Introduction

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Throughout his life, Aristotle was deeply committed to the study of natural phenomena: About one-third of the surviving *Corpus Aristotelicum* investigates and explains the motions and attributes of things that have a nature, that is, of things that have an internal principle of change and rest. The *Physics* – an intellectual masterpiece in itself and one of the most widely read Aristotelian treatises – forms Aristotle's most fundamental treatise in his studies of natural philosophy.

In this treatise, Aristotle investigates the principles and causes of all natural things in general, and, in the course of doing so, defines a large number of key concepts of his natural philosophy, such as motion and change, space and time, matter and form, causal explanation, luck and spontaneity, teleology, and necessity. In addition, Aristotle specifies in the *Physics* the methodological guidelines for how one should study natural entities and their properties if one wants to gain scientific knowledge of them, which includes the famous – but still ill-understood – recommendation to start from things that are "more known and clearer to us" and to work from there to what is "more known and clearer by nature." In this way, the *Physics* lays out Aristotle's conceptual apparatus and methodological framework for *all* of his natural philosophy, including his psychology, biology, and other inquiries into the more specific and more complex segments of the natural world preserved in Aristotle's remaining natural treatises.

The *Physics* is relevant not just for Aristotle's natural philosophy, however. For, since the objects of metaphysics do not, for the most part, exist independently of the objects of physics and can thus only be studied through those, the science of metaphysics often has to rely on the same concepts, definitions, and approaches as are presented in the *Physics*. And the same might be said for certain aspects of Aristotle's political science: For instance, the very notion of the perfection of human nature builds on Aristotle's on natural teleology and involves a type of change ("perfection")

that is introduced in the *Physics*. In this way, the *Physics* forms the conceptual entry-way into much of the Aristotelian Corpus.

Despite what its ancient title might suggest, Aristotle's "Lecture concerning Nature" (Φυσικὴ ἀκρόασις) barely counts as a unified treatise. The eight books naturally divide into five separate sections or investigations: Book I identifies the principles of change at a very general level; Books II–IV inquire into nature and natural motion and its preconditions more properly; Books V–VI provide a technical discussion of how motion works; and Book VIII establishes rather independently of the rest of the *Physics* the existence of an unmoved mover. The place of Book VII in the treatise is disputed: Parts of the book – dealing mostly with the relation between the mover and what is moved – are handed over in two quite different versions, and when Eudemus produced his paraphrase of Aristotle's *Physics* he did not include it, suggesting that it was either not part of the edition of the *Physics* he possessed or that he did not consider it part of the same investigation.[1]

The current volume is not overly concerned with the history, unity, or structure of the edition of the *Physics* as we have it today, nor does it try to provide a comprehensive treatment of the rich materials presented in it. The existing scholarship on Aristotle's *Physics* is wide-ranging and voluminous, and it would be impossible to engage with it all. Instead, as is the case with the other volumes in the *Cambridge Critical Guide* series, the fourteen chapters collected in this volume all attempt to make optimal use of the recent changes in the field of Aristotle studies – changes both in terms of its understanding of key concepts in Aristotle's philosophy and in terms of its preferred methods for gaining such understanding – and thereby to push forward the scholarship on Aristotle's *Physics.* Each of the chapters engages with these changed perspectives on Aristotle in at least one of the following three ways:

(1) **Reassessing the key concepts of Aristotle's natural philosophy.** First, most of the chapters provide a challenge to existing interpretations of some of the key concepts of Aristotle's *Physics* and argue for alternative understandings: The notions of nature, chance, teleology, and art are discussed in Chapters 2 to 7, while traditional understandings of the notion of *kinêsis* (translated as change, process, or motion) are revised in Chapters 8 to 13. These chapters not only draw from the latest research in the field, but also exhibit a greater sensitivity towards the richness and

[1] The best discussion of the structure, unity, and transmission history of Aristotle's *Physics* is Brunschwig 1991.

complexity of Aristotelian concepts, as well as towards the extent to which Aristotle builds on and reshapes his concepts in different explanatory contexts. Instead of just studying the main concepts of Aristotle's natural philosophy in the immediate context in which they are first introduced in the *Physics* and trying to provide a unified account of their definitions and roles, the chapters presented in this volume also pay attention to some of the (methodologically) later uses to which the concepts are put in other (natural) treatises, provide explanations of why these other uses require conceptual changes, and answer the meta-question about why Aristotle needs the specific understandings of, for instance, his concepts of nature and cause for his natural philosophy as a whole.

