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Two Aristotelian Puzzles about Planets and their Neoplatonic Reception

Abstract: The longevity of Aristotelian natural science consists not so much in the fact that Aristotle's solutions to puzzles were accepted by generations of philosophers, but by the fact that the presuppositions that made these puzzles look puzzling were. In what follows I consider some Neoplatonic responses to two puzzles that Aristotle poses in *De Caelo* Book 2, Chapter 12. Both Proclus and Simplicius rejected Aristotle's solutions to the puzzles he posed. In one case, but not in the other, they also reassessed the relative importance of the presuppositions that created the puzzle.

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Richard Sorabji's early collection of papers on the Aristotelian commentators was aptly called *Aristotle Transformed*.[1] The nature of this transformation was complex and subtle. This paper presents two exhibits in the transformational process.

The longevity of Aristotelian natural science consists not so much in the fact that Aristotle's *solutions* to puzzles were accepted by generations of philosophers, but by the fact that the *presuppositions* that made these puzzles look puzzling were. In what follows I consider some Neoplatonic responses to two puzzles that Aristotle poses in *De Caelo* Book 2, Chapter 12. The first of these questions concerns the level of complexity exhibited by the motions of the fixed stars, the five planets, and the sun and moon. I'll call this the Motion problem. The second concerns the number of visible inhabitants in the different spheres of the heavens. I'll call this the Population problem. Both Proclus and Simplicius rejected Aristotle's solutions to the puzzles he posed. In one case, but not in the other, they also reassessed the relative importance of the presuppositions that created the puzzle.

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1 Sorabji (1990).

1 Aristotle's two ἀπορίαι

The Motion problem is this:[2] the fixed stars exhibit a simple motion every night, rising in the east and setting in the west or rotating around the pole. Their motion is smooth and unidirectional. The motion of the planets is more complex. It would be reasonable (εὔλογος), says Aristotle, for the complexity of motions exhibited by the bodies closer to the fixed stars to be simpler, with the complexity increasing as we get closer to the sub-lunary region. But in fact this is not what is observed. Indeed, the sun and moon have *fewer* motions than the planets, in spite of the fact that the latter are farther from the center of the cosmos and closer to the 'first body', i.e. the sphere of the fixed stars.

The Population problem is this:[3] while the sphere of the fixed stars has a vast population of stars, each of the planetary spheres has at most one visible occupant – the planet. Aristotle does not say *exactly* why this should occasion surprise. But it is clear enough from his solutions that the source of the puzzlement is the apparent lack of continuity. On the one hand, we have a ratio of spheres to inhabitants that is 1 sphere : uncountably many stars. Then for each planetary sphere we have 1 sphere : 1 star. Then here on Earth we have one body with very many terrestrial inhabitants. There seems to be something wrong with a progression that goes as follows: one sphere/many stars : one sphere/one star : one sphere/many terrestrial beings.

What presuppositions are required in order to see these situations as things about which one might be reasonably puzzled (περὶ ὧν εἰκότως ἂν ὁστισοῦν ἀπορήσειε, 291b24–5)? One necessary presupposition is a kind of *axiological geography* of the universe: things are better at the far edge. This is unsurprising since the sphere of the fixed stars lies at the circumference, adjacent to the non-place that is not occupied by the unextended prime mover.[4] Second, there is

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2 *Cael.* 2.12, 291b29–a3 διὰ τίνα ποτ᾽ αἰτίαν οὐκ ἀεὶ τὰ πλεῖον ἀπέχοντα τῆς πρώτης φορᾶς κινεῖται πλείους κινήσεις, ἀλλὰ τὰ μεταξὺ πλείστας. Εὔλογον γὰρ ἂν δόξειεν εἶναι τοῦ πρώτου σώματος μίαν κινουμένου φορὰν τὸ πλησιαίτατον ἐλαχίστας κινεῖσθαι κινήσεις, οἷον δύο, τὸ δ᾽ ἐχόμενον τρεῖς ἤ τινα ἄλλην τοιαύτην τάξιν. Νῦν δὲ συμβαίνει τοὐναντίον· ἐλάττους γὰρ ἥλιος καὶ σελήνη κινοῦνται κινήσεις ἢ τῶν πλανωμένων ἄστρων ἔνια· καίτοι πορρώτερον τοῦ μέσου καὶ πλησιαίτερον τοῦ πρώτου σώματός εἰσιν αὐτῶν.

3 *Cael* 2.12, 292a.10–14 Τοῦτό τε δὴ δικαίως ἀπορήσειεν ἄν τις, καὶ διὰ τίνα ποτ᾽ αἰτίαν ἐν μὲν τῇ πρώτῃ φορᾷ τοσοῦτόν ἐστιν ἄστρων πλῆθος ὥστε τῶν ἀναριθμήτων εἶναι δοκεῖν τὴν πᾶσαν τάξιν, τῶν δ᾽ ἄλλων ἓν χωρὶς ἕκαστον, δύο δ᾽ ἢ πλείω οὐ φαίνεται ἐν τῇ αὐτῇ ἐνδεδεμένα φορᾷ.

4 For the claim that the prime mover lies at the periphery, see *Physics* 267b9. Strictly speaking, this cannot be quite right. Given that place is the inner boundary of that which contains, there is no place beyond the universe. Moreover, when we consider that the prime mover is the activity of thought thinking itself, it is hard to see how this is an activity that takes place

value placed upon *simplicity*. Consistent with the universe's axiological geography, simplicity of motion ought to be proportional to distance from the sphere of the fixed stars. From this point of view, it looks like the sun and the moon are in the wrong place, or else the other planets' complex motions are somehow a mistake. Finally, there is a commitment to a sort of *proportionality* in nature. The Population puzzle is really a puzzle about the absence of a suitably proportional intermediate case.

