analyses find unexpected evidence for Pythagoreanism in the dialogues themselves.'[28] If this sort of claim is going to be made, there needs to be further discussion of what it amounts to. What does it mean to say that Plato was 'fundamentally Pythagorean'? To say Plato was a Pythagorean on the grounds that he was interested in number and harmony is no more meaningful than saying Plato was a Heraclitean because he mentioned flux or an Eleatic because he discussed being. The notion of a Pythagorean 'aesthetic' is no more helpful. This sort of loosely defined notion could apply to a great number of people (ancient and modern) who simply are not Pythagoreans in any meaningful sense. Given that modern scholarship has pointed to significant differences between the views of Pythagoras and pre-Plato Pythagoreans, such as Philolaus and Archytas, asserting that Plato was 'fundamentally Pythagorean' is also too broad to be meaningful.[29] Kennedy also says of modern scholars that:

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26 Kennedy's treatment of the Golden Mean would certainly be open to this charge.
27 Kennedy (2010), 1.
28 Kennedy (2010), 1.
29 Taking modern scholarship on Pythagoras and his followers to date from Walter Burkert's seminal Lore and Science in Ancient Pythagoreanism, Trans. E. L. Minar,

'Even the *Timaeus* is regarded as a Platonic rather than an orthodox Pythagorean dialogue.'[30] This certainly is generally true, but to reverse the modern consensus among Plato scholars on this, there needs to be considerably more argument and evidence and a clear sense of what it means to say that the *Timaeus* is a Pythagorean dialogue.[31] Personally, I would flatly deny that the *Timaeus* is Pythagorean. My concern here is not the one that Kennedy raises, that scholars think the *Timaeus* is not Pythagorean because Plato rarely mentions of Pythagoras or Pythagoreans.[32] In my view, there are two important areas where Plato significantly diverges from key Pythagorean ideas. First, the *Timaeus* gives us a geometrical rather than an arithmetical cosmology. Aristotle tells us the Pythagorean view was that:

> 'As numbers are naturally the first among these principles, they believed in these they could find many similarities to what is and what comes to be, more so than in fire or air or water, a property of number being justice, another being soul or mind, another opportunity and so on similarly with each of the rest.'[33]

So the Pythagoreans believed that the world about us is, in some way, constituted from number. This I would term an arithmetical cosmology. Plato though has a geometrical conception of the cosmos. There are the 1, 1, $\sqrt{2}$ and 1, $\sqrt{3}$, 2 triangles from which the cubes, tetrahedra, octahedra and ikosahedra of earth, fire, air and water are formed. It is these shapes that form the basis of Plato's cosmos, not numbers. Aristotle is critical of Plato for what he takes to be the arbitrary way in which Plato allows his analysis of the elements to end at triangles, when it could have gone further to lines and points.[34]

It is interesting to note that at *Republic* 531a, there are those listening for a note between others, attempting to establish something smallest, so that they have something for measurement. This may indicate that Plato is aware of the Pythagorean view on minima. It can be argued that the Pythagoreans treated geometry arithmetically, by attempting to treat geometrical problems as part of the theory of natural numbers, as numbers composed of indivisible monads.[35] So every geometrical length ought to be expressible as the ratio of two natural numbers. If these numbers represent

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Jr. Cambridge, Mass.: Harvard University Press, 1972, cf. C. Huffman, 'The Pythagorean Tradition', in *The Cambridge Companion to Early Greek Philosophy*, A. A. Long (ed.), Cambridge: Cambridge University Press, 1999, 66–87.

30 Kennedy (2010), 20.

31 For current views on *Timaeus* scholarship, see R. D. Mohr and B. Sattler, *One Book, the Whole Universe: Plato's Timaeus Today*, Las Vegas: Parmenides Publishing, 2010.

32 Kennedy (2010), 20.

33 Aristotle *Metaphysics* I 5, 983b23–26.

34 See Aristotle *de Caelo* III 1.

35 See Popper (1952), 75 ff., and, e.g., Aristotle *Metaphysics* I 5, 985b31 ff.

a length, then if we ask how long something is, we count the number of monadic lengths involved. A problem for these schemes comes with the discovery of the irrationality of the square root of two, for here we have a number/length that cannot be expressed as a ratio of two natural numbers or as a multiple of a monadic length.[36] That Plato had a geometrical, as opposed to an arithmetical, cosmology is the reason why in the section above, I rejected Kennedy's passage from the middle of the *Timaeus* as Pythagorean. In the *Timaeus*, the demiurge imposes geometry on the primordial chaos and generates shapes, a distinctly Platonic idea. He does not generate the cosmos out of numbers.

