Four Causes of the Natural Motions of Aristotle's Sublunar and Heavenly Elements

Rhodes, Michael

Awarding institution:
King's College London

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Michael Rhodes
King's College London

Abstract

Aristotle claims in *Physics* II.3 that we do not understand something until we have grasped its primary cause (πρώτη αἰτία). However, rather than identifying just one cause, Aristotle proposes the framework of the four causes (material, formal, efficient and final) as a means to distinguish certain ways in which causation occurs, and the different explanatory role each can play. In addition, Aristotle proposes two different but complementary assessments of change: a description of the static principles of κίνησις in *Physics* I.7, and a dynamic definition of κίνησις in *Physics* III.1. Aristotle does not expressly analyse the natural motions of his elements in terms of these concepts of cause and change. By undertaking such an analysis, this thesis seeks to shed some new light on these concepts and phenomena.

Although τόπος is not a cause *per se*, the assessment of the natural motions of Aristotle's sublunar elements highlights the significant role played by the proper place of each of the sublunar elements in respect of the formal and final causation of those motions. In addition, among other things, this assessment of the sublunar elements rebuts the suggestion that Aristotle's requirement that 'every moved body is moved by something' erases the distinction between forced and natural motions.

With regard to Aristotle's heavenly element, αἰθέρ, commentators have raised significant doubts about whether any of its motions could constitute a κίνησις. In light of this, one key step in the assessment of causation and change with regard to the natural motion of αἰθέρ is a demonstration of how certain motions in the heavens could satisfy Aristotle's dynamic definition, but not his static principles, of κίνησις. This demonstration is achieved by (i) distinguishing between the rotations of the celestial spheres and the orbits of the heavenly bodies, and (ii) focussing on the extent to which those πρᾶξεις entail a change of τόπος. This approach also highlights the differences between the efficient causation of forced motions and the efficient causation of natural motions.

Ultimately, this application of the concepts of the four causes and Aristotle's two assessments of κίνησις to the natural motions of his sublunar and heavenly elements seeks to test the overall coherence of Aristotle's schema.

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1. Overview of methodology

The starting point of this inquiry into the natural motions of Aristotle's sublunar and heavenly elements is his statements in *Physics* II that

- *"we think we have knowledge of a thing only when we can answer the question about it 'On account of what?'* (διὰ τί) *and that is to grasp the primary cause* (πρώτην αἰτίαν)";[1] and

- *"these are the causes, and this is how many there are. They are four, and the student of nature should know about them all".*[2]

On this basis, an assessment of the four sorts of cause, which can answer the question 'On account of what?' in respect of the natural motions of Aristotle's sublunar and heavenly elements, should facilitate a better understanding of those motions. It is notable, however, that the examples of αἴτιαι given by Aristotle in the *Physics* often arise in the context of explaining why artifacts are as they are. As a result, the material and formal causes, for example, of processes including locomotion are rather unclear. In order to clarify the concept of the four causes and apply it to natural motions, this thesis has specific regard to Aristotle's static principles of κίνησις and his dynamic definition of κίνησις. The assessment of former (in section 2.3 below) assists in the identification of the material and formal causes of a κίνησις.

As the concepts of the four causes and the static principles and dynamic definition of κίνησις are all proposed by Aristotle in the *Physics*, the question arises whether these concepts are applicable not only to the natural motions of the sublunar elements but also to the natural motion of Aristotle's heavenly element, αἰθέρ. This question is specifically addressed in section 2.4 below (after the relevant concepts have been discussed in some detail) and is provisionally answered in the affirmative.

An attempt is then made to identify in turn each of the four causes of the natural motions of the sublunar elements, following which the assessment switches to the heavens. One way in which the heavenly element, αἰθέρ, differs from the sublunar elements is that it only comprises the celestial spheres and the heavenly bodies and these objects together make up the whole of the heavens –

[1] 194b19.
[2] 198a21.

there are no other portions of αἰθέρ. Therefore, the assessment of the motion of αἰθέρ must be based on the motions of these spheres and bodies.

However, before an attempt is made to identify the four causes of the natural motion of αἰθέρ, consideration is given to the question whether there is, in fact, motion in Aristotle's heaven. This is required because commentators have highlighted the fact that Aristotle's static principles indicate that a κίνησις takes place between termini, and his dynamic definition indicates that a κίνησις is incomplete while it is ongoing, and yet the visible heavenly motions are everlasting and appear to be complete. The assessment in Chapter 4 seeks to show that whereas the orbits of the heavenly bodies are κινήσεις, the rotations of the celestial spheres should be regarded as ἐνεργείαι rather than κινήσεις. In the course of this assessment, the provisional conclusion (in section 2.4 that, among other things, Aristotle's concepts of κίνησις are applicable to the heavens) is revised as, for the reasons outlined in section 4.3 below, the everlasting circling round the centre of the universe which αἰθέρ undertakes is not susceptible to analysis on the basis of Aristotle's static principles of κίνησις.

In light of the determination that the rotations of the celestial spheres are ἐνεργείαι, the further methodological question arises as to whether the concept of the four causes is applicable to ἐνεργείαι, and this is addressed in section 5.2. An attempt is then made to identify each of the four causes of the everlasting rotations of the celestial spheres and the four causes of the orbits of the heavenly bodies.

Pursuant to this methodology, this thesis seeks to apply concepts which Aristotle introduces in the *Physics* to phenomena and entities which he describes in the *Physics*, *On the Heavens* and the *Metaphysics.* Consideration is, therefore, given in Chapter 7 to the overall coherence of Aristotle's schema in light of the experience of this attempt to identify the four causes of the natural motions of Aristotle's sublunar and heavenly elements.

The following translations, in the Clarendon series, have been quoted below:

- *Physics* I and II – Charlton;
- *Physics* II and III – Hussey;
- *Physics* VIII – Graham;
- *Metaphysics* Zeta – Bostock; and

- *Metaphysics* Lambda – Judson.

The following translations have also been cited briefly:

- *On the Heavens* – Guthrie;
- *On Generation and Corruption* – Forster;
- *Meteorology* – Lee; and
- *Nicomachean Ethics* – Aufderheide.

2. Aristotle's concepts of cause and change

This Chapter presents the key Aristotelian concepts which will then be applied in order to analyse the natural motions of Aristotle's sublunar and heavenly elements. These concepts are the four causes, the static principles of change, and the dynamic definition of change.

2.1 Translation of the word αἴτια

In Aristotle's account of what are referred to as the 'four causes', the Greek word which is translated as 'cause' is αἴτια. It has, however, been well observed in the literature that αἴτια has a broader meaning than that English word.[3] Hocutt and Vlastos suggest that in English the word 'cause' refers to a productive agent or event, which would correspond to just the efficient cause among Aristotle's four causes.[4] As Hocutt notes, in the *Physics* Aristotle expressly uses the term αἴτια to denote an answer to the question 'Why?' or 'On account of what?' (διὰ τί),[5] and in many cases the answer to the question 'Why?' does not contain any hint of productive agency. There is, for example, no suggestion that a phenomenon's final cause, which is Aristotle's term for a teleological goal or purpose, exerts some sort of pull or productive agency from the future that brings about the phenomenon in question.

In order to emphasize the broader meaning of the word αἴτια, Charlton highlights the cognate verb αἰτιάομαι which means to 'blame' or 'hold accountable',[6] and it is perhaps in such a sense that Aristotle identifies, in the *Posterior Analytics,* the Athenian raid on Sardis as an αἴτια of the subsequent Persian invasion of Attica.[7] Charlton proposes that *"X is called an αἴτιον in respect of Y, if it is responsible for Y in any way whatever, if Y can for any reason be set down or ascribed to it",*[8] and that *"one thing can be responsible for another in that it stands to it as one of the four causes".*[9] Thus, for example, health is an αἴτια of an after-dinner constitutional, as it is the goal for the sake of which one walks after dinner and so is, in that sense, responsible for the occurrence of that exercise.

[3] See Vlastos (1969), Charlton (1970), Hocutt (1974), Hankinson (2013).
[4] Hocutt, p.386; Vlastos, p.294.
[5] 194b19, 198b5.
[6] Charlton, p.98.
[7] 94a36.
[8] Charlton, p.98.
[9] Charlton, p.99.

In concluding what Hocutt describes as a *"masterful"* discussion of this issue, Charlton suggests that an αἴτια is an *"explanation"* of why something is as it is, and for Aristotle such an explanation can be provided in the four different ways which he identifies.[10] Despite this understanding of the wider meaning of the word αἴτια, it is notable that Charlton himself translates it as 'cause'.

In practice, the expressions 'formal explanation' and 'final explanation' would seem to be rather awkward (and also unfamiliar). In addition, as Aristotle uses one term, αἴτια, for all his four causes, it would not seem appropriate to translate that term differently for the different αἴτια, e.g. as 'cause' for the efficient αἴτια and as 'explanation' for the final αἴτια.

Given this background, this thesis follows the practice of translating the word αἴτια as 'cause' while noting, with Charlton and others, that care should be taken not to be misled by that relatively narrow translation.[11] In light of this reservation about care over the translation of αἴτια as 'cause', multiple passages below emphasize the broader interpretation of an αἴτια as an explanation of why Aristotle's elements naturally move in the way that they do.

2.2 The four causes

In *Physics* II.3, Aristotle introduces the four causes and refers to them as the four 'manners' of cause (τρόπον αἴτιον) which can be identified in answer to the question 'Why?'. These are the material, formal, efficient, and final causes, and are outlined in turn below.

- **The material cause**

  τὸ ἐξ οὗ γίγνεταί τι ἐνυπάρχοντος

  194b23 *that out of which as a constituent a thing comes to be.*

The material cause is said to be the matter out of which a thing is formed. The examples Aristotle gives include the bronze of a statue and the silver of a cup. Later in *Physics* II.3 Aristotle refers more generally to the matter of an artefact as its material cause.[12] The bronze of a statue is not the productive agent which causes the statue to come into being, and so would not be labelled as a 'cause' in contemporary English. However, as the material cause of the statue, the bronze is

[10] Hocutt, footnote 11.
[11] Charlton, p.98.
[12] 195a8.

responsible for (and thus can explain) some of that artefact's properties, e.g. its weight and rigidity, and it seems that it is referred to as an αἴτια by Aristotle for this reason.

While Aristotle's examples clearly indicate the material causes of certain artefacts, those examples do not really assist in identifying the material cause of a κίνησις such as the natural motion of an Aristotelian element, as that κίνησις does not seem to come to be *'out of'* matter in the same way as a tangible object, such as an artefact, is formed from its matter. Aristotle does, though, sum up his examples of material causes as the *'underlying thing'* (ὡς τὸ ὑποκείμενον).[13] As the concept of an *'underlying thing'* is central to Aristotle's static principles of κίνησις, the assessment of those principles in section 2.3 below seeks to identify, among other things, the role that is performed by the ὑποκείμενον within a κίνησις, and thereby identify the material cause of a κίνησις in quite general terms.

- **The formal cause**

  τὸ εἶδος καὶ τὸ παράδειγμα, τοῦτο δ' ἐστὶν ὁ λόγος ὁ τοῦ τί ἦν εἶναι καὶ τὰ τούτου γένη

  194b26 *the form or model … this is the account of what the being would be, and its genera.*

The formal cause is the formula or definition of a phenomenon, i.e. the account of what it is to be that thing. The examples which Aristotle gives include the ratio of two to one which is the formal cause of an octave.[14] Aristotle also says that the formal cause is the whole, the composition, and the form.[15] As with the material cause, the identity of the formal cause of an artefact, like a statue, is reasonably clear and is the composition (i.e. the arrangement) and form of that artefact, which is responsible for (and thus can explain) some of that artefact's properties, e.g. its shape. However, while the formal cause of an artefact is the form or account of that which the matter constitutes, the formal cause of a κίνησις, such as locomotion, is less clear and is not specifically addressed in the discussion in *Physics* II.3.

In the *Nicomachean Ethics* X.4, Aristotle considers the forms of walking and the other types of locomotion and says that *"[the] many movements are incomplete and differ in form since the from-where and the to-where determine the form"* (αἱ πολλαὶ ἀτελεῖς καὶ διαφέρουσαι τῷ εἴδει, εἴπερ τὸ πόθεν ποῖ εἰδοποιόν).[16] On this basis, the form and formal cause of the natural motion of

[13] 195a19. See also 1013b21.
[14] 194b27.
[15] 195a21. See also 1013b22
[16] 1174b4-5.

an Aristotelean element would seem to be determined by the path of that motion (i.e. by both the whence and the whither). However, the formal cause of the κίνησις of building would seem to be the form of the house which is the product of the κίνησις. Thus, it seems it may be possible to identify the formal cause of a κίνησις just by reference to the form that is acquired at the completion of the κίνησις rather than by reference to the whole path (i.e. the whence and the whither) of the κίνησις. This possibility is explored further in the assessment of Aristotle's static principles of κίνησις in section 2.3 below.

- **The efficient cause**

  ὅθεν ἡ ἀρχὴ τῆς μεταβολῆς ἡ
  πρώτη ἢ τῆς ἠρεμήσεως

  194b29-30 *the primary source of the change or the staying unchanged.*

The examples which Aristotle gives of efficient causes include the father who is the efficient cause of a child, and more generally that which makes something is the efficient cause of that which is made, and that which changes something is the efficient cause of that which is changed.[17] It is notable that the efficient cause is the 'primary source' of the change and so initiates a process of change. In light of this, the efficient cause is closer to the contemporary concept of a cause as a productive agent or event than Aristotle's other causes and, in the case of building a house, it might be thought that the efficient cause is the builder. However, Aristotle states that the art of building (τὴν οἰκοδομικήν), which the builder possesses, is a prior cause to the builder (πρότερον τὸ αἴτιον),[18] and that the art of statue making is the efficient cause of the statue.[19] This suggests that Aristotle's focus, even in the case of efficient causes, is perhaps more on providing explanations for why things are as they are, rather than on identifying productive agents.

- **The final cause**

  ὡς τὸ τέλος· τοῦτο δ' ἐστὶν
  τὸ οὗ ἕνεκα

[17] 195a8.
[18] 195b24.
[19] 195a11.

194b32 *the end. That is what something is for.*

The final cause is the goal and 'that for the sake of which' a thing is done. As is noted above, the examples which Aristotle gives include health which is the goal and final cause of walking. Therefore, processes and entities can, to some extent, be explained by reference to their final causes which are the objectives for the sake of which (τὸ οὗ ἕνεκα) these processes occur and entities exist (e.g. the final cause of building a house is the house and the final cause of sharp incisors is to cut food). Aristotle's concept of the final cause is considered in more detail in sections 3.3, 5.4, and 6.2 below, in the context of assessing sublunar and heavenly motions.

Aristotle says that in order to understand a phenomenon, a natural philosopher should identify all four causes.[20] In light of this exhortation, the following Chapters seek to identify the four causes of the natural motions of Aristotle's sublunar and heavenly elements in order to shed light on those κινήσεις and on the four causes themselves. Before that analysis is undertaken, consideration is given to Aristotle's comments on κίνησις and change in general.

2.3 The principles and definition of κίνησις

With regard to the concept of change, it should be noted that Aristotle's use of terminology is not always consistent in the *Physics* and elsewhere. He employs the term μεταβολή to describe change of accidental properties, i.e. change in respect of quantity, quality and place.[21] Aristotle sometimes extends the term μεταβολή to apply as well to the substantial change of generation and destruction (i.e. coming-to-be and passing-away). Aristotle also uses the term κίνησις to denote change of quality, quantity and place, while sometimes employing κίνησις in the broader sense which includes substantial change, and sometimes even in a narrower sense solely as a reference to change of place (i.e. locomotion).

In the *Physics*, Aristotle proposes two somewhat different but complementary assessments of κίνησις, the static principles and the dynamic definition which are both discussed below.

[20] 198a21-23.
[21] See *Physics* II.2; *Physics* VIII.9; *Metaphysics* Lambda.2.

- **The description of the static principles of κίνησις in *Physics* I.7**

Aristotle sets out his static principles of κίνησις as follows:

> πόσαι μὲν οὖν αἱ ἀρχαὶ τῶν περὶ γένεσιν φυ-
> σικῶν, καὶ πῶς ποσαί, εἴρηται· καὶ δῆλόν ἐστιν ὅτι δεῖ ὑπο-
> κεῖσθαί τι τοῖς ἐναντίοις καὶ τἀναντία δύο εἶναι. τρόπον δέ
> τινα ἄλλον οὐκ ἀναγκαῖον· ἱκανὸν γὰρ ἔσται τὸ ἕτερον τῶν
> ἐναντίων ποιεῖν τῇ ἀπουσίᾳ καὶ παρουσίᾳ τὴν μεταβολήν.

> 191a3 *How many principles there are of natural things [which are involved in coming-to-be], and in what way they are so many, has now been said. It is clear that there must be something to underlie the opposites, and that the opposites must be two in number. Yet in another way this is not necessary. One of the opposites, by its absence or presence, will suffice to effect the change.*

A specific example of κίνησις that Aristotle gives in *Physics* I.7 is of a change to an accidental property; namely, an unmusical man becoming a musical man.[22] The man is the underlying thing which transitions from being unmusical to being musical. Thus, although the extract cited above includes the words περὶ γένεσιν, the principles which are described here are identified by Aristotle in the context of considering accidental change (e.g. change of quality) as well as substantial change (i.e. generation). One corollary of Aristotle's use here of the words περὶ γένεσιν is, however, specifically considered in section 4.3 below, with reference to the heavenly bodies which are everlasting and thus not *"involved in coming-to-be"*.[23]

Aristotle elaborates on these principles of κίνησις a little later in *Physics* I.7 when he says:

> ἡ
> δὲ ὑποκειμένη φύσις ἐπιστητὴ κατ' ἀναλογίαν. ὡς γὰρ πρὸς
> ἀνδριάντα χαλκὸς ἢ πρὸς κλίνην ξύλον ἢ πρὸς τῶν ἄλλων
> τι τῶν ἐχόντων μορφὴν [ἡ ὕλη καὶ] τὸ ἄμορφον ἔχει πρὶν (10)
> λαβεῖν τὴν μορφήν, οὕτως αὕτη πρὸς οὐσίαν ἔχει καὶ τὸ
> τόδε τι καὶ τὸ ὄν. μία μὲν οὖν ἀρχὴ αὕτη, οὐχ οὕτω μία

[22] 190a1.
[23] Charlton's use of square brackets around these words is considered in footnote 100 below.

οὖσα οὐδὲ οὕτως ὂν ὡς τὸ τόδε τι, μία δὲ ἧς ὁ λόγος, ἔτι
δὲ τὸ ἐναντίον τούτῳ, ἡ στέρησις.

191a7 *As for the underlying nature, it must be grasped by analogy. As bronze stands to a statue, or wood to a bed, or [the matter and] the formless before it acquires a form to anything else which has a definite form, so this stands to a reality, to a this thing here, to what is. This, then, is one principle, though it neither is, nor is one, in the same way as a this thing here; another principle is that of which we give the account; and there is also the opposite of this, the lack.*

Thus, in *Physics* I.7, Aristotle describes how κίνησις generally (e.g. an unmusical man becoming a musical man, and a statue coming-to-be out of a piece of bronze) involves an underlying object, and two opposites, and the opposites entail a form and a privation (i.e. the lack of the form in question). Aristotle reiterates this point in *Metaphysics* Lambda.2 when he says of the three static principles of κίνησις:

δύο μὲν ἡ ἐναντίωσις, ἧς τὸ
μὲν λόγος καὶ εἶδος τὸ δὲ στέρησις, τὸ δὲ τρίτον ἡ ὕλη.