Aristotle's discussion in *De Caelo* evinces no hesitation about the reasonableness of the questions, though he is concerned that it may seem rash to expect that we can gain very certain answers to these questions. We have little evidence to start from and the things in question are very far away (292a14–17). It will be properly deemed modesty rather than rashness if we settle for τὴν ἐπὶ πλεῖον σύνεσιν (292a15) or μικρᾶς εὐπορίας περὶ ὧν τὰς μεγίστας ἔχομεν ἀπορίας (291b27–8). The questions we are putting to the universe are reasonable ones, and if there is any lack of precision or uncertainty about the answers, this is the result of our limited epistemic position – not any presuppositions behind the questions which might be mistaken.

2 Aristotle's solution to the Motion problem and the commentary tradition

Since I am concerned more with the reception of Aristotle's philosophy than with Aristotle's own views, I will concentrate on the explication of *De Caelo* 2.12 given by Simplicius in his massive commentary on the work. Thus I have been quite vague about the nature of the complexity involved in planetary motion. Simplicius seems to think that Aristotle had in mind station and retrogradation. Bowen (2002) has argued that Simplicius reads later concerns back into his understanding of the history of astronomy. For our purposes, this does not matter. If it is true, it is another example of the way in which Aristotle (and Plato) are transformed in the commentary tradition. But this is not the specific transformation that concerns us here.

It is uncontroversial that Aristotle begins his resolution of the Motion problem by urging a certain point of view regarding celestial motion. A solution to the puzzles requires us to take up a perspective on the objects in the heavens that sees them as *alive* and capable of *action*. We will not be able to solve them

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somewhere. Hence *Physics* 267b9 does not seem to sit entirely comfortably with the rest of Aristotle's physics or theology. On this puzzle, see Lang (1981).

if we think of them simply as inanimate bodies that have non-normative numeric relations to one another. When we take up this stance towards them, nothing in the two puzzles will appear παράλογον. This stance, of course, echoes Plato's insistence in Book 10 of the *Laws* that the motions of the heavenly bodies are the result of psychological acts, not inanimate forces. Needless to say, this is a stance that Simplicius finds appropriate. Indeed, he stipulates that if we are to see the heavenly bodies as capable of action, then the kind of soul responsible for their life is *rational* soul (*in Cael.* 482.10–14).

How does attributing action to the heavenly bodies help to resolve the Motion puzzle? Simplicius locates two kinds of solutions in Aristotle's text. The first of these he thinks is a bit unclear or not fully spelled out. The second strategy has implications that Simplicius would prefer to avoid.

We can think of two hierarchies of action. Consider plants in relation to human beings. Plants don't do much because there are only a few things at which they can succeed. Human beings, by contrast, perform many different kinds of actions because there are many more ways in which they can act successfully. Call this the hierarchy of *availability*. On this hierarchy, more is better. Contrast this with the hierarchy of *means*. Here we focus on a single goal shared by a variety of better or worse agents. Suppose the goal is health. Person A, who is in the best condition, attains the goal towards which his action aims with no effort: for example, he is simply healthy without needing a special diet or exercise regimen. Another person, B, is perhaps so situated that he achieves the same goal with only a little effort. He sheds a couple of pounds, works out a bit, and runs his first triathlon. Yet another person, C, must go through a great many steps in order to achieve the goal. Finally, there is the person, D, who is *incapable* of attaining the end realized by the others but whose efforts toward some intermediate step nonetheless constitute an improvement of his condition. So perhaps D is incapable of health, yet if he has the goal of exercising he will nonetheless be in as good a condition as is possible for him. He may achieve a goal related to, but not identical with, health – perhaps greater longevity, albeit hampered by his congenital defect. In the hierarchy of means, less – i.e. fewer actions – is better.

Aristotle's most clear and obvious solution to the puzzle of Motion invokes the hierarchy of means. The Earth (which is stationary) and the sun and moon (which have only simple motions) are in the position of person D. The prime mover, of course, is analogous to A. The fixed stars and/or their sphere are analogous to B, while the complex motions of the planets reveal that they are analogous to person C, who must undertake many activities in order to attain health.

Aristotle's solution has clear consequences for the lives of various heavenly bodies. It appears that the Earth, as well as the sun and moon, are not able to attain the same blessed life as the other heavenly bodies. Aristotle recognizes this implication explicitly.

> And that is why the Earth does not move at all, and things close to it [sc. the sun and moon] have but few motions. For these *things do not reach the ultimate*, but they attain as much of the divine starting point as they are able. But the first heaven attains it straightaway with one motion. But the things in between what is first and what is last do reach it, but they reach it with more motions. (292b19–25, trans Mueller)[5]

Simplicius is clearly troubled by this implication. He first weighs the possibility that in this passage 'Earth' and 'the things close to it' might simply refer to the sublunary elements. He recognizes, rightly, that such a reading would not yield a position for Aristotle that would constitute a response to the puzzle.[6] Simplicius prefers to qualify Aristotle's apparent demotion of the Earth, sun and moon:

> ... the words 'these things do not reach the ultimate' seem to be harsh, unless he were saying that they are not equal to its complete perfection because they are more partial [or more individual]; for he says clearly that these things share in the first starting point according to their own measures, since he says that they share in the most divine starting point as much as they are able. (486.28–487.3, trans. after Mueller)

Simplicius locates another solution to the Motion puzzle in Aristotle's text. I say he locates it because this solution is far less clearly expressed than the solution in terms of the hierarchy of means alone. This solution would combine the two hierarchies. Some heavenly beings will engage in more actions because their superiority means that there are more opportunities for successful action *available* to them. In other cases, heavenly beings will do few things. This is not a mark of their inferiority. In their case, their superiority entails that they require few *means* to realize their end. As Simplicius puts it:

> The whole argument would amount to the following. If things that move in many ways are more honourable, they move in more ways because there are more ways to be successful; but if they are worse, they move in more ways because they are not able to attain the best by means of a single motion ... So when Aristotle says these things, he is not judging the worth of the gods, since saying such things is precarious, but he is giving the starting points for a solution. (483.28–484.1)

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5 Mueller (2005).