(2) **Reconstructing Aristotle's methods for the study of nature.** Second, several of the chapters provide a reconstruction of the methods Aristotle uses and/or describes for the study of nature, and do so either directly, as in Chapter 1, or as part of a reassessment of one of Aristotle's key notions in his *Physics*, as for instance in Chapters 3, 8, 9, and 14. Scholars working on Aristotle have become increasingly interested in the relationship between Aristotle's "geometric-style" theory of scientific demonstration and investigation as presented in the *Posterior Analytics* and his practice in the natural treatises, and although much work has been done on the methodological connections between the *Posterior Analytics* and Aristotle's biology (i.e. his study of living nature), the connections with his *Physics* remain largely unexplored territory. The chapters in this volume aim to work towards closing this gap in the existing scholarship by offering interpretations of (a) what it means according to Aristotle to investigate things *physikôs* – i.e., in the manner of a natural scientist; (b) how this method relates to other methods available to a philosopher (such as conceptual analysis or dialectic), as well as to the scientific method outlined in the *Posterior Analytics*; and (c) how methodological concerns stemming from the *Posterior Analytics* drive the investigations in the *Physics*.

(3) **Determining the boundaries of Aristotle's natural philosophy.** Third, some chapters – most notably Chapter 14, but also Chapters 1, 9, 11, 12, and 13 – concern themselves with the boundaries (and the extent to which these boundaries are crossed) between Aristotle's natural philosophy and his metaphysics or even his ethics. In recent years, there has been a growing awareness among scholars of Aristotle that Aristotle's full views can rarely be plucked out of single passages, or even single treatises. This has led to modifications in how we believe one should conduct conceptual analysis in Aristotle (e.g. as taking into account the different uses to which concepts are put in different parts of a science, as described under item

number one above), but it has also highlighted problems concerning Aristotle's division of the sciences and his requirement that principles that belong properly to one science cannot be used in the generation of knowledge in another science (unless the two sciences are subordinated to each other). Several of the chapters in this volume examine the ways in which Aristotle demarcates the science of nature and sets it apart from other theoretical sciences, as well as how his accounts in the *Physics* relate to or are fundamental for Aristotelian views that belong properly to other sciences, such as his metaphysics, but also his ethics.

The opening chapter by James Lennox addresses the three methodological questions concerning the science of nature head on, while also providing a reconsideration of several of Aristotle's key notions in the *Physics*. Lennox argues that even though the order of and method for the investigation of nature Aristotle presents in the *Physics* reflect in important ways the recommendations for scientific investigation he had already laid out in the *Posterior Analytics*, ultimately Aristotle believes that every scientific domain is governed by norms for inquiry that are quite specific to that domain. This means that an important task of Aristotle in the *Physics* is to specify how *natural* entities – which undergo change and are always enmattered – ought to be studied, and thereby to establish the norms for scientific inquiry at a general level for the whole domain of natural science. These norms will then have to be specified even further in the other natural treatises which deal with particular kinds of natures. In his chapter, Lennox identifies these "local" norms for natural science and also shows how Aristotle's concern for establishing these norms for natural inquiry drives much of the conceptual analysis that can be found in Books II and III regarding especially the notions of change, nature, and motion.

Chapters 2 to 7 offer reassessments of some of the most fundamental notions Aristotle introduces in *Physics* II, such as nature, chance, teleology, and art, and often do so by drawing from other Aristotelian texts or from the pre-Socratic and Platonic traditions.

Sean Kelsey, in Chapter 2, turns to Aristotle's definition of nature in *Physics* II.1 with the idea of tracing its role in the remainder of Book II, where explicit appeals to the definition are surprisingly scant. According to Kelsey, the definition ultimately functions as a kind of instruction for how to interpret the phenomena of nature. Aristotle defines nature as a principle of motion and rest; taken together with the idea that nature is above all form, this implies that *form* is a principle of motion. Kelsey argues that this is a result that Aristotle expects us to find difficult: How can form, which is immobile, be a principle of movement? This difficulty, Kelsey suggests, sets

a tacit agenda for the rest of *Physics* II, and the key to unraveling it lies in realizing that the *way* form is a "principle" (*archê*) is by being an "end" (*telos*). Put another way, the suggestion is that the definition of nature, together with the identification of nature with form, instructs us (in effect) to put a certain interpretation on natural phenomena; it tells us to read the "behaviour" of things due to nature – their characteristic ways of moving and staying at rest – as for the sake of perpetuating their distinctive forms of being. The moral is that if nature as form stands at the beginning of natural phenomena, it must do so by being its end.