1069b33 *two are the pair of opposites – of which one is the formula and form, and one the privation – and the third is the matter*.

Aristotle's discussion of the static principles of κίνησις assists in overcoming the difficulty with identifying the material cause of a κίνησις, which is noted in section 2.2 above. The material cause of an object like an artefact is the matter from which the object is made or comes to be but, in the case of a κίνησις such as locomotion, the κίνησις itself does not seem to come to be from matter. In the discussion of the four causes Aristotle also describes the material cause as the underlying thing (τὸ ὑποκείμενον),[24] although he does not elaborate on what he means by this expression in that context. However, in his discussion of the static principles of κίνησις, Aristotle explains that the underlying thing is the physical object which persist through a κίνησις. Thus, on the basis of the static principles, an object which undergoes locomotion is the underlying thing which persists through that κίνησις, and this is the material cause of the κίνησις. For example, a stone which falls to the ground is the underlying thing and thus the material cause of that locomotion. The stone is not a cause in the sense of being a productive agent which initiates that motion, but it does provide

[24] 195a19.

some explanation for why that particular motion occurs; i.e. when released the stone falls to the ground due to its weight (and the fact that it is predominantly made up of the element earth which naturally moves down). This issue of the material cause of the natural motions of the sublunar elements is considered further in section 3.5 below.

Aristotle's static principles of κίνησις also assist with the identification of the formal cause of a κίνησις. According to these principles, the underlying thing moves from a privation to its corresponding form. So, a κίνησις, such as the unmusical man becoming musical, entails the man changing from the privative state of being unmusical to the state of possessing the form of being musical. As noted in section 2.2 above, Aristotle says that *"the from-where and the to-where determine the form"* of a κίνησις.[25] However, in his discussion of the static principles, Aristotle confirms that *"One of the opposites, by its absence or presence, will suffice to effect the change"*.[26] Therefore, as the κίνησις of the man becoming musical entails the form of being musical and its privation, the formal cause of that κίνησις might perhaps be the form of being musical (as that form by its absence or presence will suffice to effect the change). A corresponding assessment would lead to the form of a house constituting the formal cause of the κίνησις of building a house. If this approach is correct, then the formal cause of a κίνησις would be the form that is acquired at the completion of the κίνησις. This possibility is considered further in section 3.4 below, in the context of attempting to identify the formal cause of the natural motions of the sublunar elements.

As a final preliminary comment on Aristotle's principles of κίνησις, it should be noted that they involve a static analysis because they focus on the start and finish of the κίνησις (i.e. the termini which are the privation and the form) and the underlying object which transitions between those termini and remains constant throughout the κίνησις. As this description focusses on the termini of a κίνησις, it sheds no light on the nature of the process by which the underlying thing transitions from the privation to the form. In contrast, Aristotle's second assessment of κίνησις in the *Physics*, which amounts to a definition, focusses on the process of change itself.

- **The dynamic definition of κίνησις in *Physics* III.1**

Aristotle set out his dynamic definition of κίνησις as follows:

[25] 1174b4.
[26] 193a6.

διῃρημένου δὲ καθ'
ἕκαστον γένος τοῦ μὲν ἐντελεχείᾳ τοῦ δὲ δυνάμει, ἡ τοῦ δυ-
νάμει ὄντος ἐντελέχεια, ᾗ τοιοῦτον, κίνησίς ἐστιν, οἷον τοῦ μὲν
ἀλλοιωτοῦ, ᾗ ἀλλοιωτόν, ἀλλοίωσις, τοῦ δὲ αὐξητοῦ καὶ τοῦ
ἀντικειμένου φθιτοῦ (οὐδὲν γὰρ ὄνομα κοινὸν ἐπ' ἀμφοῖν) αὔ-
ξησις καὶ φθίσις, τοῦ δὲ γενητοῦ καὶ φθαρτοῦ γένεσις καὶ
φθορά, τοῦ δὲ φορητοῦ φορά.

201a9 *There being a distinction, in respect of each kind [of being], between [being] actually and [being] potentially, the actuality of that which potentially is, qua such, is change. For example: the actuality of what admits of qualitative change, is qualitative change; of what admits of increase and decrease (there is no common term to cover both), it is increase and decrease; of what admits of coming-to-be and ceasing-to-be, it is coming-to-be and ceasing-to-be; of what admits of locomotion, it is locomotion*.

In contrast with the description of the static principles of κίνησις in *Physics* I.7, the definition in *Physics* III.1 focuses on the 'process' of change rather than the termini, and highlights the dynamic aspect of κίνησις as *"the actuality of that which potentially is, qua such"*.[27] This expression is, though, extremely compressed, and also rather opaque as it seems to define a κίνησις both as an *"actuality"* (ἐντελέχεια) and as something *"which potentially is"* (ἡ τοῦ δυνάμει ὄντος). Applying those two terms at the same time to a κίνησις might, at first blush, appear problematic if not contradictory. For example, while the κίνησις of building a house is ongoing, the building materials are potentially a house; yet when that κίνησις is complete, the building materials cease to be potentially a house and instead are in actuality a house (which is the product of the building process). So, in this example, the potentiality to be a house is extinguished at the point when the house comes into being and exists in actuality. In light of this, and also Aristotle's comment cited above that there is *"a distinction … between [being] actually and [being] potentially"*, it is not immediately clear how a κίνησις can be *"the actuality of that which potentially is"*.

[27] In this thesis, the word ἐντελέχεια in the dynamic definition of κίνησις is, following Hussey (1983), Kosman (1994), Coope (2013) and others, translated as '*actuality*'. Ross, among others, translates ἐντελέχεια as *'actualisation'* (1936, p.359). That approach is compellingly rejected by Kosman (1994) and Coope (2013). Among other things, Kosman describes the definition of change in terms of the process of *'actualization'* by which a potentiality is actualized as *"astonishingly vacuous"* (p.41) and Coope describes it *as "circular"* (p.279).

Aristotle provides some clarification of this issue when he paraphrases the definition a few lines later as:

> ὅτι δὲ τοῦτο ἔστιν ἡ κίνησις,
> ἐντεῦθεν δῆλον. ὅταν γὰρ τὸ οἰκοδομητόν, ᾗ τοιοῦτον αὐτὸ
> λέγομεν εἶναι, ἐντελεχείᾳ ᾗ, οἰκοδομεῖται, καὶ ἔστιν τοῦτο
> οἰκοδόμησις· ὁμοίως δὲ καὶ μάθησις
>
> 201a15 *That this is change is clear from the following: when that which is buildable is in actuality, in the respect in which we call it such, it is being built, and this is the process of building, and similarly with learning...*

Thus, the paraphrasing of the definition at 201a15 confirms that the κίνησις of building involves that which is buildable (i.e. building materials) being in actuality as the buildable, and this is the process of building. However, this still seems to be rather ambiguous as building materials which are lying idle in a builder's yard would seem to be in actuality building materials (i.e. bricks and stones) but, when they are not being used in the process of building, it seems that Aristotle does not think they are in actuality *"the buildable"*. Aristotle elaborates on this issue, and further clarifies the dynamic definition of κίνησις, when at 201a27 he again paraphrases the definition as:

> ἡ δὲ τοῦ δυνάμει
> ὄντος ≤ἐντελέχεια≥, ὅταν ἐντελεχείᾳ ὂν ἐνεργῇ οὐχ ᾗ αὐτὸ ἀλλ'
> ᾗ κινητόν, κίνησίς ἐστιν.
>
> 201a27 *The actuality, then, of what is potentially – when being in actuality it is operating not qua itself but qua changeable – is change.*

Thus, when building materials are lying idle in a builder's yard, they are in actuality building materials (i.e. bricks and stones) but, in the terms of 201a27, a brick is in that situation *"operating … qua itself"* (i.e. it is being a brick). However, when building materials are being employed in the process of building, they are, in the terms of 201a27, *"operating … qua changeable"* and they are then in actuality *"the buildable"* (i.e. they are in actuality being potentially a house rather than just being bricks and stones) and that *"is change"*. This second paraphrase of the dynamic definition also seems to clarify the "*qua such"* component of the definition (i.e. that a κίνησις is the actuality of

what potentially is, qua such). The "*qua such"* component of the definition confirms that a κίνησις is the actuality as a potentiality of something which is potentially. So, by way of example, it is not the actuality of bricks and stones *qua* bricks and stones which constitutes the κίνησις of building a house, but their actuality *qua* potentially being a house.[28] Although building materials are potentially a house even when they are lying idle in a builder's yard, it is only when the building materials are actually being employed in the process of building that they are as Kosman says *"fully manifesting their potentiality to be a house qua potentiality".* [29] In the terms of the paraphrase at 201a27, the building materials are in this situation *"in actuality … operating … qua changeable"*. Furthermore, on this basis a κίνησις is not the actuality of a potentiality in the sense of the actuality which results from a process (in the way that a house is the actuality which results from the building process), but rather in the sense of the actuality of a potentiality in its full manifestation as a potentiality (such as the building materials while they are operating as the buildable).

Therefore, it appears from the text at 201a15 and 201a27 that Aristotle is seeking to distinguish between different types of *"actuality"* (e.g. building materials may be in actuality the buildable or in actuality a house), and also to distinguish between different types of *"potentiality"* (e.g. building materials may be in potentiality a house while they are lying idle, but only fully manifest that potentiality as a potentiality while they are being employed in the κίνησις of building).[30]

The recognition that there may be different types of *"actuality"* and *"potentiality"* seems to assist in understanding Aristotle's definition of κίνησις as *"the actuality of that which potentially is, qua such"*. In the case of the κίνησις of building, building materials have the potentiality to be a house. However, while the building materials are lying idle in a builder's yard they are, according to Kosman, *"only potentially buildable into a house",* i.e. they are *"only potentially potentially a house".*[31] That potentiality to be a house is fully manifested as a potentiality when the building materials are being built into the house, i.e. the building materials are in actuality operating as *"the buildable"*.[32] The potentiality is fully actualized when the house is built and at that point the building material cease to have the potentiality to be a house as the house exists in actuality.

[28] See Kosman, p.43.
[29] Kosman, p.50.
[30] In *On the Soul* II, Aristotle distinguishes between the different ways in which a potentiality may exist. This issue is considered further in sections 3.3.2 and 3.4.2 below.
[31] Kosman, p.54.
[32] In his text on the ontology of change, Sentesy (2020) uses the expressions *"a being-in-potency"* to describe *"a concrete particular being considered in so far as it is organized to set to work"*, and *"a being-at-work"* to describe *"the same being considered insofar as it is a functioning whole"* (p.162).

In the following chapters this assessment of Aristotle's dynamic definition of κίνησις is applied to the natural motions of Aristotle's elements.

As a final preliminary comment on Aristotle's definition of κίνησις, it should be emphasized that even though a κίνησις involves the full manifestation of a potentiality as a potentiality, it is nevertheless incomplete (ἀτελὲς) while it is ongoing. This is confirmed by Aristotle when he says:

> ἥ τε κίνησις ἐνέργεια μὲν εἶναί τις δοκεῖ,
> ἀτελὴς δέ· αἴτιον δ' ὅτι ἀτελὲς τὸ δυνατόν, οὗ ἐστιν ἐνέρ-
> γεια.
>
> 201b31 *and besides change does seem to be a kind of operation, but an incomplete one – the reason being that the potential, of which it is the operation, is incomplete.*

Thus, while a building process is ongoing, the building materials are *"operating … qua changeable"*, i.e. they are in actuality being potentially a house. Even though they are at that time fully manifesting this potentiality as a potentiality, the potentiality is ἀτελὲς and is only completed at the end of the building process, at which point the building materials cease to be potentially a house and are actually a house. One implication of this aspect of the dynamic definition of κίνησις is that although a κίνησις exists (i.e. it is an actuality) while it is taking place, at the point when the object fulfils its potentiality to change, the κίνησις itself ceases to exist, and thus the κίνησις and the fully actualized potentiality do not co-exist (e.g. the process of building and the house, which is the product that process, do not co-exist).

2.4 Application of the concepts of the four causes and change to the heavens

Before seeking to make use of these concepts in an assessment of the natural motions of Aristotle's elements, it is appropriate to consider whether they apply just to the sublunar realm or whether they also apply to the heavens. Lennox has recently proposed that Aristotle did not employ *"a single, undifferentiated method of investigation* [and] *he became quite self-conscious of the differences in principles and methods required for the pursuit of knowledge"*.[33] With regard to

[33] Lennox (2021), p.118.

zoology and meteorology, for example, Lennox suggests that *"the subjects to be investigated differ in fundamental ways that require distinctive norms of inquiry"*.[34]

In a similar vein, Waterlow states in her book entitled *"Nature Change and Agency in Aristotle's Physics"*:

> *"II.7, 198a29-31 shows that Book II does not totally ignore the eternal world. But this passage says that eternal moving things fall under a different branch of knowledge from destructible changing things: i.e. the former do not come within the scope of 'physics' as conceived in II"*.[35]

If this claim is correct then the concepts of the four causes and change, which are established in the *Physics*, might not be applicable to the heavens. However, the passage in *Physics* II.7, to which Waterlow refers, actually reads as follows:

> ἔρχεται δὲ τὰ τρία
> εἰς [τὸ] ἓν πολλάκις· τὸ μὲν γὰρ τί ἐστι καὶ τὸ οὗ ἕνεκα ἕν
> ἐστι, τὸ δ' ὅθεν ἡ κίνησις πρῶτον τῷ εἴδει ταὐτὸ τούτοις· ἄν-
> θρωπος γὰρ ἄνθρωπον γεννᾷ—καὶ ὅλως ὅσα κινούμενα κινεῖ
> [ὅσα δὲ μή, οὐκέτι φυσικῆς· οὐ γὰρ ἐν αὐτοῖς ἔχοντα κίνησιν
> οὐδ' ἀρχὴν κινήσεως κινεῖ, ἀλλ' ἀκίνητα ὄντα· διὸ τρεῖς αἱ
> πραγματεῖαι, ἡ μὲν περὶ ἀκινήτων, ἡ δὲ περὶ κινουμένων μὲν
> ἀφθάρτων δέ, ἡ δὲ περὶ τὰ φθαρτά].
>
> 198a25 *The last three often coincide. What a thing is, and what it is for, are one and the same, and that from which the change originates is the same in form as these. Thus a man gives birth to a man, and so it is in general with things which are themselves changed in changing other things – and things which are not so changed fall beyond the study of nature. They have no change or source of change in themselves when they change other things, but are unchangeable. Hence there are three separate studies: one of the things which are unchangeable, one of things which are changed but cannot pass away, and one of things which can pass away.*

[34] Ibid, p.4.
[35] Waterlow (1982), p.251, Footnote 38.

It appears, therefore, that what is outside the scope of the *Physics* (οὐκέτι φυσικῆς) is that which is not *"changed in changing other things",* e.g. the unmoved mover which is a subject covered by the *Metaphysics*. Although there may be a separate field of study concerning the bodies in the heavens which are in motion but imperishable, those bodies are not οὐκέτι φυσικῆς and so may, in principle, be susceptible to analysis on the basis of concepts established in the Physics. This is expressly confirmed by Aristotle near the start of *Metaphysics* Lambda.1, when he says:

> οὐσίαι δὲ τρεῖς, μία μὲν αἰσθητή—ἧς ἡ
> μὲν ἀΐδιος ἡ δὲ φθαρτή, ἣν πάντες ὁμολογοῦσιν, οἷον τὰ
> φυτὰ καὶ τὰ ζῷα [ἡ δ' ἀΐδιος]—ἧς ἀνάγκη τὰ στοιχεῖα
> λαβεῖν, εἴτε ἓν εἴτε πολλά· ἄλλη δὲ ἀκίνητος, καὶ ταύ-
> την φασί τινες εἶναι χωριστήν, οἱ μὲν εἰς δύο διαιροῦντες,
> οἱ δὲ εἰς μίαν φύσιν τιθέντες τὰ εἴδη καὶ τὰ μαθηματικά,
> οἱ δὲ τὰ μαθηματικὰ μόνον τούτων. ἐκεῖναι μὲν δὴ φυ-
> σικῆς [μετὰ κινήσεως γάρ], αὕτη δὲ ἑτέρας, εἰ μηδεμία
> αὐτοῖς ἀρχὴ κοινή.
>
> 1069a30-1069b2 *There are three kinds of substance. One is perceptible, of which one is eternal and one (which is acknowledged by everyone) perishable – e.g. plants and animals. Of this we must grasp the elements, asking whether they are one or many. Another kind is unchanging – and some say that this is separate (some of them dividing it into two, some taking the forms and the mathematicals to have a single nature, and some taking it to comprise the mathematicals alone of these). The former kinds of substance, then, are the subject of natural science (for they involve change), but the latter of another science, if there is no principle common to them all".*

Thus, while per *Physics* II.7 there may be differences in the study of perishable sublunar bodies and everlasting heavenly bodies, according to *Metaphysics* Lambda.1 these two types of bodies are φυσικῆς because they are μετὰ κινήσεως. Furthermore, it is notable that even though *On the Heavens* I and II deal with the heavens, the first line of *On the Heavens* I introduces its subject as the science of nature (Ἡ περὶ φύσεως ἐπιστήμη).[36] Thus, motions in the sublunar sphere and in the heavens should, in principle, both be susceptible to analysis using concepts established by Aristotle

[36] 268a1.

in the *Physics*. Nevertheless, the scope and purview of Aristotle's four causes, and his static principles and dynamic definition of κίνησις, are considered in more detail below when they are applied to the natural motions of Aristotle's sublunar and heavenly elements. In addition, the issue of domain-specific norms of inquiry is considered further in Chapter 7.

3. Identifying the four causes of the sublunar elements' natural motions

In both *Physics* II.3 and *Metaphysics* Delta.2, Aristotle lists the four causes in turn as material, formal, efficient and final. As a result, the customary practice seems to be to refer to the four causes in that order. However, as is noted in the preceding chapter, Aristotle does not specifically address formal and material causes in the case of κινήσεις such as the natural motions of the sublunar elements. Moreover, in the *Physics* Aristotle only expressly identifies the efficient cause of these natural motions, although in *Metaphysics* Lambda he alludes to the explanatory role of the unmoved mover as the final cause of change in general. Therefore, the assessment below departs from the customary order and deals initially with the efficient and final causes of sublunar natural motions and then addresses the formal and material causes. Approaching the four causes in this order has the benefit not only of starting with the cause that Aristotle explicitly identifies, but also of starting with the Aristotelian cause which most closely aligns with contemporary ideas of causation.