The second area where I would argue that Plato differed significantly from fundamental Pythagorean ideas is the derivation and conception of the musical scale. The Pythagorean derivation uses the numbers 1, 2, 3 and 4 in various ratios to generate a musical scale. The justification of this is that 1 + 2 + 3 + 4 = 10, the Pythagorean perfect number. So the justification here is numerological. The notes are then generated from the ratios of these terms. Similarly, we might note Aristotle's criticism that the Pythagoreans assume that there are 10 celestial bodies (earth, moon, sun, five naked eye planets, counter-earth, central fire) on the basis that 10 is the perfect number, and so there should be 10 celestial bodies.[37] Plato, on the other hand, simply accepts there are seven heavenly bodies (moon, sun, five naked eye planets) and has seven terms as basic to his musical scale (1, 2, 3, 4, 8, 9, 27),[38] which are the relative lengths of the soul stuff, which the demiurge uses to fashion the orbits for these bodies.[39] Plato then generates a tone and semi-tone scale from these terms.[40] The derivation is geometrical (dividing the soul stuff into circles) rather than purely arithmetical as with the Pythagoreans. So whereas the Pythagoreans have a numerological derivation of cosmology and of music, Plato has a cosmological derivation of music.

I would also note that while Archytas provided a famous argument that the cosmos was unlimited, Plato in the *Timaeus* is adamant that it is finite and spherical,[41] and that the *Timaeus* has a radically different account of the number, nature, motions and organisation of the celestial bodies from the cosmology of Philolaus.[42]

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36 Plato is well aware of the irrationality of several numbers; see *Theaetetus* 147c ff., where the square roots of 3, 5, and 17 are mentioned.
37 Aristotle Metaphysics I 5, 986a.
38 Plato, *Timaeus* 35c.
39 Plato, *Timaeus* 36d.
40 Plato, *Timaeus* 35d.
41 See Simplicius, *Commentary on Aristotle's Physics* 467,26.
42 See Aristotle *de Caelo* 293a18 ff., Aetius II, 7,7 ff.

If Plato was a secret Pythagorean, it seems that he does the job at once too well and too badly. Too badly, in the sense that Aristotle clearly and publicly put forward the view that Plato Pythagoreanises, so his Pythagoreanism can hardly have been very secret. This point should demolish the notion that there was some sort of sanction against Pythagorean beliefs, and so Plato hid his views, unless Aristotle was deliberately attempting to get Plato into trouble. Too well, in the sense that if Plato did code some form of Pythagoreanism into his writing stichometrically, then it has taken nearly two and a half millennia for anyone to catch on to this. Surely Proclus, who wrote a very detailed commentary on the *Timaeus* and dealt with the musical aspects in great detail, would have something to say about stichometry and musical structure.[43] There is though no trace of this sort of stichometric/musical structure mentioned by Proclus or, as far as I am aware, by any other ancient commentator on the *Timaeus*. On the evidence we have, Plato was aware of various Pythagorean ideas and discussed some of them in his works. On some important points, he disagreed with the Pythagoreans. To say that Plato was influenced by Pythagoreanism is fine, as long as the nature and provenance of that influence is specified. To say he was fundamentally a Pythagorean or that the *Timaeus* was a Pythagorean work seems to me utterly unjustified.

X

A couple of deflationary thoughts. Even if the dialogues are divided into twelfths, this does not prove the musical thesis. Twelve is a splendid number, with many integer factors (2, 3, 4, 6), which make it highly suitable for simple division. There may be many reasons for placing significant passages at or around twelfths, not least as one handle on finding those passages in the absence of Stephanus page numbers.[44] It would be no great surprise then if the speeches in the *Symposium* were to begin at twelfth points and to last whole numbers of twelfths as Kennedy asserts.

There seem to be some problems with this view though. It is not straightforward to determine where the speeches begin and end as we saw earlier in the section on circularity. First, do 'hiccups, banter, repartee'[45] form part of the speeches or not? Second, Socrates' speech on Kennedy's argument runs from the six and a quarter twelfth points to the nine and a quarter twelfth points, and Alcibiades' speech runs from the nine and three quarter twelfth point to the eleven and three quarters twelfth point.

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43 I owe this point to Dr. Anne Sheppherd.
44 As recognised by Kennedy, Kennedy (2010), 4–5.
45 Kennedy's terms, see Kennedy (2010), 7 note 26.

Whereas the speeches are integer multiples of twelfths long, they do not align with the twelfth points of the dialogue. What is required here is a statistical analysis of speech lengths and positions in Plato to find if the *Symposium* lengths and positions are anything statistically significant.