Chapter 3 also engages with Aristotle's definition of nature in *Physics* II.1, but, where Kelsey focused on its role, Stasinos Stavrianeas provides a reassessment of the content and meaning of this definition. However, rather than arguing that the definition yields just one criterion for judging what counts as a nature for Aristotle (such as the standard criterion that is offered in the scholarship on this topic, namely the possession of an internal principle of motion and rest), Stavrianeas believes that the definition provided in the *Physics* is left intentionally vague and general (in much the same way as Aristotle leaves his definition of soul vague and general in *On the Soul*), thereby allowing for further specifications and filling-in within the individual natural treatises. By treating Aristotle's definition of nature in this way, Stavrianeas is able to handle difficult cases in other natural treatises, such as the motion of the elements, and even hypothetical, miraculous *automata*. The aim of *Physics* II.1, then, is not to identify the one thing that characterizes all natural things, but rather to demarcate the realm – and thereby the science – of nature at the most general level possible.

In Chapter 4, James Allen reinterprets Aristotle's notions of luck and spontaneity (which are both a type of chance) in *Physics* II.4–6 by drawing not just on these chapters, but also on Aristotle's treatment of these notions in the ethical treatises. Allen shows that chance for Aristotle is not an alternative to teleological explanation, which he is determined to reject, as most standard readings hold, but rather that chance is an inevitable byproduct of final causation and unintelligible apart from it. Accordingly, the account of chance in *Physics* II.4–6 should be read as a complement to Aristotle's defense of natural teleology in *Physics* II.8. Thus, under the interpretation of Aristotle's own account of chance as a "cause by accident" as Allen defends it, chance events are a marginal exception to the teleological rule that prevails in nature, and thereby in fact constitute themselves proofs of the existence of natural teleology.

Margaret Scharle, in Chapter 5, offers a new interpretation of Aristotle's rainfall-example in *Physics* II.8. By building on Aristotle's account of the teleology of the elements in especially the *Meteorology, On Generation and Corruption*, and *On the Heavens*, Scharle shows that Aristotle understands winter rain as a natural phenomenon that is teleological in its own right, and that this teleological view of winter rain is indeed required by the dialectic Aristotle engages in with the Empedoclean opponent. As a result of this, Scharle is also able to offer a unified interpretation of the dialectic in Book II of the *Physics* as a whole: The underlying agenda that drives Aristotle's discussions in this book is his attempt to carefully carve out his own position that the natural world owes its order and regularity to teleology, and he does this against the pre-Socratic tradition that fails to properly distinguish nature from chance and against the Platonic tradition that fails to properly distinguish nature from art.

In Chapter 6, Charlotte Witt continues the focus on Aristotle's defense of natural teleology in *Physics* II.8, this time by turning to his analogy between art and nature. Against standard readings which have downplayed the importance of Aristotle's analogy between art and nature for his argument in favor of natural teleology, and which have assumed a radical ontological difference between the two (which sometimes lead them to conclude that artifacts are not substances), Witt argues that artifacts have intrinsic ends and proper functions just like natural beings (and are thus substances), and that this similarity is of crucial importance to Aristotle's appeal to the craft analogy in order to argue for natural teleology. Moreover, she shows that Aristotle is very careful to bracket off the question of the origin of change causing a creation or generation whenever he appeals to the analogy between art and nature as part of his argument for natural teleology. She thereby counters the often-heard objection that Aristotle's analogy between art and nature is mistaken or misleading, and re-establishes its importance for Aristotle's defense of natural teleology in the *Physics*.

While Chapters 5 and 6 focused on Aristotle's defense of natural teleology, Robert Bolton in Chapter 7 offers an account of its origins, and thereby corrects some longtime misunderstandings of the nature of his theory. Crucial to his innovative account is that we should appreciate the differences between Aristotle and his pre-Socratic predecessors such as Empedocles, as well as the differences between him and Plato, especially as these differences are emphasized by Aristotle himself. Aristotelian final causality, as Bolton understands it, is not – as in Plato – reducible to any other kind of causality such as efficient causality, but is instead based on the

notions of fitness and natural regularity. And in its turn, this notion of fitness is not something that holds of the natural world by chance – as Empedocles thinks – but rather something that holds of it *by nature*. In this way, Bolton introduces a thorough reassessment of Aristotle's natural teleology.

