Observation in Plato's Astronomy

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1 Introduction

After Plato's famous exposition of the divided line and the allegory of the cave, the *Republic* transitions into the education of the rulers of its ideal city. Given the sharp two-worlds distinction immediately preceding this discussion and present elsewhere in Plato's corpus, his education places great emphasis on topics that have the ability to turn one's soul around from the sensible to the intelligible realm. While arithmetic and geometry serve a critical preliminary role in this process of preparation for the ultimate goal of dialectical reasoning in philosophy, Plato discusses three intermediate sciences: stereometry, astronomy, and harmonics.[1]

In particular, these last two are considered empirical sciences which study physical objects by modern standards. How then, we might ask, do they help one's soul understand intelligible objects, objects that are necessarily unchanging and unsensible? What is the relationship between the physical phenomena associated with these last two disciplines and intelligible objects (e.g. Forms)? This paper will focus on Plato's discussion of astronomy (with analogies given to harmonics) in attempts to answer questions like these two.

The presentation will focus primarily on three interpretations of Plato's treatment of astronomy:

1. As 'saving the phenomena' observed in the heavens;
2. As an a priori discipline on par with geometry;
3. As a mixed discipline, whose objects of focus depend on whether it is being done or being taught.

While each view has multiple advocates, I focus on Vlastos 1980, Mouletaros 1980 and Gregory 2000 respectively. While the first two discussions appear in the same volume, Mouletaros indicates that he has read Vlastos' paper and so writes largely in response to him. Gregory makes comments on both of these earlier works. While writing at a later time places Gregory in a better position

[1] At first, astronomy immediately follows geometry. At 528e, however, Plato puts "astronomy as the fourth subject, on the assumption that solid geometry will be available if a city takes it up."

to win a comparative review, I will also argue that his reading pays the most attention to the textual context in which Plato's discussion of astronomy appears and thus should be favored.

By analyzing and critiquing each of these readings of Plato's astronomy, my own reading of these passages will emerge throughout the paper.

2 Saving the Phenomena

While Vlastos offers a translation of the entire *Republic* 528e-530c in his discussion of astronomy, because he is concerned with the role of observation, he emphasizes the critical passage (which will be made use of throughout the present paper) in 530b-c1:

> Then if, by really taking part in astronomy, we're to make the naturally intelligent part of the soul useful instead of useless, let's study astronomy by means of problems, as we do geometry, *and leave the things in the sky alone*.[2]

Given Plato's general anti-empirical leanings, it's no surprise that we should "leave the things in the sky alone" when doing astronomy since these are sensible objects. Many scholars have taken the italicized clause and argued from it that Plato wishes to eliminate the motions of the stars ("the things in the sky") completely from his astronomy. While such a view seems ludicrous to our modern conception of astronomy, it can be argued that such eradication is in keeping with Plato's general epistemological views, namely that no knowledge can be had of sensible objects.

Vlastos, through the use of Plato's analogy between geometry and astronomy, argues that this banishment of the sensible particulars from astronomy is only an epistemological one: we are to "dismiss the things in the heavens *as objects of knowledge*" but not to dismiss them from our ontology entirely [Vla80, p. 10, emphasis in original]. Though more will be said about the geometry-astronomy analogy later, note for now that we "study astronomy by means of problems, as we do geometry." Given that we are to somehow leave the stars and their motions alone, what exactly is a problem of astronomy?

