Part I

Place

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Aristotle's Physics and the Problem of Nature

"Nature is everywhere a cause of order."[1] This claim, together with the evidence that Aristotle marshals to support it, forms a consistent theme throughout his entire corpus. There has been and continues to be considerable disagreement about Aristotle's various arguments – their topics, what they say, if they are valid. But there can be neither doubt nor quarrel that within his philosophy as a whole this claim is central: nature is everywhere a cause of order.

As Mansion argues, nature gives the world not only order, but intelligibility.[2] I shall conclude that Aristotle's claim that nature is everywhere a cause of order constitutes a first principle that informs his physics as a science, and consequently, the particular problems and solutions within physics. Beyond his physics, it also appears at work within his metaphysics. Indeed, it constitutes one of his most important philosophic commitments.

As a first principle, this claim is never proven and so is not derived by or within physics – or any other science. Rather, as I shall argue, the topics, proofs, and arguments of Aristotle's physics and metaphysics presuppose and work in terms of the claim that nature is everywhere a cause of order. Hence, we see this claim at work because we see the physics that assumes it as a first principle. Because first principles cannot be proven directly (if they could, they would not be first),[3] Aristotle's topics and arguments provide the only, albeit *ex post facto,* evidence for his claim that nature is everywhere a cause of order. And these topics and arguments constitute the object of this study.

1 Aristotle, *Physics* VIII, 1, 252a12, 17; on this and other closely related claims, e.g., nature does nothing in vain, cf. *Physics* VIII, 6, 259a11; *De Caelo* I, 4, 271a33; II, 11, 291b14; III, 2, 301a6; *De An.* III, 9, 432b22; *Parts An.* II, 13, 658a9; III, 1, 661b24; *Gen. An.* I, 1, 715b14–16; II, 5, 741b5; 6, 744a36; III, 10, 760a31. All translations are my own, unless otherwise noted.
2 Mansion, *Introduction à la physique aristoteliciénne,* 92.
3 Aristotle, *Metaphysics* IV, 4, 1006a5–11; *Physics* I, 2, 185a1–3, 12–17.

In short, I shall not take up Aristotle's "philosophy of science," e.g., his concerns with the methodology and/or the status of science, including physics, but shall consider his actual practice of physics and the results of that practice insofar as they relate to his metaphysics and conception of the world at large.[4] Garber describes his book *Descartes' Metaphysical Physics* as "a kind of handbook of Cartesian physics, a general introduction to the mechanical philosophy as Descartes or a sympathetic but not uncritical contemporary of his might have understood it."[5] So I propose a "sympathetic but not uncritical" analysis of arguments at the heart of Aristotle's teleological physics.

Speaking of Kant, Friedman observes that "there has been a marked tendency to downplay and even to dismiss the philosophical relevance of Kant's engagement with contemporary science, particularly among twentieth-century English-language commentators."[6] And the reason for this tendency is clear: the mathematics and science of Kant's time, essentially those of Euclid and Newton, have long since been replaced; hence if Kant's achievement is to be thought significant it must be understood insofar as it transcends "the details of his scientific context."[7] If that point holds for Kant, how much more it applies to the pre-Euclidean, pre-Copernican mathematics and physics of Aristotle! Indeed, it has become common practice to read Aristotle in terms of Newtonian physics and to find his physics engaging just insofar as it appears to anticipate features of Newton's physics.[8] If the goal of analyzing Kant's philosophy has been "to transcend" his science, that of analyzing Aristotle's has been "to anticipate" a science entirely different from his own.

This study constitutes a *de facto* rejection of this view. Against it, I argue that to analyze Aristotle's physics in terms formulated in later scientific contexts and language is not only to diminish the scope and importance of his work but also, and more importantly, to skew the meaning of concepts central to his physics – in short, to misrepresent it. Thus I shall present a detailed analysis of an important set of arguments insofar as they reveal Aristotle's physics and his practice of physics as a science. The fact that in terms of post-Copernican science Aristotle's physics turns out to be wrong diminishes it neither as an extraordinary accomplishment of its time nor as a subtle and sophisticated set of arguments. Aristotle's physics