6 *in Cael.* 486.27 ἐλλείποι ἂν τῇ λύσει τῆς ἀπορίας τὸ κυριώτατον.

Of course, when we think it through carefully, it is not clear that this combined strategy is particularly successful. Given the axiological geography presupposition and the continuity presupposition, we ought to see a smooth decline in the superiority of the heavenly beings from the fixed stars to the Earth. But that is not what results. We have the fixed stars, which get an A+ on the hierarchy of means scale, followed by the 'wandering' planets, which presumably have more options open to them than the sun and moon. So the five planets above the sun get an A+ on the hierarchy of availability scale. If things get progressively inferior as we get closer to the center, then it appears that an A+ in 'means' is a better mark than an A+ in 'availability'. But then what mark do we give to the sun and moon? If they achieve their goal with one simple motion, then it looks like they are doing just as well as the fixed stars. So they get an A+ too. But then we don't have a continuous downward slope on the axiological scale as we approach the center. Nor can we combine the scales, so that the stars get an A+ for both means and availability. Presumably it will not do to say that the fixed stars have many available courses of action as a result of their superiority but do only one thing (albeit by means of a single action).

In fact, Simplicius concludes by registering some level of disquiet with the framework within which the discussion is taking place. The view that the planets engage in a variety of motions is based on the idea that their motions are the function of a variety of *moving spheres*. This is the system of Eudoxus that Aristotle adapts to a physical theory of spheres. The impetus for the theories of the astronomers allegedly came from Plato, and Simplicius does not take Plato's challenge to be an invitation to speculate on the *corporeal mechanisms* by means of which the planetary motions are mechanically produced. He writes:

> If then the several motions for each of the several planets are hypotheses and they are not demonstrated to be this way in truth, as is made clear by the fact that different people make different hypotheses, what reason is there to seek in this way the reason why the planets proximate to the fixed sphere have more motions than the last ones, as if there were in truth several bodies and therefore several motions in the cases of each of the planets? (488.25–30)

Simplicius' point seems to be that we will see station, retrogradation, another station, and resumption of progression for a planet as a *plurality* of *motions* only if we think of it as the product of the interaction of the regular motions by a plurality of *bodies*. Aristotle's way of framing the problem presupposes a principle for the individuation of distinct motions that ultimately rests on his physical theory of how they take place.

Simplicius also flirts with the idea of rejecting the presupposition of axiological geography. Perhaps, he suggests, we should determine the worth of these

things not by reference to their locations – οὐ πρὸς τὴν τῶν τόπων διαφορὰν τὰς ἀξίας αὐτῶν ἀφορίζειν (488.31) – but rather, to explain the differences among them in terms of their *different roles in making the universe good*. Thus the sun and moon are where they are (presumably with the motion that is natural to them) because of the need to illuminate the Earth.

Simplicius also mentions what he regards as the Platonic alternative at the end of his discussion of *Cael*. 292a18–b25. The basic idea behind this strategy is to see the complexities of planetary motion as an intermediate stage between the simplicity of stellar motion and the complexity and variety of rectilinear motion in the world of Becoming. Simplicius sums this up when he says:

> [According to Plato, the variegated planetary motions] are an intermediate stage between what is entirely regular [sc. simple astral motion] and what is entirely disorderly [sc. motion in the sublunary region], and therefore have a regular irregularity (τεταγμένην ἐχόντων ἀνωμαλίαν, 489.8–9).

This summary of the Platonic alternative agrees very well with Proclus' views in his *Timaeus Commentary*. Let us now turn to an explanation of the relevant Proclean passages.

Proclus explicitly rejects the idea of eccentric or epicycles and assigns the phenomena of station, retrogradation and progression to the individual wills of the divine living beings who are the planets. In this he follows Iamblichus, who regards such innovations as foreign to the spirit of Plato. He also regards such hypotheses as inimical to the simplicity of the heavenly gods.[7]

> Plato attributes the irregular [motion] to the stars themselves – though this [motion] also is something that has been given an order, since it returns to its own starting point at regular times. It is thus like an intermediary between things that undergo motion that is entirely regular [sc. the fixed stars] and things that undergo motion that is entirely irregular [sc. things in the sub-lunary], for [the planets] have been allotted a motion that is regularly irregular or irregularly regular (ὁμαλῶς γὰρ ἀνώμαλον ἢ ἀνωμάλως ὁμαλὴν ἔλαχον κίνησιν. *in Tim*. III 56.31–57.6, my translation)[8]

The regularly irregular motion of the planets serves as a paradigm for those in the sub-lunary regions. In technical Neoplatonic terminology, they 'antecedently comprehend' (προλαμβάνειν) these motions by having them in a 'causal-anticipatory way' (κατ' αἰτίαν). Neoplatonic metaphysics accepts what I earlier

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7 Cf. *in Tim*. III 65.7ff. (= Iamblichus, *in Tim*. fr. 70, Dillon (1973)) for Iamblichus' rejection of epicycles and III 56.29 for the claim that being shunted around on spheres is beneath the gods' dignity.

8 On the self-initiated regular irregularity of the planets in Proclus, see Pedersen and Hannah (2002).

called the 'continuity presupposition' as a fundamental principle that guides metaphysical and physical theorizing. Thus there must be a sequence from πάντη τεταγμένων to πάντη ἀτάκτων that goes via an intermediate stage of τεταγμένη ἀνωμαλία.[9] Nature abhors vacuums and gaps!