To get to an answer of this question, Vlastos first points to a particular feature of the geometry-astronomy analogy: that the motions of the stars serves a role in astronomy akin to that of diagrams in geometry. When Plato writes at 529d that "we should use the embroidery in the sky as a model in the study

[2] This quotation is from Grube's translation. Because Vlastos considers the passage so important, he offers his own translation of 528e-530c. The above passage reads:

> "It is by means of problems, then," I said, "that we shall proceed in astronomy, in the same way as we do in geometry, and *we shall let the things in the heavens alone* [Greek here] if, by doing real astronomy, we are to turn from disuse to use that part of our soul whose nature it is to be wise." [Vla80, p. 3]

More will be said of this translation, in particular of the notion of "doing real astronomy", later in the present paper.

of these other things [cf. the true motions of the stars, 529c-d]," he appears to be pointing out a relation between the night sky and the problems of astronomy that closely, if not identically, resembles that between the diagrams and problems of geometry. Thus, where a geometer would "think it ridiculous to examine them [diagrams] seriously in order to find the truth in them about the equal, the double, or any other ratio," [Pla97c, 529e-530a] an astronomer would think it "strange" to look to the bodies in the heavens to find truth about the ratios of night to day and other such facts. Even though the heavens are the most perfect work of a divine craftsman, they still will still "deviate" from the true motions of the stars "since they're connected to body and visible" [Pla97c, 529b].

What Vlastos adds to this facet of the analogy (that the night sky serves the same purpose to an astronomer as a diagram to a geometer) is the claim that, "If all we had to show for our belief that the sun's trajectories are circular were what we observed in the celestial mobile, then all we would have is true opinion, not knowledge"[3] [Vla80, p. 7]. While Vlastos openly acknowledges that there is no textual support that Plato holds this view, he believes (quite plausibly, given that knowledge cannot be had of sensible objects) that Plato would support this statement. Knowledge comes into play after observation: the empirical observation of the seemingly regular motions in the heavens poses problems for the astronomer to solve. While these problems are solved through purely a priori, largely mathematical methods (note that at 528d-e1, Plato abstractly refers to astronomy as that "which deals with the motion of things having depth"), observation serves as the starting point of the investigation. Under this reading, if one were to infer from the statement about leaving the heavens alone that we must ban sense perception entirely from astronomy, then astronomy would never come into existence as an independent discipline because it would have no problems to solve.

Up to this point, Vlastos' reading of the passage seems like a reasonably plausible one. As a brief note, Vlastos drags in a passage from the *Phaedrus* on harmonics in which the learning of empirical sounds and their 'ratios' serves as a necessary precursor to actually knowing harmony in order to support his claim that empirical observation provides the motivational backdrop for real astronomy. Whether or not such observation is also a sufficient condition has remained untouched, but I offer the following explanation: the empirical observation of the heavens, combined with the arithemetic, geometric and stereometric knowledge previously acquired, do in fact provide one with sufficient tools to do real astronomy. The assimilation of the problems posed by empirical observation with the methods of planar and solid geometry would constitute real astronomy under Vlastos' reading.

Where I believe Vlastos deviates from a reasonable (in the sense of consistent) reading of Plato's astronomy lies in a disanalogy he draws between geometry and astronomy: while geometry need not appeal to its diagrams for

[3] Vlastos marks this as point (ii) of his argument; because I did not explicitly refer to his first point as (i), I omit this detail here as well.

verification of its theorems, "in the last analysis it will be the phenomena that must confirm or disconfirm the [astronomical] theory" [Vla80, p. 15]. It is in fact unclear what motivates Vlastos to this conclusion besides an apparent affinity of Plato's for the work of Eudoxus. I argue, however, that Vlastos imports into his reading of Plato a much too modern conception of science and uses this conception as an indictment of Plato's theory. For instance:

> Constrainted by his metaphysical and epistemological doctrine to locate truth only in ideal objects whose instantiation in the physical world necessarily involves some "falling short" of the true properties of the instantiated patterns, Plato fails to see how important it still is in astronomy that its observational component should strive to meet the highest standards of accuracy attainable at a given time. [Vla80, p. 16]