Chapters 8 to 13 offer reinterpretations of Aristotle's notion of *kinêsis* – variously translated as change, process, or motion – while also exploring issues related to Aristotle's natural scientific method broadly construed and offering suggestions about the demarcation of (the science of) nature.

In Chapter 8, Devin Henry provides a critique of the traditional view that according to *Physics* I.5–7 Aristotle holds that every change – including substantial change – requires a persistent subject of change. Instead, Henry argues that, even though the evidence in *Physics* I.7 is silent on the matter of substantial change, evidence from other natural treatises (most prominently from *On Generation and Corruption* and *Generation of Animals*) suggests that Aristotle only believes that substantial change requires a subject from which the change proceeds, not one that persists as a constituent of the substance that comes into being. Henry thereby reshapes our understanding of change, while also showing the importance of reading the *Physics* in the context of Aristotle's broader natural scientific views.

In Chapter 9, Diana Quarantotto also analyzes Aristotle's concept of change and examines the relationship between change and substantial being (*ousia*). She observes that Aristotle's treatment of this issue exhibits a development from what is more familiar to us to what is "closer to nature" and claims that the result of this inquiry is a major innovation by Aristotle within the Greek tradition of natural philosophy. She identifies this development as mostly taking place within the *Physics*, especially in Books I–III and VIII. In Books I–III, where Aristotle presents the view that is more familiar to us, there is a clear-cut distinction between substantial being and change. However, in Book VIII (as well as in passages from other natural treatises), Aristotle presents views that are "closer to nature," and this is where Aristotle presents his innovative idea that being is itself dynamic. Critical to this inquiry is the relationship between the definition of change given in III.1–3 and the treatment of eternal change in Book VIII.

David Charles, in Chapter 10, analyzes three aspects of Aristotle's account of processes (*kinêseis*): namely, (1) Aristotle's definition of process in *Physics* III.1–3 and what exactly this definition entails when read in the broader context of the *Physics* and *Metaphysics Theta*; (2) Aristotle's account of the individuation of processes in *Physics* III.3; and (3) the nature and role

of the concept of actuality in Aristotle's definition of process, especially as it is used in *Metaphysics Theta*. One major upshot of Charles' account is that it is a mistake to think of *kinêseis* as events rather than processes; if he is right, this has major repercussions for our understanding of Aristotle's notions of action, time, and causation.

In the next chapter, Chapter 11, Jacob Rosen explores the relationship between Aristotle's account of the basic structure of motions and other continuants in *Physics* v–vi and his arguments in *Physics* viii.8 that there can be no eternal motion along a straight line, and that therefore eternal motion (which he thinks must exist) must be circular. Rather than trying to read these various accounts as presenting one unified theory of motion, Rosen zooms in on the tensions between these accounts, especially regarding Aristotle's thesis about continua as formulated in *Physics* viii.8, according to which continua do not possess any actually existing proper parts or middle-points, the defense of which conflicts with an important theorem presented in *Physics* vi.5. From this he concludes that Books v, vi, and viii – even though not completely unrelated – are, most likely, not part of one single lecture that was composed in one sitting, but also, and more importantly, that Aristotle's physics and cosmology face some difficulties establishing the priority of circular motion over rectilinear motion if some of his strongest arguments from *Physics* viii.8 in favor of this thesis are already pre-emptively defeated by claims made in *Physics* v–vi.

In my own chapter, Chapter 12, I turn to Aristotle's account in *Physics* vii.3 of the changes one undergoes when acquiring virtues of character. In this chapter, Aristotle argues, somewhat surprisingly, that "conditions" – such as the virtues of the body or soul – do not belong to the category of "quality" and do not come to be as a result of qualitative change, but that they are rather "some kind of perfections" that "exist in virtue of a particular relation," thereby seemingly introducing a fifth type of change in addition to the traditional four (substantial change, qualitative change, quantitative change, and locomotion). This chapter analyzes Aristotle's account of the type of change involved in the acquisition of virtues in the *Physics* and shows how it offers a physiological and naturalistic explanation for his account of habituation or "the perfection of human nature" in the *Nicomachean Ethics*. In a way, the *Physics* thus provides a physical grounding for Aristotle's political science, as only in the *Physics* do we learn what kind of change is involved in moral development.