What then of the difference between the sun and moon, on the one hand, and the planets on the other? Proclus recognizes that the latter exhibit station, retrogradation and progression while the former do not (III 81.6–10) and connects this fact – at least in the case of Venus and Mercury – with the puzzling claim at *Timaeus* that they have been allotted 'a contrary power' (*Tim*. 38d4).[10] But instead of concentrating on this difference, Proclus' discussion focuses on the fact that the sun, Venus and Mercury go at more or less the same speed and always appear close to one another. The fact that they are ἰσοδρόμους is one that seems more salient to him and more deserving of an explanation. Having chosen to focus on a fact that highlights the *affinity* between these three bodies, Proclus explains the *differences* among the three by making the sun primary. Because the sun in the *Republic* is such as to reveal truth, the sun is analogous to the first of the three monads in the *Philebus* (64c1): Truth, Beauty, and Symmetry. Venus (Aphrodite), of course, corresponds to Beauty. The role of Hermes (Mercury) as patron of persuasion (*logos*) and thus proportion (*logos*) means that this planet corresponds to Symmetry. These two planets are subordinate to and collaborate with the sun in its 'solar demiurgy' (III 67.20–3). Proclus gives Mercury and Venus different collaborative roles. The moon is not sharply distinguished from Venus and Mercury either, for it too collaborates with the sun in the solar demiurgy. It must, since its light is borrowed.[11] The nature of the causal influence that the different planets exercise in relation to the sub-lunary realm in Proclus (and Iamblichus) align pretty well with the astrological account that we find in Ptolemy's *Tetrabiblos* I.4.

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9 At *in Tim*. III 80.5–10 Proclus specifies more exactly the nature of this regular irregularity: the planets' motion is that of the spiral. This is an intermediate motion between the strictly circular motion appropriate to the fixed stars (79.14) and the rectilinear motion that is found in the realm of Becoming. Cf. 148.31 for the idea that the length of a spiral can be calculated from straight lines and circles.

10 I shall speak of 'Proclus' in what follows, but on this subject it is difficult to disentangle his views from those of Iamblichus. Dillon's quotation for Iamblichus fr. 70 stops at *in Tim*. III 66.9 but it is plausible that what follows represents Iamblichus' ideas on this subject.

11 *in Tim*. III 65.17–22: 'He [Iamblichus] says that the Moon has been ranked first in the region around the Earth because it has the status of mother and of nature in relation to Becoming (for everything turns with the Moon, growing when it waxes, diminishing when it wanes). The Sun is above the Moon since it widely recognised as filling the Moon with its powers and possessing the status of Father in relation to Becoming.'

The effect of all this – however mad and arbitrary we might find it – is to efface the difference between the sun and moon, on the one hand, and two of the five planets that exhibit retrogradation, etc. The sun, moon, Mercury, and Venus work as a team. The more complex motions of the latter two are, in Proclus' treatment, subsumed in the overall theme of the different contributions made by different heavenly bodies to the good of the whole:

> ... above [the sun] are the Helmsmen of universal Becoming [i.e. Mercury and Venus], who have in common that which neither the sun nor the moon exhibits – that is, progressions, stations, and retrogradations. It is through these that the nature of things in the sub-lunary realm is changed in various ways – by additions and subtractions or benefactions and remissions of the proportions of their lives or the entirety of their essences. (*in Tim.* III 68.5–10)[12]

Proclus uses two pairs of words to discuss the phenomena of planetary progression and retrogradation. Progression is sometimes denoted by προποδισμός, which has a narrower sense that is almost always astronomical, and sometimes by πρόσθεσις, which has the wider sense of 'addition' or 'increase'. Retrogradation is sometimes denoted by the narrower ὑποποδισμός and at other times by the wider ἀφαίρεσις, which means 'removal' in a more general sense. Proclus plays on this dual use here to suggest that planetary progression or retrogradation brings about corresponding effects, like addition or subtraction, among things in the sub-lunary realm.

The difference between the five planets, on the one hand, and the sun and moon, on the other, that prompted Aristotle's Motion problem has been subsumed in a conception of planetary motion that sees all the variety up there as causally responsible for the variety down here. It is not that Proclus' alternative is free of associated values. In fact, his picture is one in which the sun has a particularly important role and this reflects the theological pre-eminence of Helios.[13] Proclus, like Simplicius, would be most unwilling to suppose that the sun is – in Aristotle's words – οὐ γὰρ ἀφικνεῖται πρὸς τὸ ἔσχατον, ἀλλὰ μέχρι ὅτου δύναται τυχεῖν τῆς θειοτάτης ἀρχῆς. Rather than providing a solution, Proclus denies that the observed differences that motivate the Motion problem really demand an explanation of the sort that Aristotle thinks they do. Getting the proper perspective on differences among planetary motions requires more than

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12 ἄνωθεν δὲ τοὺς κυβερνήτας τῆς ὅλης γενέσεως, κοινὸν ἔχοντας πάντας ὃ μήτε ἥλιος ἔχει μήτε σελήνη, τοὺς προποδισμοὺς <καὶ στηριγμοὺς> καὶ ὑποποδισμούς, δι᾽ ὧν ἡ τῶν ὑπὸ σελήνην φύσις παντοίως ἐξαλλάττεται προσθέσεσι καὶ ἀφαιρέσεσιν ἐπιδόσεσί τε καὶ ἀνέσεσι τῶν λόγων καὶ τῆς ζωῆς καὶ τῆς συμπάσης αὐτῶν οὐσίας.