In a proper reading of Plato's astronomy, one cannot consider Plato constrained by his epistemological doctrines. These doctrines, mind you, immediately precede the very discussion of education in which the nature of astronomy is treated. Plato does not fail to see that it's important for a theory to be verified by sense data: the worth of doing astronomy for Plato comes in its ability to help the souls of those being educated to turn from the sensible to consider the intelligible. When Vlastos writes that, "What is unthinkable in Greek geometry is not only thinkable but mandatory in astronomy, where the theorist must submit his conclusions to the arbitrament of scientifically observed facts," he is speaking of modern astronomy. Such submission is distinctly not mandatory for Plato's astronomy, which serves an educational (and in a sense ethical) role. I find this importing of a modern conception of science into a reading of Plato ironic of Vlastos, for he earlier writes that his "interpretation of the disputed sentence [about leaving the things in the heavens alone] has put the strongest emphasis on its contextual environment" [Vla80, p, 12]. Yet here, Vlastos seems to extract Plato's astronomy out of the larger context in which it appears, namely out of the context of educating the future rulers of the ideal city.

3 A Priori Astronomy

Mourelatos' discussion in [Mou80] begins by analyzing two schools of interpretation of Plato's astronomy: those who emphasize the abstract definition of astronomy as the study of bodies in motion to maintain that it is an a priori science and those who, emphasizing the use of 'problems', maintain that astronomy should 'save the phenomena' via the positing a few mathematical (i.e. real) motions that satisfy the program of astronomy in the *Republic*. This latter view falls roughly in line with Vlastos' reading previously discussed. Mourelatos mentions a third, more minute group: those who find the possibility of the previous two conflicting interpretations so appalling that they argue no coherent interpretation can be had.

By relying heavily on the analogy between geometry and astronomy, Mourelatos argues for a position that roughly falls in the 'a priori astronomy' camp. Mourelatos, however, does not simply rely on this analogy: he provides a full analysis of it both at the conceptual and textual level. Many pieces of the conceptual analogy have been touched on already in this paper and more will be elucidated in what follows; the textual parallels drawn by Mourelatos appear here (sans the Greek) in an appendix for reference. The idea is that through similar structure and word choice (Mourelatos uses the word "phraseology" since it extends to clauses) in the relevant passages, Plato intends the analogy between geometry and astronomy to be taken much more strongly than as a mere heuristic.

Note that the connection in (d) ("things of this sort [diagrams]" vs. "the motions of the stars [things of this sort]") appears to be much looser than the other analogies, some of which use exactly the same wording. There are two lines of attack here:

1. Given the otherwise very strong lexical commonality between the two passages, we should consider this analogy as strong as the others, and thus draw the connection between diagrams and the motions of the stars.

2. Given the conceptually similar role that diagrams and the motions in the stars appear to play in their respective disciplines, we should take this linguistic difference to actually be a similarity.

Both of these takes on the discrepancy offer support both for each other and for Vlastos' reading of the similarity between diagrams and the heavenly motions. We thus have strong support for this specific analogy and reason to take the geometry-astronomy analogy quite literally. As Mourelatos puts it: "The most important general lesson of the parallels laid out above is that the analogy between the Expert Geometer and the Real Astronomer is meant to hold precisely and in detail" [Mou80, p. 41].[4]

Mourelatos uses the strictness of this analogy to attack a 'save the phenomena' interpretation.[5] To understand how this analogy applies, we must first expand on Mourelatos' reading of Plato's geometry. A key distinction between the way in which an Expert Geometer and an inexpert one appreciate the beauty of a diagram is drawn: while the inexpert geometer will appreciate the exacting detail with which a diagram is drawn, such detail is irrelevant for the Expert. For the Expert, the only 'beauty' ('perfection' may be more appropriate) that a diagram has rests in its capacity to allow the Expert to make "those idealizing stipulations that allow the theorems of geometry to bear on the solution"

[4] Mourelatos capitalizes Expert Geometer and Real Astronomer to distinguish them as referring to the respective agents in Plato. When I do so, I will be referring to Mourelatos' reading. More will be said about the very notion of a 'real astronomer' later in the paper.