4 For analogous projects concerning Descartes and Kant, cf. Garber, *Descartes' Metaphysical Physics,* and Friedman, *Kant and the Exact Sciences;* for an argument concerning the importance of such a project, cf. Hatfield, "Review Essay," 1–26.
5 Garber, *Descartes' Metaphysical Physics,* 3.
6 Friedman, *Kant and the Exact Sciences,* xi.
7 Friedman, *Kant and the Exact Sciences,* xii.
8 Like many of his contemporaries, Newton himself thought of his ideas as known in antiquity; such claims added authority to science, and in this sense, current work in this vein continues a venerable tradition. For one example, cf. Hine, "Inertia and Scientific Law in Sixteenth-Century Commentaries on Lucretius," 728–741, which includes a useful bibliography on this topic. Newton forms a theme throughout Hussey; for one example, cf. 130.

constitutes a full engagement with the problems of physics as they were defined by both his predecessors and his contemporaries. As such, he provides invaluable evidence concerning the practice of physics and the arguments constituting it as a science – a physics remarkable first in its own achievements and then as central to the history of philosophy and science in the Hellenistic world, the Byzantine world, the Islamic world, and in Europe from the thirteenth to the seventeenth centuries.

To compare Aristotle's physics with that of Newton (or others) is neither impossible nor unimportant. But such comparison cannot be conducted on a "point-by-point" basis when the language, concepts, and context of physics are so radically different. In my conclusion, I sketch a program for comparison. In short, I suggest that each view must be understood fully in its own terms before it can be meaningfully compared with another. Comparisons and evaluations must rest on the presuppositions underlying the physics, the problems that the physics is designed to explain, and the internal coherence of the arguments that purport to solve these problems. The continuing interest of Aristotle's physics derives, at least in part, from this last point: his arguments are remarkably coherent. But his presupposition – that nature is everywhere a cause of order – turns out to be wrong in important ways, and the problems that he sets out to solve are not the most important or productive for physics. And as a consequence, his enormously powerful arguments serve a project that is wrong about everything.

There is no way of knowing this outcome, however, until the starting point has been spelled out and its implications made clear. And there is no way of evaluating either Aristotle's physics or the history of science until we understand how well Aristotle does the job. This is the task of this study: to understand the conception of nature as everywhere a cause of order and the definition of problems whose solutions exhibit this presupposition. And this task is accomplished by an analysis of the arguments – their structure, language, and logic – that solve the problems defined by Aristotle as central to physics. Finally, this task is both an end in itself, i.e., understanding a complex set of arguments, and a first step in a larger project, evaluating the history of physics.

As I argue, Aristotle's physics engages then-current problems and is conducted by someone in full control of those contemporary issues. His arguments present a clearly defined structure, which in its turn reveals the practice and outcome of physics as he understands it. Furthermore, analysis of these arguments establishes not only his solutions to various problems of physics but also his conception of the problems themselves, both his own and those of opponents whose views he rejects.[9]

The text of Aristotle's *Physics* served as the starting point for the physics (and astronomy) of the so-called Aristotelian system which "continued to

9 Although I shall later criticize details of their account, for an example of Aristotle's physics treated in this way, cf. Matthen and Hankinson, "Aristotle's Universe," 417–435.

hold the allegiance of the overwhelming majority of the educated classes in the seventeenth century, its final century as a credible system."[10] As I show in examples throughout this study, translating Aristotle's physics into modern terms, e.g., those of Newtonian physics, at once falsifies his position as well as the history of philosophy and physics more generally. It falsifies his position by translating it into intellectual concepts and commitments entirely foreign to his own, and it falsifies the history of ideas by treating this history as teleological insofar as Aristotle is made into an anticipation of later ideas. Such falsification suppresses the sense in which choices have been made not with the benefit of hindsight but because of immediate pressures of local intellectual contexts, commitments, and problems. Sometimes such choices, like those Aristotle made, have in fact turned out to be flatly wrong. But translating Aristotle into an anticipation of Newton neither "saves" this physics nor adds any weight to Newton's. Rather, it falsifies the histories of science and philosophy, impedes our present understanding of them, and, finally, prevents us from grasping an important possibility: the conjunction of false starting points with powerful systematic arguments. This conjunction should give us more pause for thought than is often the case – or than *can* be the case if Aristotle is read simply as an anticipation of post-Copernican ideas.

