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Author

Johnson, Monte Ransome

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Aristotle on Kosmos and Kosmoi

Monte Ransome Johnson*

The concept of *kosmos* did not play the leading role in Aristotle's physics that it did in Pythagorean, Atomistic (Democritean or Epicurean), Platonic, or Stoic physics. Of course, Aristotle greatly influenced (or impeded, some would argue) the history of cosmology, but I contend that Aristotle does not even recognize the validity of, much less himself offer, a science of cosmology as such, meaning a science which takes the *kosmos* itself as the object of study, with its own phenomena to be explained, and its own principles that explain them. In a pretheoretical sense, *kosmos* just means "order," and Aristotle certainly has a concept of the order of the universe. But the term *kosmos* also played an important technical role in two aspects of his predecessor's accounts that Aristotle rejected and attacked: first, cosmogony and *kosmopoiia*, generation or creation of the *kosmos*; second, *diakosmêsis*, an account of a plurality of *kosmoi*.¹ Aristotle was extremely critical of accounts involving *kosmopoiia* and *diakosmêsis*, and he developed general dialectical strategies against them. In emphatically distinguishing his view from *all* his predecessors (including Plato), he prefers to use the terms *ho ouranos* (the heaven), *to holon* (the whole), and *to pan* (the totality) in preference to *ho kosmos* (the *kosmos* or world). There is usually no harm in speaking loosely of "Aristotle's cosmology" when referring to his concept of the order of nature and the *ouranos*. Nevertheless, it is important to see that Aristotle's theoretical philosophy offers something very different from

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¹ Note that both terms may be used generally: *kosmopoiia* includes not only intelligent design creationism but any account of the genesis of a *kosmos*; *diakosmêsis* includes not only the thesis of infinite *kosmoi* but any account of a plurality of *kosmoi*. Thus, although Aristotle focuses his discussions of *kosmopoiia* and *diakosmêsis* on creationist and atomist accounts, he uses the same terms in describing both Pythagorean and Anaxagorean cosmologies, which are importantly distinct from the Platonic and Democritean cosmologies.

what is offered by those of his predecessors for whom *kosmos* was a keyword.

While Aristotle was concerned to prove that the order of nature is singular and eternal, these issues arise in the course of what he calls “the science concerning nature” (ἡ περὶ φύσεως ἐπιστήμη) and not as the focus of a discourse about the *kosmos* (περὶ κόσμου). No argument in Aristotle’s physics depends entirely on a theory of *kosmos*, and every argument about *kosmos* depends on Aristotle’s account of nature (φύσις) and *ouranos*. In fact, the topic of *kosmos* hardly comes up in the eight books of Aristotle’s *Physica*² except in the context of describing a rejected view. Aristotle’s most sustained and explicit discussion of *kosmos* occurs in the first book of his work entitled *Peri ouranou*,³ but again mostly in criticizing the cosmogonical and plurality of worlds theses of predecessors, including Empedocles, Anaxagoras, Democritus, and Plato. Nor again does *kosmos* play an important role in *Peri geneos kai phthoras*,⁴ a work whose subject is the phenomena of generation and destruction. In the *Meteorologica*, the concept of *kosmos* is present, but in a peculiar way, as we will see.

I will try to show that Aristotle is dubious about if not dismissive of the enterprise that became “cosmology,” and he seeks to refocus inquiry away from theses about the origin of the *kosmos* and the plurality of *kosmoi* to what he takes to be the singular eternal order of nature. In the conclusion I will briefly reflect on what I think are some unfortunate consequences of his position. But first the case will be made not only by a review of the relevant passages in the *Physica*, *Peri ouranou*, and *Meteorologica*, but also the *Peri kosmou*⁵ (a spurious work in the Aristotle Corpus); the *Protrepticus*⁶ and *Peri philosophias*⁷ (early exoteric or popular dialogues of Aristotle surviving only in fragments) and the *Metaphysica*.⁸ The exoteric works not only offer an improved context with which to interpret the main acroamatic works of the Aristotle Corpus, but they also show a pattern of argumentation about *kosmos* that was apparently adapted and deployed in them.

² Usually translated *Physics*. This chapter will cite works of Aristotle according to their Latin titles, following the conventions of this volume.

³ Usually translated *On the Heavens*, although I will dispute this translation later in the chapter.

⁴ Usually translated *On Generation and Corruption*. ⁵ Usually translated *On the Universe*.

⁶ Usually translated *Exhortation [to Philosophy]*. ⁷ Usually translated *On Philosophy*.

⁸ Usually translated *Metaphysics*.

4.1 Pseudo-Aristotle, *Peri kosmou*

Although included in the Aristotle Corpus, the *Peri kosmou* is most likely the product of a philosophical popularizer of the late Hellenistic era (probably the first century BCE/CE), who composed “an Aristotelian rival of the Stoic treatises which bore the same title.”⁹ As Jaap Mansfeld explains, “the formula *peri (tou) kosmou* gradually became a common expression denoting an important field of inquiry, viz. the study of the *kosmos* as a whole.”¹⁰ Neither the titular expression nor the subject matter conceived as a field of inquiry seems to have crystalized until after Aristotle, apparently with the Stoics.

Although the *Peri kosmou* is in some sense Peripatetic in doctrine, Pseudo-Aristotle offers only a pat and dogmatic description of cosmological, geographical, and meteorological positions, displaying none of the diaporetic and apodeictic method characteristic of Aristotle, and thus is of limited help in understanding the Stagirite’s views. Nevertheless, it will be useful to consider the quasi-Stoic definition of *kosmos* used by Pseudo-Aristotle, and to introduce Aristotle’s own conception by way of comparison to both this and the Stoic definition. First, the classic Stoic definition:

Chrysippus said that *kosmos* is (1) a structure consisting of *ouranos* and earth and of the natures in them. Or (2) the structure consisting of gods and humans and out of the things that have come to be for their sake.

Κόσμον δ’ εἶναί φησιν ὁ Χρύσιππος σύστημα ἐξ οὐρανοῦ καὶ γῆς καὶ τῶν ἐν τούτοις φύσεων· ἢ τὸ ἐκ θεῶν καὶ ἀνθρώπων σύστημα καὶ ἐκ τῶν ἕνεκα τούτων γεγονότων. (*SVF* 2.527.1–3 = Arius Didymus Fr. 31)¹¹

And now the very beginning of the philosophical part of *Peri kosmou* (at 391b9–12, just after the “address to Alexander”):

Kosmos, then, is (1) a structure consisting of *ouranos* and earth and of the natures contained within them. And otherwise this is also called *kosmos*: (2) the order and also arrangement of the wholes,¹² protected by god and also through god.

⁹ Mansfeld 1992: 392–99. Authors of Stoic treatises entitled *Peri kosmou* include Sphaerus, Chrysippus, Antipater, and Posidonius.

¹⁰ Mansfeld 1992: 396. A recent review of the doctrine, language, style, geographical knowledge, and cultural-historical background concludes that the work was written by someone in the Peripatetic tradition who addressed it to Alexander the Great in order to lend it credibility and attributed it to Aristotle for the same reason (Thom 2014: 3–8). The exceptions to the consensus that the work is spurious are discussed by Thom (2014: 5 n. 15).

¹¹ Also referenced by Posidonius in his *Meteorology*, Fr. 14 Kidd = Diog. Laert. 7.138.

¹² English translations of τῶν ὅλων as singular, e.g., “the totality” (Furley, Thom), make more sense and are more consistent with Aristotle’s definition: ἡ δὲ τοῦ ὅλου σύστασις ἐστὶ κόσμος (280a21–

Κόσμος μὲν οὖν ἔστι σύστημα ἐξ οὐρανοῦ καὶ γῆς καὶ τῶν ἐν τούτοις περιεχομένων φύσεων. Λέγεται δὲ καὶ ἑτέρως κόσμος ἢ τῶν ὄλων τάξις τε καὶ διακόσμησις, ὑπὸ θεοῦ τε καὶ διὰ θεὸν φυλαττομένη.

Part (1) of Pseudo-Aristotle's definition is identical to part (1) of Chrysippus' and represents common ground between the Stoics and the Peripatetics: a singular *kosmos*, consisting of a singular *ouranos* and earth and the "natures" included in it. Part (2) of Pseudo-Aristotle's definition, however, seems to be an adaptation of part (2) of Chrysippus', so as to render a conception of *kosmos* acceptable to both Stoics and Peripatetics: instead of implying that the structure of the *kosmos* has *come to be* for the sake of gods and humans, the "order and arrangement of the wholes" is said to be "sustained" by and through a god.¹³ The idea of generation of the *kosmos* and the anthropocentrism in the Stoic definition is absent from the pseudo-Aristotelian definition.

Pseudo-Aristotle's definition is not present in any extant work of the Aristotle Corpus, and with its strange reference to "the wholes" (τῶν ὄλων) which are somehow arranged into a *kosmos* it is reminiscent of the definition of *kosmos* attributed to Pythagoras in the doxographical tradition: "Pythagoras was the first to call the enclosure of the wholes [τῶν ὄλων] *kosmos* because of its inherent arrangement."¹⁴ In Aristotle, such an explicit definition of *kosmos* in its own right is surprisingly hard to find; in the closest he comes, he refers to a singular whole (τοῦ ὄλου) and not to plural "wholes" (τῶν ὄλων): "the structuring of the whole is *kosmos* and *ouranos*" (ἡ δὲ τοῦ ὄλου σύστασις ἔστι κόσμος καὶ οὐρανός).¹⁵ The term "the whole" does not occur in Chrysippus' definition,¹⁶ as it does appear in Aristotle's definition, and (in plural) in the second part of Pseudo-Aristotle's. As we will see, small terminological differences like this indicate very significant theoretical differences.

Aristotle's definition is both similar to and different from the Stoic and Neo-Pythagorean definitions in a couple of other ways. First, Aristotle uses the term σύστασις (structuring) where Chrysippus, Posidonius, and the author of *Peri kosmou* use the cognate term σύστημα (structure). It would

22). But the MSS all have the plural (not the singular τοῦ ὄλου). One sees here a distinctly Neo-Pythagorean expression and not a particularly Aristotelian one.

¹³ Or "by and through gods" (plural) – the MSS differ here. ¹⁴ Aëtius 2.1.1, tr. after Horkey.

¹⁵ Arist. *Cael.* 1.10.280a21–22.

¹⁶ Note that, according to Aëtius 2.1.7, the Stoics distinguished between "the totality" (*to pan*) and "the whole" (*to holon*), holding the former to include and the latter to exclude the infinite extra-mundial void posited in Stoic physics. Aristotle, who rejected the existence of a void (see below, n. 43), uses both terms synonymously with *ouranos*, his most comprehensive term.

be going too far to read too much into this terminological difference, I think, but it is worth noting that σύστημα is the term also used by a Hellenistic Pythagorean author in this exact context (but never in this context by Aristotle).¹⁷ More importantly, the idea of “a structure consisting of *ouranos* and earth,” which is present in both Chrysippus and Pseudo-Aristotle, is not present in Aristotle. Aristotle’s “structuring” is “of the whole,” and this defines *both kosmos* and *ouranos* (ἡ δὲ τοῦ ὄλου σύστασις ἐστὶ κόσμος καὶ οὐρανός). The *kai* in the expression *kosmos kai ouranos* is epexegetic: Aristotle’s singular *ouranos* includes the earth as a (vanishingly small) part, and so he does not conceive of the *kosmos* as a “structure consisting of *ouranos* and earth” which, put that way, emphasizes the importance of the earth in a context in which Aristotle instead minimizes it. This emphasis on the importance of earth in turn entails a more geocentric and thus anthropocentric and Stoicizing conception of physics than I think should be attributed to Aristotle, though it often has been, including by the author of *Peri kosmou*.¹⁸

Aristotle’s all-embracing conception of *ouranos* is expressed in *Peri ouranou* 1.9 when, in the course of defining his own subject matter, he distinguishes three different senses of *ouranos*.