[5] He also has adds in the Real Harmonist; this present discussion will make little use of the analogy with harmonics. This is because adding harmonics to the analogy does not elucidate the conclusions much more than geometry alone does. Having a third discipline in the analogy, however, does lend credence to the strength of any conclusions drawn from the analogy and so it is worth mentioning here.

[Mou80, p. 47]. While a diagram, if actually measured, may reveal a certain 'ugly' ratio (say, 327/159 appropriately sized tiny rocks) between two lengths, the Expert Geometer uses the diagram as a heuristic and supposes (purely as a stipulation) that the ratio is 2/1. After making all the relevant such idealizations,[6] the Expert can then proceed through the "relevant deductions" to a purely a priori theorem of geometry. This theorem has nothing to say about the particular diagram which motivated the Expert; because the theorem rests on certain idealized assumptions, it will almost certainly not obtain of any particular diagram. It is in this sense that Plato often writes of sensible objects 'falling short' in their approximation of intelligible ones.

This reading of the mathematical method in *Republic* VII appears not to accord with Mueller's, both in [Mue93] and [Mue91]. In particular, "the mathematician is forced to use hypotheses because he is reasoning about sensible things in an attempt to understand intelligible ones" [Mue93, p. 185]. The picture previously laid out depicts one reasoning *from* sensible things, not *about* them. According to Mueller, mathematics reasons for the sake of understanding intelligible objects, but not about intelligible objects explicitly. It strikes me both that these two views are not as different as they first appear and that where they are different, the differences are at the linguistic, not the fundamental level.

The similarity, then, lies in the nature of the hypotheses and subsequent deduction of a geometer. Mueller argues that while the hypotheses appear to be about the existence of certain objects (e.g. the One, the Equal), they in fact are "assumptions about the nature of these objects and the ways they can be manipulated" [Mue93, p. 188]. In a word, the hypotheses are propositions and the methodology is one of propositional deduction. This view of the methodology resembles Mourelatos' very strongly. While Mueller argues that mathematics reasons about sensible objects for the sake of intelligible ones (i.e. it "uses them"), he actually paints a picture very similar to Mourelatos'. The two scholars use the word 'about' differently, but both maintain that diagrams are used to put forth hypotheses from which deduction yields theorems. Even though Mueller uses the phrase 'for the sake of' because Plato mentions doing mathematics "for the sake of the square itself, the diagonal itself" at the end of Book VI, he does not maintain that geometers reason about sensible objects in the sense of drawing conclusions about a diagram. In this sense, Mourelatos and Mueller have a very similar, and I think quite appropriate, take on Plato's mathematical method: geometers use diagrams to hypothesize statements about Forms from which they can draw mathematical conclusions.[7]

Given this account of geometry and the strictness of the geometry-astronomy analogy in Mourelatos' interpretation, we return to astronomy to see what con-

[6] These idealizations also require the Expert Geometer to be reasoning about Forms. This is because such perfect ratios never obtain a physical situation and the necessary deductive steps apply only to intelligible objects.

[7] This also bears on Plato's reasons for arguing that the theorems of mathematics amount to "agreement" and not "knowledge" (533c): mathematicians proceed from hypotheses, from "what is unknown" and draw their conclusions from there. Because the hypotheses are never examined or verified, the deduced theorems are at best agreement.

clusions can be drawn. The Expert Geometer uses diagrams to make hypotheses (including the potential insertion of new lines, etc.) and draw conclusions. Accordingly, the Real Astronomer "might fill in the diagram of the heavens with imaginary circles and radii" and "assuming, as he might, some intelligible intermediate connection between comparable periods and radii," deduce from this a result about the system he seeks [Mou80, p. 56]. While the role of hypothesizing from the motions of the stars comes to the forefront in the previous quotations, Mourelatos pushes the analogy with geometry even further. Just as an Expert Geometer would not throw out his theorem if it did not accord with the original diagram from which he made his idealized hypotheses, "the attitude that is definitory of the Real Astronomer not only permits him to adjust the numerical data to the emerging pattern, it *requires* of him to do so" [Mou80, p. 56, emphasis in original].