13 Cf. *in Crat.* 98.1–3 where the sun is associated with Apollo and credited with providing all things with the power of unification.

a naïve ranking in terms of simple (superior) versus complex (inferior).[14] It requires thinking about these different motions within the context of the *providential governance* of the universe. It is no accident that Proclus follows Iamblichus in adapting the language of the astrologers to refer to the planets: they are οἱ κοσμοκράτορες. Government is complex, and different leaders play different roles. We should evaluate the question of whether a motion is simple or complex by reference to the role the motion plays in governance. This – and not the judgment of the eye – is the proper metric of relative complexity.

3 Aristotle's solution to the Population problem in the commentary tradition

Simplicius' exegesis of Aristotle's *De Caelo* 292b25–293a11 is punctuated by a long digression on how Aristotle's account of deferents and counter-acting spheres is meant to be understood, as well as an account of criticisms leveled by subsequent proponents of eccentrics and epicycles. This information, while fascinating and perhaps evidentially problematic, is not so immediately relevant to the specific concerns of this paper – at least not down to the level of detail that Simplicius gives us. Simplicius thinks that 292b25–293a4 contains either one or two lines of response to the Population problem, depending on how we understand the text. What follows at 293a4–11 then provides a second response (or a third, depending upon what we say about 292b25–293a4). This latter response is the one that inaugurates the digression. Let us turn to it first, and then deal with the first one or two responses.

One reason that could be offered to explain why there is only one resident for each planetary sphere has to do with the limits of what such spheres can accommodate. Consider a planet such as Saturn. It moves within a system of nested spheres. Rightly or wrongly, Simplicius treats Aristotle's remarks at 293a4–11 as invoking the *effort* required by the outermost sphere in an individual planetary system:

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14 Since Proclus is keen to exhibit as much continuity as possible among the great Platonists, there is one point at which he concedes something to Aristotle's motion puzzle. At 77.1–5 he again rehearses the idea that the more complex planetary motions are an intermediary between circular and rectilinear motion. However, he then concedes that the planets have '[a variety of motion] which makes them inferior to the fixed stars, though in another sense they have been allocated a kind of independence'.

> ... [I]t would be a difficult task for the outermost sphere to move both so many corporeal spheres and the sphere having the single star, if that sphere had many stars rather than one, as the fixed sphere does. (492.1–3, trans. Mueller)

So we only have one inhabitant because of the limits of what a planetary system of spheres can handle.

Simplicius is not impressed by this argument. First, it seems to assume that the sphere of the fixed stars is *vastly* superior to the outermost spheres for the individual planetary systems – so much so that Saturn's poor outermost sphere couldn't manage to hoist another planet in addition to all those other spheres that it is driving, though the motion of the sphere of the fixed stars is communicated throughout the whole system. Simplicius also thinks that the response also treats the planets as if they had weight – a conclusion that Aristotle himself denies. Moreover, it requires one to subscribe to the reality of these spheres and Simplicius thinks that there is no rational necessity to do so. It is this remark that prompts his digression on the Aristotelian account of spheres and its competing hypotheses, which begins at 492.28 and extends to 510.8.

The Aristotelian response to the Population problem that Simplicius takes more seriously is the first one – or two – given in 292b25–293a4. The key to this response is the idea that 'nature equalizes the superiority [of the sphere of the fixed stars] and makes a specific order, assigning many bodies to one motion, but one body to many motions'.[15] The idea that we have 'one body, but many motions' refers to the fact that the observed motion of the single visible planet is – on Aristotle's way of thinking – the product of the multiple motions of the nested spheres that constitute its planetary system. This contrasts with the single motion of the sphere of the fixed stars, which moves many visible bodies.

Simplicius' hesitation about whether we have more than one solution offered in 292b25–93a4 hinges on the relation between the first and latter parts of this passage. Simplicius takes the first part of the passage to establish the superiority of the sphere of the fixed stars on three grounds.[16] First, its proximity to the prime mover. Second, the fact that it contains all the subsequent spheres and transmits its movement to them. Third, the fact that it 'attains the complete good by means of a single, simple and perfect motion'. Indeed, given

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15 Aristotle, *Cael.* 293a.2–4 Ταύτῃ τε οὖν ἀνισάζει ἡ φύσις καὶ ποιεῖ τινὰ τάξιν, τῇ μὲν μιᾷ φορᾷ πολλὰ ἀποδοῦσα σώματα, τῷ δ᾽ ἑνὶ σώματι πολλὰς φοράς; repeated by Simplicius at 490.26 and 510.9.

16 Simplicius, *in Cael.* 490.8–13 δηλοῖ δὲ τὴν ὑπεροχὴν τῆς δυνάμεως ἥ τε ἄμεσος συγγένεια πρὸς τὸ πρῶτον ποιοῦν τε καὶ κινοῦν αἴτιον καὶ τὸ πάντων τῶν ἄλλων εἶναι περιεκτικὴν καὶ τὸ συμπεριφέρειν ἑαυτῇ τὰς ἄλλας καὶ ἔτι μέντοι τὸ διὰ μιᾶς καὶ ἁπλῆς κινήσεως καὶ σχεδὸν ἀχρόνου, εἴ τις ἐννοήσοι τὸ μέγεθος, ὁλοκλήρου τυγχάνειν τοῦ τελεωτάτου ἀγαθοῦ.

how far away the sphere of the fixed stars is, its velocity must be *so* fast as to be almost instantaneous (σχεδὸν ἀχρόνου, 490.12). The latter part of the passage then introduces the considerations about the equalization of the outer sphere's superiority. Simplicius seems inclined to agree with Alexander that these two parts constitute a single line of argument (490.30–491.3). The first gives the grounds for the outer sphere's superiority. The notion that nature 'equalizes' this superiority then amounts to the thought that the degree of superiority of the outermost sphere over the subsequent planetary ones is proportional to the difference between the number of movers for each planet and the number of stars. As the one motion of the *single* sphere of the fixed stars is to the vast number of stars, so the single star is to the motion of the *multiple* planetary spheres that produce its complex motions.[17]