(1) In one sense, then, we call the substance of the extreme revolution of the totality [τὴν οὐσίαν τὴν τῆς ἐσχάτης τοῦ παντός περιφορᾶς] *ouranos*, or that natural body [σῶμα φυσικόν] whose place is the extreme circumference of the totality. We habitually and especially call the extreme or upper part *ouranos*, which we take to be the seat of all that is divine. (2) In another sense, we use this name for the body continuous with the extreme circumference which contains the moon, the sun, and some of the stars; these we say are in the *ouranos* [ἐν τῷ οὐρανῷ]. (3) In yet another sense we give this name to all body included within extreme circumference, since we

¹⁷ Pseudo-Ocellus: “I refer to the whole [τὸ ὄλον] and the totality [τὸ πᾶν] as ‘the entire *kosmos*’ [τὸν σύμπαντα κόσμον]. For it obtained this name for this very reason, that it was thoroughly arranged [διακοσμηθεῖς] out of all things. After all, a system of the nature of the wholes [σύστημα τῆς τῶν ὄλων φύσεως] is consummate and perfect, since nothing is outside of the totality [τοῦ παντός]. For, if something exists, it is in the totality, and the totality is with it, and it comprehends all things with itself – some as parts, and others as outgrowths” (p. 127.11–16 Thesleff; tr. by Horky). Notice that Pseudo-Ocellus, like the author of the *Peri kosmou*, also speaks of “the wholes” in the plural. Thanks to Phillip Horky for the reference.

¹⁸ For discussion and references, see Johnson 2005 and Sedley 2007. Aristotle does not fit neatly into either side of what Sedley, like many others, considers two “sides of the ancient debate” (2007: xvi), referred to as “creationism” and “atomism” (e.g., by Sedley), or (more often) “teleological” and “mechanistic” by others. I have recently argued that Aristotle embraces both “teleological” and “mechanistic” explanations (Johnson 2017), and I will argue here that Aristotle rejects both creationism (along with all forms of cosmogony) and atomism (along with all forms of the plurality of worlds thesis).

habitually call the whole and the totality *ouranos* [τὸ γὰρ ὅλον καὶ τὸ πᾶν εἰώθαμεν λέγειν οὐρανόν]. (Aristotle, *Cael.* 1.9.278b11–21)

Notice that Aristotle defines his overall subject matter as the *ouranos*, not the *kosmos*. In fact, it is possible to describe Aristotle's "whole" and "totality" without any reference to the term *kosmos* whatsoever – the term "universe" translates the philosophical concept perfectly. The first sense of *ouranos* refers to the extreme revolution or circumference of the totality; this is identical to the sphere of fixed stars, which Aristotle takes to be the outer limit of the spherical totality, and which we understand to be, mostly, the immediately visible portion of the Milky Way galaxy.¹⁹ For the second sense, he also refers to outer space, moving inwards to include the planets, sun, and moon, roughly what we now call the "Solar system." For the third sense, he moves again further inward, including all body whatsoever (thus all fire, water, air, and earth), which he considers continuous and entirely contained in a single "centrifocal" *ouranos*.²⁰ In this context he speaks interchangeably of "the whole" (*to holon*), "the totality" (*to pan*), and *ouranos*. We can now begin to understand why Aristotle defined "the composition of the whole" as "*kosmos*, i.e., *ouranos*." Given his view of a singular *kosmos*, Aristotle can replace all talk of the *kosmos* with talk of *ouranos* (in the third, broad sense, meaning "universe"), and so he freely uses these terms interchangeably when describing his own position, usually preferring the term *ouranos*.²¹ Note that, for this reason the title of the treatise *Peri ouranou* should be translated *On the Heaven* (as in the Latin: *De caelo*), and not (despite English idiom) *On the Heavens* – the use of the singular in the title of the treatise is significant. In fact, the translation *On the Universe* would better capture Aristotle's attempt to define the exact object of the study.

¹⁹ All the stars visible to the naked eye turn out to be located within the Milky Way galaxy, except the Andromeda galaxy, the Large and Small Magellanic Clouds, and some of the historical supernovae. There is no evidence that Aristotle observed any of these phenomena.

²⁰ In the *Peri ouranou*, Aristotle employs a variety of expressions in connection with this third sense, such as the totality (*to pan*) (1.1.268a4; 1.7.275b30); the nature of the totality (*tês tou pantos phuseôs*) (1.2.268b11); the body of the totality (*to soma tou pantos*) (1.7.275a17). The term "centrifocal" was introduced by Furley to distinguish Aristotle's theory from the "linear" or "parallel" theory of Anaximander and the Atomists (1989: 15).

²¹ English translators of *Peri ouranou* including Furley and Stocks have introduced confusion by using the English word "world" as an ambiguous translation for several distinct Greek terms: *ho kosmos*, *ho ouranos*, *to pan*, *to holon*.

4.2 *Protrepticus*

Aristotle's dialogue *Protrepticus* offered an exhortation to philosophy, and specifically a defense of mathematical and theoretical philosophy in which there was enormous interest in the Academy of which Aristotle was a member when he wrote it. This kind of philosophy was in some sense inspired by the activities of "the Pythagoreans." In the *Protrepticus*, Aristotle offered the following explanation of why the Pythagoreans put so much value into the study of mathematics in relation to the *kosmos*:

In all these things, probably, the Pythagoreans honored the effort put into mathematics, and coordinated it in various ways with the observation of the *kosmos* [πρὸς τὴν τοῦ κόσμου θεωρίαν], for example: by including in their reasoning the number that arises from the revolutions and their differences, by theorizing what is possible and impossible in the structuring of the *kosmos* [τῆ τοῦ κόσμου συστάσει] from what is mathematically possible and impossible, by conceiving the revolutions of *ouranos* [τὰς δὲ οὐρανίου περιφορὰς] according to commensurate numbers with a cause, and by determining measures of the *ouranos* according to certain mathematical ratios, and generally putting together the natural science [φυσιολογία] which is predictive on the basis of mathematics, and putting the mathematical objects before the other theorems about the *kosmos* [τὰ περὶ τοῦ κόσμου θεωρήματα], as if they were principles. (Aristotle, *Protrepticus*, *apud* Iamblichus, *On the General Mathematical Science* 23, pp. 73.17–74.1 Festa-Klein)²²

This is significant evidence that "the Pythagoreans" (Aristotle may be referring to some Pythagoreans contemporary with Philolaus of Croton, ca. 470–385 BCE) used the concept of the *kosmos* in the sense of "the world." Despite this enthusiastic description, however, Aristotle later seems reticent about the focus on *kosmos*, after he expresses a protreptic conclusion reached by Pythagoras:

Pythagoras, according to this argument anyway, said rightly that it is for the sake of understanding and observing that every human being has been constructed by the god. But later, perhaps, one should inquire whether the object of this understanding is the *kosmos* or some other nature [ὁ κόσμος ἐστὶν ἢ τις ἕτερα φύσις]. (Aristotle, *Protrepticus*, *apud* Iamblichus, *Protrepticus* 9, p. 51.6–9 Pistelli)²³

²² Translated by Hutchinson and Johnson (www.protrepticus.info). For the attribution of *DCMS* Chapter 23 to Aristotle's *Protrepticus*, see Merlan 1953 and Festugière 1956.

²³ Translated by Hutchinson and Johnson. For attribution of *Protr.* 9 to Aristotle, see Hutchinson and Johnson 2005: 258–62.

Notice that Aristotle is careful to distinguish between “the Pythagoreans” (to whom he attributes views about the *kosmos*) and Pythagoras himself.²⁴ The second passage calls into question whether the object of this philosophical speculation *should* be understood to be the *kosmos* (as the Pythagoreans apparently did) or “some other nature” (τις ἕτερα φύσις). In the other surviving fragments of the *Protrepticus*, Aristotle repeatedly discusses nature as a cause, but does not seem to refer again to the *kosmos*.²⁵ As I will argue, this follows a typical pattern according to which Aristotle moves from a criticism of a predecessor’s view about *kosmos* to his own account of nature, thus removing the debate to a field in which he occupies strong and well-defended positions.

4.3 *Metaphysica*

It is interesting to compare Aristotle’s account of the Pythagoreans in the *Protrepticus* with the more ambivalent account in the *Metaphysica*:

Since then all other things seemed in their entire nature to be modelled after numbers, and numbers seemed to be the first things in all of nature [πάσης τῆς φύσεως], they supposed the elements of numbers to be the elements of all things, and the whole *ouranos* [τὸν ὅλον οὐρανόν] to be a musical scale and a number. And all the properties of numbers and scales which they could show to agree with the effects and parts of the *ouranos* and with the whole arrangement [πρὸς τὰ τοῦ οὐρανοῦ πάθη καὶ μέρη καὶ πρὸς τὴν ὅλην διακόσμησιν], they collected and fitted into their scheme. (Aristotle, *Metaph.* 1.5.985b32–986a6, tr. after Ross)

Compared to the fragments of the *Protrepticus*, Aristotle’s approach to Pythagorean speculation is, predictably, more cautious and critical in *Metaphysica* I, where he alludes to the “harmony of the spheres” thesis ridiculed in *Peri ouranou* 2.9. The more critical approach is also reflected in other accounts of Pythagorean cosmology, such as *Peri ouranou* 2.2 and 2.13, which Aristotle concludes by saying that “they are not seeking the

²⁴ Although Pythagoras is by tradition credited with first using the term *kosmos* in the sense of “world” (Aëtius 2.1.1 = DK 14 Fr. 21), Carl Huffman has argued that in the Pythagorean tradition it is Philolaus who is most likely to have first used the term in this way (DK 44 B 1, 2, 6, and possibly 17; see the commentary of Huffman 1993: 97–98); note that this usage is as archaic as Empedocles’ B 134, which is usually taken to be the earliest such usage. This and the rest of the evidence is reviewed by Horky in Chapter 13 of this volume; for further treatment of Aristotle’s references to “the Pythagoreans,” see Horky 2013: 3–36.