Kennedy also claims that: 'Measurement of the absolute lengths of the dialogues also suggest that the number twelve has some architectural importance.'[46] Kennedy has figures for the number of letters in each Platonic dialogue. If assumptions are made about the average line length in letters, then it is possible to calculate the total number of lines in a work. These he claims come out to 'impressively round numbers involving multiples of the number twelve',[47] 'with about one or two percent accuracy'.[48] There are several problems with this. First, the process is circular. Kennedy's assumption of 35 letters per line is chosen because it produces round numbers of lines in some dialogues.[49] There are alternatives, especially as he quotes Schanz' figures of 35.56 letters per line for the *Cratylus* and 34.32 for the *Symposium*. Kennedy gives a rounded figure of 2400 lines for both works, giving a letter count of 84,000 (2400 × 35). This letter count, with Schanz' line lengths, would give 2362 lines for the *Cratylus* and 2447 lines for the *Symposium*. What we do not have here is Kennedy's raw letter count for these works. The actual letter count for these two works may help or hinder here. A smaller count for the *Cratylus* and a larger count for the *Symposium* on Schanz' line lengths would make line totals at greater variance with Kennedy's. Does Kennedy's thesis here states that the line counts for Plato's works do come out as multiples of 1200 and that what we need to do in each case is adjust the average line length slightly for each work on an ad hoc basis from 35 in order to generate those figures? Is Kennedy's thesis here that the line counts for Plato's works do come out to multiples of 1200? And that what we need to do in each case is adjust the average line length slightly for each work on an ad hoc basis from 35 in order to generate those figures? If so this looks circular. I might equally put forward the view that the total line lengths do not come out to multiples of 1200 and adjust average line lengths on a similar ad hoc basis to make this view work instead.

Second, there is the issue of statistical significance. As we have seen before, accuracy is not the same as statistical significance. We are given the figures for eight of Plato's works, but there is a desperate need to see the figures for the other works as well. With Kennedy's claim of 'about one or

46 Kennedy (2010), 9.
47 Kennedy (2010), 10.
48 Kennedy (2010), 9–10.
49 'The round number which emerge here are additional evidence for a figure close to 35 for Plato's texts'. Kennedy (2010), 9 note 35.

two percent accuracy', there is a need to know how it is computed and what assumptions are in play.[50] Even if on further analysis Kennedy can establish this claim about line lengths and total number of lines, this does not prove a great deal. That the figures cluster around multiples of 1200 lines may simply reflect scroll lengths and the fact that that is 12 × 100 may be incidental or may reflect a means of locating where the reader is in the text.

My second deflationary point is that even if there is a musical structure to a dialogue, this does not prove Pythagorean influence or secret doctrine. Take, for example, the *Timaeus*, which does want to say there is a harmonic structure to the cosmos. Plato might then have a harmonic structure for the *Timaeus* as well, mirroring the order of the cosmos. However, as argued above, Plato has his own view, distinct from the Pythagorean view, on the construction of the musical scale and of the relation of harmony to the cosmos. This may be a Platonic take on harmony, not a Pythagorean one. Second, there is no need to see any hidden or reserved doctrine or any reference to the Pythagoreans at all. We might treat the supposed harmonic structuring of the *Timaeus* as we would other literary devices that Plato employs, such as dialogue framing or characterisation of the participants in the discussion, as enhancing the arguments that Plato wishes to put across.

[50] Kennedy (2010), 9–10.

XI

Kennedy claims evidence for a 12-part structure and then claims evidence for a musical interpretation of this structure. Kennedy's parts appear to be precise twelfths of Plato's works. There are other ways to make a musical division. Let us call Kennedy's way of doing this the 'piano keyboard' method, where there are equal physical intervals between the notes. Equal spacing here represents equal ratios between the notes. Another possibility would be the 'guitar fret board' method, where the frets for notes of higher pitch are physically closer together. This would mean the first 'twelfth' of a work divided on these lines would be longest, decreasing to the final twelfth. The latter seems a more natural way for a string instrument-based culture to construct a work that exhibits a musical pattern. When Plato uses his musical scale to divide up the soul stuff at *Timaeus* 35a ff., equal ratios in successive application do not produce equal amounts of the soul stuff. Certainly, I would like to see some argument in favour of the 'piano keyboard' division, especially as the differences between them are quite large. For a work of 1200 lines, this is where the significant points would be: first, for Kennedy's scheme and, second, for the 'guitar fret board' scheme.

