

*Positioning Heaven:
The Infidelity of a Faithful Aristotelian*

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ABSTRACT

Aristotle's account of place in terms of an innermost limit of a containing body was to generate serious discussion and controversy among Aristotle's later commentators, especially when it was applied to the cosmos as a whole. The problem was that since there is nothing outside of the cosmos that could contain it, the cosmos apparently could not have a place according to Aristotle's definition; however, if the cosmos does not have a place, then it is not clear that it could move, but it was thought to move, namely, in its daily revolution, which was viewed as a kind of natural locomotion and so required the cosmos to have a place. The study briefly outlines Aristotle's account of place and then considers its fate, particularly with respect to the cosmos and its motion, at the hands of later commentators. To this end, it begins with Theophrastus' puzzles concerning Aristotle's account of place, and how later Greek commentators, such as Alexander of Aphrodisias, Themistius and others, attempted to address these problems in what can only be described as *ad hoc* ways. It then considers Philoponus' exploitation of these problems as a means to replace Aristotle's account of place with his own account of place understood in terms of extension. The study concludes with the Arabic Neoplatonizing Aristotelian Avicenna and his novel introduction of a new category of motion, namely, motion in the category of position. Briefly, Avicenna denies that the cosmos has a place, and so claims that it moves not with respect to place, but with respect to position.

Does it make sense to ask whether the cosmos as a whole has a place? If it does, then how should one understand this 'place' in which the cosmos is located? It would certainly seem odd to think that the cosmos is tucked away in some extra-cosmic absolute space, like a hat in a hatbox. Again, does it make sense to ask whether the cosmos as a whole could move? If it does, then how should one classify the motion of the whole cosmos? Again, it would seem odd to think that the cosmos, as a whole, could be shifted rectilinearly, say, one foot. Questions such as these are still being asked by contemporary philosophers and scientists, and were of no less interest to their ancient and medieval counterparts. This paper treats first how these issues were raised and addressed in the classical world – first by Aristotle and then his Greek commentators – and second how one of the immediate heirs and benefactors of the classical philosophical

tradition, the Arabic Neoplatonizing Aristotelian Avicenna, received, reconsidered and then responded to them.

Like so many of the philosophical and scientific issues debated in the ancient and medieval world, the above questions originated in Aristotle, and specifically in his account of place, and were then further clarified, developed and even challenged by Aristotle's later Greek commentators. It is this larger Aristotelian tradition to which philosophers and scientists working in the Arabic world were heir, and it is only with an eye to the evolution of the notion of place among Aristotle's Greek commentators that one can appreciate many of the breakthroughs and novel suggestions offered by later thinkers. In the following I cannot hope to do justice to the whole history surrounding the concept of place within the Aristotelian tradition; rather, I concentrate on a cluster of problems that emerge if one follows Aristotle and identifies place with the innermost limit of a containing body.¹ Specifically, I focus on the following questions: (1) whether, given Aristotle's definition of place, the heavens as a whole can have a place; (2) if they do not have a place, then can they be said to move; and (3) if so, in what sense can they be said to move?

To this end, I begin with a brief historical summary of Aristotle's account of place and the problem that the heavens and their motion posed for Aristotle and his later commentators. I then turn specifically to the criticism of Aristotle's view by Philoponus. Philoponus complained that if the heavens have a place, then Aristotle's account of place fails, whereas if they do not have a place, then one cannot explain their apparent motion. This historical background provides the context for understanding Avicenna's own analysis of circular motion, his introduction of a new kind or genus of motion, namely, motion with respect to the category of position, and finally his resolution of Philoponus' criticism. Avicenna's simple solution is that the heavens in fact do *not* have a place and so do not move with respect to the category of place; rather, they move with respect to the category of position. The study ends with the implications of Avicenna's simple idea and certain ramifications for other aspects of Aristotle's natural philosophy.

1. *Place as the Innermost Limit of a Containing Body: Aristotle*

Aristotle considered place to be one of the necessary conditions for motion. In book IV of his *Physics*, he began by surveying a number of

¹ *Physics* IV 4, 212a2-6.

puzzles associated with place, the common opinions held concerning place, and the various senses in which one thing can be said to be ‘in’ (ἐν) another. His own positive account of the nature of place begins by identifying four criteria that a philosophically and scientifically adequate account of place must meet. These are

- (1) the place of a physical body must be the first thing that surrounds that body and is distinct from the body occupying it;
- (2) the place must be neither greater nor less than the body occupying it;
- (3) place must be something separable from the body occupying it, that is to say, when a body undergoes local motion, it must move from one place to a different place;
- (4) place must possess the attributes of ‘up’ and ‘down’, and a body should naturally move to and remain in its proper or ‘natural’ place.²

Aristotle, next, suggested four candidates for place: either it is a body’s (1) matter, (2) shape or form (μορφή), (3) a certain extension between the extremities (διάστημα τι τὸ μεταξύ τῶν ἐσχάτων) or (4) the innermost, motionless limit of a containing body (τὸ τοῦ περιέχοντος πέρας ἀκίνητον πρῶτον).³ In fact, at *Physics* IV 6, Aristotle added a fifth candidate,

² *Physics* IV 4, 210b34-211a6. Some commentators find six criteria for my four. This difference in numbering is due to the fact that these commentators take the conjunctive καί in (1) and (4) to be functioning as a disjunctive particle, whereas I take it to be coordinating two related ideas, not separate criteria. For six criteria see W. D. Ross, *Aristotle’s Physics, A Revised Text with Introduction and Commentary* (Oxford: Clarendon Press, 1936), 374 and E. Hussey, *Aristotle’s Physics, Books III and IV* (Oxford: Clarendon Press, 1983), 26 and 111-112. For four criteria see H. G. Apostle, *Aristotle’s Physics* (Grinnel, IA: The Peripatetic Press, 1969), 64 and 243 and H. Lang, *The Order of Nature in Aristotle’s Physics: Place and the Elements* (Cambridge, UK: Cambridge University Press, 1998), 78-85.