3.1 Natural motions of the sublunar elements

Aristotle begins his assessment of nature in *Physics* II.1 by defining it as an internal principle of change and rest.[37] He goes on to confirm that an understanding of nature depends upon an understanding of change:

> *"Since nature is the principle of change and alteration* [ἀρχὴ κινήσεως καὶ μεταβολῆς]*, and our inquiry is about nature, it must not escape us what change* [κίνησις] *is: for if it is not known, it must be that nature is not known either".*[38]

Aristotle emphasizes:

> *"And of change* [κινήσεως]*, the most basic and general kind is change in respect of place* [τόπον]*, which we call locomotion* [φοράν]*".*[39]

Aristotle distinguishes between two types of motion – forced and natural. In general, a change is considered to be natural, in the sense of being in accordance with the nature of an object, when the

[37] 192b13, 20-23.
[38] 200b12.
[39] 208a32.

principle of change is internal to the object in question.[40] Thus, certain motion will be natural for an element if it is in accordance with the nature of the element and its internal principle of change. Forced motion is motion which is not natural (τὸ δὲ βίᾳ καὶ παρὰ φύσιν ταὐτόν).[41]

According to *On the Heavens* I.2, the sublunar elements (earth, water, air, and fire) each possess a unique natural motion.[42] Earth is absolutely heavy and naturally moves down to the centre of the universe and fire is absolutely light and naturally moves up to the inner surface of the lunar sphere. Water and air are relatively heavy and light: water naturally moves to be below air but above earth, and air naturally moves to be above water but below fire.

If an object moves or is at rest in accordance with its nature, for Aristotle the reference to 'its nature' serves to some extent at least as an explanation of that phenomenon.[43] However, the characterization of motion as natural may not be an exhaustive explanation as there may be certain preconditions to an element's natural motion and so the nature of the element may be sufficient to explain the natural motion only once the relevant preconditions have been met. Therefore, a comprehensive account of an element's natural motion may also involve an explanation of how and why the relevant preconditions are present.

3.2 Efficient cause of sublunar natural motion

3.2.1 All things in motion are moved by something

As it is a key tenet of Aristotle's *Physics* that nature is an internal principle of change and rest, it might be thought that this internal principle is the efficient cause of a sublunar element's natural motion (i.e. the primary source of the motion).

However, one implication of such an interpretation would be that all natural bodies, including the sublunar elements, would seem to be able to originate their own motion. If this were correct then not only natural things such as animals, but also the inanimate elements, could be regarded as 'self-movers'. In *Physics* VIII.4 Aristotle rejects the possibility that the elements are self-movers when he

[40] 192b21.
[41] 200a23.
[42] 269a27.
[43] 255b15.

reasons to the conclusion that all things that are in motion are moved by something (ἅπαντα ἂν τὰ κινούμενα ὑπό τινος κινοῖτο).[44] Thus, in the case of the elements at least, for each motion, whether natural or forced, there needs to be a mover.

In *Physics* VIII.4, Aristotle elaborates on this claim (that all things that are in motion are moved by something) by considering three types of motion, (i) the natural (i.e. unforced) motion of animate beings, (ii) forced motion generally, and (iii) the natural motion of the (inanimate) elements.[45] According to Aristotle, (iii) is the hardest of these cases in terms of identifying the efficient cause of the motion in question.

In seeking to identify the efficient cause of the natural motion of the sublunar elements, Aristotle notes that even though the elements move naturally to their proper places, none of them moves itself. Unlike animate beings, the elements do not exhibit the characteristics of self-movers such as stopping or starting their motion or changing direction.[46] In addition, if an object is a self-mover, it should be possible to distinguish between the part of the object which causes the motion and the part which is moved.[47] However, each element is homogeneous – one 'part' of it is indistinguishable from another. Due its homogeneity, a portion of an element is a single continuum which cannot act on itself because, within it, there cannot be a 'mover' which is distinguishable from the 'moved'.[48] Aristotle emphasizes this conclusion in *Physics* VIII.4 when he says:

> τό
> τε γὰρ αὐτὰ ὑφ' αὑτῶν φάναι ἀδύνατον· ζωτικόν τε γὰρ
> τοῦτο καὶ τῶν ἐμψύχων ἴδιον
>
> 255a5 For it is impossible to say they move themselves. For this is a property of life and belongs only to animate things.

The part of an animate being which is the 'mover' is the soul, while the rest of the being, the body, is the 'moved', and so the efficient cause of the natural motion of an animate being is the soul of the relevant being.

[44] 256a2-3.
[45] 256a2.
[46] 255a5-11.
[47] 254b30.
[48] 255a12-25.

One corollary of the homogeneity of the elements is Aristotle's view that although the nature of the elements is an internal principle of change and rest and thus a source of motion, it is not an active principle which is capable of causing motion or acting on something, but a passive principle of being acted upon (κινήσεως ἀρχὴν ἔχει, οὐ τοῦ κινεῖν οὐδὲ τοῦ ποιεῖν, ἀλλὰ τοῦ πάσχειν).[49] Because the nature of the elements, their internal principle of change and rest, is passive, it cannot be the efficient cause of the natural motions of the elements. Therefore, an external efficient cause is needed to initiate the elements' natural motions. But this external cause does not operate in the same way as the efficient cause of forced motion because, in the case of forced motion, whether of an animate being or inanimate body such as a sublunar element, the efficient cause is the discrete thing which is applying the force to the moved object.

3.2.2 Two efficient causes of sublunar natural motion

Having explained why the sublunar elements do not initiate their own natural motions, Aristotle says of *"the light and the heavy"* that the efficient cause of their natural motions is either that which generated them and made them light or heavy (the *generans*), or that which removes the impediment or obstacle to their natural motion (the *removens impedimentum*).[50] The former efficient cause is the movement of the Sun along the ecliptic.[51] (There could be other examples of a proximate *generans* – such as a cook who is boiling a pot of water over a fire. But, generally speaking, the *generans* which causes the inter-transformations of the elements is the Sun.)[52] Examples of the other type of efficient cause (the *removens impedimentum*) are a person who pulls out a column holding something up or a person who removes a stone from an inflated wineskin under water.[53]

The first type of efficient cause of the natural motions of the elements (the *generans*) not only helps to explain why natural motion occurs, it also explains why the elements do not simply stay in their proper places. The inter-transformations of the elements, which are caused by the motion of the Sun, result in quantities of the elements being generated outside their respective proper places. A cosmos without such inter-transformations would be comprised of static, immobile layers of the

[49] 255b30-31.
[50] 255b35.
[51] 337a8.
[52] The role of the Sun as the efficient cause of the natural motions of the sublunar elements is considered in more detail in section 4.5 below.
[53] 255b24.

elements – i.e. the finite universe on its own would reach a stable position in which the different elements were separated into their concentrically arranged proper places. Such a complete segregation of the sublunary elements is avoided through the periodic heating and cooling of the sublunar sphere which results from the motion of the Sun.

The two different types of efficient cause of natural motion (the *generans* and the *removens impedimentum*) act on to two types of potentiality which Aristotle identifies in *Physics* VIII.4. The light comes to be from the heavy, e.g. air from water, because matter, as water, is potentially light; and once it is transformed into air, and hence is light, it will immediately be active if nothing prevents it. The actuality of the light is to be somewhere, namely up, and it will naturally move there unless it is being prevented when it is outside its proper place.[54] Thus, Aristotle says that when something is water it is potentially light in a way, and when it is air, it is still potentially light, for something may impede it from being up. But if the impediment is removed, it becomes active and moves upward.[55] Hence it seems that water is potentially light in two senses: it is potentially air (P1) and air is potentially up (P2). Natural motion by air towards its proper place is the actuality (as a potentiality) of P2. Thus in Kosman's terms, when naturally moving up, the air is fully manifesting its potentiality to be up *qua* potentiality.[56]

The movement of the Sun (the *generans*) is the efficient cause which transforms water into air, and actualizes P1. When it is generated by such a transformation, the air is initially in the proper place of water. In the absence of an impediment, the air will automatically rise towards its proper place and actualize P2. If there is an impediment, the second type of efficient cause (the *removens impedimentum*) is needed in order to actualize P2. (This issue is considered further in section 3.4.2 below.)

3.2.3 Is there a difference between forced and natural motion?

In his commentary on *Physics* VIII, Graham asks the question *"Is the theory of motion elaborated in Physics VIII compatible with that of Book II?"*.[57] He expands on this query as follows:

[54] 255b8.
[55] 255b17.
[56] See section 2.3 ante.
[57] Graham (1999), p.xv.

"According to Book II, a natural body originates its own motion; according to Book VIII, no body in motion originates its own motion. Indeed it is precisely the ability of natural bodies to move by themselves that distinguishes their motion from forced motion caused by an external agent".[58]

Graham concludes that what he regards as the revision of the theory of motion in Book VIII conflicts with Aristotle's original theory in Book II and that:

"If we were to push the claim that every moved body requires an external mover, we would be compelled to erase the distinction between natural and forced motions, and ultimately to treat natural motion as no different in principle from forced motion".[59]

There is, for the reasons explained below, an alternative interpretation to Graham's conclusion.

In the case of forced motion, the mover (i.e. the efficient cause) possesses in actuality the motion which the moved object has potentially. Thus, in the case of forced motion, the mover itself is undergoing the motion that is imparted to the moved object. Through contact between the mover and the moved object, the process of forced motion transmits the motion in question to the moved object by actualizing the potentiality for this particular motion which the moved object possesses.

In the case of the generation of air (e.g. vapour) from the evaporation of water (e.g. surface moisture) due to the approach (and heating) of the Sun, the water initially has in actuality the property 'cold' and the potentiality to be 'hot'. The efficient cause (the Sun) has in actuality the property 'hot' and it conveys this property to the water, and thereby changes the water's potentiality of being 'hot' into an actuality which transforms the water into air.[60] As the air is not in its proper place, in the absence of impediments it naturally moves upwards.

So, in the case of forced motion, the efficient cause imparts the motion in question to the moved object. Whereas in the case of the inter-transformation of the sublunar elements, the efficient cause (the Sun) does not possess the motion which is subsequently exhibited by the elements (i.e. rectilinear motion). Instead, the Sun imparts a different quality to the elements – i.e. 'hot' when the Sun approaches and 'cold' when the Sun recedes.

[58] Ibid.
[59] Ibid, p.xvi.
[60] The mechanism by which the approach of the Sun heats the sublunar elements is outside the scope of this thesis.

Therefore, contrary to Graham's claim, the distinction between forced and natural motions does not seem to be erased by Aristotle's statement that every moved body requires a mover.

3.3 Final cause of sublunar natural motion

3.3.1 Is proper place a cause of sublunar natural motion?

According to Aristotle, phenomena which happen always (ἀεὶ) or for the most part (ἐπὶ τὸ πολύ) come about because that is their goal (τέλος),[61] and Aristotle refers to this as the final cause of the phenomena. On this basis, if a motion is directed (always or for the most part) towards a particular place, then that place would seem to be the goal in the sense of the purpose or end to which that motion is a means.[62]

In this regard, it appears that the natural motions of the elements are goal-directed (i.e. teleological) rather than chance phenomena as they happen 'always or for the most part'. As each sublunar element naturally moves towards its proper place, it might perhaps be argued that the proper place of a sublunar element is the goal and hence the final cause of the natural motion of that element. At the very least it appears that the proper place of an element has some role to play in the explanation of natural motion of that element. But, before considering what that role is, it is appropriate first to consider whether place can be a cause at all.

In this regard, Aristotle notes that:

> *"the locomotions of the natural simple bodies (such as fire and earth and the like) not only show that place is something but also that it has some power* [δύναμιν]*"*.[63]

Thus, the proper place of an element has a certain influence or δύναμις. However, Aristotle then says:

[61] 196b10.
[62] 194a29.
[63] 208b8.

> *"for what [effect] on things that are could one make place responsible? No one of the four kinds of explanation is present in it: it is not an explanation as material of things that are, for nothing is composed of it; nor as a form and definition of things; nor as an end; nor does it change things that are"*.[64]

So, on the one hand, Aristotle says that place has a certain power but, on the other hand, he says that place is not a cause. Given the teleological character of sublunar natural motion, it would appear that there is a final cause of such motion. But if the proper place of each sublunar element, towards which its natural motion is directed, is not a cause, it is not immediately clear what the final cause of that motion is. Some commentators have sought to resolve the apparent tension between these two statements (that place has a power but is not a cause) by treating the latter statement as a puzzle or *aporia*, thereby leaving open the possibility that place is one of the four causes of the natural motions of the elements. For example, Sorabji says that:

> *"The denial at Physics IV.1, 209a20 that place can serve as any of the four causes, or four modes of explanation, is merely part of an aporia".*[65]

Sorabji does not seek to elaborate on or justify this claim, but he does rely on it to support his view that:

> *"Aristotle evidently wants natural places to play an explanatory role in the natural movement of the elements towards them, for he says that such motion shows that place has power (dunamis). The most likely explanatory role, although he never says this, is as a final cause or goal (not consciously sought) of motion"*.[66]

Thus, according to Sorabji, the proper place of a sublunar element is the final cause of its natural motion, even though Aristotle expressly denies in *Physics* IV.1 that place can serve as any of the four causes. Even if the statement at 209a20 is an *aporia*, Aristotle does not explicitly refute it. Therefore, it seems appropriate to exercise caution before asserting, as Sorabji does, that place is a cause. Indeed, as Algra suggests in this regard:

[64] 209a18-22.
[65] Sorabji (1988), p.187.
[66] Ibid, p.186.

"the aporia we are dealing with offers us a second thought about the alleged dunamis of place. We are not allowed to dismiss cavalierly such a second thought, or to play down the denial that place is a cause because it is merely part of a puzzle or aporia' ".[67]

As is explained below, it seems that there are good grounds for believing that proper place of a sublunar element is not the final cause of its natural motion (and so at 209a20 Aristotle is not merely setting out a rebuttable puzzle).

3.3.2 The final cause of sublunar natural motion is a location and not a place

Aristotle defines place as the first immobile limit of the surrounding body (ὥστε τὸ τοῦ περιέχοντος πέρας ἀκίνητον πρῶτον, τοῦτ' ἔστιν ὁ τόπος.).[68] Due to a sublunar element's internal principle of change and rest, each element has a tendency to move to its proper place and rest when it gets there. Therefore, the proper place of a sublunar element is the first immobile limit of a particular sort of body or bodies within which the element rests.

Whether a sublunar element's internal tendency to move is actualized at any point in time depends upon the surrounding body, i.e. the place in which an element is located. This can be demonstrated by the following example: when air is in its proper place, it has fire as the 'surrounding' body above it and water as the 'surrounding' body below it. If a quantity of air is not in its proper place, it will not have these surrounding bodies and so it will undergo natural motion towards its proper place unless impeded. In light of this, it seems clear that the natural motion of a sublunar element is in some way dependent on the body or bodies that surround it. Therefore, even though the place in which an element is located is itself inert (and does not act on the element), place does seem to have a certain power.

For some other changes, the τέλος is manifest. In the case of building, for example, the object undergoing the change (the building material) ends up as a house which is the goal and final cause of house building. In contrast, in the case of sublunar natural motion, the object undergoing the change (the element) does not itself end up as a place (i.e. a two dimensional surface) at the conclusion of its natural motion and so place is not the goal of that motion. The element does, though, end up in a particular place and that location is a property of the element at the end of its

[67] Algra (1997) p.202.
[68] 212a20. Therefore, the proper place of an element is a two-dimensional surface.

natural motion. As the natural motion of a sublunar element ceases when the element is located in its proper place, it seems that the goal and final cause of the natural motion is not the proper place of the element *per se* but for the element to be 'in' its proper place, i.e. to have that particular location.

This view potentially gains some support from Aristotle's earlier work, the *Categories*, in which he identifies, among other things, the category of 'where' (πού).[69] Aristotle makes use of this category when he refers to someone being "*in the Lyceum*" or *"in the market-place"*.[70] Therefore, according to the approach in the *Categories*, someone (i.e. a substance) can have the property of being located in a place but not the property of place *per se*. The concept of place is only touched upon in the *Categories*, whereas it is more fully elucidated in *Physics* IV; nevertheless, this earlier text highlights the important distinction which Aristotle draws between the property 'where' (i.e. being located 'in a place') and 'place' *per se*.

Having established that the final cause of the natural motion of a sublunar element is the location of that element in its proper place, consideration is given now to the formal cause of that motion.

3.4 Formal cause of sublunar natural motion

3.4.1 The forms of the sublunar elements

Aristotle introduces his notions of matter (ὕλη) and form (εἶδος) in *Physics* I, and elaborates on them in *Physics* II. Broadly speaking, physical objects are hylomorphic compounds made up of matter and form, and the latter is said to be the 'kind' of thing an object is by definition, its essence or account (λόγος) – the 'what it is to be' that object.[71] The formal cause of an object or phenomenon is its form. Although the elements are the simplest type of matter encountered in Aristotle's universe, they are themselves matter-form composites.

As noted in section 2.3 above, according to Aristotle's static principles of κίνησις, a change involves an underlying thing, a form and a privation. The underlying thing persists through the change and

[69] *Categories* IV.
[70] 2a2.
[71] 193a30.

acquires (and/or loses) a form. In the case of substantial change, e.g. when a piece of bronze is turned into a statue, the bronze persists and becomes informed by the new substantial form of the statue. For non-substantial changes, such as a man becoming musical, the essence or substantial form of the man persists and acquires a new accidental property – the form of being musical. Therefore, there are not only substantial forms which define substances, but also non-substantial forms which define the accidental properties of substances.

This Chapter seeks to identify the forms and privations involved in the change of place which occurs during the natural motion of a sublunar element. In this context, it is notable that the natural motion of a sublunar element seems to be an essential property which is part of the λόγος or definition of the element and, as such, that motion will be related in some way to the form of the element. Therefore, before seeking to identify the formal cause of sublunar natural motion, it is appropriate first to consider the forms of the elements themselves.

The four sublunar elements have the following properties:[72]

Element	**Qualities**	**Description**	**Natural Motion**	**Proper Place**
Fire	hot/dry	absolutely light	up	periphery
Air	hot/wet	relatively light	up	above water but below fire
Water	cold/wet	relatively heavy	down	below air but above earth
Earth	cold/dry	absolutely heavy	down	centre

On the basis of Aristotle's static principles, a change, such as the transition of an object from being cold to being hot, involves an underlying thing, the initial terminus of a form/privation (e.g. cold/not hot) and the final terminus of a privation/form (e.g. not cold/hot). So, for example, when water is heated by the approach of the Sun,[73] the water initially has the form of 'cold' (and the privation of 'hot') which it loses due to the approach of the Sun, and acquires the form of 'hot' (and the privation of 'cold') and, as a result of this change, the water is transformed into air.

[72] 330b5.
[73] See footnote 60 ante.

Thus, the qualities hot, cold, dry, and wet, can each be regarded as forms which objects (including the elements) possess when they have these qualities. As the pairs of qualities listed above are essential to each of the elements, when any of these qualities changes, the element in question will be transformed into one of the other elements. So, when water is heated, it retains the form 'wet', loses the form 'cold', acquires the form 'hot' and is thereby transformed into air.

However, air not only has the qualities of hot and dry, it also has a natural motion which is 'up' and a proper place which is below fire but above water. These properties are features of the 'overall' λόγος which defines the element air – 'what it is to be' air. If a natural motion of 'up' is part of the definition or form of air, it would appear that this form might have a causal role in the natural motion of air to its proper place.

3.4.2 Is a sublunar element fully actualized when located in its proper place?

Aristotle says that the form of a natural thing is its nature,[74] and that the sublunar elements are moved by nature whenever they move to the actualities which are potentially theirs.[75] He also defines κίνησις as *"the actuality of that which potentially is, qua such"*. When considered together, these statements confirm that the form of an element does have a causal role in its natural motion and that this role is related to certain potentialities that are inherent in the element in certain situations. Aristotle elaborates on these views in *Physics* VIII as follows:

- *"the light comes to be from the heavy, e.g. air from water… The actuality of the light is to be somewhere, namely up"*;[76] and

- *"when something is water, it is potentially light in a way, and when it is air, it is still potentially light, for something may impede it from being up. But if the impediment is removed, it becomes active and goes ever upward"* (ἐνεργεῖ καὶ ἀεὶ ἀνωτέρω γίγνεται).[77]

[74] 193b7, 12 and 19.
[75] 255a28.
[76] 255b8.
[77] 255b18.