²⁵ Of course, an argument from silence cannot be probative in the context of a fragmentary text, but it is telling that in several extended passages in which Aristotle discusses nature the term *kosmos* does not appear (e.g., *apud* Iamblichus, *Protr.* 7, pp. 41.24–43.5 Pistelli, and 9, pp. 49.3–52.16 Pistelli).

accounts and the causes directed toward the things that appear, but rather drawing the things that appear toward one of their accounts and opinions, and trying to co-ordinate them” (συγκοσμεῖν).²⁶ The more positive and detailed account of the *Protrepticus* is thus valuable in filling out the overly brief description of the *Metaphysica*, describing several ways Pythagoreans related numbers to “the *ouranos* and the whole arrangement” (τὴν ὅλην διακόσμησιν). The term *diakosmêsis* appears in the authentic works in the Aristotle Corpus²⁷ as a noun only twice, here in the *Metaphysica* and once in an embryological context,²⁸ although it does appear in part (2) of Pseudo-Aristotle’s definition of *kosmos*. The term is associated in Pythagoreanism with *kosmopoïia* (and its verbal forms), as in Aristotle’s criticisms of the Pythagoreans at the end of the *Metaphysica*:

It is absurd also to attribute generation to eternal things, or rather this is one of the things that is impossible. There need be no doubt whether the Pythagoreans attribute generation to them or not, for they obviously do . . . But since they are *creating a kosmos* and wish to speak naturalistically [ἄλλ’ ἐπειδὴ κοσμοποιοῦσι καὶ φυσικῶς βούλονται λέγειν], it is fair to give some explanation of their account about nature [περὶ φύσεως]. (Aristotle, *Metaph.* 14.3.1091a12–20, tr. after Ross)

Aristotle in general is hostile to cosmogony and rejects the enterprise a priori.²⁹ What is evident here is not only his rejection of cosmogony but specifically his strategy of forcing the question about the generation or creation of the *kosmos* to be answered on the basis of a view about nature (περὶ φύσεως). This same strategy we see deployed against Anaxagoras. As with the Pythagoreans, Aristotle is extremely ambivalent in his treatment of Anaxagoras. On the one hand he congratulates Anaxagoras for saying “that intellect was present, just as in animals, so too in that which exists by nature – as the cause of the *kosmos* and all of its order (καὶ ἐν τῇ φύσει τὸν αἴτιον τοῦ κόσμου καὶ τῆς τάξεως πάσης): he seemed like a sober man in contrast with the idle talk of his predecessors” (1.3.984b15–18, tr. after Ross). On the other hand, thinkers like Anaxagoras only “got hold up to a certain point of two of the causes which we distinguished in our work about nature [περὶ φύσεως] – the matter and the source of movement – vaguely, however, and with no clearness” (1.4.985a10–13). Cosmogony is

²⁶ *Peri ouranou* 2.13.293a25–27, with reference to their hypothesis of the “counter-earth.” See also Aristotle’s criticism of Pythagorean cosmology in 2.2 (although he only refers to the term *kosmos* in that chapter in a technical aside about the transverse at 285b12).

²⁷ But the term was probably also used in *Peri philosophias*, Fr. 12b Ross (discussed in what follows).

²⁸ Arist. *GA* 2.4.740a8. This usage is due to Democritus and the Atomist embryological theory.

²⁹ Gregory 2007: 163–72.

exactly where Anaxagoras goes wrong: “Anaxagoras uses intellect as a device for his *creation of the kosmos* [μηχανῆ χρηῖται τῷ νοῷ πρὸς τὴν κοσμοποιίαν] and when he is at a loss to say by (or for) what cause something necessarily is, then he mentions it” (1.4.985a18–20).

A fifth reference to *kosmos* in *Metaphysica* appears in the context of an attack on Protagorean relativism. Notice that Aristotle does not directly discuss the *kosmos* as such, but rather “the things that are in the *kosmos*,” i.e., the *ouranos* in the narrow, first sense identified earlier in the chapter, meaning the outermost space.

In general, it is absurd to make the fact that the things of this earth are observed to change and never remain in the same state the basis of our judgments about the truth. For in pursuing the truth one must start from the things that are always in the same state and suffer no change. Such are the things in the *kosmos* [τὰ κατὰ τὸν κόσμον]; for these do not appear to be now one way and then again another, but are manifestly always the same and share in no change. (Aristotle, *Metaph.* 11.6.1063a10–17, tr. after Ross)

This is a generalization of the argument made against Pythagorean and Anaxagorean cosmology: it is wrong to reason from the changeability of the things near earth to the changeability of everything (the universe), and those who do will be led astray in their account of nature, the *kosmos*, and even truth. It is in this critical dialectical context that all the references to *kosmos* appear in Aristotle’s *Metaphysica*.

4.4 *Peri philosophias*

According to an argument attributed to Aristotle’s dialogue *Peri philosophias*, Aristotle discussed two sources for humans’ belief in the gods: (1) from the prophetic power of the soul in dreams; and (2) “from the things aloft [ἀπὸ τῶν μετεώρων] . . . seeing by day the sun running his circular course, and by night the well-ordered [εὐτακτον] movement of the other stars, they came to think that there is a god who is the cause of such movement and such good order [εὐταξίας].”³⁰ In a related passage, Sextus expands on the second reason, comparing the “well-ordered [εὐτακτον] movement of the heavens [τῶν οὐρανίων]” to the “array of Greeks approaching the plains with much organization and order” (κόσμου καὶ τάξεως); one naturally infers an “organizer of this kind of order” (ὁ διατάσσων τὴν τοιαύτην τάξιν), a commander of such well-ordered

³⁰ Sext. Emp. *Math.* 9.20–23 = Aristotle Fr. 12a Ross, tr. after Ross.

forces, “Nestor or some Hero who knew how to organize [κοσμήσαι] horses and bucklered warriors” (*Math.* 9.26–27, tr. after Ross). In both passages the word *kosmos* plainly refers to organization, i.e., order, including in the second, verbal usage, a quotation from Homer (*Il.* 2.554). These texts have been interpreted as showing Aristotle committed to supporting intelligent design creationism, in conjunction with a famous text in Cicero³¹ recounting Aristotle’s thought experiment about cave dwellers living in comfortable subterranean apartments furnished with the products of human art, who have heard by report and hearsay about divine power. If they were to go to the aboveground realm of nature, and see the grandeur and beauty of the stars, moon, and sun “their courses settled and immutable to all eternity; when they saw those things most certainly they would have judged both that there are gods and that these are the works of gods.” Philo of Alexandria reports a similar argument:

The most highly esteemed philosophers said it was from the *kosmos* and its parts and the powers inherent in these that we came to grasp their cause . . . if one comes into this *kosmos* as into a vast house or city, and sees the *ouranos* revolving in a circle and containing all things within them . . . he will surely reason that these things have not been framed without perfect skill, but that there both was and is a framer of this totality – God. (Philo of Alexandria, *Allegories of the Sacred Laws* 3.32.97–9 = Aristotle Fragment 13 Ross, tr. after Ross)

Even if all these arguments were attributable to Aristotle’s *Peri philosophias*, they would not show that Aristotle himself advocated intelligent design creationism, as some have claimed.³² First, the work *Peri philosophias* was a dialogue, and the speech reported by both Cicero and Philo could easily have been put in the voice of a Pythagorean or Platonic character, such as Heraclides of Pontus. Aristotle himself, speaking in his own voice, could have rejected the argument out of hand, or accepted part of it and criticized another part.³³ In fact, each piece of attributed evidence, including the most suspect one of Philo just quoted, only purports to explain the reason why people came to believe in gods, and what they happened to believe

³¹ Cic. *Nat.D.* 2.37.95–6 = Aristotle Fr. 13 Ross, tr. by Ross.

³² Jaeger 1923/1934 and Chroust 1973; see Johnson 2005: 259–62.

³³ Besides the fact that Aristotle absolutely rejects the creation or generation of the *ouranos*, there is the fact that the inferred concept of God as the organizer (ὁ διατάσσων) is explicitly rejected by Aristotle, e.g., in the conclusion of the *Eudemian Ethics*: οὐ γὰρ ἐπιτακτικῶς ἄρχων ὁ θεός (7.15.1249b13–14). Aristotle rejected the idea of gods intervening in nature as much as Epicurus did, and on this basis his concept of God has been fruitfully compared to theirs (Merlan 1967; Effe 1970: 157–62).

about the *ouranos* and the *kosmos*. To offer that anthropological theory entails no commitment whatsoever to the thesis that god created the *ouranos* or the *kosmos*, any more than the observation that some people believe in gods on the basis of the prophetic power of dreams entails that dreams have prophetic power. In fact, we know that Aristotle rejects both the prophetic power of dreams, and the idea that the *kosmos* or *ouranos* was created. In *Peri philosophias* Aristotle not only rejected creationism; he mocked it, as Philo reports:

Aristotle . . . insisted that the *kosmos* is ungenerated and imperishable, and convicted of grave ungodliness those who maintained the opposite, who thought that the great visible god, which contains in truth sun and moon and the remaining pantheon of planets and unwandering stars, is no better than the work of human hands; he used to say in mockery . . . that in the past he had feared lest his house be destroyed by violent winds or extraordinary storms, or by time or lack of proper maintenance, but that now a greater danger hung over him, from those who by argument destroy the entire *kosmos*. (Philo of Alexandria, *De Aet. Mundi* 3.10–11 = Aristotle Fragment 18 Ross, tr. after Ross)

It is generally held that the arguments of *Peri philosophias* against the generation of the world were directed against Plato,³⁴ who held that although the *kosmos* will be everlasting, it was created by an intelligent designer; and also against the Atomists, who held that an infinite number of *kosmoi* are continually being generated and destroyed. Besides mocking the view that the *kosmos* could be destroyed (which mockery must have been directed against the Atomists), Aristotle also offered a number of apodeictic arguments (preserved by Philo, *Fragments* 19a–c) to the conclusion that the *kosmos* is eternal, meaning ungenerated and indestructible. For our purposes the most important of these is Fragment 19b, where Philo relates an argument drawn from Aristotle:

If, then, the cause of destruction of the other animals is their unnatural order [ἡ παρὰ φύσιν τάξις], but in the *kosmos* each of its parts is situated according

³⁴ “When he began to work out his physical *methodoi*, cosmogony in the form in which it had flourished among the Presocratics was dead, while the new version which the *Timaeus* presented called for one more painstaking examination of its presuppositions” (Solmsen 1958: 266). Solmsen’s account, which in general I find persuasive (and I agree with his conclusions), tends to over-emphasize the importance of Plato to Aristotle’s positions on cosmogony: “by discrediting this last essay in cosmogony <sc. the *Timaeus*>, the whole effort was ruled out of court” (ibid.). But I will argue that the Democritean account is treated as a live option (i.e., an account to be refuted) throughout the Aristotle Corpus, and there is every reason to assume that his views were also at issue in the earlier dialogue *Peri philosophias*. In general, Aristotle considers Democritus a more advanced thinker on natural science than Plato (Johnson 2005: 104–12).

to nature and has had its proper place assigned to it, the *kosmos* may justly be called indestructible. (Philo, *De Aet. Mundi* 7.34 = Aristotle Fr. 19b Ross, tr. after Ross).

As Philo relates the argument, composite bodies are destroyed by being dissolved into their components; and dissolution is nothing but reduction to the natural state of the parts; plants, humans, and animals, which are compositions of earth, air, water, and fire, are unnatural according to this argument, and this is the reason they are perishable, because the elements, which in a composite body are prevented from reaching their natural place, will eventually be dissolved and return to their natural place. Now “the *kosmos* has no part in this disorder . . . if it is perishing, its parts must now each be placed in the region unnatural to it. But this we cannot easily suppose” (Fr. 19b). Philo goes on to describe why earth, water, air, and fire should all be thought to be in their natural position, and even the phenomena of temporary dislocation show that these elements constantly return to their natural places.

A recent study has concluded that of all Aristotle’s arguments against the generation or destructibility of the *kosmos* in *Peri philosophias*,

19b gives us perhaps the worst argument, because it is clear that for Aristotle the parts of the *kosmos* are not all in their natural positions. If they were, there would be concentric spheres of earth, water, air, and fire, with no mixing of the elements. The oddest part of this argument is that Aristotle recognizes that the parts of animals are not in their natural places, but he does not then recognize that animals are part of the *kosmos* and so not all parts of the *kosmos* are in the natural place. (Gregory 2007: 171)

I think that the argument can be salvaged by examining in detail this part of the argument:

For humans are composed from the four elements, which in their entirety are part of the totality of *ouranos* [ἄνθρωποι γὰρ ἀπὸ τῶν τεττάρων στοιχείων, ἃ δὴ ὅλα τοῦ παντός ἐστὶν οὐρανοῦ] – earth, water, air, and fire. Now these parts when mixed are robbed of their natural place. (Philo, *De Aet. Mundi* 6.29 = Aristotle Fr. 19b Ross, tr. after Ross).