Simplicius realizes that the way in which Aristotle establishes proportionality in nature requires that the simple and single motion of each of the multiple planetary spheres plays a role in bringing about the complex observed motion of the planet. This has several implications. First, it means we need to be realists about the Peripatetic hypothesis, and Simplicius has already shown hesitation about this on the ground that there are alternative hypotheses that save the phenomena at least as well (488.25–30). In fact, it is the case that the competing theories that involve eccentrics and epicycles are able to account for the difference that has been allegedly observed in the *visible size* of the heavenly bodies (505.10).[18] But while they capture this new phenomenon, and are simpler as well, the new theories surrender the Aristotelian strategy for establishing proportionality:

> For there is no room left for equalization since it is no longer true to say that the first motion, which is single, causes many divine bodies to move, and the motions which are many cause only one body to move; for the motions before the last, which has the single star, do not move many bodies. (509.21–6, trans. Mueller)

As Mueller notes, at this point Simplicius must suppose that in the theory of epicycles only the epicycle moves the star. Subsequently he seems to qualify this understanding somewhat:

> There will be room for a *partial* solution of the difficulty even on these hypotheses ⟨of eccentric spheres and epicycles⟩. For on this hypothesis it is *in a way* true to say that nature equalizes and produces a certain order by assigning many bodies to one motion

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17 *in Cael*. 491.6–8 ὡς γὰρ ἡ μία κίνησις τῆς ἀπλανοῦς ἔχει πρὸς τὰ πολλὰ ὑπ' αὐτῆς κινούμενα ἄστρα, οὕτω τὸ πλανώμενον ἓν ἄστρον πρὸς τὰς κινουμένας αὐτῷ πολλὰς κινήσεις.
18 At least this is the way that Simplicius tells the story of the evolution of astronomical theories, but see Bowen (2002), 167 on this particular point.

and many motions to one body. For even if each has its own single motion, nevertheless everything under the sphere of the fixed stars will have its motion: the epicycles will have this motion plus the motion of the homocentric or eccentric circles; and the star, which he calls one body, will have the motion of the epicycle and the motion of the homocentric or eccentric circles and the motion of the fixed sphere. (510.8–15)

Why is this a 'partial solution'? And why is it merely 'in a way true' to say that nature equalizes things and produces an order? The answer, I think, is that we have now dropped the hypothesis of the counter-acting spheres. These were introduced by Aristotle precisely in order to 'insulate' the motion of lower planets from being affected by the motions of those above them. Given this insulation, we can say that there is a determinate subset of the total number of spheres which is responsible for the observed motion of each individual planet. In effect, we have 1 : m (number of fixed stars) :: n (number of spheres responsible for Saturn's motion) : 1 (i.e. the single body, Saturn). In fact, if we assume four deferent spheres and three counter-acting spheres for it, Saturn's number is 7, as is Jupiter's, while Mars, Mercury, Venus, and the Sun will each be 'equalized' at a 9:1 ratio. However, since Ptolemy's version requires the spheres to pass through one another in order to avoid the introduction of empty space, there is really no way to say exactly how many spheres are responsible for each individual planetary motion (510.15–23). It is this inability to provide a specific division of motive labour, and thus determinate proportions for the formula τῇ μὲν μιᾷ φορᾷ πολλὰ σώματα, τῷ δὲ ἑνὶ σώματι πολλὰς φοράς, that leads Simplicius to say that the new astronomical hypotheses provide only a partial solution to the problem.

    In the case of the Motion problem, I suggested that Simplicius implicitly rejects the presuppositions that motivate the puzzle. First, he evinces some scepticism about axiological geography. In any case, the judgment that an axiological justification for the pattern 'simple stellar motion : complex planetary motion : simple solar and lunar motion' is required overlooks the possibility that these differences are properly subsumed within a universal teleology. This is exactly the sort of explanation that Iamblichus and Proclus provide. In the case of the Population problem, however, it seems that Simplicius supposes that Aristotle has latched on to something that is in fact worthy of an explanation. Aristotle's theory of the heavens with its distinct number of spheres responsible for the motion of each planet *would* provide such an explanation. Unfortunately, it is empirically inadequate, since it cannot account for the differences in the apparent size of the planets. This inadequacy has prompted the adoption of the new hypotheses of epicycles and eccentrics. These new theories, in turn, cannot solve the genuine problem that Aristotle has raised. Thus the Population problem gets no clear solution in Simplicius.

4 Proclus and the satellites[19]

Proclus takes up the Population problem at *in Timaeum* III 130.25. It is worth quoting the passage at length:

> Since Aristotle inquired into the cause through which the sphere of the fixed stars has comprehended many stars, though there is only one such sphere, while the planetary spheres which are multiple each have but one [body in them], it is possible to understand the things that he resolved on this question from his [written works]. However, we have already foreshadowed something on this subject (58.11, 118.9; 129.9) and now, writing what comports with what was said before, we shall say that each of the planetary spheres is a whole cosmos which includes many kinds of gods that are invisible to us, but in all these cases the visible star has a commanding [status]. The fixed stars are different from those in the planetary spheres in this respect: while the former have a single monad – the wholeness [sc. the sphere] that belongs to them – in the latter case, where there are invisible [satellites] that revolve on their own spheres in conjunction with each of the planets, there are two [monads]: the wholeness and also a transcendent authority that has been allocated to those that are included [within that wholeness or sphere]. After all, since they are secondary to the fixed stars, they needed twice as much care (*epistasia*) – one a more universal [sort], the other more particular. (*in Tim*. III 130.25–131.10)

This is Aristotle's strategy of equalizing the superiority of the sphere of the fixed stars by providing proportionality. But the strategy is implemented not by multiplying *spheres*, but by multiplying the *inhabitants* in the spheres. Each planet has a plurality of invisible satellites that dwell along with it. It is not the case that there is a sharp and ill-proportioned drop in population between the astral sphere and Saturn. Rather, it is just that we cannot *see* all the living beings up there with Saturn.