In light of the second bullet above, it seems that water is potentially light in two senses: it is potentially air (P1), and air is potentially up (P2). In the terms used in the assessment of Aristotle's dynamic definition of κίνησις in section 2.3 above, when air is naturally moving towards its proper place it is *"fully manifesting* [P2, the potentiality to be up] *as a potentiality"* and in that situation the air is *"in actuality … operating … qua changeable"*.

P2, the potentiality of air to be up (i.e. to be located in air's proper place), seems to be related to air's essence or form as the proper place of air is part of its essence or *'what it is to be'* air. On this basis, being located in its proper place is part of the nature or form of air, and its inner capacity of motion is the potentiality of air, when it is not in its proper place, to move to that location. Thus, being located in its proper place would be part of the full actualization by air of its essence or form.

Some support for this interpretation is gained from *On the Heavens* IV.3, where Aristotle states that *"motion towards its proper place is for each thing motion towards its proper form"* (τὸ αὐτοῦ εἶδός).[78] In light of the above assessment, it seems that the natural motion of a sublunar element towards the proper place is motion towards its form because the property of being located in its proper place is concomitant with the full actualization by the element of its form.[79]

Having assessed the way in which the form of a sublunar element is related to its natural motion, the next step is to consider the formal cause of that motion.

3.4.3 The formal cause of sublunar natural motion is the τέλος of the κίνησις

In *Physics* II.3, Aristotle describes the formal cause as *"the form … this is the account of what the [thing] would be"*. In *Nicomachean Ethics* X.4, Aristotle gives further consideration to the forms of walking and the other types of locomotion and says that *"[the] many movements are incomplete and differ in form since the from-where and the to-where determine the form"* (αἱ πολλαὶ ἀτελεῖς καὶ διαφέρουσαι τῷ εἴδει, εἴπερ τὸ πόθεν ποῖ εἰδοποιόν).[80]

Applying this assessment to sublunar natural motion demonstrates Aristotle's view that different motions have different forms. By way of example, when water is surrounded by air and naturally

[78] 310a33-34.
[79] This view receives some support in the secondary literature. See Algra (1997) p.214, Machamer (1978) p.380 and Matten (2009).
[80] 1174b4-5.

moves to its proper place, it moves down. That motion results from the internal nature of water and the motion ceases when the water is located in its proper place (the ποῖ of the natural motion). However, the 'from-where' (πόθεν) for the natural motion of water would be different if it were initially surrounded by air or if it were initially surrounded by fire or even earth. In light of this, the routes or paths of the natural motions of air may be different, in which case the forms of those motions would also seem to be different. Therefore, if the form of a motion is determined by both the πόθεν and the ποῖ of the motion, the question arises whether the formal cause of an instance of sublunar motion depends on (and varies with) the initial location of the element in question.

In this context, it is helpful to start again from Aristotelian first principles in order to identify the formal cause of sublunar natural motion. According to the static principles of κίνησις in *Physics I*.7, a change involves an underlying thing and two opposites. In the case of locomotion, these opposites are the initial and final locations (the πόθεν and the ποῖ). These locations are accidental properties of the underlying thing. In *Physics* 1.7, Aristotle confirms, by reference to the example of the κίνησις of an unmusical man becoming musical, that the accidental properties (which are acquired or lost by the underlying thing as a result of κινήσεις) are forms. On this basis, the accidental form which a sublunar element loses at the start of an instance of natural motion is the location πόθεν and the accidental form which it acquires at the end of its natural motion is the location ποῖ – i.e. location in its proper place.

In his discussion of the static principles of κίνησις, Aristotle confirms that *"One of the opposites, by its absence or presence, will suffice to effect the change"*.[81] Thus, a change can apparently be specified in terms of the underlying thing and the form which the underlying thing gains as a result of κίνησις (without also needing to mention the initial privation which the underlying thing loses). So, a non-substantial change (e.g. locomotion) can be characterized in terms of the accidental form or property (e.g. the location) which the underlying thing acquires at the end of the change. This would seem to be the λόγος of the change, and so this would seem to be the formal cause of the change.

Support for this view can be obtained by further reference to Aristotle's assessment of κίνησις in *Nicomachean Ethics* X.4, when he says *"For every movement involves time and relates to some end, such as housebuilding, and it is complete whenever it produces what it aims at"*.[82] Thus, the natural

[81] 191a7.
[82] 1174a19-21.

motion of an element towards its proper place 'relates to' and 'is complete at' its final terminus, the location in its proper place which is only fully actualized when the motion is complete. The location in its proper place is the form of the accidental property which the sublunar element acquires at the end of its natural motion, and so this is the formal cause of that motion. A sublunar element undergoes natural motion whenever it is initially located other than in its proper place,[83] and this formal cause (of being located in its proper place) explains the natural motion irrespective of the whereabouts of that initial location.

As noted in section 3.3.2 above, the final cause (τέλος) of an element's natural motion is also the location of the element in its proper place. Therefore, on the basis of the above assessment, the formal and the final causes of the natural motions of sublunar elements would be the same. This is unsurprising as Aristotle confirms in *Physics* II.7 that *"What a thing is [i.e. the formal cause], and what it is for [i.e. the final cause], are one and the same"*.[84]

This passage in *Physics* II.7 also states with regard to the four causes that *"The last three often coincide",* and *"that from which the change originates is the same in form as these",* in other words the efficient cause is often the same in form as the formal and final causes. This seems to be the case with forced motion, where the mover (i.e. the efficient cause) possesses in actuality the motion which the moved object has potentially. Through contact, the form of the motion in question is imparted by the mover to the moved, and the motion culminates in the full actualization of the potentiality for this particular motion which the moved object possesses. So, in the case of forced motion, it appears that the formal cause of the motion is not only the same as the final cause, but this form is also possessed by the efficient cause of the motion. However, as noted in section 3.2.2 above, in the case of the natural motion of the sublunar elements, Aristotle identifies the efficient cause as the *generans* or *removens impedimentum*, neither of which is the same in form as the final and formal causes of the natural motion. Thus, this assessment of the formal cause of sublunar natural motion supplements the assessment in section 3.2.3 above and provides a further reason to question Graham's claim that there is no difference between forced and natural motion.

Finally, it should be noted that the formal cause of the natural motion of a sublunar element and the form of that element are not the same. Nevertheless, the formal cause of an element's natural motion (i.e. the accidental form of being located in the element's proper place) certainly seems to be

[83] The element would also need to be unimpeded for it to move naturally.
[84] 198a25.

related to the intrinsic form of the element (i.e. what it is to be that element). It is 'part' of the essence or form of an element to be located and at rest in its proper place. When a sublunar element is located outside its proper place, it will, if unimpeded, immediately start to actualize its internal principle of motion and naturally move to its proper place. The element fully actualizes this 'part' of its essence or form when it is located in its proper place and it acquires the accidental form of that location. So, the formal cause of a sublunar element's natural motion coincides not only with the final cause of that motion but also with the full actualization of the intrinsic form of that element.

Having explained why location of a sublunar element in its proper place is both the final and formal cause of the element's natural motion, section 3.5 considers the material cause of that motion. This is, perhaps, the most self-evident of the four causes and yet, as an explanation of natural motion, it still seems rather opaque.

3.5 Material cause of sublunar natural motion

3.5.1 Should matter be 'deconstructed' in the search for the material cause?

As is noted in section 2.2 above, the material cause in the case of the generation of an object, such as an artefact, is often uncontroversial as it is the matter from which the object is made.[85] For example, when a bronze vase is melted down and reformed into a statue, the bronze is the material cause of that substantial change. But in the case of non-substantial changes, the material cause (and its utility as an explanation) may be less clear. For example, when a bronze vase is moved from one room of a house to another, it seems that the material cause of this non-substantial change might be the vase. Yet this statement appears rather uninformative. If, however, the vase is dropped out of a window, it will naturally fall to the ground and it might seem more instructive to say in this case that the material cause of that motion is the vase, and that the vase naturally moves down because it is made of bronze which is predominantly comprised of the element earth and so has the natural motion of earth.

As this example shows, matter can be regarded as being progressively informed and so the material of a complex object, such as a statue, can be viewed as bronze and can also be assessed in terms of

[85] 194b23.

its constituent elements, such as earth. Thus, the question arises as to whether the matter of an object undergoing a κίνησις should be 'deconstructed' in order to identify the material cause of the κίνησις. In practice, it appears that the answer to this question is 'no', for the reasons outlined below.

In *Physics* II.3, Aristotle unequivocally says that the material cause of the production of a bronze statue is the bronze, and so he does not seek to equate the material cause with the matter (e.g. the sublunar elements) out of which the bronze is made. In addition, in this context Aristotle not only says that the material cause of an object, such as an artefact, is the matter from which the object is made, he also describes the material cause as the underlying thing (τὸ ὑποκείμενον)[86]. In the discussion of the four causes in *Physics* II.3, Aristotle does not elaborate on what he means by this expression. However, in his discussion of the static principles of κίνησις, Aristotle explains that the underlying thing is the material substrate (i.e. the physical object) which persists through a κίνησις. Thus, pursuant to the static principles of κίνησις, it appears that the material cause of a κίνησις is the underlying thing which persists through the κίνησις. This conclusion is reinforced by Aristotle's comment in the *Meterology* that *"we call the passive subject of change the material cause".*[87] On this basis, it is not necessary to 'deconstruct' the underlying thing into its constituent elements in order to identify the material cause.

3.5.2 The sublunar elements are the material causes of their natural motions

In the case of the natural motion of a sublunar element, the underlying thing, which persists through the change of location, is the element itself. It seems, therefore, that the sublunar elements are the material causes of their natural motions.

This claim that the material cause of the natural motion of a lump of earth, for example, is the earth itself seems rather unenlightening and of limited value as an explanation – i.e. earth naturally moves down towards the centre of the universe because that is what earth does. However, Aristotle gives such an explanation when he rhetorically asks why light and heavy things move to their proper places, and answers that it is their nature.

[86] 195a19.
[87] 399a29-30.

διὰ τί ποτε κινεῖται εἰς τὸν αὐτῶν τόπον τὰ κοῦφα
καὶ τὰ βαρέα. αἴτιον δ' ὅτι πέφυκέν ποι, καὶ τοῦτ' ἔστιν τὸ (15)
κούφῳ καὶ βαρεῖ εἶναι, τὸ μὲν τῷ ἄνω τὸ δὲ τῷ κάτω
διωρισμένον.

255b14 *Just why do the light and the heavy move to their own place? The explanation is that it is their nature to go somewhere, and this is what it is to be light or heavy, the one being defined by up and the other by down.*

Thus, according to Aristotle, earth moves down because that is its nature. However, having applied Aristotle's concepts of the four causes, the static principles of κίνησις and the dynamic definition of κίνησις to the natural motions of the sublunar elements, it has been possible in the preceding chapters to unpack this cryptic comment and thereby provide further explanation of why these κινήσεις are as they are. In the following chapters, these concepts of the four causes and Aristotle's principles and definition of change are applied to the heavens in order to in order to gain a better understanding of the properties and natural motion of αἰθέρ. The first step of this assessment of αἰθέρ is to determine whether there are actually any κινήσεις in the heavens.

4. Is there motion in the Aristotelian heaven? (An astronomical perspective on the distinction between κίνησις and ἐνεργεία.)

4.1 The problem – can everlasting heavenly motion be a κίνησις?

As the circular motions in the heavens are apparently complete and everlasting and thus have no termini, it is not clear how any of them can constitute a κίνησις, which, according to the static principles in *Physics* I.7, is the transition between termini and, according to the dynamic definition in *Physics* III.1, is incomplete while it is ongoing. This challenge has been highlighted by commentators, including Waterlow and Coope.

In her book entitled *"Nature, Change, and Agency in Aristotle's Physics"*, Waterlow stated the following:

> *"let us consider whether this [eternal heavenly] motion could by the standards implicit in the definition of III.1 be properly described as* κίνησις *or process at all. The problem is to see how it can count as an incomplete actuality, an actuality of what is potential qua only potential. Changes that fall neatly under the original definition all naturally culminate in states of non-change, the change itself being actual only up to that point. But where there is no future culmination, there is no corresponding present potentiality for this, and hence, it would seem, no process".*[88]

> *"Sublunary changes are incomplete actualities by contrast with the complete ones in which they naturally terminate; but there is no such contrast to justify the term 'incomplete' as applied to the eternal case. The consequence seems clear: either the eternal motion counts as a complete actuality, or its incompleteness derives from an entirely different contrast. As a natural phenomenon, the eternal circular motion is as complete as anything in nature could be. Since it never started, it follows that at every moment every part of the rotating body has just completed a circle; and since it will never end, there is never any falling short of a complete number of circles".*[89]

[88] Waterlow (1982), p.249, paragraph 43.
[89] Ibid, p.250, paragraph 44.

> *"Now the natural motions of the sublunary bodies are clearly incomplete actualities, so they fit the definition of* κίνησις *in III.1. The criterion of their incompleteness, hence of their kinetic status, is that they proceed to a culmination. … But to turn now to the case of eternal rotation: here Aristotle lacks the criteria upon which he has so far been relying to divide kinetic from non-kinetic, incomplete from complete. If he takes the criterion of incompleteness to be 'proceeding to a culmination', the eternal rotation is not incomplete".*[90]

Coope has raised similar concerns in an article entitled *"Change and its Relation to Actuality and Potentiality"*:

> *"Aristotle holds that the most primary kind of change is an unending rotary motion. … Our question is: how can there be an unending motion …, if motion (being a species of change) is the actuality of a potential to be in some definite end state? … Since the movement is unending, there is no end point at which it will naturally culminate. It cannot, then, be the incomplete actuality of a potential to be at such an end point (for the moving thing has no such potential). Moreover, since the movement is rotary, it is not even directed towards an unreachable end point …. The path traced out by rotary movement is entirely occupied by the moving body. Any part of that path that is being approached by one section of the moving thing will already be occupied by another section".*[91]

These comments invite an assessment of the basis on which any of the everlasting heavenly motions could constitute a κίνησις. It is, though, perhaps worth mentioning at this point that Aristotle clearly indicates in a number of places that he believes there is such a thing as everlasting motion. For example, near the beginning of *Metaphysics* Lambda.7, Aristotle says:

> καὶ ἔστι τι ἀεὶ κινούμενον κίνησιν ἄπαυστον, αὕτη
> δ' ἡ κύκλῳ
>
> 1072a21 *and there is something which is always being moved in an unceasing motion, and this motion is in a circle.*

[90] Ibid, p.254, paragraph 48.
[91] Coope (2013), pp.288-9.

This is a reference to the everlasting circular motions in the heavens which are caused (or inspired) by the unmoved mover that Aristotle goes on to describe in some detail in *Metaphysics* Lambda.7. In the circumstances, it would be a significant setback for Aristotle if his unmoved mover is not (in some way) responsible for κίνησις in the heavens. The assessment below seeks to show that such a setback does not arise.

4.2 Rotations, orbits, and τόποι

Before outlining a potential solution to the challenge identified by Waterlow and Coope, it may be helpful to highlight the following considerations.

(i) In the Aristotelian universe, the visible heavenly bodies (i.e. the Sun, Moon, planets and stars) are embedded in invisible, concentric, contiguous, celestial spheres.[92] The heavenly bodies and the celestial spheres are all solely comprised of αἰθέρ. The celestial spheres rotate independently around their own axes, which all pass through the centre of the universe and thus the centre of the Earth.[93] In contrast, each heavenly body is carried round by the celestial sphere in which it is embedded, and therefore each heavenly body follows an orbit around the centre of the universe, which is external to all the heavenly bodies.[94] Thus, there are significant differences between the rotations of the celestial spheres and the orbits of the heavenly bodies.[95]

(ii) As previously stated in Chapter 2 above, Aristotle confirms that κίνησις can occur in respect of coming-to-be, quantity, quality and place. However, as the celestial spheres and the heavenly bodies are comprised of αἰθέρ they are not only everlasting but also

[92] The fact that the heavenly bodies are visible and the celestial spheres are not, and yet both are comprised solely of αἰθέρ which is considered to be homogenous, does not seem to be explained by Aristotle. That potential tension is, however, outside the scope of this thesis.
[93] At *Metaphysics* Lambda.8, 1074a1, Aristotle describes a relationship between the celestial spheres which results in each sphere being carried round by the sphere immediately outside it. Athough the spheres are concentric, they are not coaxial. So, each sphere rotates independently around its own axis while being carried around by the adjacent larger sphere.
[94] In practice, the orbits of some heavenly bodies (e.g. the Sun) reflect the aggregate motions of more than one celestial sphere. This is discussed further in section 4.5 below.
[95] Although the word 'rotate' is in some contexts (rather inaccurately) used to describe the action of an orbiting body, it is more precise to limit that term to the action of a body which spins on an internal axis. The word is used in this way in this thesis.

immutable, save possibly in respect of τόπος.[96] Therefore, the only κίνησις that can occur in the heavens is locomotion.

With regard to the concerns of Waterlow and Coope, it should be noted that in the passages cited in section 4.1 above:

- neither Waterlow nor Coope distinguishes between the rotations of the celestial spheres and the orbits of the heavenly bodies and, in fact, neither of them expressly mentions the orbits of the heavenly bodies around the Earth;

- it seems that Waterlow and Coope may both be considering just the rotations of the celestial spheres about their respective central axes, and not the orbits of the heavenly bodies around the Earth, as Waterlow says that *"at every moment every part of the rotating body has just completed a circle"*, and Coope says that *"The path traced out by rotary movement is entirely occupied by the moving body"*; and

- both Waterlow and Coope refer to change and motion without specifically identifying what if any change of τόπος could arise in respect of the only possible κινήσις in the heavens (i.e. locomotion).

It appears, therefore, that these assessments by Waterlow and Coope do not address the orbits of the heavenly bodies or whether any of the celestial spheres or the heavenly bodies is changing its τόπος. The implications of this are outlined below.

When considering a potential instance of locomotion, the scope for a change of τόπος would seem to be of critical importance. Aristotle defines τόπος as follows:

> ὥστε τὸ τοῦ περιέχοντος πέρας ἀκίνητον πρῶτον, τοῦτ'
> ἔστιν ὁ τόπος
>
> 212a20 *So that is what place is: the first unchangeable limit of that which surrounds*.

[96] 270b1.

Thus, the first immobile boundary of the surrounding body of an object is the place in which that object is located. A key feature of any rotation of a spherical body around a central axis, including the rotations of each of the celestial spheres, is that the body undergoes no translation (i.e. no lateral displacement). Therefore, unlike an object which is undergoing lateral displacement, the surrounding body of a rotating sphere maintains the same first immobile boundary with the sphere notwithstanding the latter's rotation. Thus, despite their rotations, none of the celestial spheres is changing its τόπος.

Aristotle expressly confirms that this is the case in *On the Heavens*, where he says *"with regard to the body which revolves, … it cannot change its place"*.[97] Aristotle also states in respect of the stars, which he argues are spherical, *"If their motion were rotation, they would remain in the same place and not change their position"*,[98] and *"the sphere is at once the most useful shape for motion in the same place – since what is spherical … can most easily maintain its position unchanged"*.[99]

In light of these considerations, it is clear that the rotations of the celestial spheres cannot be κινήσεις because they entail no change of τόπος. This conclusion holds whether or not these rotations are regarded as 'complete', as Waterlow and Coope suggest.