English translations have followed Cumont in expunging οὐρανοῦ from the text; here I follow Bernays in keeping οὐρανοῦ and taking it with παντός, adding in support of this proposal that Aristotle uses this very expression in a related context at *Peri ouranou* 1.9: τοῦ παντός οὐρανοῦ (279a25). Keeping οὐρανοῦ in the text attributed to *Peri philosophias* requires interpreting the term in the third, broad sense identified by Aristotle: “we habitually call the whole and the totality *ouranos*”

(278b20–21), and interpreting the genitive inflection of τοῦ παντός οὐρανοῦ (in Philo's text) as partitive, so that the four Empedoclean bodies are understood in their entirety to form only "a part of the totality of *ouranos*." This in turn allows us to avoid an even more urgent problem than the one mentioned by Gregory: according to Aristotle, the totality does not consist only of the four elements – there is also what Aristotle calls "the primary body," the aether, the matter of the stars, planets, sun, and moon. This is by far the largest and most important part of the *ouranos* and the totality – the earth and its environment are as a point relative to the magnitude of the *ouranos*.³⁵ But this primary part of the *kosmos* would, absurdly, be ignored here if *ouranos* is deleted from Philo's text (or ignored). Aristotle had already affirmed the existence of the "primary" body, aether, in *Peri philosophias* (Fragments 21–2 Ross). This body, at least, can never be dislocated, and in fact it serves as the absolute limit of all the natural locations in the *kosmos*. What about the other bodies? Aristotle argued that humans and the other animals as composites of the four Empedoclean bodies are perishable. But the four elements as a whole are not perishable (because they are not composites but elements, and they are not destroyed upon dissolution of the composite but return to their natural places). Thus, to answer Gregory, even though animals are parts of the *kosmos* (i.e., the *ouranos* in the broad, third sense, meaning universe), the crucial point is that they are not the totality, and the cause of their perishability (being unnatural and temporary compositions of elements) does not affect either the system of four elements, or the *ouranos* in the narrower first and second senses (the fixed stars, and solar-lunar-planetary system), and so applies only to a vanishingly small part of the all-embracing *ouranos*. It would be poor form to extrapolate from the destructibility of the things around earth to the destructibility of everything, including the whole *ouranos*, as Aristotle argues in *Metaphysica* II.6.1063a10–17 (referenced earlier).

I dwell on this argument because the passage represents an argumentative strategy Aristotle repeatedly deploys against all of his predecessors: they worked under the misapprehension that the *kosmos* and hence *ouranos* was generated; and the cause of this misapprehension was an insufficient grasp of the natural principles of simple bodies. The purpose of the rest of this chapter is to show the deployment of that argument in the acroamatic texts of the Aristotle Corpus.

³⁵ Arist. *Cael.* 2.14.279b30–298a20 and *Met.* 1.14.352a17–28 (discussed in what follows).

4.5 *Physica*

In the early work *Topica*,³⁶ Aristotle's paradigm of a theoretical and "natural" dialectical problem is "whether the *kosmos* is eternal or not [πότερον ὁ κόσμος αἰδίου ἢ οὐ]." ³⁷ Aristotle explains that such problems arise because there are persuasive arguments on both sides of the issues, and because the issues "are so vast, and we find it difficult to give our reasons."³⁸ This should be compared with *On the Parts of Animals* 1.5.644b21–645a25, where Aristotle points out that the *remoteness* of the phenomena is the cause of difficulties in astronomical research, which reveals one of the comparative advantages of biological research.

As we have seen, the problem was hotly debated in the *Peri philosophias*. Despite the fact that this problem is a paradigm of a natural problem in the *Topica*, Aristotle does not address the problem "Is the *kosmos* eternal or not?" in the *Physica* itself – and in fact not until the final three chapters of *Peri ouranou* book 1.³⁹ He does note that "the writers on physics obviously do discuss . . . whether the earth and the *kosmos* are spherical or not" (*Physica* 2.2, 193b29–30). This is additional secondary evidence that the early Greek philosophers did discuss *kosmos* in the sense of "world."⁴⁰

All the other references to *kosmos* in the *Physica* are in the context of the rejection of predecessors' cosmogonical views. In *Physica* 2.4, Empedocles is criticized for not explicitly discussing luck, even though he seems to assign it as a cause of motion ("separation") of air: "he says in his creation of the *kosmos* [ἐν τῇ κοσμοποιίᾳ] that "*it happened to run that way at that time, but it often ran otherwise*"; he also tells us that most of the parts of animals came to be by luck" (196a22–24).⁴¹ Immediately following this

³⁶ Usually translated *Topics*.

³⁷ Arist. *Top.* I.II.104b9. Aristotle refers to the dialectical problem and proposition of whether or not the *kosmos* is eternal as an example of something that would be beneficial to know, not with a view to choice or avoidance, but "merely with a view to knowledge" (104b8); the question arises not in ethics or logic but in natural science (105b25). In a later handbook, the paradigm of a "physical" problem is "whether there is one *kosmos* or many" (πότερον εἷς κόσμος ἐστὶν ἢ πλείους) (*Divisiones Aristoteleae* 56.1).

³⁸ Arist. *Top.* I.II.104b16.

³⁹ I will discuss the possibility that he wrote a work entitled *Peri kosmou genesēs* later.

⁴⁰ See above, n. 24.

⁴¹ Empedocles DK 31 B 53. A related point is made in *Peri genesēs kai phthoras* (the only occurrence of the term *kosmos* in that work): "But, again, it is obvious that they <sc. the bodies> move. For though strife dissociated, it was not by strife that the aether was borne upwards. On the contrary he attributes their motion to something like luck (ὡσπερ ἀπὸ τύχης): 'for thus, as it ran, it happened to meet them then, though often otherwise' (= B 53); while at other times he says it is the nature (πεφυκένα) of fire to be borne upwards, but (to quote his words), 'the aether sank down upon the earth with long roots' (= B 54). But at the same time, he also says that the *kosmos* (τὸν κόσμον) has

Aristotle accuses the Atomists of not making explicit their account of spontaneity, even though

they ascribe to spontaneity the parts of animals and all the *kosmoi* [τῶν κόσμων πάντων]. They say that the vortex arose spontaneously, i.e. the motion that separated and established the totality in its present order [τὴν κίνησιν τὴν διακρίνασαν καὶ καταστήσασαν εἰς ταύτην τὴν τάξιν τὸ πᾶν]. (Aristotle, *Ph.* 2.4.196a25–28)

This is not the place to assess the veracity of Aristotle's interpretation, much less his criticism, of Empedocles and Democritus.⁴² The important point for the present investigation is that Aristotle's entire discussion of the principles of natural science and of causation in *Physica* 2 makes no positive use of the concept of *kosmos* whatsoever.

The Atomists' views are mentioned as Aristotle explains why people believe in the existence of infinity: one reason is because of "what is outside the *ouranos*" (τὸ ἔξω τοῦ οὐρανοῦ): "if what is outside is infinite, it seems that body is also infinite, and that there are also infinite *kosmoi*" (3.4.203b25–26). Aristotle is explaining why people are led, wrongly, to the conclusion that infinity somehow actually exists. In Aristotle's view there is nothing "outside the *ouranos*" – literally nothing, no body, not even void – and so the affirmation of anything actually infinite is rejected.⁴³ A fortiori infinite *kosmoi* outside the *ouranos* are rejected.

The concept of *kosmos* appears in only three other significant passages of the *Physica*, all in Book 8, and all again in the context of the rejection of cosmogony. In the first, Aristotle asserts that *all* of his predecessors in natural science have been concerned with the problem of motion, because all have offered a cosmogony:

The existence of motion is asserted by all who have anything to say about nature, because they all concern themselves with the creation of *kosmos* [τὸ κοσμοποιεῖν] and study the question of generation and destruction, processes which could not come to be without motion. But those who say that

a similar nature both now, in the reign of strife, as it was formerly, in the reign of love. What then is the first mover and the cause of motion?" (2.6.333b35–334a8, tr. after Joachim).

⁴² On Aristotle's treatment of Empedocles, see Johnson 2005: 95–104; and for Democritus, see Johnson 2005: 104–12; 2009.

⁴³ Aristotle treats as similar the physicists who hold that there is an infinite body (or void) outside the *kosmos*: "But in respect of addition there cannot even potentially be an infinite which exceeds every assignable magnitude, unless it is accidentally infinite in fulfillment, as the physicists hold to be true of the outer body of the world (*to exo soma tou kosmou*), whose substance is air or something of the kind" (*Ph.* 3.6.206b20–24). Nor is any void admitted within the *kosmos* (4.8.216b17–18). Thus Aristotle has no motivation, as the Stoics do, to support a distinction between *to pan* and *to holon* on the basis of the inclusion of void or not (see above, n. 16).

there are also infinite *kosmoi* [ἄπείρους κόσμους], some of which are in the process of becoming while others are in the process of being destroyed, assert that there is always motion. (Aristotle, *Ph.* 8.1.250b15–23)

In a later passage he makes an equally generally statement about “all who have ever said anything about motion”:

They all assign their principles of motion to things that impart motion of this kind. Thus separation and combination are motions in respect of place, and the motion imparted by love and strife takes these forms, the latter separating and the former combining. Anaxagoras, too, says that intellect, his first mover, separates. Similarly those who assert no cause of this kind but say that void accounts for motion – they also hold that the motion of natural substance is motion in respect of place . . . The process of increase and decrease and alteration, they say, are effects of the combination and separation of atoms. It is the same too, with those who make out that the becoming or perishing of a thing is accounted for by rarity or density. For it is by combination and separation that these things are arranged [συγκρίσει γὰρ καὶ διακρίσει ταῦτα διακοσμοῦσιν]. (Aristotle, *Ph.* 8.9.265b16–32)

The term “arranged” translates the verbal form of the term *diakosmēsis*, which we saw used in the description of the Pythagorean cosmology in *Metaphysica* 1.5. In this passage Aristotle groups Empedocles, Anaxagoras, and the Atomists in a general criticism of *diakosmēsis*.⁴⁴ The predecessors’ explanations of the present arrangement of the *kosmos* all reduce to locomotion, but none of them gives an adequate account of locomotion. Aristotle’s general strategy against the enterprise of cosmogony depends on this reduction. All cosmogonies must give an account of the cause of change, since they hold that the *kosmos* has been generated, and generation is a kind of change. But their accounts of generation can all be reduced to locomotion, because they depend on separation and combination, and separation and combination depend on locomotion (e.g., of infinite atoms in infinite void).⁴⁵ The predecessors’ accounts of locomotion are all weak:

⁴⁴ Both Leucippus and Democritus authored works entitled *Diakosmēsis*. These works must, then, have discussed how atoms in locomotion generate compounds, and how they undergo increase, decrease and alteration by a process of combination and separation of atoms. Leucippus’ *Great Diakosmēsis* may have been an account of how our *kosmos* and the infinite *kosmoi* were generated by atomic processes, while Democritus’ *Small Diakosmēsis* may have been a description of how plants, animals, and humans are generated by similar atomic processes. See Schofield, in Chapter 3 of this volume.