I would also like to see some argument as to why Plato would divide into twelfths rather than into the eight sections, the eight sections being related to the notes he produces in the *Timaeus*. Plato does not generate more than these eight notes in the *Timaeus* and gives no indication of how other notes might be generated.[51] It is possible to project Plato's eight notes onto a modern musical stave. This can give the impression that Plato selects a scale of 8 notes from a possible 12. That should be resisted as Plato only gives us the eight notes.

In modern musical theory, there is 12-tone equal temperament (12ET), where for an octave there are 12 equally sized semi-tones. Both the ratios between notes and the position of the notes within the octave can be expressed in terms of 'cents'. Ratios are said to be '100 cents' when they match the 12ET ratio, where 1200 cents make up one octave. Positions are said to be 100 cents when they match the 12ET positions. The

Kennedy 'piano'	0	100	200	300	400	500	600	700	800	900	1000	1100	1200
Guitar Fret board	0	135	262	382	495	602	703	798	888	973	1053	1129	1200

[51] As noted previously, *Timaeus* 36b says the material is spent once these notes have been generated.

musical theory of the Pythagoreans and of Plato, though, is not equal tempered. They are forms of what is known as 'just intonation', where notes are defined as ratios of small whole numbers, such as 4:3 or 3:2. These ratios do not always produce the same notes as 12ET and can be significantly different.[52] In particular, the 256/243 ratio used by both Pythagoreans and Plato comes out to 90.22 cents, an important difference with equal temperament.[53] The 9/8 ratio he uses for whole tones also does not match the 12ET ratio (203.91 cents for the whole step, 200 in 12ET). Successive applications of the 9/8 ratio will generate greater difference of position of notes with 12ET. Both make a difference to where a supposed musically significant point would be in the text, especially as Kennedy claims accuracy of 0.5% in places. To be precise here: (see table next page)

One simple calculation here is that the eleventh twelfth point is misplaced by over nine lines in a 1200 line work. This works out to 0.815% of the whole text, greater than Kennedy's 0.5% accuracy claim. The displacement of the fourth twelfth and nine twelfth points are 0.652% and 0.489% of the whole text, respectively.

This table also illustrates a further difficulty with the division into 12 thesis. It is by no means clear how Plato would generate semi-tones between the tones he already has, even if he wanted to. If he does it using the 256/243 ratio, he will get two different-sized semi-tones, as 256/243 does not split 9/8 equally, neither part matching 12ET. If he tries to split

0	100	200	300	400	500	600	700	800	900	1000	1100	1200
		203.91		407.82	498.04		701.96		905.87		1109.78	1200
1		9/8		81/64	4/3		3/2		27/16		243/128	2
		9/8		9/8	256/243		9/8		9/8		9/8	256/243
		203.91		203.91	90.22		203.91		203.91		203.91	90.22
C		D		E	F		G		A		B	C

The first row is the note position in 12ET expressed in cents.
The second row is Plato's note positions expressed in cents.
The third row is Plato's note positions expressed as ratios.
The fourth row is Plato's ratios between notes.
The fifth row is Plato's ratios between notes expressed in cents.
The sixth row gives the modern note names in the key of C major.

[52] The ratio between all neighbouring semi-tones in modern 12ET is $\sqrt[12]{2}$ (the 12th root of 2).

[53] It is audible, too – the modern value for the threshold of audibility for different sounds is 6 cents, to answer the 'smallest' question asked at *Republic* 531a. 256/243 is $4^4/3^4$ and so counts as a ratio of small integers.

the tone equally, he still has two different semi-tones, the 9/8 split and the 256/243 semi-tone, and again, neither match 12ET. Kennedy's quarter note thesis is also problematic in this respect. It may well assume 24ET (24 note equal temperament where the octave is divided into 24 equally spaced notes, the ratios and positions being said to be 50 cents). Plato's scheme will not match this either, and how quarter notes are supposed to be generated is anyone's guess. There is certainly no indication in Plato how this might be done. There is also no indication in Plato how 12 equally spaced notes might be generated. If he had that concept, it is odd that it is not discussed at some point given that he does discuss how to generate note spacing in the *Timaeus*. 12ET is not an obvious idea. Neither is it mathematically simple nor does it produce harmonies as pure as just intonation, all of which argue against Plato using it.[54]

So if Plato divided his works on some musical principle, I find it hard to believe he would do so in terms of equally sized twelfths. If there is an equally spaced 12-part structure, this is much more likely to reflect a means for the reader to locate themselves in the text rather than be a musical structure. One odd aspect of Kennedy's thesis is that he claims significant Pythagorean influence on Plato but then has Plato rejecting not only all the known Pythagorean scales but basic Pythagorean musical principles as well (notes as ratios of small whole numbers) in the supposed musical structure of his works.[55] A second oddity is the *Timaeus*, where the scale Plato derives is tightly related to the benevolence of the demiurge and the structure of the cosmos. That Plato, in the same work, would use 12ET for its musical structure to me looks highly implausible. An interesting test of Kennedy's thesis would be to substitute the *Timaeus* scale for 12ET as the supposed musical structure and see what results are generated.