Nevertheless, the fact that the everlasting rotations of the celestial spheres cannot be κινήσεις does not preclude the possibility that the orbits of the heavenly bodies may be κινήσεις for the reasons explained below.

4.3 Undertaking a dynamic rather than a static analysis

In light of the issues outlined in section 4.2 above, an assessment of heavenly motions should (a) distinguish between the rotations of the celestial spheres and the orbits of the heavenly bodies, and (b) consider how, if at all, the motion of an object affects its τόπος. In addition, the assessment should be dynamic rather than static, for the reasons outlined below.

As previously noted, in *Physics* I.7 Aristotle describes how κίνησις involves an underlying object, a form and a privation. That explanation reflects a static analysis as it focuses on the termini of the

[97] 278b28-30.
[98] 290a13.
[99] 290b1.

change (the form and the privation) and the underlying object which transitions between those termini. As Waterlow and Coope clearly state, the everlasting heavenly motions have no end points at which they culminate. In light of this, the everlasting heavenly motions (of both the celestial spheres and the heavenly bodies) would not seem to satisfy the static principles of κίνησις described by Aristotle in *Physics* I.7. This should, though, not be a surprise as the fact that the celestial spheres and the heavenly bodies are never at rest means that their motions cannot satisfy these static principles. As was noted in Chapter 2, Aristotle's description of the static principles refers to αἱ ἀρχαὶ τῶν περὶ γένεσιν φυσικῶν, i.e. 'the principles of natural things which are involved in coming-to-be'. The objects in the heavens are everlasting and immutable (save perhaps with regard to τόπος) and so are not involved in coming-to-be. Thus, due to Aristotle's qualification of the static principles of κίνησις as applicable to natural things in so far as they are περὶ γένεσιν, it is not appropriate to apply these principles to motions in the heavens.[100]

Nevertheless, Waterlow and Coope suggest that the motions in the heavens can be shown not to be κινήσεις through the application to those motions of Aristotle's dynamic definition of κίνησις in *Physics* III.1, that a change is *"the actuality of that which potentiality is, qua such"*. In this regard, Waterlow states that *"where there is no future culmination, there is no present potentiality for this",*[101] and Coope asks *"how can there be an unending motion …, if motion (being a species of change) is the actuality of a potential to be in some definite end state?".*[102]

It should be noted that, in the way she frames this question, Coope seems to have imported one of the static principles of κίνησις into Aristotle's dynamic definition, by supplementing the latter with an express reference to the terminus cited in the former (i.e. by adding the word *"definite"* when referring to the potential to be in some end state). Yet in the case of heavenly motion, there cannot be a *"definite"* end state to the κίνησις because such motion is everlasting. So, Coope's stipulation

[100] In his commentary, Ross suggests (at page 494) the possible exclusion of the words περὶ γένεσιν but does not offer any supporting reasoning. Charlton acknowledges this suggestion and puts his translation of these words in square brackets (at page 18), again without any supporting reasoning. It is, however, notable that the Greek commentators (Philoponus, Simplicius and Themistius) all retain these words and the former two note that the principles of κίνησις do not apply to the heavenly bodies because they are everlasting. The fact that the static principles of κίνησις cannot be applied to everlasting motions in the heavens would seem to be one reason why the words περὶ γένεσιν may have been included in Aristotle's text in the first place.
[101] See footnote 88 ante.
[102] See footnote 91 ante.

of a *"definite"* end state, as a prerequisite for κίνησις, actually precludes the possibility of an everlasting heavenly motion being a κίνησις.[103]

In the case of the unimpeded natural motions of the sublunar elements, the termini (i.e. the definite end states) of the motions are clear at the outset; for example, earth naturally moves towards the centre of the universe and fire naturally moves towards the inner rim of the celestial sphere which carries the Moon. But it is not the case that all κινήσεις have predetermined termini. By way of example, a plant (such as an agricultural crop, e.g. wheat) will naturally grow to maturity. However, the size to which the mature crop grows will depend upon a number of factors including the quantity of summer rainfall. If a crop receives too much or too little rain in the summer, it will not grow to its maximum potential. However, as Aristotle explains in *Physics* II.8, summer rain happens due to chance rather than always or for the most part. A mature crop may have the nature of growing to size S_1 if it receives the quantity of rain Q_1, and size S_2 with rain Q_2 etc, but the quantity of rain throughout the summer is not determined before it occurs. So, in the absence of controlled irrigation, the amount of water a crop receives, and thus the actual size to which the mature crop will grow, will not be determined before the crop is planted or after the crop has reached maturity and is still growing (until near the time when it is due to be harvested). Thus, while it is still growing (i.e. while that κίνησις is ongoing), the mature crop has the potential to be larger but not the potential to be a *"definite"* larger size. Therefore, the change of quantity (i.e. growth) of the mature crop does not have a *"definite"* end state while it is in progress. Nevertheless, this growth should be (and is) regarded as a natural κίνησις. Indeed, Aristotle expressly identifies growth and diminution (αὔξησις καὶ φθίσις) as a type of κίνησις when he sets out his dynamic definition in *Physics* III.1.[104]

This lack of a definite end state to the growth of a mature crop, while it is ongoing, results from an external factor (i.e. the quantity of rainfall). As is explained in section 4.4 and Chapters 5 and 6 below, the lack of a definite end state to either the rotations of the celestial spheres or the orbits of the heavenly bodies also results in each case from external factors.

If the above assessment of growth is correct, then it would not seem to be appropriate to require an everlasting motion to have a *"definite"* end state for it to constitute a κίνησις. Instead, it should be sufficient that it has multiple potential end states, even if the eventual end state cannot be specified

[103] If it were a prerequisite of any motion that it culminates, then the expression 'eternal (or everlasting) motion', to which Aristotle refers in *Physics* VIII, would be an oxymoron and it would appear that Aristotle erred when he identified such motion in the heavens.
[104] 201a13-14.

in advance or even while the κίνησις is ongoing. In practice, it appears that Aristotle endorses such an assessment in *Physic*s VIII, before he goes on to discuss everlasting motion. Specifically, in this context, Aristotle refers to:

> φαμὲν δὴ τὴν κίνησιν εἶναι ἐνέρ-
> γειαν τοῦ κινητοῦ ᾗ κινητόν.
>
> 251a9 *Now we say that motion is the actuality of the movable in so far as it movable*.

Thus, κίνησις is described as *"the actuality of the movable in so far as it is movable"* without specifying a definite end state. In her monograph entitled *"The Concept of Motion in Ancient Greek Thought"*, Sattler adopts a similar approach and avoids any reference to a definite end state for heavenly motions when she states:

> *"There are also motions for Aristotle that are not goal-oriented and thus simply continuous … for example, the heavenly bodies' circular motion … In these cases it is better to think of the movement as actualised potential for moving. What is, nevertheless, essential for* κίνησις *also in these cases is the fact that there is always some unrealised potential (even if it is not a goal-oriented motion) in contrast to a mere actuality without unfulfilled potential"*.[105]

The next section follows Sattler's approach and undertakes an assessment of the orbits of the heavenly bodies as an *"actualized potential for moving"* (i.e. for being in a different τόπος) which is not contingent on the orbits having a definite end state. Thus, the assessment reflects a dynamic analysis which focuses on the process of change, rather than the (non-existent) termini. In this context, the following section also identifies the *"unrealised potential"* which Sattler describes as *"essential"*.

4.4 Identifying κίνησις and ἐνεργεία in the heavens

For the reasons outlined in section 4.2 above, the rotations of the celestial spheres cannot be κινήσεις because they do not involve any change of τόπος. But the same conclusion does not arise in respect of the orbits of the heavenly bodies.[106]

[105] Sattler (2020), p.283.

[106] In *Physics* IV.4, Aristotle confirms that place is neither less nor greater than the object in the place (211a2), place is equal in size to the object in the place (211a33), and the limits of an object and its place are contiguous

Unlike the celestial spheres, a heavenly body does not remain in the same τόπος while it proceeds round its orbit because the first immobile boundary of its surrounding body is changing. In fact, while the heavenly bodies are orbiting the centre of the universe, they are not in any place because a body which is actually undergoing locomotion is not located in a τόπος; a body can only be located in a τόπος when it is at rest and there is a first immobile boundary of its contiguous surrounding body.

The significance of this issue is highlighted by Aristotle's response to Zeno's paradox of Achilles and the tortoise.[107] In this paradox, Zeno claims that having given the tortoise a head-start in a race, Achilles will never be able to overtake the tortoise because he must first catch up with it. But each time Achilles reaches the tortoise's previous location, the tortoise has moved on. Hence, Zeno claims that to overtake the tortoise, Achilles will have to complete an infinite number of tasks, which is impossible. Aristotle's response to this paradox acknowledges that it is not possible to complete an infinite number of actual tasks and that traversing an actual part of a line would be an actual task. Nevertheless, Aristotle argues that an actual part of a line must be bounded by actual points, and the points that Achilles passes through are potential but not actual points unless Achilles actualizes them by occupying them as places (e.g. by momentarily being located in them). Merely passing through a point is not sufficient to actualize it. Therefore, Achilles can move continuously until he catches up with the tortoise because that is not an infinite series of tasks but just one actual task.[108]

Thus, according to Aristotle, Zeno's paradox is resolved because each point on Achilles' path is a potential place but not an actual place, unless Achilles stops and is located in it. In a similar vein, each point on the orbit of a heavenly body is a potential place but not an actual place because the heavenly body passes through it and is not located in it (even momentarily) as the motion of each heavenly body is continuous. So, even though a heavenly body is not actually located in a τόπος while it is moving, it is potentially located in every τόπος it passes through (as Achilles is potentially located at every point on the path of his race against the tortoise).

(212a30). Therefore, as the surface of a heavenly body and its place are contiguous, the celestial sphere which encompasses the whole of the orbit of that heavenly body cannot constitute the place of that heavenly body. See also footnote 15 in Burnyeat (1984).

[107] 263a4-b9.

[108] Sattler (2020), PP. 153-5, discusses why continuous motion such as this does not constitute an infinite series of discrete tasks.

Therefore, in the terms of Aristotle's dynamic definition of κίνησις in *Physics* III.1, the orbiting of a heavenly body around the centre of the universe is in each case the actuality of the potentiality to be located in a τόπος along the path of the relevant orbit (in so far as it is a potentiality). That actuality is incomplete, as specified in Aristotle's dynamic definition of κίνησις, because the heavenly body is only potentially (and not actually) located in a τόπος while it is revolving around its orbit. The heavenly body would actually be located in a τόπος only if the revolutions around its orbit were to cease. As those revolutions do not cease, the κίνησις that the heavenly body undergoes is not only everlasting, it is also forever incomplete because the body lacks a τόπος.[109]

Nevertheless, as Waterlow suggests, the question arises whether a body can potentially be in a τόπος when its motion never ceases and, in fact, cessation of the motion seems to be impossible. In this context, it is notable that Aristotle regards a line as being infinitely divisible, even though to divide a line infinitely many times would involve the completion of an infinite number of tasks which is impossible.[110] In light of this, Aristotle contends that a line is potentiality infinitely divisible but not actually infinitely divisible. Thus, despite the fact that an actuality may be impossible to achieve, the corresponding potentiality may still exist. It appears that a heavenly body (which is orbiting with everlasting revolutions) may potentially be located in a τόπος in a similar sense to Aristotle's approach to the infinite divisibility of a line.

In addition, in this regard it may also be relevant that the orbits of the heavenly bodies are forced motions, as these bodies are carried round by the celestial spheres in which they are embedded. (When assessing heavenly motion in many places in both *On the Heavens* and in *Metaphysics* XII, Aristotle employs the term φορὰ rather than κίνησις as a label for that motion; and Liddell & Scott give *"a carrying"* as the primary definition of φορὰ and *"a being borne or carried along, motion, movement"* as secondary definitions. Thus, Aristotle's use of the term φορὰ as a label for heavenly motion may emphasize the forced nature of that motion in respect of the heavenly bodies.[111]) In the case of the forced motion of bodies in general, the final terminus of the motion is not an inherent attribute of the bodies themselves but is determined by the attributes of the agents which cause the forced motion and, in particular, the force that is applied. The fact that it is impossible for a heavenly body actually to be located in a τόπος along the path of its orbit is due to the everlasting rotation of the celestial sphere which is the agent of the forced motion of the heavenly body. Therefore, it is the attributes of the celestial spheres (and the unmoved mover) which prevent the

[109] This is the *"unrealised potential"* to which Sattler alludes. (2020) p.283.
[110] Physics III.4 – III.8.
[111] The translation of the word φορὰ is considered further in section 6. 1 below.

heavenly bodies from actually being located in a τόπος and not the attributes of the heavenly bodies themselves. However, even though a heavenly body cannot, due to these external factors, actually be located in a τόπος, that does not preclude the heavenly body in question from itself having the potentiality to be located in any τόπος along its orbit.

In the article which is cited in section 4.1 above, Coope makes the following comments about forced motion:

> *"Consider, for instance, a stone that is inadvertently knocked out of the way by a walker. Its movement is not natural to it (since it is moving under the influence of an external force), but nor is this movement directed towards some end set by the agent: there is no potentiality of the walker that is fulfilled by the stone's being in one place rather than another. It is hard, then, to see what ground there is for thinking that this movement is the actuality of a potential to be some particular place rather than another. Aristotle could, of course, insist that there is some place at which this movement would stop (barring interference) and the movement is the incomplete actuality of a potential to be in this place. But this seems arbitrary. There is no independent reason for supposing that a movement of this sort is (like the other changes we have considered) directed towards a particular end".*[112]

In the case of forced motion generally, it certainly appears that a body which is the subject of that motion does not itself determine the terminus, if any, of the motion. Furthermore, where the force in question is being applied without cessation, there will be no such terminus. Nevertheless, as a heavenly body undergoing forced motion is a three-dimensional object, it has itself the potential to be located in a τόπος. In light of these considerations, it might be argued that as the forces applied to the heavenly bodies are everlasting, there will be no terminus to their orbits; nevertheless, the heavenly bodies themselves have the potential to be located at every point through which they move. On this basis, each of their orbits would be a κίνησις because it constitutes the actuality (as a potentiality) of the potentiality to be located in any of those τόποι even though it is, in Coope's words, not *"the actuality of a potential to be some particular place rather than another"*. (This issue is considered further in section 6.4 below.)

In contrast with the orbits of the heavenly bodies, the rotations of the celestial spheres do not entail the potentiality to be in a different τόπος because each celestial sphere, save for the outermost

[112] Coope (2013), p.289.

sphere which carries the 'fixed' stars, is actually located within the innermost boundary of the adjacent larger sphere; and so it is at rest within that particular τόπος and thus is not undergoing a κίνησις even while it rotates. The outermost celestial sphere has no surrounding body and hence no actual or even potential τόπος, and for that reason cannot undergo locomotion (i.e. change of τόπος).

It is notable not only that the everlasting rotations of the celestial spheres do not entail a change of τόπος and so do not constitute κινήσεις, but also that each of those rotations is a πρᾶξις which is complete at every point. As Coope says *"The path traced out by rotary movement is entirely occupied by the moving body. Any part of that path that is being approached by one section of the moving thing will already be occupied by another section".*[113] Similarly, Waterlow says *"As a natural phenomenon, the eternal circular motion is as complete as anything in nature could be"* and *"at every moment every part of the rotating body has just completed a circle"*.[114] Thus, the rotation of each celestial sphere is in fact fully performable and complete in any period of time, however short. On this basis, it appears that the rotations of the celestial spheres constitute ἐνεργείαι, as described by Aristotle in the *Metaphysics*.

In *Metaphysics* Theta.6, Aristotle distinguishes between πρᾶξεις which are complete at every moment (and hence perfect) and those that are incomplete (and hence imperfect). The πρᾶξεις which are incomplete are for the sake of ends or goals which are not yet in existence whilst the πρᾶξεις are ongoing. These πρᾶξεις are κινήσεις. In contrast, a πρᾶξις which is complete at every moment is an end in itself, and that end or goal is present while the πρᾶξις is ongoing. Such a πρᾶξις is an ἐνεργεία. The examples given by Aristotle of ἐνεργείαι, which are complete at every moment, include seeing and thinking; whereas the examples of κινήσεις, which are incomplete and for the sake of some end, include building and walking.

The everlasting rotations of the celestial spheres seem to be complete at every moment and are, perhaps, ends in themselves. As Coope notes, the whole path of a rotating celestial sphere is at all times occupied by the sphere itself and, per Waterlow, the rotation *"is as complete as anything in nature can be"*.[115] Thus, it appears that the everlasting rotations of the celestial spheres constitute ἐνεργείαι rather than κινήσεις, as distinguished by Aristotle in *Metaphysics* Theta.6.

[113] See footnote 91 ante.
[114] See footnote 89 ante.
[115] See footnote 89 ante. It would, however, not be correct to say that the orbits of the heavenly bodies are complete as, while they are ongoing, the heavenly bodies are not located in a τόπος.

4.5 It is apposite that the unmoved mover causes an ἐνεργεία

To date, commentators seem to have shied away from the conclusion that the rotations of the celestial spheres are ἐνεργείαι. This may perhaps be because (i) given its epithet, the unmoved mover should on the face of it be responsible for motion rather than an ἐνεργεία, and (ii) a continuous, complete ἐνεργεία could not explain the unceasing multiplicity of changes in the sublunar domain.

For example, in *"Nature Change and Agency in Aristotle's Physics"*, Waterlow stated the following:

> *"[If the primary motion were] to be classed as complete, … it could not figure as* κίνησις. *But no amount of juggling with classifications can obliterate the palpable difference between this sort of complete actuality, which involves passage through space, and one that goes nowhere".*[116]

As is explained in section 4.2 above, the primary motion of the outermost celestial sphere is rotation without changing place. Hence, the outermost celestial sphere in fact *"goes nowhere"* and does not undergo *"passage through space"* and thus these objections do not seem to justify refraining from classifying that rotation (and, indeed, the rotation of every celestial sphere) as a *"complete actuality"* (ἐνεργεία). Furthermore, for the reasons outlined below, it might even be considered apposite that the proximate effect of the pure actuality of the unmoved mover, Aristotle's ultimate divinity, should be to inspire the ensouled outermost celestial sphere to undertake a πρᾶξις which is a perfect and complete ἐνεργεία, rather than an imperfect and incomplete κίνησις.

With regard to the concern that a continuous, complete ἐνεργεία could not explain the unceasing multiplicity of changes in the sublunar domain, Waterlow states in the same text:

> *"But unless the eternal rotation is indeed a* κίνησις*, it cannot fulfil the function for which it was postulated, which was to account for the inexhaustibility of change in the universe while allowing for the seriality and transience on the sublunary level. … For if eternal rotation*

[116] Waterlow (1982), p.256, paragraph 50.

counts only as a changeless ἐνεργεία*, it is as remote, metaphysically, from the transient as is a changeless incorporeal cause".*[117]

It seems incontestable that, as Waterlow says, if the everlasting rotation of the celestial spheres is not a κίνησις then it cannot by itself account for change in the sublunar realm. But, in the Aristotelean canon the everlasting rotation of the celestial spheres does not provide this account; it is the κίνησις of the Sun which performs that role. In particular, it is the periodic motion of the Sun towards and away from each hemisphere of the Earth which is the efficient cause of coming-to-be and passing-away in the sublunar realm (i.e. the Sun's annual movement in the ecliptic circle, as is explained in *On Generation and Corruption* II.10).