⁴⁵ It is interesting that although the Atomists recognized a plurality or infinity of *kosmoi*, they offer a unified account of motion (the cause of motion of the atoms in all possible worlds); whereas Aristotle, who insists on a singular *kosmos*, is forced to embrace a dualistic account of natural motion (the cause of motion in the sublunary region is essentially different from that in the superlunary).

in Empedocles' case, it amounts to "luck"; in Democritus' case "spontaneity";⁴⁶ Anaxagoras makes a notable advance with his "intellect." But none of these causes can be the primary intrinsic cause of all motion. That cause must be: "a principle or cause of being moved and being at rest in that to which it belongs primarily, in virtue of itself and not incidentally" (*Physica* 2.2.192b20–22). This is Aristotle's definition of nature. Things that exist by nature include all the plants and animals, all the simple bodies, and all the stars, sun, and moon (192b8–10). These things all have the causes of their motion in virtue of themselves, and not any other cause, and thus cannot have been caused to exist by anything else external, like luck, spontaneity, or intellect. Hence cosmogony is impossible, and what we should focus on is the eternity of the stars, planets, sun, and moon, and the natural cause of their continual motion. (For a related reason, we should abandon zoogony: Aristotle assumes that the forms of animals are eternal, just like the stars.) And so Aristotle in his natural science systematically works through the aethereal body and the elements, followed by their combinations in the spheres in which they mix (the meteorological and biological spheres), and gives an account of all the unchanging forms contained therein. Throughout he rejects the possibility that these things have been generated by some cosmic process other than nature itself, even those that continue to exist by transmutation (the four elements) or reproduction (living things).

4.6 *Peri ouranou*

Not surprisingly, *kosmos* is referred to more in *Peri ouranou* than in any other work of Aristotle. But even here, it is mostly in the context of the refutation of cosmogony and the plurality of worlds thesis.⁴⁷

⁴⁶ The characterization of Democritus' view according to which the motions of the *kosmos* could have originated in the same way that animals originate locomotion, i.e., "spontaneously," is the third major context in *Physics* 8 in which Aristotle uses the concept of *kosmos*: "Now if this can occur in an animal, why should not the same be true of the totality [τὸ πᾶν]? If it can occur in a small *kosmos* it could also occur in a great *kosmos* [εἰ γὰρ ἐν μικρῷ κόσμῳ γίγνεται, καὶ ἐν μεγάλῳ]; and if it can occur in the *kosmos*, it could occur in the infinite; that is, if the infinite could as a whole possibly be in motion or at rest" (8.2.252b24–28). Of course, Aristotle is completely critical of this argument and of the whole conception that the motion of the *ouranos* ever had a beginning (see 8.3.253a7–21 and 8.6).

⁴⁷ Kukkonen offers an interpretation of *Peri ouranou* that is largely consistent with the interpretation offered here: "despite the tendency on the part of modern commentators to side with Alexander and to call Aristotle's *On the Heavens* his cosmology; the term *kosmos* does not appear to have any special significance in Aristotle's exposition in this particular treatise" (2014: 312; see below, n. 57, for an important difference between our interpretations). Kukkonen's study is especially useful for his detailed examination of the commentators, beginning with Alexander and Simplicius, and their influence on later commentators, including those in the Arabic tradition.

According to Simplicius, Alexander of Aphrodisias

says that the subject of Aristotle's treatise *Peri ouranou* is the *kosmos* [περὶ κόσμου]. He says that *ouranos* is used in three senses by Aristotle in this work, to mean both the sphere of the fixed stars and the whole of the divine, revolving body, which in this book he also calls the "furthest *ouranos*" (with the adjective), and additionally, the *kosmos* [καὶ ἔτι μάλιστα τὸν κόσμον], as Plato called it. (*in Phys.* p. 1.2–6 Diels, tr. Hankinson)

The reference is clearly to the passage in 1.9, quoted earlier, in which Aristotle defines the third, broad sense of *ouranos*: "In yet another sense we give the name to all body included within extreme circumference, since we habitually call the whole and the totality *ouranos* [τὸ γὰρ ὅλον καὶ τὸ πᾶν εἰδῶθαμεν λέγειν οὐρανόν]." The problem with Alexander's interpretation is that the term *kosmos* is notably absent from that passage, and so it cannot literally be evidence for the claim that *kosmos* is the actual subject of *Peri ouranou*. In fact, what the passage shows is that Aristotle's comprehensive account of the totality can be given without any reference to the concept of *kosmos* whatsoever, and hence the name of the inquiry (and title of the treatise) is *Peri ouranou* and not *Peri kosmou* (or *Kosmopoia* or *Diakosmêsis*). His focus is on the singularity and eternity of the universe. Now it is true that for Aristotle the single and unique *ouranos*, since it is identical with "the whole" and "the totality," is therefore identical with the *kosmos*, and thus the investigation *Peri ouranou* subsumes the investigation of the *kosmos*. There is nothing else that an investigation of *kosmos* could have as its object, in Aristotle's view, other than the elements contained in the *ouranos* (in the broad third sense meaning "universe"), since this is identical with the totality of everything. Accordingly, the *Peri ouranou* contains a comprehensive discussion of the primary body and the four elements.⁴⁸ The descriptions of the movements of these bodies are the subject matter of Aristotle's natural science, "the science concerned with nature" as he describes it in the opening of *Peri ouranou* 1.1; he does not even mention a "science concerned with the *kosmos*." For this reason, one should avoid speaking loosely of Aristotle's "cosmology": yes, he has views about the *kosmos* (about its shape, order, arrangement, eternity,

⁴⁸ As Simplicius says, "he clearly does not explain the *kosmos* in this treatise as Plato did in the *Timaeus* . . . very little is said about the *kosmos* as a whole, and only such things as it has in common with the *ouranos*, i.e. that it is eternal, limited in size, and single . . . But if anyone wishes to inspect Aristotle's theory of the *kosmos*, it must be said that he presents his account of the *kosmos* in all of his physical treatises taken together. . . . Aristotle himself does not say, either when setting out in summary in the third book of this treatise what is said in it, or in the prelude to the *Meteorology*, that he has discussed the *kosmos*, or the *ouranos* in the sense of the *kosmos*" (*in Phys.* pp.3.17–4.2 Diels, tr. after Hankinson).

singularity, etc.); but these views follow from his physics, his account of the principles, elements, and causes of nature and natural things, not from an account of the *kosmos* as such. It would be more accurate to speak of Aristotle's "ouranology" rather than his "cosmology," if we needed a specific term and were required to speak in anachronisms. In the predecessors and many successors, on the other hand, views about the origin of the *kosmos* or arrangement of *kosmoi* were used as the basis for explaining nature, and thus the term "cosmology" seems more or less apt. Aristotle's contribution to the history of cosmology as an independent science is largely critical and negative.

Aristotle only refers to *kosmos* in stating his own positive views twice in *Peri ouranou*: "It is plain from the foregoing that the *kosmos* is spherical" (Aristotle, *Cael.* 2.5.287b15); and "the order of the *kosmos* is in fact eternal [ἡ δὲ γὰρ τοῦ κόσμου τάξις αἰδῖος]" (Aristotle, *Cael.* 2.14.296a33–34). In the second case, the context is the dispute about whether the earth moves or is immobile. In both cases the term *kosmos* could easily be replaced with *ouranos* (in the broad third sense) without any loss of meaning, as far as Aristotle is concerned. Every other reference to *kosmos* in the *Peri ouranou* occurs in the context of refuting cosmogony or plurality of worlds.

In the first book, after introducing his subject as the science of nature, bodies, and magnitudes (in Chapter 1), Aristotle argues for the following theses (in the chapters noted): that the primary body moves in a circle (Chapters 2–4), that no body is infinite (Chapters 5–7), that there cannot be more than one *ouranos* (Chapters 8 and 9), and that the *ouranos* is ungenerated and indestructible (Chapters 10–12 and 2.1). The term *kosmos* does not appear in the chapters in which Aristotle explains his own positive view (Chapters 1–4), that "there must necessarily be some simple body which moves naturally and in virtue of its own nature with a circular movement" (269a5–7, tr. Stocks). And the term *kosmos* appears only once in the course of Aristotle's argument (Chapters 5–7) against an infinite body: "The infinite, then, cannot revolve in a circle; nor could the *kosmos*, if it were infinite" (1.5.272a20).

The majority of the references to *kosmos* in *Peri ouranou* occur in the argument of 1.8 that there cannot be more than one *ouranos*. Aristotle anticipates the argument in 1.7 by distinguishing the question of the plurality of worlds from the question of an infinite body:

After these things, one should investigate whether the totality [τὸ πᾶν], although not infinite with respect to body, is nevertheless great enough to admit more *ouranoi* [πλείους οὐρανοῦς]. For someone might well be

puzzled about whether, since the *kosmos* around us [ὁ περὶ ἡμᾶς κόσμος] is constituted as it is, nothing prevents there also being more than one, although not an infinite number. (Aristotle, *Cael.* 1.7.274a24–28)

Aristotle does not, here at least, accept even this limited plurality of *kosmoi*:

We must now proceed to explain why there cannot be more *ouranoi* [πλείους οὐρανοῦς], the further question mentioned above. For it may be thought that we have not proved universal of bodies that none whatever can exist outside of the *kosmos* [ἐκτὸς εἶναι τοῦ κόσμου τοῦδε ὅτιοῦν αὐτῶν], and that our argument applied only to those of infinite extent. (Aristotle, *Cael.* 1.8.276a18–22)

Aristotle's argument to the conclusion that that there cannot be more than one *ouranos* depends on the principles of his doctrine of natural place, and thus his physics. According to the doctrine, each simple body (earth, water, air, fire, and aether) has a natural motion defined by its natural motion within the totality. Motion toward (or, in the case of aether, within) a natural place is natural, motion away from it is unnatural or "constrained"; these are conceived as opposites. Now Aristotle argues that since earth naturally moves to the center, and must have this nature wherever it exists, then if there are more *kosmoi*, the earth in one *kosmos* would naturally move to the center of both its own and another *kosmos*, but at the same time the earth in the other *kosmos* would move to the center of the first; this would result in motions at once natural and "by constraint," an absurdity.

If, then, it is by constraint that earth moves from a certain place to the center here, its movement from here to there will be natural, and if earth from there rests here without constraint, its movement hither will be natural. And the natural movement in each case is one. Further, the *kosmoi*, being similar in nature to ours, must all be composed of the same bodies as it. (Aristotle, *Cael.* 1.8.276a27–31)

From these assumptions, Aristotle shows that the hypothesis of plural *kosmoi* is absurd, necessitating simultaneous natural and unnatural motion of the earth element in opposite directions in the two *kosmoi*. It is remarkable that in the course of the argument, Aristotle says that the point is made clear by "positioning the *kosmoi* in relation to one another," or what one translation describes as a "juxtaposition of the worlds" (Stocks). This seems to refer to a diagram depicting the hypothetical movement of an element of [E]arth with respect to two different spherical *kosmoi* centered on points (A) and (B), the circumferences of which meet at point X. Here is a schematic and hypothetical reconstruction:

$$[E] \rightarrow (A) \rightarrow X \rightarrow (B)$$

If E moves naturally toward the center of *kosmos* A, then since it has the same tendency relative to the center of *kosmos* B, it will continue to move in the direction of point X; but at that point it will be moving both “upwards” away from the center of *kosmos* A and “downwards” toward the center of *kosmos* B. This, however, is impossible because it is the nature of each element to move in exactly one direction relative to a center point, and toward different places in the totality.