³ *Physics* IV 4, 211b5-9 and 212a20. Since Aristotle would argue for his preferred candidate for place by disjunction, if his argument is to be sound, these four must exhaust all possible ways that place can be understood. Unfortunately, Aristotle provided no such justification, although perhaps one may be offered. Assume that a thing’s place must be either what limits the thing or what is limited, where these two might, then, be thought of as mutually exclusive and so exhaustive. Further, assume that what limits or is limited must either belong to the thing itself or not, where ‘belonging to the thing itself or not’ again are exhaustive. If one couples these two pairs, then a thing’s place would be either (1) what is limited and belongs to the thing itself, namely, its matter; (2) what limits and belongs to the thing itself, namely, its shape; (3) what is limited and does not belong to the thing itself, namely, a certain extension

namely, void (κενόν). Although Aristotle was not explicit, it appears that the difference between (3), extension, and void is a difference between relative extension and absolute extension. By 'relative extension' I mean an extension that is never considered independent of a body that occupies it; in other words, it is the internal dimensions of an object or simply the space associated with being a three-dimensional object. By 'absolute extension' I mean an extension that can exist and be considered independently of any body that might occupy it; indeed in itself it is simply space absent of any body and as such is not related to any body. In contemporary terms one might understand absolute extension as akin to an independently existing Cartesian coordinate system with three axes in which the set of coordinates occupied by an object indicates that object's place. Thus in the final analysis Aristotle offered up five possible candidates as accounts of place: (1) matter, (2) form or shape, (3a) relative extension, (3b) absolute extension or void and (4) the innermost motionless limit of a containing body.

In a relatively quick fashion, the details of which are not important for our purposes, Aristotle eliminates the first three candidates; for in one way or another they fail to meet one or more of the criteria for place. Aristotle's critique of the void is lengthier and covers chapters IV 6-9 of the *Physics*. The reason for his detailed treatment of the void, it seems, is that the notion of an empty, absolute extension that bodies come to occupy is truly what one has in mind when one claims that a thing's place is the extension it occupies. Moreover, the proponents of void had argued that void, understood as an extension deprived of body,⁴ is a necessary condition if there is to be motion. In some of Aristotle's most technical and sophisticated argumentation, he turned the tables on the advocates of void and argued that far from permitting motion, the existence of the void would in fact absolutely preclude the possibility of motion. Again, it is beyond the scope of this paper to give detailed analyses of Aristotle's

between the extremities; or (4) what limits and does not belong to the thing itself, namely, a limit of a containing body. Given the initial two sets of contraries, namely, 'what limits or what is limited' and 'what belongs to the things itself or does not', Aristotle's list would exhaust all possible couplings. I do not insist on this suggestion, but it would explain why Aristotle hit upon the four candidates that he did and why he thought the list was exhaustive. Benjamin Morison offers a slightly different justification of Aristotle's four candidates, which would likewise work (*On Location: Aristotle's Concept of Place* (Oxford, UK: Clarendon Press, 2002), 104-105).

⁴ *Physics* IV 7, 214a16-20.

arguments against the void. Suffice it to say that Aristotle found the notion of a void philosophically and scientifically wanting.

Given that all other accounts of place were in some way or other inadequate, Aristotle concluded by disjunction that the proper account of place must be the first or innermost motionless limit of that which contains.

*2. Problems Concerning the Place of the Heavens and Their Motion:
Early Greek Commentators*

Almost from its inception, Aristotle's account of place as the innermost, motionless limit of a containing body was called into question. Theophrastus, Aristotle's immediate successor at the Lyceum, collected five puzzles or problems (*aporiai*) associated with Aristotle's preferred candidate for place:⁵

- (1) A body will be in a surface;
- (2) place will be in motion;
- (3) not every body will be in a place, for example, the sphere of the fixed stars will not be in a place;
- (4) if the spheres are taken together, the heavens as a whole will also not be in a place;
- (5) things in a place will no longer be in a place if their surroundings are removed, even though they themselves have not changed in any way.

The third and fourth points would take on a particular urgency in the later Aristotelian tradition. For certain Neoplatonists, most notably John Philoponus, took Aristotle's apparent inability to account for the place of the heavens and their motion in terms of an innermost containing limit as sufficiently damning to reject Aristotle's preferred account of place.⁶

Aristotle anticipated some of these objections and gestured at answers at *Physics* IV 5, which is a miscellany of comments and clarifications concerning his preferred account of place. At 212b7-22 Aristotle addressed

⁵ *Apud* Simplicius, *In Aristotelis Physicorum libros quattuor priores commentary*, ed. H. Diels, *Commentaria in Aristotelem Graeca*, vol. IX (Berlin: George Reimer, 1882), 604, 5-11.

⁶ A detailed summary and analysis of Theophrastus' puzzles and the problems they pose for Aristotle's account of place can be found in R. Sorabji, *Matter, Space, and Motion: Theories in Antiquity and their Sequel* (Ithaca, NY: Cornell University Press, 1988), 192-201, esp. 193-196 for our purposes. For an alternative reading of Theophrastus' puzzles see K. Algra, *Concepts of Space in Greek Thought* (Leiden: E. J. Brill, 1995), 231-248.

issues concerning the heavens and their motion. Of themselves (καθ' αὐτό), Aristotle argued, the heavens do not have a place; for there is no body outside of them to contain them. Accidentally, though, they do have, in a way, a place; for each part of the celestial sphere contains another.⁷ The suggestion is that because the outermost celestial sphere can be divided into parts, at least conceptually, the various adjacent parts in a sense contain any given part and so as it were provide its place. Since Aristotle was insistent that whatever moves must have a place, presumably the accidental places of the parts of the outermost celestial sphere play the requisite role in order to account for the heavens' motion.

Aristotle's comments concerning the role of place with respect to the heavens and their motion are brief, and one cannot help but feel that Aristotle's account is at best *ad hoc*. First, in virtually the whole of Aristotle's discussion concerning place there is a 'vertical ordering' of the situated object and its place. For example, if we can idealize Aristotle's cosmos, the sphere of water provides the place for earth; in turn the sphere of air provides the place for water and so on for the rest of the elements. The same vertical ordering would apparently hold with respect to the planets, with the sphere of any immediately higher planet providing the place for the planet immediately below it. When one comes to the outermost sphere of the fixed stars, however, Aristotle dropped the vertical ordering – as he must if his account of place is to be correct – and adopted a 'horizontal ordering', that is, it is now whatever is immediately adjacent that provides the place of the thing, not what is above. Yet there is no reason to adopt this horizontal ordering except as a makeshift means to avoid the conclusion that the heavens, according to Aristotle's account of place, cannot have a place and so should not be able to undergo motion with respect to place.