In fact, the aggregate motion of the Sun includes the following components: (i) the diurnal motion parallel to the Earth's equator, and (ii) the annual motion along the ecliptic (i.e. at an oblique angle to the Earth's equator). The combined effect is that the Sun orbits the Earth on a daily basis while slowly regressing along the ecliptic and taking a year to complete its full orbit along that path. Thus, the Sun's orbit is an everlasting spiral which involves a latitudinal component between the Tropic of Cancer (+23.4 degrees North) and the Tropic of Capricorn (-23.4 degrees North). Considered solely relative to the North/South axis of the Earth, the Sun's motion is rectilinear. From the winter solstice the Sun moves North until the summer solstice, when the Sun changes direction and starts to move South.[118] This 'double motion' is the feature that enables the Sun (as the *generans*) to be the efficient cause of coming-to-be and passing-away, and ultimately of all other change, in the sublunar realm.

This is confirmed in *On Generation and Corruption* II.10, where Aristotle says:

"movement will produce coming-to-be uninterruptedly by bringing near and withdrawing the 'generator' ";[119]

[117] Ibid, p.255, paragraph 49.
[118] Although the Sun's Northerly motion actually ceases at the summer solstice, the Sun does not cease moving entirely at that point as it would (momentarily) if it were only shuttling between the two Tropics. Because the Sun is engaged in everlasting motion along the ecliptic, it approaches the Tropic of Cancer at the summer solstice in a similar fashion to an asymptote before immediately commencing its southerly motion.
[119] 336a20.

"It is not, therefore, the primary motion [of the first heaven] which is the cause of coming-to-be and passing-away, but the motion along the inclined circle [the ecliptic]; for in this there is both continuity and also double movement";[120] and

"coming-to-be occurs when the Sun approaches and passing-away when it withdraws".[121]

Thus, the latitudinal motion of the Sun relative to the Earth is a critical feature of the Aristotelian universe, and Aristotle acknowledges that it enables the Sun to be the efficient cause of change in the sublunar realm.

When considered solely relative to the Earth's North/South axis, the motion of the Sun seems to satisfy not only the dynamic definition of κίνησις in *Physics* III.1 but also the static principles of κίνησις in *Physics* I.7. This is because the motion from the winter solstice to the summer solstice is the actuality (as a potentiality) of the potentiality for the Sun to be located above the Tropic of Cancer. The motion from the summer solstice to the winter solstice is the actuality (as a potentiality) of the potentiality for the Sun to be located above the Tropic of Capricorn. The momentary termini of the North/South motion of the Sun at the ends of these six-month periods are its orbital positions above the two Tropics. (However, as is noted above, the actual, aggregate motion of the Sun is relatively complex and involves an eternal spiral around the Earth but between the two Tropics.)

Therefore, in light of Aristotle's clear exposition of the role of the Sun as the *generans* of change in the sublunar sphere, the concern expressed by Waterlow (that if the everlasting rotation of each celestial sphere is an ἐνεργεία and not a κίνησις, it cannot account for sublunar change) does not seem to be problematic.

Furthermore, it actually seems apposite that the everlasting rotations of the celestial spheres are ἐνεργείαι and hence complete and perfect at every moment. The souls of the celestial spheres are apparently inspired to rotate by their love for the unmoved mover. In the circumstances, it seems appropriate for that emulation of the pure actuality of Aristotle's most divine being to constitute the only everlasting ἐνεργεία which the ensouled celestial spheres are capable of undertaking. As Aristotle's unmoved mover is pure actuality, it might be considered incongruous if it were to inspire

[120] 336a32.
[121] 336b17.

the souls of the celestial spheres to engage in κινήσεις which would, by definition, be incomplete and imperfect.

A further reason why it is apposite for the rotations of the celestial spheres to be ἐνεργείαι is provided in section 5.4 below as part of the consideration of the role of the unmoved mover as final cause of these rotations.

4.6 Conclusion on motion in the heavens

Aristotle's concept of τόπος is critical to the consideration of locomotion (which entails a change of τόπος). In the Aristotelian universe, the outermost celestial sphere is not in a τόπος because it has no surrounding body. Save for this exception, all bodies in the Aristotelian universe are either at rest and actually located in a τόπος, or in motion and in the process of changing their τόπος. Therefore, each body, save for the outermost celestial sphere, is actually located in a τόπος or has the potential to be so located.

Notwithstanding their everlasting rotations, all the celestial spheres, save for the outermost one, are located in the τόπος established by the first immobile boundary of the adjacent larger sphere. Thus, their everlasting rotations do not entail any change of τόπος and so are not κινήσεις.

In contrast, none of the heavenly bodies is located in a τόπος due to their everlasting revolutions around the Earth. However, as they are bodies, they have the potential in themselves to be located in any τόπος along the path of their respective orbits. They are prevented from being so located by the everlasting force which is applied to them by the celestial spheres in which they are embedded. Nevertheless, each orbit constitutes the actuality of the potentiality (insofar as it is a potentiality) for a heavenly body to be located in a τόπος along its orbital path, and thus is a κίνησις according to Aristotle's dynamic definition in *Physics* III.1.

5. Identifying the four causes of the celestial spheres' rotations

5.1 The natural motion of αἰθέρ

In *On the Heavens* I.2, Aristotle establishes that (a) there is such a thing as simple motion (ἁπλῆ κίνησις), (b) circular motion (κύκλῳ κίνησις) is simple, and (c) simple motion is the motion of a simple body (ἁπλοῦ σώματος). On the basis of these premises, he concludes that:

> ἀναγκαῖον εἶναί τι
> σῶμα ἁπλοῦν ὃ πέφυκε φέρεσθαι τὴν κύκλῳ κίνησιν κατὰ
> τὴν ἑαυτοῦ φύσιν
>
> 269a5 *it follows that there exists a simple body naturally so constituted as to move in a circle by virtue of its own nature*.

This simple body is αἰθέρ. It is described as being more divine and prior to the sublunar elements.[122] It undergoes no other changes besides its natural motion,[123] and that involves circling around the centre of the universe (i.e. around the Earth). One further way in which αἰθέρ differs from the sublunar elements is that it only comprises the celestial spheres and the heavenly bodies and these objects together make up the whole of the heavens – there are no other portions of αἰθέρ. Therefore, an assessment of the motion of αἰθέρ must be based on the motions of these spheres and bodies.

Aristotle emphasises in *On the Heavens* I.2 that because the heavenly motions are continuous (συνεχῆ) and everlasting (ἀΐδιον), they cannot be unnatural as:

> φαίνεται γὰρ ἔν γε τοῖς ἄλλοις τάχιστα φθειρό-
> μενα τὰ παρὰ φύσιν
>
> 269b9 *seeing that in the rest of nature what is unnatural is the quickest to fall into decay*.

As the celestial spheres and the heavenly bodies are both entirely comprised of αἰθέρ, one can conclude on the basis of *On the Heavens* I that the rotations of the former and the orbits of the

[122] 269a32.
[123] 270a13, b2.

latter, which entail circling round the centre of the universe, are both consistent with the natural motion of the matter out of which these spheres and bodies are made.

5.2 Do the four causes arise in respect of ἐνεργεία?

As the heavenly bodies are carried round by the celestial spheres in which they are embedded, this analysis of the motion of αἰθέρ starts with an assessment of the rotations of the celestial spheres before considering in the next chapter the orbits of the heavenly bodies.

As is explained in section 2.4 above, although there may be differences in the study of, on the one hand, perishable sublunar bodies and, on the other hand, the everlasting celestial spheres and heavenly bodies, according to *Metaphysics* Lambda.1 these two types of bodies are both φυσικῆς because they are μετὰ κινήσεως.[124] Thus, the κινήσεις in the sublunar realm and in the heavens should both be susceptible to analysis using the concepts established by Aristotle in the Physics.

Nevertheless, as is explained in section 4.4 above, the everlasting rotations of the celestial spheres would seem to be ἐνεργείαι rather than κινήσεις. Therefore, the question arises whether the framework of the four causes, which Aristotle specifies in *Physics* II.3, can be applied to πρᾶξεις generally in the heavens, including ἐνεργείαι.

The beginning of *Physics* II.3, which prepares the way for Aristotle's introduction of the four causes, is written in general terms. Aristotle observes that *"we think we have knowledge of a thing* (ἕκαστον) *only when we can answer the question about it 'On account of what?'".*[125] In light of this observation, and as the term ἕκαστον appears quite broad, it seems reasonable at least to attempt to identify the four causes of the ἐνεργείαι which consist of the everlasting rotations of the celestial spheres.[126] Even if this attempt were ultimately to fail because it transpires that the framework of the four causes is not applicable to ἐνεργείαι, then that could still be an illuminating outcome, as it might suggest among other things that the substantial volume of literature on the role of the unmoved mover as final cause of these rotations is misconceived.

[124] 1069b1.
[125] 194b17-20.
[126] It is notable that ἐνεργείαι are not confined to the heavens, as they also arise in the sublunar sphere, e.g. seeing, thinking and being happy (see *Metaphysics* Theta.6).

5.3 Efficient cause of the celestial spheres' rotations

Several commentators, including Judson and Guthrie, have adopted what Judson refers to as the *"traditional view that De Caelo I-II, Physics VIII, and Metaphysics Lambda represent three different stages or phases in Aristotle's thinking about the explanation of the heavens' motion"*.[127] Although the debate about the apparent evolution of Aristotle's thinking across these three texts is outside the scope of this thesis, the approaches adopted in these texts to heavenly motion can illuminate the issue of efficient causation of the rotations of the celestial spheres. Therefore, these three approaches are summarized below.

The extracts from *On the Heavens* which are mentioned in section 5.1 above confirm Aristotle's view that the natural motion of αἰθέρ is to circle round the centre of the universe. In *On the Heavens*, Aristotle does not undertake a specific assessment of causation (either along the lines of the approach in the *Physics* or at all), and so he does not seek to identify an efficient cause of the natural motion of αἰθέρ. This text reads as though the circling of the heavens is just a brute fact which can be attributed to the nature, and the inner principle of change, of αἰθέρ without the need for any further explanation. In such circumstances, the everlasting circular motion of αἰθέρ would be natural and self-generated.

However, as is noted in section 3.2.2 above, in *Physics* VIII.4 Aristotle rejects the possibility that the elements are self-movers, and indicates that all things that are in motion are moved by something (ἅπαντα ἂν τὰ κινούμενα ὑπό τινος κινοῖτο).[128] Although *Physics* VIII.4 deals specifically with sublunar elements and makes no mention of αἰθέρ, the principles it espouses would appear to be applicable to the heavenly element. This is because αἰθέρ, like the sublunar elements, does not exhibit the characteristics of self-movers such as stopping or starting its motion or changing direction.[129] In addition, αἰθέρ itself is homogeneous[130] and so, within a portion of αἰθέρ, there cannot be a 'mover' which is distinguishable from the 'moved'.[131] Therefore, on the basis of the reasoning in *Physics* VIII.4, the elements themselves, including αἰθέρ, are incapable of being self-movers.

[127] Judson (1994) and Guthrie (1933) and (1934).
[128] 256a2-3.
[129] 255a5-11.
[130] In this regard, see the caveat at footnote 92 ante.
[131] 255a12-25.

Section 3.2.3 above explains that in the case of the sublunar elements, Aristotle identifies the *generans* and the *removens impedimentum* as the efficient causes of their natural motions. A corresponding solution is not available in respect of αἰθέρ as (i) it is everlasting and so has no *generans*, and (ii) the heavens are unchanging (save for their concentric rotations and orbits) and so no object can become an impediment to these actions of αἰθέρ.

There is, though, a key difference between the sublunar elements and the celestial spheres; namely, the latter are ensouled. As such, they can initiate their own motions because self-motion is, according to *Physics* VIII.4, a property of life and animate things (ζωτικόν τε γὰρ τοῦτο καὶ τῶν ἐμψύχων ἴδιον).[132] Therefore, the soul of each heavenly sphere is capable of being the first principle of their respective rotations (ἡ ἀρχὴ τῆς μεταβολῆς ἡ πρώτη) and thus the efficient cause of the natural motions of their constituent αἰθέρ. But this invites the question 'why would the souls of the celestial spheres cause their everlasting rotations?'. A brief answer to this question is provided in the third text cited in what Judson refers to as the *"traditional view"* – i.e. *Metaphysics* Lambda. This explanation of why the rotations of the celestial spheres are initiated by their souls is set out in the following section, as it is inextricably connected with the final cause of those rotations.

Before turning to the issue of final causation, it should be noted that while the soul of the outermost celestial sphere is the efficient cause of the rotation of that sphere, the situation is more complicated in respect of the other spheres. This is because *Metaphysics* Lambda.8 confirms that each celestial sphere transmits its rotation to the sphere immediately inside it.[133] Thus, the rotation of this adjacent smaller sphere is a combination of self-motion (which is caused by that sphere's soul) and forced motion (which results from the rotation of its larger neighbour). Therefore, the efficient cause of the rotation of each celestial sphere, save for the outermost one, is a combination of the soul of the sphere in question and its larger neighbour.

5.4 Final cause of the celestial spheres' rotations

In *Metaphysics* Lambda, Aristotle initially investigates the principles of perceptible and changeable substances. He then revisits some of the arguments in *Physics* VIII that the changes which natural substances undergo are ultimately caused in some way by unchanging substances. Aristotle examines the character of the unchanging substances and identifies one such substance as the

[132] 255a6.
[133] 1074a25.

principle on which the heavens and nature depend.[134] Specifically, this unchanging substance, which Aristotle says 'is actuality', is identified as the final cause of the rotation of the outermost celestial sphere. Aristotle initially only speaks about one unmoved mover. In Lambda.8, Aristotle introduces the additional complexity that there is in fact one separate unmoved mover for each of the many celestial spheres. For the sake of clarity of explanation, this section focuses primarily on the first unmoved mover to which Aristotle initially refers, and the way in which it is responsible for the everlasting rotation of the outermost celestial sphere.

The pivotal chapter in respect of the Aristotle's description of the causal role of this unchanging substance is Lambda.7, the text of which is incredibly dense. In this chapter, Aristotle states:

> καὶ ἔστι τι ἀεὶ κινούμενον κίνησιν ἄπαυστον, αὕτη
> δ' ἡ κύκλῳ ⟨καὶ τοῦτο οὐ λόγῳ μόνον ἀλλ' ἔργῳ δῆλον⟩,
> ὥστ' ἀΐδιος ἂν εἴη ὁ πρῶτος οὐρανός. ἔστι τοίνυν τι καὶ ὃ
> κινεῖ. ἐπεὶ δὲ τὸ κινούμενον καὶ κινοῦν [καὶ] μέσον, †τοίνυν†
> ἔστι τι ὃ οὐ κινούμενον κινεῖ, ἀΐδιον καὶ οὐσία καὶ ἐνέργεια
> οὖσα.
>
> 1072a21 *and there is something which is always being moved in an unceasing motion, and this motion is in a circle. This is clear not only through argument but in fact. Consequently the first heaven must be eternal. There is also, therefore, something which causes its motion; and since that which is moved and causes motion is an intermediate, there is a mover which causes motion without being moved, being eternal, and substance, and activity*.

This extract confirms that the πρῶτος οὐρανός is being moved (κινούμενον – line 21) in an everlasting circle and that this is clear not only through argument but also in fact (ἔργῳ). Aristotle's use here of the expression πρῶτος οὐρανός seems to be a reference to the fixed stars (i.e. the heavenly bodies other than the Sun, Moon and five planets) and not the celestial sphere in which they are embedded. This is because the celestial spheres are not visible, so belief in their rotations (and, indeed, their existence) can only be derived from argument. In contrast, because the fixed stars are visible, belief in their circular motion can be derived from fact as well as argument.

[134] 1072b13-14.

In the passage cited above, Aristotle says that there is something which causes the motion of the πρῶτος οὐρανός, and adds 'that which is [being] moved and causes motion is an intermediate'. The reference in this specific context to an intermediate entity (which causes motion) would seem to be redundant, and potentially confusing, if Aristotle believed that the motion of the πρῶτος οὐρανός were directly caused by the unmoved mover. Thus, by mentioning here an intermediate entity which moves the πρῶτος οὐρανός but is not the unmoved mover, Aristotle could, perhaps, be making an implicit reference to the ensouled celestial sphere in which the fixed stars are embedded, as that appears to be the only intermediate between the fixed stars and the unmoved mover. (It should, though be noted that one challenge for this interpretation is the fact that on the assessment in Chapter 4 above, the everlasting rotation of the celestial sphere is a πρᾶξις and an ἐνεργεία but not a κίνησις, yet Aristotle here refers to the intermediate mover as κινούμενον at line 24. This issue is considered further in section 6.2 below in connection with the final cause of the everlasting circular motions of the heavenly bodies.)

Having referred to the intermediate mover, Aristotle then says that there is a mover that causes motion (of the intermediate mover) without itself being moved and this unmoved mover, which is not intermediate, is eternal and substance and activity/actuality (ἀΐδιον καὶ οὐσία καὶ ἐνέργεια). Aristotle briefly elaborates on the manner of the unmoved mover's causation when he says:

> κινεῖ δὲ ὧδε τὸ ὀρεκτὸν καὶ τὸ νοητόν· κινεῖ οὐ κινού-
> μενα.
>
> 1072a26 *This is how the objects of desire and of intellect cause motion; they cause motion without being moved*.

Aristotle goes on to explain that we desire something because it seems good and the intellect is moved by the object of thought. This references in Lambda.7, to motion being caused by desire, reflects Aristotle's arguments in *On the Soul* III.9-10. In that text, Aristotle confirms that the object of desire produces movement,[135] and every appetite/desire is directed towards an end,[136] and thus the object of desire constitutes a final cause. In light of this, Lambda.7 might be suggesting that the unmoved mover causes the outermost celestial sphere (i.e. the intermediate mover) to rotate because the unmoved mover is desired by the soul of the sphere and this causes the soul to initiate

[135] 433a19.
[136] 433a16.

the rotation of the sphere. It is, though, not immediately clear in what sense the unmoved mover is desired by the soul of the celestial sphere.

Aristotle provides the following brief comment on the operation of the unmoved mover as a final cause:

> ὅτι δ' ἔστι τὸ οὗ ἕνεκα ἐν τοῖς
> ἀκινήτοις, ἡ διαίρεσις δηλοῖ· ἔστι γὰρ τινὶ τὸ οὗ ἕνεκα ≤καὶ≥
> τινός, ὧν τὸ μὲν ἔστι τὸ δ' οὐκ ἔστι.
>
> 1072b1 *That the 'for the sake of which' is among the things which are unmoved is made clear by the distinction: the for the sake of which is 'for' something and 'of' something, and of these the one is moved and the other is not*.[137]

Aristotle's somewhat cryptic explanation is interpreted by Judson as follows: if an action, for example, is said to be for the sake of something (the final cause), then either:

- the final cause could be the beneficiary, and the action is 'for' something (τινὶ) which typically changes; or
- the final cause could be the goal or end, and the action is 'of' something (τινός) which need not change.[138]

Applying these propositions to the issue at hand, it appears that the rotation of the outermost celestial sphere is not for the benefit of the unmoved mover but on account of the unmoved mover, which is the goal but does not change.