The history of Aristotle's physics bears witness not to the achievement of Newton's physics, but to the power of Aristotle's ideas and arguments. Indeed, as the literature on them testifies, they fascinate their readers still. Herein lies the mystery for contemporary readers. From our post-Copernican perspective, Aristotle's views are often wrong both in their larger claims (e.g., nature is not necessarily a principle of order) and in their details (e.g., the earth is not in the center of the cosmos with the stars going around it). And when Aristotle is "right," as when he argues that the earth is a sphere, often he is "right" for the wrong reasons; for example, he claims that all individual pieces of earth are oriented toward the center of the cosmos and so cohere together there, making the earth a sphere (*De Caelo* II, 14, 297a8–297b20). Perhaps worst of all, Aristotle offers explanations that seem positively feeble for problems central to post-Copernican physics; e.g., he apparently says that the motion of a projectile, such as a stone, after it has left the hand of the thrower, is caused by the air that rushes in behind it.[11] All in all, it is a mystery not only why anyone would be interested in these arguments now, but why anyone would ever have found them persuasive or engaging.[12]

10 Grant, *In Defence of the Earth's Centrality and Immobility*, 3.
11 Aristotle, *Physics* VIII, 10, 266b27–267a10, and *De Caelo* III, 3, 301b17–30, are often read in this way. I shall suggest a different reading later.
12 O'Brien, "Aristotle's Theory of Movement," argues that Aristotle's physics is now of only antiquarian interest: "Does Aristotle's theory of movement, does his theory of weight, have any more than an antiquarian interest, today? Quite frankly, no," 78.

But the arguments constituting Aristotle's physics were and are gripping: "The general excellence of the 'secondary literature' on Aristotle, extending from the Greek commentators to the present, is unrivaled (as far as I know) by what has been written on any other philosopher."[13] Why? Unlike later physics (and much philosophy), Aristotle's arguments respond immediately and directly to experience. We experience objects as heavy and as always going down when they are left "to do their own thing"; the stars appear to move while we feel ourselves to be stationary in the center. Indeed, the range of Aristotle's examples, consistently appealing to everyday experience and common sense, may be unequaled in the history of science or philosophy (except perhaps by Plato). By answering to experience, these arguments speak and have always spoken to their readers. And so they speak also to us – modern readers who inhabit a profoundly different world from that of Aristotle.

The appeal to experience raises an important issue. Aristotle's claim that "nature is everywhere a cause of order" is a starting point that cannot be proven directly; but he marshals impressive *ex post facto* evidence and arguments for it. Consequently, it presents the problem of any genuine starting point: it was not obviously false when Aristotle assumed it, nor is it obviously false for anyone now setting out to examine the presentation of nature in everyday experience. And Aristotle's analysis, using this starting point, often seems to penetrate to the very heart of natural phenomena as it appears to any observer. In this sense, he offers a starting point that is both powerful and promising.

That Aristotle's position on central issues is now universally recognized as wrong is itself the outcome of a long history involving complex sets of choices. Sometimes these choices arise out of criticisms of Aristotle's physics (and various interpretations of it) and would have been impossible without the full articulation of his "false" view, resting as it does on a "false" starting point. And herein lies a second important issue.

Aristotle's starting point, that nature is everywhere a cause of order, lies at the heart of his practice of physics, which defines the problems to be solved by the physicist and divides phenomena in such a way that those problems can be solved successfully. I shall argue that much of the cogency of his arguments lies in his success in conducting physics as a project given his first principle and the problems defined by it. That is, he defines the problems that his starting point is best able to solve; he divides phenomena in the most useful way, given the problems he wishes to solve; and he develops powerful arguments to solve these problems. So, for example, I shall argue that his definition of "nature" is intimately linked to his definition of "motion" and that these two together define the terms required by his account of nature; "place" is such a term, and his analysis

13 Irwin, *Aristotle's First Principles*, vii.

of it is designed to support his definitions of motion and, ultimately, nature. In this way, he constructs a coherent science of physics that he uses not only to account for a wide range of phenomena but also to present strong claims for a universal principle embracing a remarkable set of details.

Thus according to Aristotle, several facts bear witness to the claim that "nature is everywhere a cause of order": (1) The same cause, assuming it is in the same condition and acting in the same way, always produces the same effect; (2) nature is everywhere opposed to chance – chance presents rare events whereas nature presents those that occur always or for the most part.[14] Furthermore, (3) as a cause of order, nature everywhere "flees" the infinite;[15] hence (4) nature always desires what is best.[16] For these reasons, nature cannot but remind us of god and what is divine. Like god, nature does nothing in vain or uselessly.[17] And the absence of what is vain or useless in nature clearly returns us to the view that nature desires what is best and is thus everywhere a cause of order.