Benjamin Morison in a recent study of Aristotle's account of place notes that Aristotle distinguishes between having a place and being somewhere.⁸ Thus, for Aristotle although the cosmos as a whole *has no place*, it nonetheless *is somewhere*. Being somewhere (ποῦ), that is to say, being related to the category ποῦ, then, might let someone say that the cosmos is moving with respect to the category of 'where' (ποῦ) even though it does not technically have a place. Although Morison himself does not suggest as much, Eudemus of Rhodes, one of Aristotle's earliest commentators,

⁷ τὰ γὰρ μέρη ἐν τόπῳ πως πάντα· ἐπὶ τῷ κύκλῳ γὰρ περιέχει ἄλλο ἄλλο (212b12-13).

⁸ B. Morison, *On Location*, 97-102, esp. 99.

seems to have done so. One finds in one of the few extant passages from him, which is purported to be a verbatim quotation, the following account:

For what moves is a vessel, and it is on account of this that we make reference to the heavens concerning places, since they do not change to another place, except with respect to [their] parts; for rotation is in the same place. We should consider whether the [heavens] themselves are in a place or not, and in either case, how; for they are not in a place as a whole, unless there is something outside, in which case they would be contained. The stars and everything within the outermost body are within [the outermost body's] limit insofar as it is what surrounds. In this way [the stars and everything within the outermost body] are said to be in a place, but we also say that the whole is in that in which the parts are. Thus in this way [the outermost body] might be in a place. In another way it is also somewhere; for the whole is in the parts, and 'somewhere' [is said] in many ways.⁹

Although this suggestion sheds some light on how the outermost celestial sphere might be said to be somewhere, even though it has no place, namely, as the whole of the outermost celestial sphere is *in* its parts, this sense of 'being somewhere' still leaves the problem of the locomotion of physical bodies, and particularly the problem of the rotation of the outermost celestial sphere, in the dark. More exactly the question concerns in what physically meaningful sense one can say that the whole of the outermost celestial sphere is changing on this understanding of 'being somewhere'?¹⁰ The parts do not change vis-à-vis one another nor does the whole change vis-à-vis the parts, and yet the outermost celestial sphere is undergoing change inasmuch as it is rotating. As an explanation of how the outermost celestial sphere undergoes motion Aristotle's distinction between having a place and being somewhere and Eudemos' subsequent development based upon this distinction seem fruitless.

This question concerning Aristotle's account of place and its relation to the heavens and their motion exercised a number of Aristotle's later Greek commentators as well. For instance, Simplicius related that the Neoplatonist, Maximus of Ephesus, had attempted to give a reconstruction of Aristotle's own solution. Thus, argued Maximus, since the outermost sphere, it was believed, moves to the left,¹¹ and right and left are differences of place, the parts will have a place, namely, to the right or left of

⁹ *Apud* Simplicius, *In Phys.* 595, 6-15.

¹⁰ Algra suggests this line of criticism in *Concepts of Space in Greek Thought*, 257.

¹¹ Cf. Aristotle, *De caelo* II 2, 285b28. Also see G. E. R. Lloyd, "Right and Left in Greek Philosophy," in *Methods and Problems in Greek Science, Selected Papers*

one another.¹² Maximus' novel suggestion is likewise, however, *ad hoc*, inasmuch as he must appeal to a horizontal ordering rather than a vertical ordering to account for the place of the heavens. Moreover, as Philoponus would complain, this suggestion does not really account for the heavens' motion.¹³ Inasmuch as the relative ordering of the heavens' parts in terms of right and left never changes during the heavens' revolution, whereas local motion necessarily involves a change of place, one cannot account for the apparent local motion of the heavens in terms of right and left.

Another suggestion was that of Themistius, who maintained that the sphere of Saturn could, in a sense, provide the place for the outermost celestial sphere, not, however, by being outside and containing it, but by being inside and touching it. "Neither all the parts [of the heavens] nor the outermost sphere are in place – for all are not contained; nevertheless, they would be in place at the inside – for they are touched by Saturn and in a way, that is to say, contained by it – whereas, at the outside they wholly lack a place."¹⁴ Although this suggestion preserves the vertical ordering of places, it too is clearly *ad hoc*; for, as Philoponus would later note, this suggestion flies in the face of Aristotle's claim that a thing's place is outside and contains the situated thing.¹⁵ Furthermore, we might add, inasmuch as Aristotle's canonical account of place made place a *motionless* limit, whereas the sphere of Saturn is moving, the sphere of Saturn again would fail to meet the requirements for the outermost sphere's place.

Alexander of Aphrodisias offered yet another suggestion, one that would be influential on Avicenna's own resolution of the problem. Although Alexander's commentary on the *Physics* is no longer extant, his answer to this problem is preserved in Simplicius' commentary. Alexander, Simplicius related, had argued that the heavens do not undergo

(Cambridge, UK: Cambridge University Press, 1991), 27-48; and B. Morison, *On Location*, 41-46.

¹² *Apud* Simplicius, *In Phys.*, 592, 6-10.

¹³ Philoponus, *In Physicorum octo libros commentaria*, ed. H. Vitelli, *Commentaria in Aristotelem Graeca*, vols. XVI and XVII (Berlin: George Reimer, 1888), 566, 17-31.

¹⁴ Οὐ πάντα δὲ ἐν τόπῳ τὰ μόρια (οὐδὲ γὰρ ἅπαντα περιέχεται), οὐδὲ ἡ ἕξω σφαῖρα, ἀλλ' αὐτὴ κατὰ μὲν τὸ ἐντὸς εἴη ἂν ἐν τόπῳ (ἀπτεται γὰρ τῆς τοῦ Κρόνου καὶ οἶον περιέχεταιί πως), κατὰ δὲ τὸ ἕξω παντελῶς ἀμοιροῖ τόπου (Themistius, *In Aristotelis Physica paraphrasis*, ed. H. Schenkl, *Commentaria in Aristotelem Graeca*, vol. V, pars. 2 (Berlin: George Reimer, 1900), 121, 1-4).