Here we see Mourelatos' primary departure from Vlastos' 'save the phenomena' interpretation. This divergence follows naturally from Mourelatos' strict adherence to the analogy with geometry because it was at this point that Vlastos drew his dis-analogy. Recall that for Vlastos, "the theorist must submit his conclusions to the arbitrament of scientifically observed facts" even though this act would be "unthinkable in Greek geometry." On Mourelatos' strict analogy, it is *because* such submission is unthinkable in Greek geometry that it must also be unthinkable in astronomy. Whereas Vlastos' astronomical theories were supposed to verify observation, this relation is completely inverted under Mourelatos' reading. Even though both see the motions of the stars as analogous to the diagrams of geometry, they diverge at the degree to which they push the analogy with geometry. Given my previous criticisms of Vlastos' reasons for his dis-analogy, I believe that Mourelatos' reading, based on a thorough textual analysis of the analogy, aligns much more strongly with what Plato actually wrote.[8]

4 'Real' Astronomy?

Mourelatos' interpretation acts as an attempt to answer the question: "What exactly is the 'real astronomy' discussed in 530C?" This can also be seen in the title of his paper: "Plato's 'Real Astronomy"'. Recall that Vlastos personally translates what he considers to be the most problematic passage, 530B-C, as

> "It is by means of problems, then," I said, "that we shall proceed in astronomy, in the same way as we do in geometry, and *we shall let the things in the heavens alone* [Greek here] if, by doing real astronomy, we are to turn from disuse to use that part of our soul whose nature it is to be wise."

Though Vlastos emphasizes the clause on leaving things in the heavens alone, I wish to focus for a moment on his translation of "doing real astronomy." In

[8] This is not, however, to say that I fully agree with Mourelatos' a priori reading. Some problems with his reading will become clear in the rest of this paper.

particular, Vlastos uses this translation in his reading to try and determine the nature of the problems which constitutes 'real astronomy'. Both of these readings, Mourelatos' more fundamentally, take as their mission the explicating of the nature of a discipline called 'real astronomy.'

Many scholars, however, translate the above passage differently, tying the adverb form of 'real' to the verb and not to the object (astronomy).[9] Thus, both Grube and Bloom translate the relevant passage as "really taking part in astronomy". Under this translation, problems serve as the best methodology for 'taking part' in astronomy, but do not form the bedrock of 'real astronomy'.

At 530a we have another minor discrepancy: Grube and Vlastos translate what Mourelatos refers to as the Real Astroner as, well, "the real astronomer". Bloom, in keeping with his adverbial translation of 530b-c, translates this as "a man who is really an astronomer". This difference occurs at the beginning of the passage which fleshes out the night skies-as-diagrams analogy and so the discrepancy again creates a disagreement about whether Plato discusses proper methodology or the subject matter of a distinctive discipline.

While such discussions of which word the adverb refers to may seem petty, we will soon see that Gregory uses the 'really partaking in' translation to yield a conception of Plato's astronomy in *Republic* VII that is completely different from the two interpretations Mourelatos and Vlastos consider and which would, in fact, not be possible under the 'real astronomy' translation.

5 Doing vs. Teaching Astronomy

Gregory, in his book *Plato's Philosophy of Science*, draws on a wide range of examples from Plato's œuvre to advocate that Plato dealt with the foundations of modern scientific realism. While these sorts of broad discussions are beyond the scope of this paper, Gregory's second chapter on "Astronomy, Observation and Experiment" bears a lot of weight in light of the previous readings discussed. In particular, Gregory uses the distinction in translation to advocate for a distinction between doing and teaching astronomy.