The particles of earth, then, in another *kosmos* [ἐν ἄλλῳ κόσμῳ] would move naturally also to our center and its fire to our circumference. This, however, is impossible, since, if it were true, earth must, in its own *kosmos*, move upwards, and fire to the center; in the same way the earth must move naturally away from the center when it moves toward the center of the other. This follows from positioning the *kosmoi* in relation to one another [τὸ τοὺς κόσμους οὕτω κείσθαι πρὸς ἀλλήλους]. For either we must refuse to admit the identical nature of the simple bodies in the plurality of *ouranoi* [ἐν τοῖς πλείοσιν οὐρανοῖς], or, admitting this, we must make the center and the extremity one as suggested. This being so, it follows that there cannot be more *kosmoi* than one [κόσμους πλείους ἐνός]. (Aristotle. *Cael.* 1.8.276b11–21.)

The thesis about natural motion is the sole basis of Aristotle’s rejection of the plurality of worlds hypothesis in the *Peri ouranou*; if the doctrine of natural motion were abandoned, then the *reductio ad absurdum* argument against the plurality of worlds thesis would be baseless. And so Aristotle offers further arguments in this chapter in support of the doctrine: that the simple bodies cannot have different natures in different places or *kosmoi*; that all locomotion must be finite and defined by both start and end point; and there cannot possibly be an infinite speed. He also refers to arguments from earlier in book I (the argument that there is a primary body which naturally moves in a circle, demonstrated in 1.2–4). Moreover, he relates an apparently independent metaphysical argument: “The same could also be shown with the aid of the discussions which fall under First Philosophy, as well as from the nature of the circular movement, which must be eternal both here and in the other *kosmoi* [ἐν τοῖς ἄλλοις κόσμοις]” (1.8.277b9–12). But when one follows up the reference, evidently to *Metaphysica* 12.8, one finds an extremely compact argument to the conclusion that “there is only one *ouranos*” (εἷς ἄρα οὐρανὸς μόνος) (1074a38). I will not here digress to

discuss the long history of commentary on this passage,⁴⁹ except to note that the entire argument is expressed without reference to *kosmos* at all but, as we might now expect, only *ouranos*.⁵⁰ The domain of this argument is *Peri ouranou*, not *Peri kosmou*. Also, note that Aristotle in the very next chapter of *Peri ouranou* elaborates a similar argument. He begins, aporetically, by constructing an argument in favor of plural *kosmoi* but in the end concludes that

it is quite right to say that the formula of the shape apart from the material must be different from that of the shape in the material, and we may allow this to be true. We are not, however, therefore compelled to assert there to be more *kosmoi* [πλείους εἶναι κόσμους]. Such a plurality is in fact impossible since this one contains the entirety of material, as in fact it does. (Aristotle, *Cael.* 1.9.278a23–28)

It is, however, worth digressing to consider the epistemic implications of Aristotle's solution to this problem:

a thing whose substance resides in a substratum of material can never come into being in the absence of all matter. Now the *ouranos* is certainly a particular and a material thing . . . composed not of a part but of the whole of material. (Aristotle, *Cael.* 1.9.278b1–6, tr. after Stocks)

One obvious implication of the fact that the *ouranos* (in the third, broad sense, meaning the “universe”) is a particular material thing is that it is sensible. But if it is sensible then it is not, as such, knowable: “what actual sensation apprehends is individuals, while what knowledge apprehends is universals.”⁵¹ In a way, then, the *ouranos* in the sense of *kosmos* is a sensible particular, not a knowable thing. What is knowable within the *kosmos* are the universal and eternal forms that are repeatedly generated in plural or infinite material things: the transmutation of the eternal elemental forms, and the reproduction of the eternal forms of living things. Aristotle also holds that the “eternal” cycles of the stars are knowable, but there is a problem in that the moon, sun, planets, and stars, insofar as they are particular, sensible

⁴⁹ Ross 1924: *ad loc.* and cxxxix–cxl provides a useful overview of the difficulties and the commentarial history.

⁵⁰ It is often said that *Metaphysics* 12 is a key text for Aristotle's cosmology (e.g., Wright 1995: 69), but this is only true if we are speaking loosely. It cannot literally be true, since the word *kosmos* does not appear in that book – the operative notions are order (*taxis*) and nature. Nevertheless, the term *kosmos* is frequently read into the text (e.g., the translation of *Metaph.* 12.10.1075a12–20 by Wright 1995: 70; this does not necessarily cause confusion).

⁵¹ Arist. *An.* 2.5.417b22; cf. *APo.* 1.4 *passim*; 1.33.88b31; 2.5.417b22; *Metaph.* 13.9.1086b5; *EN* 6.6.1140b31.

things, would seem to be unsuitable as objects of knowledge as opposed to sensation.⁵²

If Aristotle could conceive of our *ouranos* as one *kosmos* among many, then he could conceive of a general science of cosmology, which would explain how plural or infinite *ouranoi* and *kosmoi* are generated, just as his elemental transmutations and organic reproductions are infinitely generated. The motions of our moon and sun could be explained according to universal principles that apply to all cosmic bodies – to all stars, suns, moons, planets, and earths – and not just these particular ones we see with our own eyes. But Aristotle rejected this Democritean approach completely.

From our arguments then it is evident not only that there is not, but also that there could never come to be, any bodily mass whatever outside the circumference. The total *kosmos* [ὁ πᾶς κόσμος], therefore, includes all its appropriate matter, which is, as we saw, natural sensible body. So that neither are there now, nor have there ever been, nor can there ever be formed more *ouranoi* [πλείους οὐρανοί], but this *ouranos* of ours is one and unique and perfect [εἷς καὶ μόνος καὶ τέλειος οὗτος οὐρανός ἐστιν]. (Aristotle. *Cael.* 1.9.279a6–11 tr. after Stocks).

Thus Aristotle concluded that the *kosmos* and *ouranos* must be identical, and it must also be singular and unique.⁵³ Having arrived at this conclusion, Aristotle moves on to his last major argument of *Peri ouranou* I, which runs from 1.10–12, and includes 2.1: that the *ouranos* is eternal, i.e., ungenerated and indestructible.

I digress briefly to mention that, according to an ancient list, Aristotle wrote a work entitled *Peri kosmou geneseōs*. As Moraux (1951: 263–65) explained, the title is awkward since it seems to suggest Aristotle wrote “*About the generation of kosmos*” – but we know he rejected the generation

⁵² For this reason, Aristotle subordinates the empirical science of “star-gazing” to mathematical astronomy in *APo.* 1.13; similarly, the empirical sciences of acoustics and meteorology are subordinated to mathematical sciences like arithmetic and geometry. This is necessary in order to secure universality of the principles by means of which the empirical phenomena are explained; see Johnson 2015: 175–77.

⁵³ For this reason, my interpretation, despite much agreement, differs from that of Kukkonen, who explains why “cosmological perspectives provide such an ill fit for the overall Aristotelian pattern of explanation and understanding” (2014: 327) as follows: “The first and most fundamental stumbling block, I submit, is that for Aristotle there simply is no world, conceived of as a single object, such as would admit of a unified investigation. The physical universe just is not a single being” (ibid.). In my view the problem is just the opposite: because he conceives of the *kosmos* as a single object identical to the visible *ouranos*, this *kosmos* cannot itself be the object of its own science; rather the objects of the relevant science have to be understood to be the generic substances that constitute the *ouranos* in the third, broad sense, namely: aether, fire, air, water, and earth. These are precisely the subject matter of *Peri ouranou* 1–4.

of the *kosmos*. One is thus tempted to read it as a polemical work “*Against the generation of kosmos*”; but in that case, as Moraux pointed out, we should expect the preposition *Pros* as opposed to *Peri*.⁵⁴ Setting that consideration aside, I speculate that *Peri ouranou* 1.10–12 + 2.1 may have circulated separately under the title *Peri kosmou geneosês*, as these chapters form an apparently self-sufficient unit addressing the dialectical problem announced in the *Topica*, whether the *kosmos* is eternal, and specifically whether it came into being (as the cosmogonies have it). This is compatible with the interpretation of the arguments of *Peri ouranou* 1.10–12 and 2.1 as largely adapted from arguments in the *Peri philosophias* (as argued by Effe 1970: 20–23 and 132–39). I should point out that in this section of *Peri ouranou*, Aristotle begins with a review of earlier theories (1.10), and definition of key terms (1.11), followed by a series of proofs that the *ouranos* (and thus the *kosmos*) is finite, singular, eternal, ungenerated, and indestructible (1.12). The next chapter (2.1), which argues that this view of the *ouranos* is consistent with traditional views about the gods (unlike the predecessors’ views), is linked with these chapters and may have been part of the lost work *Peri philosophias* as well.

Thus, *Peri ouranou* 1.10–12 has the structure of a self-contained diaporetic inquiry. Aristotle begins this inquiry with a review of previous theories:

That it was generated all are agreed, but, generation over, some say that (1) it is eternal, others say that (2) it is destructible like any other natural formation; (3) others again, with Empedocles of Agrigentum and Heraclitus of Ephesus, believe that there is alternation in the destructive process, which takes now this direction, now that, and continues without end. (Aristotle, *Cael.* 1.10.279b14–17, tr. after Stocks)

The first crucial point is that Aristotle characterizes the debate as one about *ouranos*, not *kosmos*, and the second is that *all* of Aristotle’s predecessors had argued that the *ouranos* was generated. So we see here Aristotle’s exact contribution to the debate, and what sets him apart from *all* his predecessors: according to Aristotle the *ouranos* is ungenerated, indestructible, and eternal in both directions. Since he holds that the *kosmos* is identical with the eternal *ouranos* (in the broad, third sense of “universe”), he offers the classical version of the theory that has become known as steady-state cosmology, and his view would have to be opposed to intelligent design creationism, the big bang model, and any of the

⁵⁴ An anonymous reader for the Press usefully pointed out to me that the *Peri ideôn* seems to be a critical work (i.e., critical of the Platonic theory of forms). That is a good point, although its fragmentary status prohibits us from inferring anything with certainty about the meaning of the title.

multiple big bang models (big bang followed by big crunch, rebounding totality, etc.). Steady-state theory has been continuously defended since at least Aristotle, but has lately fallen out of favor in scientific cosmology almost as much as intelligent design creationism.

From Aristotle's point of view, then, the alternatives are as follows: (1) according to Plato, *ouranos* is indestructible; (2) according to Democritus it is destructible; and (3) according to Heraclitus and Empedocles it alternates between periods of generation and destruction. In the rest of 1.10, Aristotle employs the term *kosmos* in arguing against the first⁵⁵ and third views. In arguing against the cyclical model, he offers his own definition of *kosmos*:

If the whole body [τὸ ὅλον σῶμα], which is a continuum, is so disposed and arranged [διατίθεται καὶ διακεκόσμηται] now in one way, but then in another, and if the system of the whole is *kosmos*, i.e. *ouranos* [ἡ δὲ τοῦ ὅλου σύστασις ἐστὶ κόσμος καὶ οὐρανός], then it will not be the *kosmos* [ὁ κόσμος] that comes into being and is destroyed, but only its dispositions [αἱ διαθέσεις]. (Aristotle, *Cael.* 1.10.280a19–23)

This argument eliminates the third view, attributed to Heraclitus and Empedocles.