¹⁵ Philoponus, *In Phys.* 565, 21-566, 7.

locomotion, but revolution, and that revolving is distinct from locomotion.¹⁶ Although this argument is essentially the one that Avicenna will subsequently develop and put forward as the correct account of the heavens' motion, at least in the form that Simplicius characterized Alexander's argument, it too is *ad hoc*. As Simplicius complained against Alexander, the canonical enumeration of the types of change, taken from Aristotle himself, are change with respect to the categories of substance, quantity, quality and place. Since rotational motion does not belong to the category of substance, quantity or quality, the only type of motion it could be is motion with respect to the category of place. Simplicius then referred the reader to Aristotle's *De Caelo* and maintained that there Aristotle had held that rectilinear and circular motion are two species of motion falling under the genus locomotion.¹⁷ In fact, Alexander himself in his commentary on *Metaphysics* V 14 implied that there are only three kinds of motion: namely, alteration, that is, motion with respect to quality; growth/diminution, that is, motion with respect to quantity; and local motion, that is, motion with respect to place.¹⁸ In short, if, as Alexander suggested, rotation or revolution is generically different from locomotion, some justification for this novel claim should be provided and yet none is forthcoming, at least not from what we know of Alexander.

3. *The Rejection of Aristotle's Account of Place: Philoponus*

In stark contrast with Aristotle and many of Aristotle's earlier commentators the Neoplatonist John Philoponus argued that a thing's place is the extension that it occupies.¹⁹ Thus, he maintained that place properly and philosophically speaking is a finite, three-dimensional extension that though never devoid of body on its own, considered in itself is self-subsistent and so in theory could exist independent of body.²⁰ Philoponus'

¹⁶ *Apud* Simplicius, *In Phys.*, 595, 16-26.

¹⁷ Diels suggests that the passage in question might be *De Caelo* I 2, 268b17, but thinks the more likely locus is *Physics* VIII 8, 261b28.

¹⁸ Alexander of Aphrodisias, *In Aristotelis Metaphysicacommentaria*, ed. M. Hayduck, *Commentaria in Aristotelem Graeca*, vol. I (Berlin: George Reimer, 1891), V 14, 401, 9-10.

¹⁹ For a discussion of the theoretical motivation for Philoponus' account of place see D. Sedley, "Philoponus' Conception of Space" in *Philoponus and the Rejection of the Aristotelian Sciences*, ed. R. Sorabji (London: Gerald Duckworth & Co. Ltd., 1987), 140-153.

²⁰ Philoponus, *In Phys.* 578, 5-579, 18.

project, then, involved two stages: first, disarming Aristotle's arguments against extension's being place; and second, showing that Aristotle's preferred account of place, namely, the innermost motionless limit of a containing body, is itself philosophically and scientifically untenable. For our purposes we need only consider Philoponus' arguments concerned with the second facet of his project, namely, what he found objectionable about Aristotle's account of place.

Philoponus provided five arguments against Aristotle's definition of place, which can in turn be classified under two rubrics: (1) problems connected with place as a surface and (2) problems associated with the place of the heavens and their motion.²¹ Under the first rubric there are four arguments that involve ridiculing the suggestion that place is a surface (ἐπιφάνεια). It is important to note that Philoponus surreptitiously introduced the term 'surface' into his presentation of Aristotle's account. In fact, Aristotle himself only used this term once in his entire discussion of place, and even then only in his presentation of the *aporiai*.²² Nowhere that I can discern did Aristotle himself describe his preferred account of place in terms of 'surface'; rather, he describes it as an extremity (ἔσχατον) or limit (πέρας).²³ Given his careful avoidance of the term 'surface', it seems reasonable to conclude that whatever Aristotle might have meant by 'limit' and 'extremity', he did not mean surface and certainly not a two-dimensional, mathematical plane surface as Philoponus frequently described it.²⁴ Thus, in effect, four of Philoponus' criticisms are simply straw-man arguments.

The second category of argument, namely, the one involving the place of the heavens and their motion, is, by far, Philoponus' most protracted and developed argument, and by my lights his most compelling one.²⁵ Philoponus' version of the argument might be reconstructed in the form of a dilemma. It begins: either the outermost celestial sphere has a place or it does not. Consider the first horn: if the outermost celestial sphere has a place, then according to Aristotle's account of place, there must be

²¹ *Ibid.*, 563, 26-567, 29.

²² *Physics* IV, 1, 209a8.

²³ The one seeming exception is at *Physics* IV 4, 212a28, where Aristotle says that "on account of this [i.e., place's being an extremity] it seems to be a surface (καὶ διὰ τοῦτο δοκεῖ ἐπιπέδον)." There is no reason, however, to think that Aristotle is in fact endorsing the claim that place is a surface; rather, I suggest, he is merely explaining why some people might (erroneously) think that it is.

²⁴ For a careful analysis of what Aristotle does mean by a limit see H. Lang, *The Order of Nature in Aristotle's Physics*, 91-113.

²⁵ Philoponus, *In Phys.* 565, 1-567, 7.

something outside of the heavens that contains them; however, on the Aristotelian cosmological world view, the cosmos is finite. There is no extra-cosmic, void space 'beyond' our cosmos that contains the universe; there is absolutely *nothing* 'beyond' our cosmos that could contain the universe and be beyond it. Although there might be a temptation to consider 'nothing' in the claim 'nothing is beyond our cosmos' as meaning something like empty space or the like, both Aristotle and Philoponus would insist that one resist this temptation; 'nothing' in this claim is not a referring expression. Consequently, on both Aristotle's and Philoponus' view, there is no 'beyond' the universe and as such the universe is not something contained and so it has no innermost containing limit that could provide its place. In short, if the outermost celestial sphere has a place, then Aristotle's account of place must be wrong.