The theme of universal governance that we observed in Proclus' response to the Motion problem appears here too. In this passage Proclus equates the unparticipated monads that stand at the head of every series and the wholeness-prior-to-parts with the celestial spheres.[20] These monads are treated as exercising authority over the contents of the sphere. The sphere of the fixed stars is like a monarchy where the citizens are sufficiently good as to require only one ruler. Each planetary sphere, however, has both an Augustus and a

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19 It has long been recognized that Proclus manages to say something about the existence of planetary satellites (or moons) that is in fact true – albeit on the basis of bizarre, *a priori* reasons. Most recently see Siorvanes (1996), 269–71 and his notes on p. 312 for earlier references. However, I do not think anyone has yet drawn the connection with the relevant passage in Aristotle's *De Caelo*.
20 Cf. *Elements of Theology*, props. 100 and 69.

Caesar – the sphere itself and the visible planet. The citizens of these spheres are planetary satellites that are invisible to us.

Proclus' most explicit argument for the existence of these invisible denizens of the planetary spheres appeals to just the sort of natural proportionality that lies behind Aristotle's solution to the Population problem.

> One could also construct an argument from the extreme [terms for the conclusion] that there is a plurality in each of them [sc. the spheres] that is coordinate with that sphere; for if the sphere of the fixed stars has a plurality that is coordinate with it and if the Earth [has a plurality] of *terrestrial* living beings, as the former sphere [of the fixed stars has a plurality] of *celestial* [living beings], then it is necessary for each wholeness [i.e. each sphere] to have some sort of living beings that are coordinate with it, through which it is said to be a wholeness. Though the intermediate [cases] escape our sense perception, the [existence of the living beings] at the extremes is obvious – at one extreme [sc. the fixed stars] it is clear due to the outstanding brightness [of the celestial living beings], while at the other extreme [the existence of living things coordinate with the sphere in question] is clear due to the fact that [the terrestrial living beings] belong to the same kind as us. (*in Tim.* III 131.10–18)

In this passage, Proclus reasons ἀπὸ τῶν ἄκρων – that is, from the end terms of the natural *analogia* that binds the center of the cosmos to its outer limit. We do not know what relation he supposes to obtain between the number of terrestrial living beings (t) and the stars in the heavens (m). It may be the case that there are more stars than terrestrial living beings, or fewer. But it seems clear that whatever the relative values of t and m, the proportion m : 1 :: 1 :: t is somehow not right. We need more than one inhabitant in each of the planetary spheres to ensure proper *analogia*.[21] Hence we should posit the existence of invisible planetary satellites.

This argument is followed – as is often the case with Proclus – by an appeal to the harmony of Plato's *Timaeus* and the wisdom of the 'Theologians'.

> In addition, if particular souls have been 'sown' (*Tim.* 41e4) round about them – some around the Sun, others around the Moon, others around each of the remaining [planets] – and if even prior to this there are *daimones* that fill up the 'herds' (*Pol.* 271d) of which they are the leaders, then it is clear that it has been well said that *each of the spheres is a cosmos*. And the Theologians teach us these things too when they say about each one that, prior to the *daimones*, there are gods in them, with different gods [for different ones] depending upon the leadership role they play ***[22] for instance, concerning our

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21 In this context it is important to remember *Timaeus* 32b–c where the Demiurge must utilize four elements to effect a geometric proportion that binds the three-dimensional solids of fire and Earth through the two intermediates of air and water. Proclus takes binding by proportion to be a universal principle; cf. *in Tim.* II 18.20 ff.
22 Diehl marks a lacuna here.

sovereign mistress, the Moon, they say that there are some specific goddesses in her – a Hecate and an Artemis. And concerning the King, Helios [the Sun], and the gods up there, the Theologians celebrate the higher Dionysius as:

> Associate of Helios, gazing upon the holy, celestial pole (*Or. Chald.* *226; *Orph. fr.* 188)

They praise the higher Zeus, the higher Osiris, and the solar Pan [and] the other gods which fill the books of the Theologians and the Theurgists. From all this it is clear how it can be true to say that each of the planets is a *captain* of the many gods that fill up the specific orbit that belongs to him or her. Therefore we resolve these issues in this way. (*in Tim.* III 131.18–132.5)

Proclus supposes that it clinches any line of independent argument if you can show that it culminates in a conclusion that is consonant with Plato and the tradition of the Oracles and/or (what he regards as) the Orphic texts. But these texts are themselves very plastic. The italicized portions identify what seem to me to be the themes that Proclus regards as really central.

The first of these themes is that of a universal continuity that proceeds through proportion. The heavens are not radically different from the regions down here. They contain the same four elements, albeit in their purest forms.[23] Consonant with this idea of universal continuity, Proclus is very fond of the idea of extra-terrestrial living beings – not only the familiar divine living beings that we identify as stars and planets, but other life-forms as well. It appears that souls will inhabit bodies associated with the various planets for periods of time in their descent into the sub-lunary (*in Tim*. I 147.28–148.16). Unsurprisingly then, he endorses the (putatively) Orphic idea of cities on the moon (II 48.19– 21 = *Orph. fr.* 91). And the life-forms up there may not only be human ones, but others as well (III 280.22–28)!