The history of choices and criticism that has proven Aristotle's account wrong – wrong from its universal principles to its treatment of details – has neither merely criticized details nor grandly rejected universal principles. That history is itself very complex, and this complexity arises not only from a progressively more sophisticated analysis of Aristotle's arguments but also from other sources. Physicists have taken up problems, such as a creating God as the first cause of the universe, originating outside Aristotle's physics as a science; they have redefined the problems within Aristotle's physics (e.g., the problem of projectile motion), and they have devised new answers to those problems (e.g., impetus theory). And we are bound to lose sight of this important and complex history if we judge the details of Aristotle's physics only, or even mainly, as anticipating or failing to anticipate later ideas.

Furthermore, we also lose a full sense of *modern* physics as it represents our own intellectual commitments, if we fail to see that the problems and starting points of physics are not "given" but are themselves constructed within a historical process called "science."[18] So, as I argue later, the problem of how to account for the motion of a body, such as a stone after it

14 Aristotle, *De Gen. et Corr.* II, 6, 333b5; 9, 336a27; *Physics* II, 8, 198b35; *De Caelo* III, 2, 301a7.
15 Aristotle, *Gen. An.* I, 1, 715b14; *Physics* VIII, 6, 259a11.
16 Aristotle, *Physics* VIII, 6, 259a11; 7, 260b23; *Gen. An.* I, 1, 715b14; *De Gen. et Corr.* II, 10, 336b28.
17 Aristotle, *De Caelo* I, 4, 271a33; II, 11, 291b13; *De Anima* III, 12, 434a31; *Parts of Animals* II, 13, 658a8; III, 1, 661b24; IV, 6, 683a24; 11, 691b4; 12, 694a15; 13, 695b19; *Progression of Animals* 2, 704b15; 8, 708a9; 12, 711a18; *Gen. An.* II, 4, 739b19; 5, 741b4; 6, 744a37; V, 8, 788b20.
18 Cf. Hatfield, "Review Essay," who criticizes Garber (*Descartes' Metaphysical Physics*) because he "does not inquire into the origin of the concept of physics assumed in the book itself," and such inquiry "might have brought the difference between Cartesian and Newtonian physics into stronger relief," 9.

leaves the thrower's hand, appears to us as central to physics because, standing on this side of its history, we live with a physics that defines it as such. But there is nothing *necessary* about this supposed centrality. Aristotle's physics defines *its* problems in a way that renders this problem marginal, and *consequently,* he never treats it directly but always "in parentheses." Thus – and here is the crucial issue for the history of physics and philosophy – his "parenthetical" treatment occurs *not* because he cannot solve the problem and so chooses to sidestep it, but because as a problem it is of little interest within his physics. The failure to understand this background in Aristotle's work is simultaneously the failure to understand the project *we* call physics and how it defines its characteristic problems, significant phenomena, and solutions.

Here is the methodological crux of my thesis. We do not understand Aristotle's position until we understand its starting points, the definition of problems that it presents, and the solutions to those problems as they are presented through his actual practice of physics. Furthermore, if we fail to understand Aristotle's position, we also fail to understand the history of choices that have led to our own physics, and so we fail to understand our own scientific surroundings as shaped by the history of choices that ultimately rejects Aristotle's physics.

The world that Aristotle constructs is, as it must be, a world very different from the world that appears within the constructs of contemporary physics. Aristotle presents a cosmos with the earth stationary at its center, the stars going around eternally, and each element – earth, air, fire, and water – is moved always toward its natural place. Because it is like form, place renders this cosmos determinate in respect of direction, i.e., up, down, left, right, front, and back; and all things within the world are determined in respect of place. In this world, nature operates always and everywhere as a cause of order.

That this world is so strange and so different from our own – and yet so coherent and responsive in its own right – tells us something important about the nature of conceptual starting points, the definition of problems, and the power of arguments. Among other things, it tells us that a position constructed from a starting point with extraordinary appeal and developed through coherent, even elegant, arguments may be entirely wrong. It also tells us something about the nature of criticism and history – that history has a way of making our own world and its familiar problems look real and absolute ("given as a fact") rather than the outcome of a set of historical choices, which, as historical, may be compared and evaluated.