Now consider the second horn: if the outermost celestial sphere does not have a place, then *a fortiori* it cannot move with respect to place; however, on the ancient and medieval astronomical world view it was an empirical fact that the heavens do move, that is, the sphere of the fixed stars was assumed to undergo a diurnal motion, rotating around the earth roughly once every twenty-four hours. Thus, one can rightly ask, "What type of motion is the outermost celestial sphere undergoing?" As we have already noted in our discussion of Alexander's solution concerning the heavens' motion, for the ancient Greek commentators there were only three varieties of motion: motion with respect to the categories of quantity, quality and place. The division is Aristotle's, whose general argument for including these and only these types of motion is that there can only be motion between contraries, and only the categories of quantity, quality and place have contraries, for example, fat/thin, hot/cold and here/there. As far as I have been able to discern, this list represents the canonical enumeration of the kinds of motion accepted by Aristotle's Greek commentators; it certainly represents the only varieties that Aristotle explicitly acknowledged as well as the only ones that either Simplicius or Philoponus allowed. Consequently, for these commentators if there is a certain motion, then it must be classifiable into one of these three types of motion. The problem is that the outermost celestial sphere's diurnal motion is neither a quantitative nor qualitative motion. Thus given the canonical enumeration of the varieties of motion, it has to be a motion with respect to place, but we are assuming that the outermost celestial sphere does not have a place, and so we have arrived at a contradiction. In short, then, if the outermost celestial sphere were not to have a place, then it could not move with respect to place, but it was thought that it

did. Whichever option one chooses – whether the outermost celestial sphere has or does not have a place – leads to either contradiction or irreconcilable differences with other elements of Aristotle’s philosophy. For Philoponus the most economical response to this dilemma was simply to jettison Aristotle’s account of place and replace it with a finite, three-dimensional void space.

4. *Rotation and a New Enumeration of the Kinds of Motion: Avicenna*

Avicenna had access to a paraphrastic Arabic translation of Themistius’, Alexander’s and Philoponus’ *Physics* commentaries and so was aware of the classical debate within the Greek Aristotelian tradition surrounding the subject of place.²⁶ In marked opposition to Philoponus, Avicenna sided with the original Aristotelian position that place is the innermost limit of a containing body. Moreover, in contrast with earlier Greek attempts to deal with the problems that the heavens posed for Aristotle’s account of place, which we have seen were *ad hoc*, Avicenna desired to provide a response that was well integrated into his overall account of physics, and so would proceed as a natural outgrowth of what had preceded. The challenge before Avicenna, then, was to provide a response to Philoponus’ dilemma, while simultaneously upholding the position that place is the innermost limit of a containing body.

One of the first places where Avicenna discussed the motion of the heavens comes at II.1 of his *Physics*, where he treated the essence of motion. A *terminus a quo* (*mā minhū*) and a *terminus ad quem* (*mā ilayhī*), Avicenna maintained following Aristotle, are among the things to which motion is necessarily related; for these two termini function as the contraries between which there is motion.²⁷ The *terminus a quo* is the initial state of actuality with respect to some accident that changes in the moving object. The *terminus ad quem* is the final state of actuality that is realized at the completion of the motion. For example, if a ball is to move

²⁶ Neither the Arabic translations of Themistius’ nor Alexander’s *Physics* commentaries are extant. Fortunately, Philoponus’ commentary is; see *Aristuṭālīs, at-Ṭabī‘ī*, ed. ‘A. Badawī, 2 vols. (Cairo: The General Egyptian Book Organization, 1964/65). P. Lettinck has provided an analysis of this edition of the *Physics* as well as providing correspondences between the Arabic passages ascribed to Yahyā (John) and Philoponus’ original Greek; see P. Lettinck, *Aristotle’s Physics and Its Reception in the Arabic World* (Leiden: E. J. Brill, 1994).

²⁷ Avicenna, *Shifā’, at-Ṭabī‘iyāt*, ed. S. Zayed (Cairo: The General Egyptian Book Organization, 1983), II.1, 87.5; henceforth *Ṭabī‘iyāt*.

from some spot x to a different spot y , x is its initial state of actuality, or its *terminus a quo*, and y is its final state of actuality, or its *terminus ad quem*.

An apparent problem arises, however, if one makes the *termini a quo* and *ad quem* necessarily related to motion; for it would seem to preclude the continual motion of the heavens, especially if one believes, as Avicenna did, that this motion was eternal both *ante parte* and *post parte*. The heavens simply are never actualized at some initial *terminus a quo* from which they begin to move, nor do they ever come to some *terminus ad quem* at which they realize their final state of actuality. If having these two termini is a necessary condition for motion, and again Avicenna said that they are, then the heavens could not move, certainly not eternally at any rate, as Avicenna himself believed along with the majority of philosophers working within the Aristotelian tradition.

To appreciate fully Avicenna's response to this difficulty, we must briefly consider some earlier comments that he made about the essence of motion. Avicenna had defined motion, following Aristotle, as an actuality of potential insofar as there is potential. He likewise followed certain later Greek commentators in distinguishing between a first and second actuality (Gr. *entelekheia*, Arb. *fīl wa-kamāl*).²⁸ Roughly, 'actuality' in Aristotle's definition of motion could, according to these ancient commentators, refer either (1) to the intermediate state or states of the motion considered from its initial beginning point to its final ending point, and as such is the 'first actuality of the motion'; or (2) to the end of the process at which the moving object ultimately realizes its final actuality and perfection, and as such is the 'second actuality of the motion'.²⁹ Unlike some of Aristotle's Greek commentators, Avicenna denied that 'first actuality' referred to the traversal or procession across the intermediate interval; rather, for him it referred to an object's actually being at one of the various intermediate locations or states between the *termini a quo* and *ad quem*, while not actually being at rest at those intermediate locations or states.³⁰

²⁸ *Ibid.*, II.1, 82.7-83.5. For a detailed discussion of this distinction both among Aristotle's Greek commentators and Avicenna see R. Wisnovsky, *Avicenna's Metaphysics in Context* (Ithaca, NY: Cornell University Press, 2003).

²⁹ See Themistius, *In Phys.*, 206, 22f.; Philoponus, *In Phys.*, 351, 1-15; and Simplicius, *In Phys.*, 415, 2-24.