In Chapter 13, Ursula Coope turns to Aristotle's account of self-motion in *Physics* viii.5. In this chapter, Aristotle characterizes self-movers as involving two components – a part that produces the movement while

being itself unmoved, and a part that is moved. Although Coope also offers an analysis of Aristotle's notion of self-motion in her chapter – in particular of how it forms a response to Plato's suggestion that all motion must ultimately be grounded in self-motion – and solves some problems that seem particular to Aristotle's alternative, she is mostly interested in determining the role of Aristotle's appeal to self-motion in the overall project of establishing the existence of an unmoved mover (an appeal that seems surprising, given Aristotle's arguments in *Metaphysics L*, which establish its existence without such an appeal to self-motion). According to Coope, Aristotle's overall aim is to show how motion must ultimately be caused by something that is not itself moving. She argues that his account of self-movers in Physics VIII.5 gives necessary but not sufficient conditions for being a self-mover properly speaking. As such, it is able to apply both to genuine self-movers, such as animals, and also to the conjunction of the first unmoved mover together with the thing it causes to be in eternal motion. Providing a single account that covers both these cases helps Aristotle to show how physics, in so far as it is the study of motion, is a single unified science.

For this volume, the issue concerning the relation between the different sciences arises most prominently with regard to Aristotle's concept of the unmoved mover – the origin of all motion in the universe – which he introduces in *Physics* VIII. Since this unmoved mover is a divine being that is pure form and is without matter, it is technically speaking not part of the physical world, but rather belongs to Aristotle's "first philosophy" or metaphysics. Aristotle's treatment of the unmoved mover in the argument of *Physics* VIII and the questions it raises for the boundaries between Aristotle's physics and metaphysics are the topics of the fourteenth and final chapter, by Andrea Falcon. Falcon argues that, against traditional readings of *Physics* VIII, Aristotle's treatment of the unmoved mover there does not, and need not, go beyond the boundaries of natural philosophy, but that instead he offers a single extended natural scientific argument concerned with eternal motion. This argument proceeds in two stages that follow the two stages of inquiry as presented in the *Posterior Analytics*: Aristotle first sets out to determine *whether* there is eternal motion and then tries to identify *what* eternal motion is. The unmoved mover comes into play as the efficient causal factor that ultimately needs to be picked out by the definition of eternal motion. In this way, Falcon's chapter also contributes to our understanding of Aristotle's scientific methods in the *Physics*.

CHAPTER 1

How to study natural bodies: Aristotle's μέθοδος

James G. Lennox

Introduction

If, as the opening sentences of the *Physics* strongly suggest, the basic framework for inquiry in the pursuit of scientific knowledge presented in *Posterior Analytics* II is shaping Aristotle's views about *natural* inquiry, then there are a number of features one would expect to find. In light of *Posterior Analytics* II.1–2, there ought to be two intimately related *goals* of natural inquiry: knowledge of *what* natural beings are, ideally to be formulated in definitions; and knowledge of causes used to demonstrate *why* natural beings have the necessary but non-essential attributes that they do; *and* fact-establishing stages *on the way* to those goals.[1] The intimate relationship between these two lines of inquiry stems from Aristotle's conviction that the essences of things are, in various ways, causally responsible for their non-essential features – if one has scientific knowledge of *what* something is, one will thereby be able to explain *why* it has the other non-accidental features it has.

Nevertheless, the conviction motivating this chapter is that, notwithstanding the generality of this framework, Aristotle sees different subject matters or domains as governed by norms that are quite specific to them.[2] This specificity derives from (at least) three sources: (1) differences in the objects being investigated; (2) differences in our epistemic access to those objects; and (3) differences in the perspective we take on those objects.[3]

This chapter has benefitted greatly from comments on an earlier draft by Marko Malink, Tom Ainsworth, and our editor, Mariska Leunissen; and from discussions with Christopher Shields, David Charles, Michael Peramatzis, and Alan Code about this chapter's concerns. I am reasonably confident none of them will fully agree with the conclusions I have reached.

[1] See *Posterior Analytics* II.1–2. The view is, of course, much more complicated than this brief summation suggests. For detailed discussion of the complications, see Charles 2000, 2010b; Lennox 2004.

[2] This is the primary thrust of my forthcoming *Seeking and Knowing: Aristotle on Norms of Inquiry*.

[3] For concrete examples of how each of these sources might affect the way in which inquiry is carried out, consider Aristotle's remarks in *Parts of Animals* I.1 on the differences between studying natural