As for the second view, Simplicius, following Alexander of Aphrodisias, correctly identifies Democritus as the target of Aristotle's argument against a destructible totality:

Those who talk of the *kosmos* as being generated and destroyed . . . as if it were like any of the other composite things, would be Democritus and his circle. For just as, according to them, everything else is generated and destroyed, so too is each of the infinite number of *kosmoi*. (Simplicius, in *Cael.* p. 295.20–22 Heiberg)⁵⁶

Simplicius quotes an invaluable passage from Aristotle's lost work *On Democritus* in which Democritus is said to speak "of this generative combination and of the separative destruction which is contrary to it not only in the case of animals, but also in that of plants and *kosmoi*, and in general in the case of all perceptible bodies."⁵⁷ The views of

⁵⁵ "Suppose that the *kosmos* was formed out of elements which were formerly otherwise conditioned than as they are now. Then if their condition was always so and could not have been otherwise, it could never have come into being. And if so, then, clearly, their condition must have been capable of change and not eternal: after combination therefore they will be dispersed, just as in the past after dispersion they came into combination, and this process either has been, or could have been, indefinitely repeated. But if this is so, it cannot be indestructible, and it does not matter whether the change of condition has actually occurred or remains a possibility" (Aristotle, *Cael.* 1.10.279b24–31, tr. after Stocks).

⁵⁶ Alexander of Aphrodisias Fr. 208, *apud* Simplicius in *Cael.* p. 294.27–31 Heiberg, tr. by Hankinson.

⁵⁷ Note that this passage confirms that it is Democritus that is the target of the argument at *Physics* 196a25–28 (referenced earlier in the chapter).

Democritus on the destructibility of the *kosmos* have already been discussed in the context of the refutation of the plurality of worlds thesis in 1.8–9. Democritean cosmology does not arise as an issue again until the discussion of corpuscular movement in Book 3. By that point, the theories of motion of Democritus and Plato are, remarkably, grouped and dismissed together.

Leucippus and Democritus, who say that the primary bodies are in perpetual movement in the void or infinite, may be asked to explain the manner of their motion and the kind of movement which is natural to them. For if the various elements are constrained by one another to move as they do, each must still have a natural movement which the constrained contravenes, and the prime mover must cause motion not by constraint but naturally. If there is no ultimate natural cause of movement and each preceding term in the series is always moved by constraint, we shall have an infinite process.

The same difficulty is involved even if it is supposed, as we read in the *Timaeus*, that before the *kosmos* was made the elements moved without order [ἀτάκτως].⁵⁸ Their movement must have been due either to constraint or to their nature. And if their movement was in accordance with nature [κατὰ φύσιν], a moment's consideration shows that there was already a *kosmos*. For the prime mover must cause motion in virtue of its own natural movement, and the other bodies, moving without constraint, as they came to rest in their proper places, would fall into the order in which they now stand, the heavy bodies moving toward the center and the light bodies away from it. But that is the order of their distribution in our *kosmos* [ταύτην δ' ὁ κόσμος ἔχει τὴν διάταξιν]. (Aristotle, *Cael.* 3.2.300b9–25, tr. after Stocks).

This sequence of dialectical argumentation is remarkable because Aristotle understands his doctrine of natural movement at once to undermine both Democritean and Platonic cosmogony. Here we see Aristotle himself clearly distinguishing his own views from those of Plato and Democritus – the two greatest influences on his natural philosophy. In Aristotle's view, nature explains order, and order the *kosmos*; this is the proper explanatory order. The principles of nature are primary and indemonstrable, they are responsible for and the basis of all explanation of order and *kosmos*. But since both Democritus and Plato fail to explain natural movement, their attempts to explain order and *kosmos* are doomed from the beginning. The fatal flaw in both cases is taking

⁵⁸ Cf. Pl. *Ti.* 30a5.

cosmogony as the starting point for explaining nature, and not nature as the starting point for explaining the *kosmos*.

The argument deployed against the Atomists is more developed and carefully argued. Aristotle argues that if infinite bodies in infinite void move with an infinite variety of motions (as opposed to with one or several definite kinds of motion), then a certain order would be impossible. But a certain order is necessary. Therefore, infinite bodies do not move with an infinite variety of motions.⁵⁹ Aristotle represents this as a self-sufficient refutation of Atomism. Crucial to Aristotle's argument is what he means by "a certain order" (τάξις τις). And that becomes clear in the following passage, in which order is explained by reference to a thing's nature:

The disorderly is nothing other than the contrary to nature [τὸ ἀτάκτως οὐθὲν ἔστιν ἕτερον ἢ τὸ παρὰ φύσιν], since the order proper to perceptible things is their nature [ἢ γὰρ τάξις ἢ οἰκεία τῶν αἰσθητῶν φύσις ἔστιν]. And there is also absurdity and impossibility in the notion that the disorderly movement is infinitely continued. For the nature of things is the nature which most of them possess for most of the time. Thus their view brings them into the contrary position that disorder is in accordance with nature [τὴν μὲν ἀτάξιν εἶναι κατὰ φύσιν], and the order i.e. the *kosmos*, is contrary to nature [τὴν δὲ τάξιν καὶ τὸν κόσμον παρὰ φύσιν]. But no natural fact can originate as luck has it. (Aristotle, *Cael.* 3.2.301a4-11, tr. after Stocks)

Again, we see Aristotle's method of explanation. Order is explained by nature ("the order proper to perceptible things is their nature"), and the *kosmos* just is the order of nature. The Atomists, postulating an infinite variety of motions, undermine order and embrace what is contrary to nature, making it impossible to explain the *kosmos*. Aristotle compares Anaxagoras's cosmogony favorably: his starting point is unmoved things (Arist. *Cael.* 3.2.300b31-301a13: ἐξ ἀκινήτων γὰρ ἄρχεται κοσμοποιεῖν). But Aristotle does not think Anaxagoras's position much better, since Aristotle considers cosmogony in general to be a pseudo-science. Even in the above argument we can see that the concept of *kosmos* is not essential to

⁵⁹ "The answer to the view that there are infinite bodies moving in an infinite is that, if the cause of movement is single, they must move with a single motion, and therefore not without order [οὐκ ἀτάκτως]; and if, on the other hand, the causes are of infinite variety, their motions too must be infinitely varied. For a finite number of causes would produce a kind of order [τάξις τις], since absence of order is not proved by diversity of direction in motions: indeed, even now we know that not all bodies, but only bodies of the same kind, have a common goal of movement" (3.2.300b32-301a3, tr. after Stocks).

the argument – it appears epexegetically with *taxis* (order), and it is the notion of order which does all the work in the argument.⁶⁰

4.7 *Meteorologica*

In the opening words of the *Meteorologica*, Aristotle introduces and situates his topic by summarizing the contents of the *Physica* and *Peri ouranou*, and *Peri geneos kai phthoras*:

We have previously spoken about the first causes of nature and about all natural change [περὶ μὲν οὖν τῶν πρώτων αἰτίων τῆς φύσεως καὶ περὶ πάσης κινήσεως φυσικῆς], and also about the stars having been arranged [διακεκοσμημένων] in accordance with the upper motion, and about the elements of the bodies (how many and what quality, and their transformation into one another), and about generation and destruction in general. (Aristotle, *Mete.* 1.1.338a20–25)

Given the considerations in *Peri ouranou* just reviewed, it comes as no surprise that Aristotle reiterates that his own enquiry begins with an account of the principles of nature and natural change, and that precisely these are the first principles. The issue that arises for the present investigation is why Aristotle should choose to use the verb *diakosmeō* to refer to the discussions of *Peri ouranou* 1–2 since, as we have seen, Aristotle associates the term *diakosmēsis* with the Atomist plurality of *kosmoi* hypothesis.⁶¹ Is it

⁶⁰ The following argument, attributed to the *Peri philosophias*, follows the same pattern of argument and method of explanation: “To Aristotle belongs the following: there is either one first principle, or many. If there is one, we have what we are looking for; if there are many, they are either ordered or disordered. Now if they are disordered, their products are more so, and the *kosmos* is not a *kosmos* but a disorganized thing (*akosmia*); besides, that which is contrary to nature belongs to that which is by nature non-existent. If, on the other hand, they are ordered, they were ordered either by themselves or by some outside cause. But if they were ordered by themselves, they have something common that unites them, and that is the first principle” (Scholiast in *Proverb. Salomonis* = Fr. 17 Ross, tr. after Ross). But if this argument does belong to Aristotle, whether from *On Philosophy* or elsewhere, it is very important because it is the most explicit case I have seen which would show Aristotle making a positive argument on the basis of the nature of the *kosmos* itself, where this term is not attached to another term epexegetically, like *ouranos* or *taxis*. So he argues to the conclusion that there is a single principle of motion, because if there were several, they would have to be ordered by a single one (whether internal or external to themselves), or else be disordered, but they cannot be disordered because then “the *kosmos* would not be a *kosmos* but an *akosmia*.” But then here again the argument ultimately depends for its warrant on a claim about nature: “that which is contrary to nature belongs to that which is by nature non-existent.” The longer passage from *Peri ouranou* 3.2 quoted earlier explains what Aristotle means by nature here (which indicates that Democritus, like Plato, was a target in Aristotle’s *Peri philosophias*, since the Atomist view is attacked in the parallel argument). In each case we see Aristotle adverting to his theory of nature in order to explain the *kosmos*.

⁶¹ Schofield, in his chapter in this volume (Chapter 3), defines *diakosmēsis* as “an attempt to capture the idea that physics cannot restrict itself to talking about how a *kosmos* comes into being and how it is

possible that Aristotle could be referring to a *diakosmêsis* in his own sense – an account of an ordering or “organization” of a finite number of *kosmoi*? In what remains of this chapter I will suggest a way that he could be.

In the *Meteorologica*, Aristotle uses the expression “the *kosmos* around the upper motions” (ὁ περὶ τὰς ἄνω φορὰς κόσμος), to refer to the aetherial bodies in the places above the moon (i.e., outer space).⁶² But he also on several occasions uses the expression “the whole *kosmos* around the earth” (ὁ δὴ περὶ τὴν γῆν ὅλος κόσμος), with reference to the natural places of the four Empedoclean elements (earth, air, water, and fire) which as a “whole *kosmos*” are located under the moon.⁶³ Furthermore, he uses the expression “the *kosmos* around the earth which is continuous with the motions <of the *ouranos*>” – this is of course the “meteorological” sphere.⁶⁴ These expressions, which refer to at least two different *kosmoi*, are not used in the *Peri ouranou*, and indicate either an earlier stage in Aristotle’s regimentation of scientific concepts, or an adaptation of his diction for the specialized subject matter of meteorology.⁶⁵

It would seem from these expressions that Aristotle is committed to a view about the relation between “the upper *kosmos*” (i.e., the stars, planets, sun, and moon) and “the lower *kosmos*” (the *kosmos* around the earth, composed of fire, air, water, and earth). This could explain why he used the term *diakosmeô* in describing the contents of the *Peri ouranou*. This clearly does not imply that he recognizes a plurality of worlds in the Atomist sense. As Aristotle recognizes exactly two *kosmoi* (which we have come to call the sublunary and the superlunary spheres, which are both

structured. Physics must discuss the whole arrangement of *kosmoi* (in the plural) – the organization of the entire system.” This is useful, although the term “organization” is potentially misleading in describing the Democritean account of the arrangement of the plurality of *kosmoi*; indeed, if the infinite Democritean *kosmoi* could be shown to have an overall “organization,” Aristotle’s objections to his theory would lose much of their force.

⁶² “We earlier discoursed about the first element, what quality its power is, and why it is that *the kosmos around the upper motions* is entirely full of that body” (ἡμῖν μὲν οὖν εἴρηται πρότερον περὶ τοῦ πρώτου στοιχείου, ποῖόν τι τὴν δυνάμιν ἔστιν, καὶ διότι πᾶς ὁ περὶ τὰς ἄνω φορὰς κόσμος ἐκείνου τοῦ σώματος πλήρης ἐστί) (Arist. *Mete.* 1.3.339b18–19, tr. after Lee).