³⁰ *Ṭabī'iyāt* II.1, 84.9-19. For an analysis of Avicenna's view that there can be motion at an instant see A. Hasnawi, "La définition du mouvement dans la *Physique* du *Šifā'* d'Avicenna" in *Arabic Sciences and Philosophy* 11 (2001): 219-255, and J. McGinnis, "On the Moment of Substantial Change: A Vexed Question in the History

He returned to this distinction in his response to the problem concerning the heaven's motion and their requiring a *terminus a quo* and *ad quem*, but here he used it to draw a correlative distinction between two types of potency: 'potency proximate to act' and 'potency remote from act'.³¹ The proximate potency of a moving object during its motion is any intermediate location over which the mobile passes at which one can posit the mobile's actually being there, but only for an instant and so it is not at rest at that location. In short, it is the potentiality that is actualized by the motion's first actuality. In contrast, the remote potency of a mobile is that final point at which the mobile actually comes to rest and so is the potentiality that is actualized by the motion's second actuality. For example, in a ball's continual motion over a distance *xyz*, a proximate potency is actualized when the ball passes over *y*, whereas its remote potency is actualized only when it comes to rest at *z*. In this case, *y* is not some point in the motion where the ball actually comes to rest; rather, the ball is simply posited as having actually passed over *y* at some hypothesized instant during the motion.

In certain motions, Avicenna continued, the *termini a quo* and *ad quem* can be one and the same positions, albeit they are not simultaneously *termini a quo* and *ad quem*, but only so at two distinct instants. Clearly, the motion he had in mind is circular motion or rotation. Thus, if one now imagines that the ball rotates in the same place instead of rolling across a distance, a complete rotation occurs when some posited point on the ball returns to the position where it began. Furthermore, if one imagines that the ball makes several rotations, some point on the ball returns to its initial position several times, but continues on without resting at that position. That position, then, functions as *termini a quo* and *ad quem* in proximate potency during the ball's rotation.

Given this analysis, Avicenna explained in what sense the heavens' motion has a *terminus a quo* and *ad quem*, namely, as some conventionally assumed position to which some point on the celestial sphere can be in proximate potency. For example, astronomers as a matter of convention posit the sun's being directly overhead as the position by which to

of Ideas," in *Interpreting Avicenna: Science and Philosophy in Medieval Islam, Proceedings of the Second Conference of the Avicenna Study Group*, ed. J. McGinnis (Leiden: E. J. Brill, 2004), 42-61; *id.*, "A Medieval Arabic Analysis of Motion at an Instant: The Avicennan Sources to the *Forma Fluens/Fluxus Formae* Debate" in *The British Journal for the History of Science* (forthcoming, 2006).

³¹ The following discussion comes from *Ṭabī'iyāt* 91.9-92.4.

calculate a sidereal day, where a sidereal day is defined as the length of time between the sun's being directly overhead and its subsequently returning to that overhead position. What is important in Avicenna's analysis is that he has made clear how the heavens can move without needing to posit two spatially distinct points that would function as the *termini a quo* and *ad quem*, as rectilinear motion requires. In effect, circular motion or rotation, for Avicenna, needs a different analysis than that for rectilinear motion. With rectilinear motion, on the one hand, an object moves from one place to another spatially distinct place, where the motion is natural when the object moves to that place according to its natural disposition or inclination. With circular motion, on the other hand, an observer posits, as a matter of convention, some point, and the relative position of that point functions as both *termini a quo* and *ad quem*. As such, circular motion needs no spatially distinct absolute or natural points or locations by reference to which one defines or describes the motion, as is demanded by rectilinear motion. In addition, natural circular motion is not motion to some natural place; rather, it is the motion of an object whose natural tendency is to move in a circle, namely, the heavens.

Avicenna's most important contribution to addressing Philoponus' dilemma came in his very novel discussion of the varieties of motion, that is, the categories with respect to which there is motion.³² Again, the canonical types of motion enumerated in the Greek Aristotelian tradition were those with respect to the categories of quality, quantity and place only. Unlike Aristotle, who had provided only a brief discussion of motion's relation to the categories, Avicenna provided detailed and systematic analyses of all ten of Aristotle's categories, providing arguments why motion should either be included in or excluded from any given category.³³ Moreover, and more significantly, he identified four categories, not merely the canonical three, with respect to which there is motion, namely, quantity, quality, place and in addition the category of position.

Avicenna's analysis of motion with respect to the category of position³⁴ begins by observing that some had explicitly argued that there can be no motion in the category of position, since there are no actual contraries in this category, whereas motion is always between contraries or their intermediaries.³⁵ Avicenna quickly responded to this argument by referring his

³² *Ibid.*, II.3.

³³ See *Ṭabī'iyāt* II.3, 98.5-107.18.

³⁴ *Ibid.*, II.3, 103-105.13.

³⁵ Although this general argument appears in Aristotle (*Physics* V 1-2), its specific

reader back to his earlier discussion of the various ways a motion's *termini a quo* and *ad quem* may be understood, where the *termini a quo* and *ad quem* clearly function as contraries. Again, in the case of circular motion these termini are nothing more than conventionally assumed positions or locations in proximate potency. Thus circular motion is always between contraries, albeit contraries by supposition or convention. If the only instance of such a motion were the motion of the outermost celestial sphere, then Avicenna's account would be *ad hoc*; however, Avicenna observed that instances of such motion are commonplace. Avicenna's own example is of a person who flips from lying on his face to lying on his back. Clearly, this person's place did not change, but certainly he has moved. One can multiply similar examples at will; for all instances of spinning and rotating will be of motion with respect to the category of position, as Avicenna described positional motion.³⁶

Avicenna's introduction of a new genus of motion, namely, positional motion, in effect results from a generalization of the problem of the heavens' rotation, which we have been considering. The specific problem was "how could the outermost celestial sphere undergo motion with respect to place if it has no place with respect to which it changes?" Avicenna seemed to realize that there is a deeper issue at stake here: how could any rotating object be said to undergo motion with respect to place given that in rotation there is no change of place in the sense of a motion from one spatially distinct place to another spatially distinct place.³⁷ Circular motion or rotation, then, not only requires a different analysis than that of rectilinear motion, but also requires an entirely different categorization as to what kind of motion it is.³⁸

application to the category of position is not found in Aristotle, Themistius or the Arabic Philoponus; it might come from Alexander's lost *Physics* commentary, but confirming this would be difficult. In fact the entire category of κείσθαι is absent from Aristotle's discussion about the categories to which motion belongs. Ross suggests that perhaps Aristotle no longer considered either 'position' or 'possession' as independent categories, but as sub-categories subsumed under 'action'; see W. D. Ross, *Aristotle's Physics*, 620.