The suggestion that the unmoved mover is the goal invites the question 'in what way does the unmoved mover constitute an attainable goal for the celestial sphere?'. On the face of it, the heavenly sphere cannot attain the unmoved mover *per se*, at least not in the same way that a hungry animal can desire food and be moved by its soul so as to attain food. Judson highlights this puzzle when he suggests that a celestial sphere *"cannot attain its cosmic unmoved mover, or even its form of perfection – or if it could, it would be in virtue of its thinking, not in virtue of its eternal*

[137] Ibid.
[138] Judson (2019), p.226.

motion".[139] Judson's solution is to suggest that the final cause of the rotation of the celestial sphere gives rise to a desire not to attain the unmoved mover but to emulate it and thus the soul of the sphere pursues what it *"takes to constitute appropriate emulation for itself"*.[140] One possible interpretation of such 'emulation' is considered below.

For the reasons explained in Chapter 4 above, the rotation of the celestial sphere is not a κινήσις because rotation around a central axis involves no lateral translation and so does not entail any change of τόπος (and, furthermore, there is no body beyond the outermost celestial sphere and so it does not have a τόπος which could change). Instead, this rotation is an ἐνεργεία as it is complete and perfect at every moment. This could explain the way in which the ensouled celestial sphere emulates the unmoved mover. If the soul of the celestial sphere desires the unmoved mover on account of the latter being pure and eternal ἐνεργεία, it can never achieve that status because, among other things, it is embodied in the αἰθέρ which makes up the outermost celestial sphere. (An ensouled being, such as a person, can undertake the ἐνεργεία of thinking, but not in perpetuity.[141]) Nevertheless, that soul can initiate and be engaged in an everlasting ἐνεργεία by being the efficient cause of the sphere's rotation.[142] In this way, the ensouled sphere can attain ἐνεργεία to its fullest extent. This assessment (of how the ensouled celestial sphere might be able to attain its maximum ἐνεργεία, which it desires due to the unmoved mover) would further support the contention in section 4.5 above that, rather than being a problem for Aristotle if the rotation of the outermost celestial sphere is an ἐνεργεία, it is in fact necessary for it to be so, as that πρᾶξις could not be otherwise due to the manner in which the unmoved mover is the final cause.

Judson highlights a further way in which the unmoved mover may have a causal role in the rotation of the outermost celestial sphere.[143] In Lambda.5, Aristotle distinguishes between the proximate and remote efficient causes of people: the proximate efficient cause of a person is the father and the remote efficient cause is the Sun (as the Sun provides some explanation of how the father came into being).[144] As is noted in section 5.3 above, the soul of the outermost celestial sphere is the efficient cause of the rotation of that sphere because it desires the ἐνεργεία that is the unmoved mover. However, the object of a desire explains how the desire came into being. In the case of an

[139] Ibid, p.183.
[140] Ibid, p.184.
[141] 1072b15.
[142] Due to being enmattered, this is the only way that the soul of the celestial sphere can engage in an everlasting actuality.
[143] Judson (1994), p.165.
[144] 1071a14-17.

intentional action which is focused on a particular object, that object is not only the final cause of the action but also a remote efficient cause by virtue of being the final cause. So, on this basis, the soul of the celestial sphere (or, perhaps more particularly, the desire in that soul) is the proximate efficient cause of the rotation and the unmoved mover (which is the object of that desire) is the remote efficient cause.

On the Soul III.10 potentially provides some support for Judson's suggestion that the unmoved mover is the remote efficient cause of the rotation of the outermost celestial sphere, as that text confirms that thought produces movement because the object of desire is the beginning of the action (οὗ γὰρ ἡ ὄρεξις, αὕτη ἀρχὴ τοῦ πρακτικοῦ νοῦ, τὸ δ' ἔσχατον ἀρχὴ τῆς πράξεως).[145] As the unmoved mover is the object of the thought and desire of the soul of the outermost celestial sphere, it can be regarded as the beginning of the rotation and hence its remote efficient cause.

5.5 Formal cause of the celestial spheres' rotations

Having identified the ἐνεργεία, which is the unmoved mover, as the final cause of the everlasting rotation of the outermost celestial sphere, an attempt will now be made to identify the formal cause of that rotation. To recap two points outlined above in respect of the formal cause of sublunar natural motion:

- In *Physics* II.3, Aristotle says the formal cause is *"the form* (εἶδος) *… this is the account* (λόγος) *of what the [thing] would be"*.

- In *Nicomachean Ethics* X.4, Aristotle gives further consideration to the forms of walking and the other types of locomotion and says that *"[the] many movements are incomplete and differ in form since the from-where and the to-where determine the form"* (αἱ πολλαὶ ἀτελεῖς καὶ διαφέρουσαι τῷ εἴδει, εἴπερ τὸ πόθεν ποῖ εἰδοποιόν).[146]

The assessment in section 3.4.3 above demonstrates that the formal cause of the natural motion of a sublunar element is the accidental form which the element acquires at the final terminus of that motion, i.e. the location of the element in its proper place. In the case of the celestial spheres, their

[145] 433a15.
[146] 1174b4-5.

rotations are everlasting and so there is no initial or final terminus. On the face of it, the lack of termini might suggest that these rotations also lack a from-where (πόθεν) and a to-where (ποῖ).

In *On the Heavens* I.8, Aristotle anticipates the static principles of κίνησις in *Physics* I.7 when he says that motion in general is a change from one state to another and these two states are formally different.[147] Specifically with regard to locomotion, the change involves a place from-where (ποθέν) and a place to-where (ποι).[148] However, given the context of a discussion about the heavens, a sentence is added as an apparent afterthought which says:

> Ἐπεὶ καὶ ἡ κύκλῳ ἔχει πως ἀντικεί-
> μενα τὰ κατὰ διάμετρον, τῇ δ' ὅλῃ οὐκ ἔστιν ἐναντίον οὐδέν,
> ὥστε καὶ τούτοις τρόπον τινὰ ἡ κίνησις εἰς ἀντικείμενα
> καὶ πεπερασμένα.
>
> 277a23 *Even circular motion has quasi-opposites in the opposite ends of the diameter, though there is no opposite to the motion as a whole. In this qualified sense it too is the motion of things passing between opposed and finite goals.*

In practice, this appears to be a rather strained attempt to shoehorn everlasting circular motion into a static assessment of change which focusses on the termini. For the reasons outlined in Chapter 4 above, it does not seem appropriate to undertake a static assessment of heavenly motion. In *On the Heavens* I.9, Aristotle highlights a dynamic aspect of ongoing circular motion when he says:

> πάντα γὰρ
> παύεται κινούμενα ὅταν ἔλθῃ εἰς τὸν οἰκεῖον τόπον, τοῦ δὲ κύ-
> κλῳ σώματος ὁ αὐτὸς τόπος ὅθεν ἤρξατο καὶ εἰς ὃν τελευτᾷ.
>
> 279b1 *For things only cease moving when they arrive at their proper places, and for the body whose motion is circular the place where it ends is also the place where it begins*.

On this basis, it might be argued that every point along the path of a perpetually rotating sphere can be regarded as the from-where and the to-where of the rotation. As a motion is defined by its from-

[147] 277a14.
[148] 277a18.

where and to-where, everlasting rotation would be defined by all the points along its path. If the path of the rotation is its λόγος, then it would seem that the formal cause of the everlasting rotation is the form of the rotation itself.

Section 5.4 above sought to show that the final cause of the rotation is the pure ἐνεργεία which is the unmoved mover, and this is attained, so far as is possible by the ensouled sphere, through the ἐνεργεία that is the essence of the everlasting rotation. In practice, there is a difference between the pure ἐνεργεία of the unmoved mover and the ἐνεργεία which is attained by the ensouled celestial sphere, as the former is eternal contemplation whereas the latter is everlasting rotation. Nevertheless, the formal cause of the sphere's ἐνεργεία (i.e. the form of the rotation) is the same as the sphere's attainable goal (i.e. its maximum ἐνεργεία which is everlasting rotation). On this basis, the formal and final causes of the everlasting rotations of the celestial spheres would be the form and essence of the rotation. Thus, these two causes coincide, as was the case for the formal and final causes of the natural motions of the sublunar elements. As is noted in section 3.4.3 above, this correspondence between these two causes is unsurprising as Aristotle confirms in *Physics* II.7 that *"What a thing is [i.e. the formal cause], and what it is for [i.e. the final cause], are one and the same"*.[149]

5.6 Material cause of the celestial spheres' rotations

Section 3.5 above explains that in the case of the natural motion of a sublunar element, the element itself is the underlying thing which is the subject of the change of location, and so the element is the material cause of its natural motion. A similar conclusion arises in respect of the celestial spheres: the underlying thing which is the subject of the rotation of a celestial sphere is the sphere itself and so the sphere is that material cause of its natural motion. This role of the sphere as the material cause of its everlasting rotation is, to some extent, explained by the fact that the celestial spheres are entirely comprised of αἰθέρ, the natural motion of which is to circle around the centre of the universe. It should be noted, however, that the way in which αἰθέρ explains the rotation of the celestial spheres seems to differ from the way in which a sublunar element operates as a material cause of its natural motion.

[149] 198a25.

According to Aristotle's account in *On the Heavens*, αἰθέρ's natural capacity for circular motion appears to be a sufficient explanation of a sphere's rotation. As is noted in section 5.3 above, that view evolved in the *Physics* and *Metaphysics* Lambda.

When considering the nature of αἰθέρ in light of the latter texts, Judson suggests that *"the requirement of an unmoved mover must mean that* αἰθέρ*'s capacity for natural motion is insufficient by itself to produce motion, and that it is activated in some way by the unmoved mover, either directly or indirectly via the soul of the sphere"*.[150] So Judson is inferring, from Aristotle's postulation about the existence of the unmoved mover, that αἰθέρ's natural capacity for circular motion cannot by itself cause the rotations of the celestial spheres. However, in *Physics* VIII Aristotle reasons in the opposite direction – i.e. from the limitations of αἰθέρ's natural capacity for circular motion to the necessary existence of an unmoved mover. Thus, when assessing the material cause of the rotations of the celestial spheres, it seems appropriate to start by considering αἰθέρ*'s* capacity for natural motion, and its internal principle of change and rest, together with any limitations on that capacity.

As discussed in section 3.2.1 above, Aristotle confirms in *Physics* VIII.4 that all things that are in motion are moved by something (ἅπαντα ἂν τὰ κινούμενα ὑπό τινος κινοῖτο).[151] One corollary of this conclusion, together with the homogeneity of the elements, is Aristotle's view that although the nature of the elements is an internal principle of change and rest and thus a source of motion, it is not an active principle which is capable of causing motion or acting on something, but a passive principle of being acted upon (κινήσεως ἀρχὴν ἔχει, οὐ τοῦ κινεῖν οὐδὲ τοῦ ποιεῖν, ἀλλὰ τοῦ πάσχειν).[152] Thus, the nature of the elements (i.e. their internal principle of change and rest), is not the efficient cause of their natural motions: a separate efficient cause is needed to initiate the elements' natural motions, precisely because the elements' internal principle of change is passive.

As is explained in sections 5.3 and 5.4 above, the soul of the outermost celestial sphere is the proximate efficient cause of its rotation and the unmoved mover is the final cause and remote efficient cause of the same. This bifurcation of efficient causation is not unusual. An animated being is prompted to move by the desire in its soul for an external good, and as a result the soul is the proximate efficient cause of that motion and the external good is a remote efficient cause.[153] In the case of the self-motion of an animal, the efficient causation doesn't cease until the external good

[150] Judson (1994), p.158.
[151] 256a2-3.
[152] 255b30-31.
[153] *On the Soul* III.9-10.

has been attained. Thus, the efficient cause, which is the stimulus towards motion and which is provided by the desire of the soul of the animated being for the external good, is coeval with the motion. (This is also the case for other efficient causes, such as the art of building in the builder which operates throughout the process of building a house.)

This coeval existence (of the efficient cause of a change and the change itself) also seems to arise in respect of the rotation of the outermost celestial sphere; namely the efficient causation, through its soul's desire for the unmoved mover, is coeval with the sphere's rotation. As Judson notes, the celestial sphere would only come to rest if the unmoved mover failed to inspire, or the soul of the celestial sphere failed to be inspired, so as to activate the sphere's capacity for rotation. [154] In the absence of that efficient causation, it appears that the αἰθέρ which makes up the sphere would not rotate, precisely because αἰθέρ's inner principle of change is passive (as Aristotle implicitly indicates at 255b30-31).

For the reasons outlined above, αἰθέρ's internal capacity for circular motion must be an entirely dormant one in the sense that it requires ongoing activation by something else. This produces a disanalogy with the way in which the four sublunar elements naturally move. Those elements are not ensouled and their natural motions require no ongoing activation by any sort of agent. The Sun, in its capacity as the *generans* of the sublunar elements is the efficient cause of their natural motions, but its role in that regard is not one of ongoing activation like a soul. Instead, the Sun causes, for example, water to be transformed into air by heating it. As the air is initially located in the proper place of water, it immediately moves 'up' towards the proper place of air provided it is not impeded. So, while a sublunar element is not a self-mover, if it is located outside its proper place and unimpeded, it will immediately move towards its proper place without the need for any ongoing efficient cause. In contrast, the αἰθέρ which makes up a celestial sphere requires the ongoing efficient causation of the soul of that sphere for it to continue rotating.

Having identified the four causes of the rotations of the celestial spheres, Chapter 6 now undertakes a corresponding assessment of the circular orbits of the heavenly bodies, with the latter assessment drawing quite heavily on the former.

[154] Judson (2019), p.188.

6. Identifying the four causes of the heavenly bodies' orbits

6.1 Efficient cause of the heavenly bodies' orbits

Among the four causes of (a) the natural motions of the sublunar elements, (b) the rotations of the celestial spheres, and (c) the orbits of the heavenly bodies, the efficient cause of the latter might appear to be the easiest to identify. This is because Aristotle confirms in *On the Heavens* II.8 that the heavenly bodies are carried round the centre of the universe by the celestial spheres in which they are embedded.[155] Thus, in the case of the πρῶτος οὐρανός, for example, the efficient cause of the circular orbit of the fixed stars is the rotation of the outermost celestial sphere.

There is a, however, a gloss on this conclusion, because the unmoved mover could be regarded as the remote efficient cause of the rotation of the outermost celestial sphere due to inspiring the soul of that sphere to engage in that rotation (see section 5.4 above). As the outermost celestial sphere is in turn the efficient cause of the circular orbit of the fixed stars, the unmoved mover could, via a chain of efficient causes, perhaps be regarded as a remote efficient cause of the circular orbit of the fixed stars.

Metaphysics Lambda.7 provides the following indication that the causation of the unmoved mover can operate in this way:

> κινεῖ δὴ ὡς ἐρώμενον,
> κινούμενῳ δὲ τἆλλα κινεῖ.
>
> 1072b3 *It causes motion as a beloved thing, while it is by means of a moving thing that it causes motion in the rest*.[156]

Therefore, it is as a 'beloved thing' that the unmoved mover inspires the outermost celestial sphere to rotate, and by means of a 'moving thing' that the unmoved mover moves 'the rest', i.e. other things in the universe. As is explained in section 4.4 above, the moving thing which is the efficient cause of all motion in the sublunar sphere is the Sun. As each celestial sphere transmits its motion

[155] 289b31.
[156] With the word κινούμενῳ Judson follows Jaeger's text. Ross has κινούμενα δὲ τἆλλα κινεῖ and translates this as *'while all other things are moved by being moved'*.

to the adjacent inner celestial sphere, there is a chain of causation from the outermost celestial sphere to the Sun. So, by virtue of causing the initial rotation of the outermost celestial sphere, the unmoved mover, via the transmission of the rotation of each sphere to the adjacent smaller sphere, ultimately causes the motion of the Sun, and hence all change 'in the rest' (e.g. in the sublunar sphere).

By way of a brief aside it should be noted that, in order to try to explain the observable motions of all the heavenly bodies by reference to combinations of the rotations of concentric spheres, Aristotle says in Lambda.8 that there are multiple unmoved movers and each one is the final cause of the rotation of a different celestial sphere. Nevertheless, the motion of any particular celestial sphere is still transmitted to the adjacent smaller sphere, and the motion of this latter sphere is a combination of the rotation transmitted from the larger neighbouring sphere and the motion which is inspired by the smaller sphere's 'own' unmoved mover. Therefore, even though there are multiple unmoved movers which inspire ensouled spheres to rotate in particular ways, Aristotle confirms that the rotation of the outermost sphere, which is caused by the 'first' unmoved mover, is still transmitted via all the other celestial spheres to the Sun.[157] On this basis, the unmoved mover would not be the sole cause of the rotations of all the 'inner' celestial spheres but it would contribute to the causation of those rotations, with each one of the other unmoved movers also contributing to the motion of one particular sphere and its smaller neighbours.

One challenge for the suggestion at 1072b3-4 that the 'first' unmoved mover ultimately causes (or at least contributes to the causation of) all motion in the universe 'by means of a moving thing' is that, for the reasons detailed in section 4.2 above, the rotation of the outermost celestial sphere (and, indeed the rotation of each of the other celestial spheres) is not a κίνησις. So, on that basis, none of the celestial spheres is κινούμενον. Nevertheless, 'as a beloved thing' the unmoved mover causes the outermost celestial sphere to rotate, and this sphere forces the fixed stars to move; in addition, that rotation is transmitted to the other celestial spheres in turn, and they force the other heavenly bodies to move. So, the unmoved mover does, indirectly, cause all that motion. Furthermore, as the text in *Metaphysics* Lambda.7 deals with a complex issue in a fiercely compressed way, it is possible that this account of causation at 1072b3-4 glosses over a number of links in the chain and,

[157] 1073b25. The situation is further complicated by the introduction at 1073b38- 1074a5 of spheres which perform a 'back-winding' motion. Nevertheless, the rotation of the outermost celestial sphere is not subject to such 'back-winding', and so its motion is transmitted to all the other spheres in turn. See Judson (2019) pp.263-268.

in effect, jumps from discussing the πρῶτος οὐρανός to the Sun (which could then be the referent of κινούμενῳ at 1072b4).

There is one further extract from Lambda.7 which might be taken to indicate that the unmoved mover is a cause of (or responsible for) the circular orbit of the fixed stars, and that the causation of the unmoved mover can operate through intermediaries:

> φορὰ
> γὰρ ἡ πρώτη τῶν μεταβολῶν, ταύτης δὲ ἡ κύκλῳ· ταύ-
> την δὲ τοῦτο κινεῖ.
>
> 1072b8 *For locomotion is the first of the kinds of change, and of this the first kind is locomotion in a circle; and this is the motion which this [the first mover] causes*.

Judson here translates φορὰ as 'locomotion', as does Bury; whereas Ross refers to 'local motion' and Reeve to 'spatial motion'. While all these expressions can certainly be what φορὰ means, it does not seem particularly illuminating to translate this sentence in this way, as the issue which Aristotle seems to be addressing in this part of Lambda.7 is not whether the first change is locomotion but how this first change is brought about by the unmoved mover. The Sixth edition of Liddell & Scott (1869) suggests that φορὰ (from the active φέρω) can be an act such as 'a carrying'. It also suggests that φορὰ (from the passive φέρομαι) can be an act such as 'a being borne or carried … the course, career, orbit in which a body moves'. It cites as an example of the latter the reference at 451c of the Gorgias to the φορὰ of the stars, Sun and Moon.