⁶³ In addition to Arist. *Cael.* 1.7.274a24–28 (discussed above), see also *Mete.* 1.7: “For we suppose that the dry and warm exhalation is the outermost part of the *kosmos* around the earth [τοῦ κόσμου τοῦ περὶ τὴν γῆν], which falls below the circular motion. It, and a great part of the air that is continuous with it below, is carried round the earth by the motion of the circular revolution” (Arist. *Mete.* 1.7.344a9–14, tr. after Lee). “For such is the motion of the *kosmos* around the earth [τοιαύτη γὰρ ἡ φορὰ τοῦ κόσμου τοῦ περὶ τὴν γῆν]” (1.7.344b11–12, tr. after Lee).

⁶⁴ “We have spoken concerning the things that come to be in the *kosmos* around the earth which is continuous with the motions <sc. of the *ouranos*> [περὶ μὲν οὖν τῶν γιγνομένων ἐν τῷ περὶ τὴν γῆν κόσμῳ τῷ συνεχεῖ ταῖς φοραῖς εἴρηται]” (*Mete.* 1.9.346b10–15, tr. after Lee).

⁶⁵ Kahn (1960: 99 and 109) argues that meteorology is a remarkably conservative line of inquiry from the tradition of Anaximander forward (see also Taub 2003: 9–10). If so, this may help explain why Aristotle in the *Meteorologica* seems to use the term *kosmos* more like his predecessors, and specifically more like Anaximander (see later).

centered round the earth, and which are completely bounded by a singular *ouranos*), his *diakosmêsis* consists precisely in an account of how these two *kosmoi* are arranged and causally related to one another. And Aristotle offers precisely such an account in *Meteorologica* 1.2:

So the whole *kosmos* around the earth is made out of these bodies; concerning which one should grasp the occurrences that we claim to be effects. [ὁ δὴ περὶ τὴν γῆν ὅλος κόσμος ἐκ τούτων συνέστηκε τῶν σωμάτων· περὶ οὗ τὰ συμβαίνοντα πάθη φαμέν εἶναι ληπτέον.] This necessarily has a certain continuity with the upper motions; consequently all its power is derived from them. For the originating principle of all motion must be deemed the first cause. Besides, that element is eternal and its motion has not an end with respect to its place, but is always at an end [ἡ μὲν αἰδῖος καὶ τέλος οὐκ ἔχουσα τῷ τόπῳ τῆς κινήσεως, ἀλλ' αἰεὶ ἐν τέλει]; whereas all these other bodies have separate places which limit one another [ταῦτα δὲ τὰ σώματα πάντα πεπερασμένους διέστηκε τόπους ἀλλήλων]. So we must treat fire and earth and the elements like them as the material causes of the things that are generated (meaning by material what is subject and affected), but must assign causality in the sense of the originating principle of motion to the power of the eternally moving bodies. (Aristotle, *Mete.* 1.2.339a19–32, tr. after Lee)

The lower *kosmos* is continuous with the upper *kosmos*, and the things that happen in the lower *kosmos* are effects of the causes operating in the upper *kosmos*. In a sense the expression “the upper *kosmos*” refers to a *kosmos*, the one which consists exclusively of eternal aetherial bodies in constant circular motion, and which is not itself limited in its motion with respect to place, in distinction from “the lower *kosmos*,” which is limited both below and above, consisting of the four elemental bodies that are constantly moved by the upper *kosmos*, thus generating and destroying living substances. There is a precedent for speaking this way. Anaximander seems to have used the plural terms *kosmoi* and *ouranoi* to indicate different regions or parts of the totality: “he says that it is neither water nor any other of the so-called elements, but some other unbound nature from which been generated all the *ouranoi* and the *kosmoi* in them [ἀλλ' ἑτέραν τινὰ φύσιν ἀπειρον, ἐξ ἧς ἅπαντας γίνεσθαι τοὺς οὐρανοὺς καὶ τοὺς ἐν αὐτοῖς κόσμους].”⁶⁶ Although there has been a tendency in later doxographic

⁶⁶ Anaximander DK 12 A 9 = Simpl. in *Phys.* p. 24.17–18 Diels. Notice the variant versions: “he said that the *apeiron* contained the whole cause of the generation and destruction of the world, from which he says that the *ouranoi* are separated off, and in general all the *kosmoi*, being *apeirous*” (A10 = Ps.-Plutarch, *Strom.* 2); “he said that the material principle of existing things was some nature coming under the heading of the *apeiron*, from which come into being the *ouranoi* and the *kosmos* in them” (A11 = Hippol. *Haer.* 1.6.2). Hippolytus’s reference to a singular *kosmos* is probably inaccurate.

literature to conflate Anaximander's references to plural *kosmoi* and *ouranoi* with the Democritean plurality of worlds thesis, it has been persuasively argued by Charles Kahn that the *kosmoi* here must refer to "different departments or regions" of the totality, "some lower 'arrangements' of atmosphere or earth," and the *apeiron* or boundless "can thus surround both the *ouranoi* or *kosmoi* within the framework of the one and only world system."⁶⁷ This fits well with Aristotle's own usage. How closely Aristotle seems willing to follow Anaximander's way of speaking (in the *Meteorologica*, at least) is indicated by his remark that, whereas the lower *kosmos* is "bounded" or "limited" in respect of place, the upper *kosmos* is not so bounded (rather it *is* the boundary or limit itself for all the natural places). And in Book 2, Aristotle seems to be referring to Anaximander's theory when using the expression "the *kosmos* around the earth":

they are met by the same difficulty as those who say that at first the earth itself was moist and the *kosmos* around the earth [τοῦ κόσμου τοῦ περὶ τὴν γῆν] was warmed by the sun, and so air was generated and the whole firmament grew, and the air caused winds and the solstices. (Aristotle, *Mete.* 2.2.355a21-25, tr. after Lee)

So it would seem reasonable to attribute to Aristotle the thesis there is not one *kosmos* but two, and they are, unlike Democritean *kosmoi*, tightly causally connected to one another (i.e., as mover to material). But in fact, Aristotle never uses the plural expression *kosmoi*, except with reference to the cosmogonies and plurality of worlds theories that he rejects, as we saw. So in the *Meteorologica* he usually uses expressions like "the upper place" instead of "the upper *kosmos*," even while he has no compunction about using the expressions "the *kosmos* around the earth" and "the lower *kosmos*" (τοῦ κάτω κόσμου).⁶⁸

Whatever his own conception of *diakosmêsis*, Aristotle in no uncertain terms deploys his generic attack on cosmogony against meteorological arguments of his predecessors who "think the cause of such effects to be the transformation of the whole [τὴν τοῦ ὅλου μεταβολήν] in the sense of a coming-to-be of the *ouranos* [ὡς γιγνομένου τοῦ οὐρανοῦ]."

⁶⁷ Kahn 1960: 48–49.

⁶⁸ "After the exposition of the difficulties involved, let us go on to state our own opinion, with a view at once to what follows and to what has already been said. *The upper* <place, *topos*> [τὸ ἄνω] as far as the moon we affirm to consist of a body distinct from both fire and from air, but varying in degree of purity and in kind, especially towards its limit on the side of the air, and of *the kosmos around the earth* [καὶ πρὸς τὸν περὶ τὴν γῆν κόσμον]. Now the circular motion of the first element and of the bodies it contains dissolves, and inflames by its motion, whatever part of *the lower kosmos* (τοῦ κάτω κόσμου) is nearest to it, and so generates heat" (Arist. *Mete.* 1.3.340b6–10, tr. after Lee).

We must not suppose that the cause of this is the coming-to-be of the *kosmos* [τὴν τοῦ κόσμου γένεσιν]. For it is ridiculous for the totality (τὸ πᾶν) to change by being transformed [μεταβολᾶς κινεῖν] because of small and trifling things [διὰ μικρᾶς καὶ ἀκαριαίας], when the bulk and size of the earth are surely as nothing in comparison with the whole *ouranos* [πρὸς τὸν ὅλον οὐρανόν]. (Aristotle, *Mete.* 1.14.352a17-28, tr. after Lee).

Notice that in the context of this argument Aristotle makes it clear that he sees the entire earth and meteorological sphere (“the *kosmos* around the earth”) to be a vanishingly small part of the whole universe, that is, the entire *ouranos* (in the third, broad sense). It is wrong, he thinks, to infer from the phenomena of generation and destruction in this *kosmos* – “the *kosmos* around here” – to the nature of the *ouranos* or the totality of the universe. This is the fundamental mistake, as he sees it, of all his predecessors, including Plato. He thinks they all get off on the wrong foot by attempting to explain the sea’s saltiness (etc.) according to causes operating to bring the *kosmos* as a whole into existence. Aristotle’s procedure is the opposite. He infers from the eternity of the *ouranos* the eternity of the sea. Aristotle complains that everyone thinks that the sea “has been generated, if the entire *kosmos* has been too [ὅτι γέγονεν, εἴπερ καὶ πᾶς ὁ κόσμος]; for they generate them at the same time.” Against this he opposes the view: “if the totality is eternal [εἴπερ ἀίδιον τὸ πᾶν], the same must be assumed for the sea.” In this context he ridicules Democritus’s views, comparing them to Aesop’s fables.⁶⁹

Given the importance of an account of the origin and history of the sea to modern oceanography and climatology, Aristotle’s uncompromising rejection of an account of the origin of the sea seems unfortunate, but it is not the only unfortunate consequence of his thoroughgoing rejection of cosmogony. Even worse, he misses the value, universally recognized by modern cosmologists, of explanations for natural bodies and their motions (e.g., the elements) on the basis of an account of the origin and evolution of the *kosmos* (e.g., over a roughly 14-billion-year period). In a way, the generation and arrangement of the *kosmos* is explanatorily prior to the account of natural things and their movements, including the elements. Similarly, Aristotle failed to imagine the plurality of *kosmoi* in the sense of solar systems beyond the one bounded by the stars visible to us. The big bang and the existence of plural galaxies and “galactic clusters” consisting of countless solar systems beyond those visible to our naked eyes (not to mention the possibility of the multiverse, etc.) are absolutely essential to

⁶⁹ Arist. *Mete.* 2.3.356b4–12.

modern cosmology, and so in a way are the ancient projects of *kosmopoiia* and *diakosmêsis* initiated by Aristotle's predecessors.

I suggested earlier that Aristotle's philosophy of science discourages a science of cosmology, since he also holds that only universal propositions about natural kinds can be demonstrated, and particular sensible things are not the proper objects of natural science, and yet he vehemently argues that the universe is a singular and unique sensible thing (generally known as the *ouranos*). Thus, Aristotle's physics focuses on the generic forms of natural bodies and their various material and moving instantiations, especially as these are transformed or move regularly ("always or for the most part"), or are involved in regular cycles of reproduction. Aristotle stands out from all his predecessors by being the first philosopher to focus on zoology and psychology in his theoretical philosophy, and in so doing he saw a different picture and developed a different theory than his predecessors, who had focused on the natural history of our *kosmos* and of other possible *kosmoi*. Aristotle's change of focus was certainly productive for psychology and zoology, but his influence on the history of cosmology was much less successful. Aristotle was too dismissive of the views of his predecessors and too quick to embrace his own a priori argumentation against those who should rightly be considered the forerunners of scientific cosmology.

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EDITED BY

PHILLIP SIDNEY HORKY

University of Durham



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