³⁶ Certain cases of rotation will be more complex than others; for example a rotating cube will undergo a motion with respect to both the category of position as well as the category of place.

³⁷ I am extremely grateful to an anonymous *Phronesis* referee for pointing out that the problem of the outermost celestial sphere's rotation in fact involves these two distinct questions.

³⁸ Algra briefly observes in a footnote that the ultimate solution to the problem we have been considering must in some way involve distinguishing rotation from

Avicenna now had all the elements to respond to Philoponus' dilemma. Philoponus' criticism ran: if, on the one hand, place is the innermost limit of a containing body, then the outermost heavens could not have a place; for there is nothing outside of the heavens to contain them. On the other hand, if the outermost heavens did not have a place, then they could not move with respect to place; however, it was believed to be an observed fact that they do move so. Since Aristotle's definition apparently entails what is known to be false, his definition, so Philoponus concluded, must be rejected.

Avicenna's response is that in the strict philosophical and scientific sense the outermost heavens do not have a place. The heavens and their purported motion would only need a place if they moved rectilinearly from one place to some spatially separated and distinct place, that is to say, from a *terminus a quo*, where the cosmos was initially actualized, to a *terminus ad quem*, where it is ultimately actualized. The *termini a quo* and *ad quem* of the heavens' motions, according to Avicenna, as we have seen, are not two distinct places, but simply a single, conventionally assumed point, albeit different in account, to which the heavens during their motion are in proximate potency; for this description is the proper one for rotational motion, as opposed to rectilinear motion. An object rotates when

rectilinear motion (*Concepts of Space in Greek Thought*, 185 n. 142). Morison goes further and provides an analysis of rotation that is strikingly similar to Avicenna's own, albeit *sans* the introduction of a new genus of motion with respect to the category of position (*On Location*, 166-169). He writes concerning a general definition of rotation that "x is rotating if there is a partition P of x such that all the members of P are changing potential place circularly" (*ibid.*, 168). It should be noted that nowhere in Morison's analysis of rotation does he once defer to the works of Aristotle, and so one might say that Morison's analysis is an 'Aristotelian solution' or 'in the spirit of Aristotle' rather than Aristotle's own explicit solution to the problem that we have been discussing, but of course this is all that Avicenna would have claimed for his solution as well. Morison, however, goes on to claim that "a proper account of rotation recognizes that *all that is necessary* for something to rotate is that its parts be P-items – be the sorts of thing which have a place or a potential place, which they can change circularly" (*ibid.*, emphasis added). Such a claim does not seem exactly right; for although in rotation the whole must be somewhere and the parts must also be somewhere, if not in fact having some place, it is *the position* of the whole that is changing, not its 'where' or even the places of its parts loosely speaking (i.e., the parts of the outermost celestial sphere loosely considered as having a place inasmuch as they are adjacent to one another, though not surrounded by a body beyond them). Thus, if there is to be a complete analysis of rotation, one must introduce change of position as a legitimate kind of change in addition to simply change of 'where' or place, which is just what Avicenna did.

the relative position of its parts changes with respect to some posited point chosen by convention, such as the point directly overhead. The heavens, then, do not move with respect to place, which would in fact be rectilinear motion, but only with respect to position.³⁹ Since positional motion only requires that the *termini* be conventionally assumed positions, and not absolute or natural reference points, the heavens in principle need have no place and yet can be said to move.

It has already been noted that Avicenna could well have drawn the inspiration for this argument from Alexander of Aphrodisias' commentary on the *Physics*.⁴⁰ Still, the evidence does not suggest that Avicenna simply took the argument fully developed from Alexander; for Simplicius, we saw, criticized Alexander on the grounds that he could not classify rotation as anything but a species of locomotion. Had Alexander provided the same careful analysis of circular motion as Avicenna would subsequently do and so make explicit that circular motion is generically different from locomotion in that locomotion concerns motion with respect to the category of place, whereas circular motion is with respect to the category of position, then, I contend, Simplicius could not have leveled this charge. At the very least Simplicius would have wanted to mention that Alexander had added a new type of motion, and yet Simplicius did not even gesture in that direction. Further, as already mentioned, Alexander himself claimed that there only three kinds of motion in his *Metaphysics* commentary. In short, it seem reasonable to think that, though Alexander had planted the seed, Avicenna nurtured it and saw it to fruition.

5. Implications and Conclusion

I conclude by briefly considering some of the implications of Avicenna's argument for other aspects of his own Aristotelian based natural philosophy. Others before me have observed that Aristotle's natural philosophy is extremely well integrated and that one cannot make significant changes to one part of that system without its affecting other parts. This point, as

³⁹ Hasnawi in his article "La Dynamique d'Ibn Sinā" (in *Études sur Avicenne*, ed. J. Jolivet and R. Rashed (Paris: Les Belles Lettres, 1984), 106) observes that Avicenna's introduction of the category of position as one in which motion occurs provides a solution to "'la grande question' de savoir si l'orbe suprême se trouve dans un lieu"; however, he does not provide a detailed analysis of Avicenna's answer, which indeed was not his intention in this otherwise extremely rich article.

⁴⁰ *Apud* Simplicius, *In Phys.*, 595, 16-26.

we shall see, is borne out in the present case. When Avicenna put circular motion into the category of position, he was not merely marking a trivial difference between circular motion and rectilinear motion; he was claiming that the two are generically different kinds of motion. The effect of making this strong distinction between the two is that it no longer follows that if something is true of locomotion, that is, rectilinear motion, it also must necessarily hold of positional motion, that is, rotational motion. More specifically, there are a number of cases where Aristotle presented arguments that take circular and rectilinear motion as two species subsumed under the single genus of motion with respect to place. Since Avicenna distinguished these two categorically, he could not immediately adopt such Aristotelian arguments; rather, it was incumbent upon him to show that either the same argument can be extended to both genera of motion or provide new arguments specific to one or the other kind of motion.