While I criticized Vlastos for taking Plato's discussion of astronomy out of historical context, it can also be argued that Mourelatos, in pushing the analogy of astronomy as a discipline with geometry too far, takes the discussion of astronomy out of the larger context in which it appears in the *Republic*. Gregory's analysis depends on this context. By emphasizing the way in which the discussion of astronomy arises, namely as a discipline that must be learned by the future rulers of an ideal city, Gregory analyzes the educatory role that astronomy plays. This analysis depends on a discussion of why geometry must be studied. At 526d-e:

> What we need to consider whether the greater and more advanced part of it [the discipline] tends to make it easier to see the form

[9] Because I do not know Greek, I leave a more thorough discussion for other scholars. The relevant phrase, however, is *ontos astronomias metalambanontes*. See [Gre00, p. 58] for a more thorough treatment.

> of the good. ... Therefore, if geometry compels the soul to study being, it's appropriate, but if it compels it to study becoming, it's inappropriate. [Pla97c, p. 1143]

While we are still exploiting an analogy with geometry, the analogy is not one about the subject matter and methodology of the disciplines, but rather on the role they server in educating the guardians. We must put Plato's discussion of astronomy in the context of determining whether or not (and eventually coming to the conclusion that it is) it is an appropriate discipline for the future gaurdians to learn.[10] This context, explicitly in relation to astronomy, appears immediately preceding the passage on considering the "decorations in the sky" as a diagram. At 529c:

> ...what did you mean when you said that astronomy must be learned in a different way from the way in which it is learned at present *if it is to be a useful subject for our purposes.* [emphasis added]

With this context added, Plato's discussion of the nature of astronomy clearly concerns not how it should be *done* but how it should be *taught*. While Mourelatos believes Plato to be providing "the articulation of the science practiced by the Real Astronomer," Plato in fact provides an articulation of the science of astronomy to be taught to the future rulers. This contextualization also lends some support to the 'really taking part in astronomy' translation: the future rulers are not being trained to become astronomers, but rather are learning the part of astronomy that will be useful in helping them consider intelligibles instead of sensibles. It is for this reason that Plato emphasizes the component of astronomy in which we "leave the things in the sky alone." Considerations of such sensible objects serve no purpose in the education of the rulers.

Gregory uses this emphasis on education to draw a distinction between teaching and doing astronomy. Such a distinction gets some support from 530c: "The task you're prescribing is a lot harder than anything now attempted in astronomy." This task to which the interlocutor Glaucon refers is that of studying "astronomy by means of problems, as we do geometry," leaving the motions of the stars alone. There still exists some ambiguity: is this task harder than anything currently done by astronomers or than anything currently taught? According to Gregory, if we take the passage at 530c in conjuction with the discussions of learning at 529c and studying geometry at 526d-e, we see that 530c refers to the educational role and power of astronomy. This role is being contrasted with how astronomy currently is taught.

Seen in this light, the higher *part* of astronomy deals with intelligibles and so is the part that must be taught. Consider that, in the transition to his discussion of teaching harmonics, Plato writes, at 530e,

> That those whom we are rearing should never try to learn anything incomplete, anything that doesn't reach the end that everything

[10] Gregory also considers it important to translate 529c as 'to learn' and not 'to study' because the latter "would introduce an ambiguity which is not in the Greek" [Gre00, p. 56].

> should reach–the end we mentioned just now in the case of astronomy.

This provides overwhelming evidence that Plato's preceeding discussion of astronomy serves as a prescription on how to teach astronomy. Thus, when Plato tells us to "leave the things in the sky alone," he is not necessarily providing a recommendation to the practicing astronomer, but pointing out that we should not teach anything concerning sensible objects. For the education of the guardians, we are interested only in the power of the things in the sky to turn the guardians' souls around and make them consider intelligibles. Plato does not explicitly ban sense perception or empirical observation from astronomy itself, but only from that part of astronomy which gets taught.

Under this educational reading of Plato's astronomy, there may still exist implicit recommendations for how to do astronomy. As Gregory puts it, "How we ought to teach astronomy is going to be derived from how we ought to do astronomy, and contrasted with how it is taught now" [Gre00, p. 56]. Because it is the higher part of astronomy that must be used in education, and this is the part in which we must leave alone sensible objects, it seems as though there is a leftover part of astronomy which does deal with sensibles. This Gregory takes to be the part of doing astronomy.