These points taken generally seem neither surprising nor profound. Yet they have not in their particulars been appreciated in the history of physics, perhaps because as a science physics claims to yield not a moral or a legal world, but the "real" world. A recent essay, which falls within a

long-standing tradition of analysis of Aristotle's physics, makes the latter claim explicit: "Aristotle's ideas so far appear to us as hardly more than cardboard cut-outs, because, so far, I have said nothing about the origins of Aristotle's theory. I began instead (as most histories of science do begin) with the facts."[19] It is against this background that I present a quite different account of Aristotle's analysis of nature as always and everywhere a source of order: a conception of physics as the construction of a world complete with its starting point, the definition of its problems, and the development of solutions to those problems – and all the choices entailed thereby.

My analysis focuses on the two fundamental features of Aristotle's account of nature: "place," which I examine in Part I, and the elements, along with their respective "inclinations," which occupy Part II. At the conclusion of the examination of the elements, I shall also examine the account of potency and actuality in *Metaphysics* IX insofar as it bears upon the elements. Taken together, I shall conclude, place and the elements constitute nature, and so an examination of them exhibits nature as everywhere a cause of order.

Place, according to Aristotle, resembles form and is the first limit of the containing body (*Physics* IV, 4, 211b10–13; 212a20). Hence, the cosmos is intrinsically directional: "up," "down," "left," "right," "front," and "back" are not just relative to us but are given in the cosmos itself. I shall argue that place is the formal constitutive principle that renders the cosmos directional in this sense and so constitutes all place within the cosmos as "up," "down," and so forth.

Within the cosmos all things, whether made or natural, animate or inanimate, are made up of the elements – and there is nothing material outside the cosmos. Each element possesses a specific nature, its "inclination": the active orientation of each element toward its proper place, e.g., up or down. Consequently, place and inclination work together: place constitutes the formal limit and directionality of the world – the "where things are" – while each element is limited and possesses inclination toward its proper place. As a result of this partnership, natural motion in things (in the absence of hindrance) is completely regular: it exhibits the order of nature and the account of nature as itself orderly.

The account of place found in *Physics* IV and the account of the elements and their relation to place found in the *De Caelo* yield not only regular natural motion, but the cosmos itself. Because (as Aristotle argues) there can be only one cosmos within which the elements comprise both natural things and artifacts, an account of place and the elements yields a universal account of nature and of all things that either are by nature or, like artifacts, are composed of natural things. In *Metaphysics* IX, Aris-

19 O'Brien, "Aristotle's Theory of Movement," 73.

totle examines the notions of potency and actuality (the terms that define motion), claiming that these terms are important not only for becoming but also for being; he concludes that the elements imitate the heaven because they too are ever active (*Metaphysics* IX, 8, 1050b28–30). In short, by examining the accounts of place and the elements as they appear in these texts, we examine the constitution of the natural world itself insofar as it is limited, determinate, and orderly in respect to both its becoming and its being.

The sense in which the cosmos and all things within it are constituted by place and the elements comprises the heart of this study. I here anticipate my analysis more fully, turning first to the method of analysis utilized within this study and then to a brief outline of its substantive parts.

Methodological Assumptions/Methodological Restrictions

Any study of Aristotle must address the method of analysis to be used. Several are available. The "genetic" or developmental method informed much of the scholarship on Aristotle's work earlier in this century and has recently been revived. This method argues in effect that one cannot analyze any given argument in Aristotle's corpus without first establishing a chronology for the development of his thought across the entire corpus.

In contrast to the genetic method is the "acontextual" method: any given argument in Aristotle may be analyzed without referring to the corpus as a whole or even to the local context of the argument. On this method, all arguments are, as arguments, subject to the same analysis and thus comparable to one another. Taking a problem such as motion in a void, one can ask how – or if – Aristotle solves it in a given argument and how his argument compares to any other, e.g., that of Philoponus or of Newton.

I shall propose a third method, a "method of subordination." It is generally agreed that Aristotle wrote *pragmateiai,* or *logoi* – what are now referred to as "books" (e.g., *Physics* I, *Physics* II, *Metaphysics* IX), and that these were later bound into treatises, for example, the *Physics* and the *Metaphysics,* which now comprise the corpus traditionally termed "Aristotelian."[20] I shall argue that at or near the beginning of each *logos* Aristotle announces a problem or topic and then develops arguments that define and/or solve that topic or problem. Replies to objections, criticisms of alternate views, and so on follow. Thus arguments are subordinated to the particular topic or problem that they address. With this method, no decision need be made about the corpus as a whole to understand an

20 For a brief but helpful account of the issues surrounding the Aristotelian corpus, cf. Barnes, "Life and Work," 6–15.