Two such instances can be found in Aristotle's and Avicenna's refutation of the void. Although Aristotle considered several arguments against the void, I shall simply focus on one, and even then in a very cursory way. The argument I have in mind anticipates two points that Aristotle made later in the *Physics*. These are (1) there are only three varieties or genera of natural motion, namely, motion with respect to the categories of quantity, quality and place, a premise that we have encountered numerous times already;⁴¹ and (2) motion with respect to place is the primary kind of motion, that is to say, the other two types of motion are subordinate to and so require local motion.⁴² From the second point, Aristotle could argue that if local motion is impossible in a void, then motion absolutely is impossible in a void, since the other types of motion cannot occur without local motion. Aristotle next distinguished natural and violent, or forced, local motion. Violent motion is motion away from a thing's 'natural place' or contrary to its natural inclination. For example, earth naturally tends to the center of the universe and so naturally moves downward. Thus when earth is raised or thrown upward it is forced out of and away from its natural place. Since violent motion is motion contrary to nature, if there were no natural motion, then *a fortiori* there would be no violent motion. As already intimated, however, natural motion requires differentiated places to which the elements are naturally inclined and naturally rest, namely, 'up', 'down' and 'middle'. On the traditional view of void,

⁴¹ *Physics* V 1, 225a34-b9.

⁴² *Physics* VIII 7, 260a26-b15.

Aristotle continued, void is an infinite, undifferentiated expanse; however, if it is infinite and undifferentiated, it cannot be differentiated into natural 'up', 'down' or 'middle'. Consequently, there can be no natural places to which things naturally incline and naturally rest, and so there can be no natural motion; however, in that case neither can there be forced local motion or any of the other types of natural motion. Consequently, motion in a void is impossible, concluded Aristotle.

Given that Avicenna identifies a fourth type of generic motion, he was no longer immediately entitled to at least two of the premises that Aristotle's argument assumes. The first is that local motion is the primary type of motion; for it is no longer clear whether rectilinear or circular motion would be primary in Avicenna's system. The second premise is that since natural locomotion is impossible in a void, necessarily natural circular motion – no longer a species of natural locomotion in Avicenna's system – must be impossible in a void; for since on Avicenna's account, circular motion does not require a differentiation of natural places, it is not obvious that a void's lack of such natural places would preclude natural circular motion.

The first point Avicenna could accommodate relatively easily. Aristotle himself had argued that the primary motion must be eternal and continuous. In other words, it must never come to a stop no matter how brief the time. In contrast, rectilinear motion, in a finite universe, must come to one terminus, stop and then return to the other terminus. Thus, given that locomotion for Aristotle is the primary motion and rectilinear motion cannot be eternally continuous, circular motion in fact must be the primary motion.⁴³ Avicenna simply could, and did, adopt this very line of reasoning, except now the primary motion is not one species of local motion, but instead is positional motion, which is a generically different kind of motion from local motion.⁴⁴ Nothing seems to be lost in this shift and in fact Avicenna's position seems to be more principled.

⁴³ *Physics* VIII 8, 261b27-263a3.

⁴⁴ See *Ṭabī'iyāt* III.14, 251-258. Although in this chapter Avicenna argued that circular motion is the primary kind of motion, he further distinguished two divisions of circular motion: what might be called 'circumambulation' and strict positional motion. In the first case, Avicenna gave the example of the elements' cyclical transformation, although one might simply think of someone's walking around in a circle. This type of motion in fact appears to belong to the category of place. Strict positional motion, i.e., motion with respect to the category of position, is further divided into motion around a point and motion around two poles. For instance the motion might be either an entire circle's rotating around its center or a sphere's rotating around its poles. For

The second point, however, Avicenna cannot so easily accommodate. Again the issue at stake is whether Avicenna was entitled to Aristotle's argument against the void based on the impossibility of natural local motion. Fairly clearly, he was not; for insofar as Avicenna's analysis of circular motion eliminates the need for natural places in the case of revolutions, nothing in the argument precludes a body's simply rotating in void space. That conclusion follows since in the case of rotation there is no need for a spatially separated natural place to which an object moves and naturally rests. Be that as it may, Avicenna was aware of this challenge to his physical system and it testifies to his genius that in his discussion of the void he provided an argument, which appears to be unique to him, specifically directed against circular motion in a void.⁴⁵ It is beyond the scope of the present study to give the details of Avicenna's geometrically technical argument.⁴⁶ Suffice it so say, however, that his argument nowhere assumes that circular motion requires natural places; rather, the entire argument is framed in terms of conventionally assumed positions on a sphere rotating in infinite void space, with the conclusion that a contradiction arises in such a case. Whether there are further ramifications of Avicenna's introducing positional motion as a new genus of motion, as well as how and if Avicenna responded, must be the subject of further investigation.

I end by way of a brief summary. Aristotle's account of place sparked a controversy that extended through the Greek classical period and into the medieval Arabic world. The Greek Neoplatonist, John Philoponus, had rejected Aristotle's account of place, since it could not provide a place for the cosmos as a whole and so made the apparent motion of the heavens impossible. Avicenna argued for a return to the original Aristotelian position concerning place, but did so in a way that went beyond both Aristotle and the Greek Aristotelian tradition defending Aristotle. He claimed that the problem of the motions of the outermost sphere was rooted in a failure to recognize that motion not only occurs in the categories of quantity,

Avicenna the primary type of motion is not merely strict positional motion; rather, it is the revolution of the heavens, since it is by reference to the celestial sphere that one defines natural 'up', 'down' and 'middle' as well as its Westward motion that gives an absolute sense to 'right' and 'left'.

⁴⁵ *Ṭabī'iyāt* II.8, 127, 1-18.

⁴⁶ I have discussed Avicenna's argument in detail in my forthcoming "Avoiding the Void: Avicenna on the Impossibility of Circular Motion in a Void", which will appear in *Classical Arabic Philosophy: Sources and Reception*, ed. P. Adamson, London: Warburg.

quality and place, but also occurs in the category of position. Ironically, then, it was Avicenna's infidelity to Aristotle's classification of the kinds of motion that made his fidelity to Aristotle's account of place possible.⁴⁷

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