While Gregory does not offer much of a positive account of doing astronomy under this reading (largely because most of Plato's discussion now deals with teaching), there are some points that can be clarified from this analysis. In particular, while we must only teach the intelligible, or 'higher', parts of astronomy, I see no ban on such parts in doing astronomy. In fact, given that Plato speaks of the 'real astronomer' or he who 'really takes part in astronomy' in conjuction with an expectation not to find truth in the heavens, it seems that Plato would grant the astronomer the right to proceed from observation to problems. The relationship, rather, is that teaching must be concerned *only* with the intelligible part of astronomy.[11] Doing astronomy might be, and in fact probably is, a mixed discipline dealing both with sensibles and intelligibles.

This interpretation has residues of Vlastos': the role of the motions of the stars is that of posing problems. The difference is that these problems are ones to be considered for the education of the rulers; the text is mute on whether astronomy shall actually work with such problems. As per my earlier criticism of Vlastos, there does not exist a 'submission of the theory to empirical observation' under this reading. The theory developed serves a purely educational role: it helps the future gaurdians contemplate and reason about intelligibles. Whether or not their solutions to astronomical problems conforms to observation thus seems completely irrelevant. Similarly, Mourelatos' considerations of the practice of the Real Astronomer appear misguided. Yes, Plato discusses astronomy as a purely a priori discipline. But he does so in the context of how it should be taught to the future gaurdians, not how the Real Astronomer should do astronomy. On this last point Plato offers only scant hints.

[11] To the extent that it can be, and that geometry can be. Thus, the heavens may be appealed to, but *only* to pose intelligible problems for the students to solve.

6 Conclusion

As mentioned earlier, Mourelatos refers to a third group of interpreters, who find the apparent tensions in Plato's discussion of astronomy a cause for despair and thus rule out any hope of a coherent interpretation. As I.M. Crombie puts it: "There is a variety of possible positions which we might ascribe to Plato, and I do not think that his language is clear enough to allow us to choose with confidence between them" [Cro63, p. 191].

Vlastos offers one such position, namely that astronomy proceeds form problems posed by observation and then attemps to solve them in order to 'save the phenomena.' Vlastos, however, consciously infers conclusions which are not present in Plato's text and so he cannot eradicate Crombie's worries. Mourelatos would argue that his language is in fact plenty clear: the strength of the analogy with geometry serves as a reason to take the analogy quite literally and thus reach a reading where Plato advocates an a priori conception of astronomy.

Gregory believes that the language is clear enough at a more macroscopic level than Mourelatos: by embedding both geometry and astronomy in their educational setting,[12] the analogy can be exploited to draw the distinction between teaching and doing astronomy. The view we end up with serves both as a synthesis of Vlastos and Mourelatos, retaining the initial role of observation in posing problems that we see in Vlastos and preserving the a priori methodology of Mourelatos in the educational role, and as a linguistic analysis that would satisfy Crombie. This analysis occurs on a higher level than the language analyzed for the preceding two views, placing emphasis on the macro-level structure of Book VII and not solely on the microscopic detail of the astronomy passage. Thus, while I believe Gregory stumbles on a few minor details, his reading provides a very coherent and plausible interpretation of Plato's astronomy.

[12] Plato discusses geometry extensively outside of the educational setting, but does not do so with astronomy. This is one reason why drawing analogies with geometry can be fruitful: Plato's account is generally quite explicit.