Aristotle uses this verb in the passive voice, φέρεσθαι, when he confirms in *On the Heavens* II.8 that the heavenly bodies do not move themselves but instead are carried round by the celestial spheres:

> λείπεται τοὺς μὲν κύκλους κινεῖσθαι, τὰ δὲ ἄστρα ἠρεμεῖν
> καὶ ἐνδεδεμένα τοῖς κύκλοις φέρεσθαι
>
> 289b31 "*we are left with the conclusion that the circles move and the stars stay still and are carried along because fixed in the circles".*

Therefore, given the context of Lambda.7, and as Aristotle clearly states in *On the Heavens* that the heavenly bodies are carried round by the celestial spheres in which they are embedded, it seems possible that Aristotle is using the word φορὰ at 1072b8 in this passive sense.[158] Thus, as an alternative to Judson's translation above, and given the prior reference to the πρῶτος οὐρανός at 1072a23, the word φορὰ at 1072b8 could be a reference to the orbit of the fixed stars.[159] On this basis, the text could be translated as:

> *'for being carried is the first of the changes, and of this the orbit in a circle; and this [the circular orbit] this [the unmoved mover] sets in motion'*.

If φορὰ is translated in this way and taken to be a reference to the orbit of the fixed stars rather than circular locomotion in general, then the sentence would be a confirmation that the unmoved mover is a cause of (or responsible for) that orbit. This would mean that the causation (or explanatory role) of the unmoved mover is not limited to the rotation of the outer celestial sphere but extends to the orbit of the fixed stars.

One final consideration in respect of the efficient cause of the heavenly bodies' circular orbits is whether these bodies are undergoing natural motion while being carried round by the celestial spheres. In the case of forced motion, the mover (i.e. the efficient cause) possesses in actuality the motion which the moved object has potentially. Therefore, in the case of forced motion, the mover itself is undergoing the motion in question and, through contact between the mover and the moved object, the mover imparts the motion in question to the moved object. This seems to be what is happening when the celestial spheres carry round the heavenly bodies which are embedded in them.

However, as section 5.1 above explains, the natural motion of αἰθέρ is to circle around the centre of the universe (i.e. the Earth). Furthermore, Aristotle notes in *On the Heavens* I.2, the circular motions of the heavenly bodies cannot be unnatural as they are everlasting and do not decay.[160] Aristotle does, though, also acknowledge that circular motion could be forced.[161] So it appears that the orbits of the heavenly bodies are consistent with the natural motion of the αἰθέρ which comprises those

[158] Additional research on Aristotle's use elsewhere of the word φορὰ could be undertaken to validate this conjecture. Such additional research is beyond the scope of this thesis.
[159] The reference to φορὰ at 1072b5 could also be interpreted in this way.
[160] 269b5.
[161] 270a10.

bodies but, nevertheless, those orbits result from the application of force by the celestial spheres in which the bodies are embedded. This issue is considered further in section 6.4 below in connection with the passive capacity of αἰθέρ's internal principle of change.

6.2 Final cause of the heavenly bodies' orbits

The final cause is described in *Physics* II.3 as the τέλος and 'that for the sake of which' something exists or occurs. In the case of a sublunar element, its natural motion terminates when the element is located in its proper place, and that location is the τέλος of the motion. The everlasting revolutions of the heavenly bodies around their orbits have no such terminus, and the bodies themselves are not located in a place because they undergo perpetual motion. Therefore, it appears that the τέλος of the everlasting revolutions of the fixed stars, for example, may be the orbit itself: it is, though, not immediately clear in what sense the expression τὸ οὗ ἕνεκα would apply to that orbit. In the circumstances, it is helpful to consider again the final cause of the rotation of the outermost celestial sphere.

As is noted in section 5.4 above, the ἐνεργεία, which is the unmoved mover, is the final cause of the rotation of the outermost celestial sphere. The sphere cannot 'attain' the unmoved mover as such, but it can engage in perpetual ἐνεργεία through everlasting rotation. In *Metaphysics* Lambda.7, Aristotle says of the unmoved mover:

> ἐξ ἀνάγκης ἄρα ἐστὶν ὄν· καὶ ᾗ ἀνάγκη,
> καλῶς, καὶ οὕτως ἀρχή.
>
> 1072b10 *It exists, then, of necessity; and inasmuch as it exists of necessity, it does so well and in this way it is a principle*.

Thus, the unmoved mover is good (καλος) and in this way it is the principle (ἀρχή) of, among other things, the rotation of the outermost celestial sphere and hence that rotation is apparently also good. Aristotle alludes to this sentiment in *Physics* II.2 when he says:

> βούλεται γὰρ οὐ πᾶν εἶναι τὸ ἔσχατον τέλος, ἀλλὰ
> τὸ βέλτιστον
>
> 194a32 *for the end should not be just any last thing but the best*.

On the basis of this claim, engaging in the ἐνεργεία of everlasting rotation is the best state for the ensouled celestial sphere. Aristotle indicates in a number of places that the causation (or explanatory role) of the unmoved mover is not limited to the rotation of that sphere, and so the good of the unmoved mover may extend beyond the ἐνεργεία undertaken by the outermost celestial sphere. In this context, it is notable that when Aristotle introduces the concept of the final cause in *Physics* II.3, he indicates that such causation can also operate on intermediate entities. Having cited the example of health as the final cause of walking, Aristotle says:

> καὶ ὅσα δὴ κινήσαντος ἄλλου μεταξὺ
> γίγνεται τοῦ τέλους, οἷον τῆς ὑγιείας ἡ ἰσχνασία ἢ ἡ κάθαρ-
> **(195a)** σις ἢ τὰ φάρμακα ἢ τὰ ὄργανα· πάντα γὰρ ταῦτα τοῦ
> τέλους ἕνεκά ἐστιν, διαφέρει δὲ ἀλλήλων ὡς ὄντα τὰ μὲν
> ἔργα τὰ δ' ὄργανα.
>
> 194b35 *And anything which, the change being effected by something else, comes to be on the way to the end, as slimness, purging, drugs, and surgical instruments come to be as means to health: all these are for the end, but differ in that the former are works and the latter are tools*.[162]

Therefore, things which come to be 'on the way' and 'as means' to the τέλος are also τοῦ τέλους. If the intermediate things are τοῦ τέλους then the final cause would seem to be capable of operating 'instrumentally' through them.

If, as this passage suggests, final causes can operate via intermediaries, then perhaps the good of the unmoved mover can not only be the τέλος of the everlasting rotation of the outermost celestial sphere but also the τέλος of the everlasting revolutions of the fixed stars. In which case, the outermost celestial sphere would be the intermediary that enables the fixed stars to achieve this good.

Furthermore, as each celestial sphere transmits its rotation to the adjacent smaller sphere, the effect of the unmoved mover's causation extends to all the spheres, and the heavenly bodies embedded in them; and, via the Sun, the unmoved mover is a remote efficient cause of all motion in

[162] In light of Judson's analysis of 1072b2-3, τοῦ τέλους at 194b36 should perhaps be translated as 'of the end' rather than Charlton's rendering as 'for the end'. See section 5.4 above.

the sublunar sphere. The τέλος of all these motions would, according to 194a23 'not be just any last thing but the best' and would seem to be related to the good of the unmoved mover.

In this regard, Sedley proposes that the unmoved mover is *"the ultimate cause which, directly or indirectly, inspires all beings to achieve the maximum actuality within their power".*[163] This seems to be the case with the ἐνεργείαι of the celestial spheres' rotations. It is, though, less clear in what respect 'maximum actuality' may be achieved by the everlasting motions of the heavenly bodies, and by κινήσεις more generally in the sublunar sphere. In this context, it is notable that the orbiting Sun is the efficient cause of the natural motion of the sublunar elements towards their proper places, and this motion results in the elements fully actualizing their forms and thus achieving their maximum actuality (see section 3.4.6 above). However, one possible concern with this view is that the Sun transmutes an element, which is located in its proper place, into another element, which is initially located outside its proper place and then naturally moves there if unimpeded. So, in the absence of the Sun's efficient causation of the inter-transformation of the elements, they would arguably be at rest in their proper places and thus already fully actualizing their forms. Therefore, it seems that to understand the way in which the existence of motion and change in the universe is the best state of affairs, it will be necessary to have regard to the good of κινήσεις in general. In light of this, further consideration of Sedley's intriguing proposal is beyond the scope of this assessment of the motions of the elements.

But, to sum up, the τέλος of the orbit of the fixed stars is the orbit itself, and this would seem (in some sense) to be for the sake of the good which results from there being motion and change in the universe.

6.3 Formal cause of the heavenly bodies' orbits

As is noted in section 6.1 above, in the case of forced motion the mover (i.e. the efficient cause) possesses in actuality the motion which the moved object has potentially. Therefore, in the case of forced motion, the mover itself is undergoing the motion in question and, through contact between the mover and the moved object, the mover imparts the motion in question to the moved object. This seems to be what is happening in respect of the celestial spheres carrying round the heavenly bodies.

[163] Sedley (2000), p.327.

The formal cause of each of the rotations of the celestial spheres is the form of the rotation itself (see section 5.4 above). As a celestial sphere is substantially larger than a heavenly body, and as the former surrounds the whole of the sublunar realm while the latter orbits around the sublunar realm, the orbit of the heavenly body would only coincide with part of the path mapped out by the rotating sphere in which it is embedded. Nevertheless, as the celestial sphere carries the heavenly body round, it will transfer to it that part of its rotation which is commensurate with the form of the orbit of the heavenly body.

On this basis, the formal and final causes of the everlasting revolutions of a heavenly body around its orbit would both be the form of the orbit itself.

6.4 Material cause of the heavenly bodies' orbits

As is explained in sections 5.1 and 5.6 above:

- the underlying thing, which is the subject of the rotation of a celestial sphere, is the sphere itself, and so the material cause of that rotation is the celestial sphere itself;

- each celestial sphere is entirely comprised of αἰθέρ, the natural motion of which is to circle around the centre of the universe; and

- as αἰθέρ's internal principle of change is passive, the αἰθέρ that makes up a celestial sphere requires the ongoing efficient causation of the soul of that sphere for it to continue rotating.

Corresponding conclusions arise in respect of the orbits of the heavenly bodies: the underlying thing which is the subject of the revolution of a heavenly body around its orbit is the body itself, and so the material cause of that orbit is the heavenly body which is comprised solely of αἰθέρ; but as its internal principle of change is passive, the αἰθέρ that makes up a heavenly body requires the ongoing efficient causation of the rotating celestial sphere in which it is embedded for it to continue moving.

In his consideration of the material nature of the celestial spheres and the heavenly bodies, Judson expresses the concern that:

> *"the natural condition of the* αἰθέρ *of which the heavenly bodies are composed is to be in circular motion or to be at rest: it has, we might say, a natural capacity for being in these two conditions. This would mean, however, that the [bodies] would possess a potentiality for being at rest which is never exercised"*.[164]

In this context, the terms 'motion' and 'rest' appear to be opposites, and hence rest is the antithesis of κίνησις. On this basis, a sphere that rotates around a central axis but undergoes no lateral translation, and so no change of τόπος, would be at rest. Therefore, following the interpretation set out in the preceding Chapters:

- the celestial spheres would be at everlasting rest as their rotations do not entail any κίνησις, and so their capacity for motion would never be exercised; and

- the heavenly bodies would be in everlasting motion due to their orbits, and so their capacity for rest would never be exercised.

This situation, where one of these capacities is never exercised, necessarily follows when an object is either at rest or in motion for all time. In *On the Heavens*, Aristotle confirms that the everlasting circular motion of αἰθέρ must be natural as:

> φαίνεται γὰρ ἔν γε τοῖς ἄλλοις τάχιστα φθειρό-
> μενα τὰ παρὰ φύσιν
>
> 269b9 *seeing that in the rest of nature what is unnatural is the quickest to fall into decay*.

If *"what is unnatural is the quickest to fall in to decay"* then, among the instances of rest, those which are contrary to nature (i.e. forced rest) would arguably also fall away fastest. Therefore, as there is some αἰθέρ which undergoes everlasting rest notwithstanding its rotation (i.e. the material of the celestial spheres) and some αἰθέρ which undergoes everlasting circular motion (i.e. the

[164] See Judson (2019), p.187.

material of the heavenly bodies), it would seem that it is natural for αἰθέρ to be either at rest or in circular motion, and these states can be perpetual.

Finally, it is worth closing the loop with section 4.4 above and emphasizing in this regard that the orbit of the fixed stars is coeval with the efficient cause of that orbit (i.e. the rotation of the outermost celestial sphere in which the fixed stars are embedded). For the reasons explained in section 5.6 above, because the soul of that sphere never ceases to desire the unmoved mover, the sphere never ceases to rotate and so the potentiality for the fixed stars to be at reset is never exercised. Nevertheless, due to the nature of the αἰθέρ which is the material that makes up the heavenly bodies, the fixed stars have the potentiality to be at rest, and thus they have the potentiality to be in a τόπος. Thus, the everlasting revolution of the fixed stars around their orbit is *"the actuality of that which potentially is, qua such"*, and so satisfies Aristotle's dynamic definition of κίνησις in *Physics* III.1. Because the efficient causation of that orbit never ceases, the fixed stars never come to rest and are never located in a τόπος, and it is precisely for this reason that the κίνησις does not end. This is consistent with αἰθέρ's internal principle of change being passive and dependent on the ongoing operation of an efficient cause not only to initiate motion but also to perpetuate it.[165]

[165] Judson (2019), p.188.

7. Conclusion

The starting point of this inquiry into the natural motions of the sublunar and heavenly elements is Aristotle's claim in *Physics* II.3 that we do not understand something until we can answer the question 'On account of what?'. By making use of Aristotle's framework of the four causes (i.e. the different explanations given in answer to the question 'On account of what?'), his static principles of κίνησις, and his dynamic definition of κίνησις, it has been possible to shed some light on both the nature of Aristotle's sublunar and heavenly elements and their natural motions.

The application of these concepts from the *Physics* to the natural motions of the sublunar elements is reasonably straight forward. Although some of the results are rather prosaic, for example the conclusion that the material cause of a sublunar element's natural motion is the element itself,[166] others seem to have greater explanatory efficacy. For example, the conclusion that the final cause and goal of the natural motion of a sublunar element is the location of the element in its proper place, rather than the proper place itself, is interesting as it seems to resolve an apparent tension between Aristotle's claims that an element's proper place has a certain influence but is not a cause *per se*.[167]

The application of the concepts from the *Physics* to the motions of αἰθέρ is, however, more challenging and necessitates a somewhat revised approach. For example, for practical (and textual) reasons it is not appropriate to use Aristotle's static principles of κίνησις to analyse the rotations of the celestial spheres and the orbits of the heavenly bodies, as these πρᾶξεις are everlasting and so the celestial spheres and the heavenly bodies are never static.[168] Furthermore, it seems that Aristotle's dynamic definition of κίνησις can assist in the analysis of the orbits of the heavenly bodies but not the rotations of the celestial spheres, as the latter appear to be ἐνεργείαι rather than κινήσεις. Therefore, an assessment of motion in the heavens should focus on the former not the latter. Nevertheless, both these phenomena seem to be susceptible to analysis on the basis of the framework of the four causes.[169]

The extension of this analysis to the heavens highlights, among other things, a disanalogy between the natural motion of αἰθέρ and the natural motions of the sublunar elements. αἰθέρ's internal

[166] Section 3.5.2 ante.
[167] Section 3.3.2 ante.
[168] Section 4.3 ante.
[169] Chapters 5 and 6 ante.

capacity for circular motion is entirely dormant, and so that motion requires coeval efficient causation (i.e. ongoing activation by the souls of the celestial spheres). In contrast, the sublunar elements do not require ongoing activation by any sort of agent in order to undergo their natural motions. Aritstotle confirms that the Sun, in its capacity as the *generans* of the sublunar elements, is the efficient cause of their natural motions, but its role in that regard is not one of ongoing activation like a soul.[170] So, while a sublunar element is not a self-mover, if it is located outside its proper place and unimpeded it will immediately move towards its proper place without the need for any ongoing efficient cause. Yet the αἰθέρ which makes up a heavenly body requires the ongoing efficient causation of the rotation of the celestial sphere in which it is embedded for it to continue moving; and that celestial sphere requires the ongoing efficient causation of its soul for it to continue rotating.

There is, though, one very important issue in particular which these concepts from the *Physics* struggle to accommodate, namely the final cause of the everlasting rotations of the celestial spheres. Although it is clear from *Metaphysics* Lambda that this final cause is the unmoved mover, the way in which the unmoved mover explains (or is responsible for) those rotations is rather obscure.[171] Furthermore, it appears from *Metaphysics* Lambda that the unmoved mover may also be in some sense responsible for the everlasting revolutions of the heavenly bodies.[172] Sedley proposes that the unmoved mover is *"the ultimate cause which, directly or indirectly inspires all beings to achieve their maximum actuality within their power"*.[173] The concepts from the *Physics* (in particular, the four causes and the principles and definition of change) do, however, seem ill-suited for the analysis of such an extensive proposal.

These conclusions invite further consideration of the proposal by Lennox that different subjects require domain-specific norms of inquiry. Aristotle says that all the perceptible substances (both the perishable ones in the terrestrial realm and the everlasting ones in the heavens) are subject to natural science because they involve change.[174] Nevertheless, Aristotle also says that there are different studies of these phenomena.[175] The experience of applying Aristotle's concepts from the *Physics* to the natural motions of Aristotle's sublunar and heavenly elements seems to support both these statements, as there are necessary differences in the way these motions are studied but both

[170] Section 3.2.2 ante.
[171] Section 5.4 ante.
[172] Section 6.2 ante.
[173] Sedley (2000), p.327.
[174] 1069a30; 268a1.
[175] 198a29.

sublunar and heavenly motions seem to be within the same field of inquiry.[176] Indeed, Aristotle confirms that they are both within the science of nature (Ἡ περὶ φύσεως ἐπιστήμη).[177]

However, the experience with regard to the *Metaphysics* is somewhat different, as the analysis of natural motions on the basis of concepts from the *Physics* was least productive when trying to deal with the role (and impact) of the unmoved mover as the final cause of heavenly motion.[178] Lennox suggests that when *"subjects to be investigated differ in fundamental ways* [they] *require distinctive norms of inquiry"*.[179] This view certainly seems to be endorsed by Aristotle when he confirms that metaphysics deals with entities which do not change and so fall beyond the study of nature.[180] Therefore, if, in respect of heavenly motion, the explanation given in answer to the question 'On account of what?' is the unmoved mover, then that explanation would be οὐκέτι φυσικῆς and so not analysable on the terms of the concepts from the *Physics*. There is, though, a further difficulty in this instance, as the study of the final cause of heavenly motion could fall between two stools, as it involves a natural phenomenon which is caused by (or explained by the existence of) a being which is beyond nature. As such, it might not be possible to address fully the role of the unmoved mover as the final cause (or explanation) of heavenly motion using the concepts from either the *Physics* or the *Metaphysics*.

[176] The fact that Aristotle's static principles of κίνησις are not applicable to the heavens because nothing is static in the heavens does not, of itself, suggest that the sublunar realm and the heavens should by subject to different norms of inquiry.
[177] 268a1.
[178] Sections 5,4 and 6.2 ante.
[179] Lennox (2021), p.4.
[180] 198a25; see also section 2.4 above.

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