XII

A small point, but one that needs considerable further consideration, is this. There is ancient testimony that when Plato died, the *Laws* was 'on the wax'.[56] If Plato wrote on wax tablets, as this would suggest, how did the wax lines relate to the scroll lines? If the relation was not 1:1 (and

[54] Although the harmonies produced by 12ET are not as pure as those produced by just intonation, 12ET has the advantage that keyboards tuned to 12ET can be played in any key equally well without retuning, allowing key changes within one piece of music and facilitating ensemble playing as well. Neither the demiurge constructing the cosmos nor Plato supposedly dividing his works needs to change key though.

[55] Archytas generated several scales based on ratios of integers.

[56] Diogenes Laertius III.37

perhaps not even known), he would have had the devil's own job calculating line numbers. There needs to be more consideration on how Plato physically wrote if the stichometric thesis is to be plausible. If the idea is that Plato moved from a wax draft to a scroll draft to get a stichometric count, then some evidence needs to be given to support that view. If the *Laws* was on the wax at Plato's death and the version of the *Laws* we have is supposed to exhibit the stichometric features, how did they get there? This would credit whoever got the *Laws* from wax to published scroll with a significantly greater role in the preparation of the *Laws* than scholars have as yet been willing to give them.

XIII

I am interested in the possibility of a stichometric analysis of Plato and the results that may produce. If Kennedy's stichometric theses were to be proved, I would need to rethink my views on how and why Plato wrote. On the evidence presented in Kennedy's first paper, though, I am unconvinced that there is any significant result that comes from applying stichometry to Plato. The methodology needs to be much more rigorous.

There needs to be a proper analysis of statistical significance rather than quotations of accuracy, which can be highly misleading. There needs to be a rigorous definition of band width, how near a significant point a passage needs to occur before it is accepted. There needs to be a clear statement on which devices Plato uses to mark significant points. So, too, there needs to be a clear statement on how broadly we interpret certain ideas when they are used as markers. These tasks need to be done in a non-circular manner with independent argument to establish the parameters. We then need a proper count of instances in all of Plato, a distribution of instances and justified consideration of the appropriate tests for significance. We would also need to formulate appropriate null hypotheses.

The musical thesis also needs much more thought and justification. Given Plato's views on music in the *Timaeus*, division into 12 equal parts seems highly implausible as a means of expressing musical structure. We need some argument as to why Plato would choose this alternative among several others.

The critical assumption that undetected scribal additions and omissions will compensate for each other is both highly optimistic and mathematically suspect. We cannot simply assume these errors are similar in size and number, as there are many other plausible possibilities. Even if they are similar in size and equally probable, they will follow a Bernoulli distribution, which does not guarantee equal numbers and a uniform distribution. This means that figures for the absolute length of works and for the relative placing of twelfth points within a work are suspect.

The *Timaeus* appears to be a problematic case for Kennedy. There is no plausible marker passage as its midpoint and key transitions in that work do not fit into Kennedy's significant points. The latter, in my view, is a key independent test, which the stichometric thesis simply fails and does so in a work where the stichometric thesis might be thought of most likely to apply.

Kennedy claims two checks on his methodology, analysis of the pseudo-Platonica and of the Golden Mean. Analysis of the pseudo-Platonica though merely shows that Kennedy's method does not induce data from all texts. The proper test is a randomised study of Plato to establish statistical significance once the parameters have been properly established. Kennedy interprets references to the Golden Mean so broadly that I very much doubt the results he produces are statistically significant.

It is also important that the nature of the assorted theses Kennedy presents are clarified and differentiated. Twelve-part structure can be asserted quite independently of a musical interpretation of that structure, and that, in turn, can be asserted independently of any claim about Pythagoreanism or Pythagorean doctrine. It is important to separate these theses for their proper assessment.

It will be interesting to see if Kennedy's theses can be reformulated and analysed with more rigour and, if so, whether any statistically significant results are obtained. It is surely important to know, if we can, whether Plato organised his works stichometrically and, if so, to what extent. Personally I doubt, on the evidence I have seen so far, whether a properly rigorous study will produce statistically significant results. However, I remain open to the possibility.[57]

[57] My thanks to Michalis Sialaros who made many useful comments on a draft of this paper.