This sounds barking mad, of course, but it is simply an application of one of the most central principles of Iamblichean Platonism: all things are in all, though in the manner appropriate to each subject.[24] This principle stands behind the reasoning ἀπὸ τῶν ἄκρων that has been invoked above. We can see the living creatures that exist in the terrestrial mode. We can also see living creatures that exist in the astral mode (the stars). The principle πάντα ἐν πᾶσιν, οἰκείως δὲ ἐν ἑκάστῳ means that there *must be* living beings in the intervening planetary regions as well. Since we can't see them, it must be that what is οἰκείως δὲ ἐν ἑκάστῳ in these cases is for them to be invisible.

The second theme is the perspective of universal teleological governance. Proclus distinguishes the fixed stars from the planets and the planets from the sub-lunary region on the basis of the number of rulers that are necessary. For

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23 Cf. Baltzly (2002).

24 Two prominent examples, though there are many more: *ET* prop. 103 and *in Tim*. I 8.16.

the fixed stars, one will suffice. For each planetary sphere, we have both an Augustus and a Caesar, as it were. Here in the sub-lunary region, we have many, many levels of governance. The passage in which he foreshadowed the introduction of the invisible satellite creatures makes this analogy with governance here very clear:

> In the case of the latter [i.e. the spheres of the planets] what does the leading is twofold. There is the sphere and then there is each of the Rulers of Cosmos – a monad that has been rendered coordinate with plurality – for things that are inferior require a plurality of rulers and the multitude in each [of the planetary spheres] is invisible due to their inferiority. Among the things in the sub-lunary realm the ruling orders of the divine genera corresponding to each element are even greater in number, as we will learn through the generation of the gods that we will be provided with. (*in Tim.* III 58.16–23)

The general rule is that we get increasing plurality of governors, corresponding to the increasingly unruly nature of the beings that are governed. Once we arrive at the sub-lunary region all hell breaks loose, so to speak. As inferior as things are down here, we will need many more rulers than were needed in the case of the planetary spheres. These will be the sub-lunary or generation-producing gods, who are identified with daemons in Proclus' interpretation of *Timaeus* 40d6–7. This is the account of the generation of the gods that he refers to in the final line in this passage.

5 Conclusion

We began by noting the Aristotelian presuppositions that underlie the Motion problem and the Population problem. These included the idea that the universe has an *axiological geography* so that things get better the closer that one approaches to the sphere of the fixed stars. Moreover, there was the presupposition that *simple* circular motion – without the complex back-tracking of planetary motion – was *better*. Finally, there was the idea that there should be some sort of *proportionality* in nature.

We have seen that our Neoplatonist authors, and Proclus in particular, provide an answer to the Population problem. The Aristotelian presupposition that allows one to see the Population problem as a problem is *proportionality*. This presupposition plays a major role in Neoplatonic metaphysics, so it is unsurprising that this Aristotelian *aporia* is deemed worthy of a solution.[25]

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0 The notion of proportionality is *so* pervasive in Proclus' exposition of Plato's *Timaeus* that it is invoked not only to explain what holds the cosmos together, but even the order of exposition

The Motion problem is subtly redefined. Looking at planetary motion from the point of view of a conjunction between *axiological geography* and *simplicity* ignores the more fundamental perspective of *universal teleology*. The Neoplatonists do agree that things are better at the limit of the universe. This is because the sphere of the fixed stars is such as to include the others and what is inclusive is superior to that which gets included.[26] In the case at hand, this superiority is revealed in the fact that the stars that dwell in this sphere need only a single ruler. The subsequent multiplication of rulers is proportional to the inferiority of the inhabitants who are governed. So there is a sense in which Proclus adheres to something like the axiological geography assumption.

The Neoplatonists also agree that, *ceteris paribus*, simplicity is superior to complexity. The difference is that determining what counts as simple is itself not a simple matter! We should actually mistrust our initial, perceptual judgments about what is simple and what is complex. Judgments about simplicity should in fact be made from the perspective of universal teleology. A simple motion is one that is *just what it needs to be* in order to play its role in harmonizing the cosmos and rendering it maximally good. Viewed in terms of their roles in harmonizing the cosmos, the voluntary motions of the 'wandering stars' are just what they need to be. The perspective of universal teleology makes the Motion problem disappear. The Population problem remains, however, because it conflicts with the presupposition, made explicit in *Timaeus* 32c, that nature is bond together and unified by *analogia*. Each of these subtle adjustments to the

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in Plato's dialogue. Thus Proclus argues that Plato discusses the planets first, then the fixed stars and then the Earth. This order is determined by an *analogia* in Plato's text that mirrors the *analogia* in nature. He writes:

> Moreover, he has made the power of proportion manifest through the order in which [he has gone about his] task since he undertakes the account of the planets first, and then in the middle, while giving that which deals with the Earth prior to the account of the other sub-lunary daimones. [This illustrates the power of proportion] for in this manner the extreme terms also become the first and the middle, while on the other hand the middle terms are substituted into the position of the extreme terms themselves. But 'by nature this [bonding] is best accomplished by proportion' (*Tim.* 31c3–4). (*in Tim.* III 134.20–27)

Proclus seems to suppose that the order of presentation somehow mimics the geometric proportion that is discussed at *Timaeus* 31c–32a. So, for instance, 2, 4, 8 is a geometrical progression since 2 : 4 :: 4 : 8. The middle terms can become the extremes since 4 : 2 :: 8 : 4. It appears that Proclus supposes that Plato's order of presentation somehow mimics the transposition of terms permitted with geometric proportions, but the exact details are unclear

1 Cf. *in Tim.* III 46.20 and 52.25. Such a view is consonant with Proclus' view about the ontological priority of wholes over the parts that they include.

presuppositions that generate Aristotle's puzzles is pregnant with possibilities for the future of natural science.

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