7 Appendix

Below you will find a recreation of Mourelatos' exposition of the textual parallels between Plato's treatment of geometry and astronomy in *Republic* 529e-530b (see [Mou80, p. 37] for the full treatment):

	Geometry	Astronomy
a	"someone who is expert in geometry"	"the one who is... the real astronomer"
b	"would come to consider"	"(that) he will believe"
c	"having taken a look at"	"when he looks"
d	"things of this sort" (viz. "diagrams")	"at the motions of the stars" (cf. "things of this sort")
e	"to be sure"	"to be sure"
f	"most beautifully"	"most beautifully to as high a degree"
g	"that they have been put together, in respect of workmanship"	"as works of this sort might have been fashioned, that they have been fashioned thus (superlatively)"
h	"by the... craftsman"	"by the craftsman"
j	"however"	"but"
k	"someone who is expert in geometry" [see (a)]	"the one who is... the real astronomer" [see (a)]
m	"would come to consider"	"he will think" [see (b)]
n	"laughable"	"absurd"
p	"to scrutinize these things"	"to seek, to quest"
q	"intently"	"in every way, assiduously"
r	"with the expectation that he would obtain"	"to obtain"
s	"truth, the ultimate reality"	"truth, the ultimate reality"
t	"in them"	"of them/from them"
u	"of what are equal, or...of some other relations of *symmetria*"	"of the relation of *symmetria* between night and day, and of... and... and of the others"

References

[Ant80] John P. Anton (ed.), *Science and the Sciences in Plato*, Eidos, New York, 1980.

[Bow91] Alan Bowen (ed.), *Science and philosophy in classical greece*, Garland, 1991.

[CH97] John M. Cooper and D.S. Hutchinson (eds.), *Plato: Complete Works*, Hackett, Indianapolis, 1997.

[Cor32a] F.M. Cornford, *Mathematics and Dialectic in the Republic VI-VII (I)*, Mind **41** (1932), no. 161, 37–52.

[Cor32b] ———, *Mathematics and Dialectic in the Republic VI-VII (II)*, Mind **41** (1932), no. 162, 173–90.

[Cro63] I.M. Crombie, *An examination of plato's doctrines: Vol. 2, plato on knowledge and reality*, Law Book Co, London, 1963.

[Gre00] Andrew Gregory, *Plato's Philosophy of Science*, Duckworth, London, 2000.

[Gul58] Norman Gulley, *Greek Geometrical Analysis*, Phronesis: A journal for Ancient Philosophy **3** (1958), no. 1, 1–14.

[Mou80] Alexander P.D. Mourelatos, *Plato's "Real Astronomy": Republic VII. 527D-531D*, pp. 33–74, in Anton [Ant80], 1980.

[Mou91] ———, *Plato's science–his view and ours of his*, pp. 11–30, in Bowen [Bow91], 1991.

[Mue80] Ian Mueller, *Ascending to Problems: Astronomy and Harmonics in Republic VII*, pp. 103–122, in Anton [Ant80], 1980.

[Mue91] ———, *On the Notion of a Mathematical Starting Point in Plato, Aristotle, and Euclid*, pp. 59–97, in Bowen [Bow91], 1991.

[Mue93] ———, *Mathematical method and philosophical truth*, Cambridge University Press, New York, 1993.

[Pla60] Paul Plass, *Socrates' method of hypothesis in the Phaedo*, Phronesis: A journal for Ancient Philosophy **5** (1960), no. 2, 103–115.

[Pla97a] Plato, *Phaedo*, pp. 49–100, in Cooper and Hutchinson [CH97], 1997.

[Pla97b] ———, *Phaedrus*, pp. 506–556, in Cooper [CH97], 1997.

[Pla97c] ———, *Republic*, in Cooper and Hutchinson [CH97], pp. 971–1223.

[Vla69] Gregory Vlastos, *Reasons and Causes in the Phaedo*, Philosophical Review **78** (1969), 16–44.

[Vla80] ———, *The Role of Observation in Plato's Conception of Astronomy*, ch. 1, pp. 1–32, in Anton [Ant80], 1980.

[Wed55] Anders Wedberg, *Plato's Philosophy of Mathematics*, Almquist & Wiskell, Stockholm, 1955.