I

Anaximander’s argument purporting to establish that the Earth necessarily is at rest at the center of the cosmos has been regarded as indicative of a general tendency in Presocratic philosophy toward a method that prioritizes pure reason and cosmic speculation over explanations grounded in mundane observation. Partly, this is because the argument makes use of the Principle of Sufficient Reason (PSR): the Earth is “situated at the center and is equally far from the extremes”; it is “not fitting” for something so-placed to move one direction, rather than the opposite; so, it must be at rest. According to James Warren, for example, the argument “depends on no empirical evidence or on any general principle derived from observation.” This understanding of Anaximander’s view is also motivated by the sense that, in the words of Karl Popper, the cosmology supported by this argument is “counter-observational” with “no analogy whatever in … observational facts.” Indeed, Popper even enlists Anaximander as an avatar in his campaign against a picture of the scientific method according to which science advances by way of humdrum observations that issue, eventually, in verifiable hypotheses, to be accepted to the degree that they are confirmed.

1 This paper is prepared for the International Association for Presocratic Studies fifth biennial conference and space is limited. A longer version of this paper would include a more thorough discussion of the role of experiment and observation in the development of Hobbes’s theory of light and optics. I have also avoided long quotations in the body of the essay, but the relevant texts are reproduced in the “Textual Appendix.”
2 Text A. Translation by Richard McKirahan, Philosophy Before Socrates, p. 40.
3 Presocratics, p. 33.
4 “Back to the Presocratics,” p. 4. For a critical response to Popper’s general thesis regarding Presocratic methods and theories see G. S. Kirk, “Popper on Science and the Presocratics” and “Sense and Common-Sense.” For an adjudication of the dispute see G. E. R. Lloyd, “Popper versus Kirk.” Lloyd’s admonition that “what are needed are more, and more detailed, case-studies of specific scientific problems in antiquity, to throw further light on … questions of the methods… of early Greek scientists,” (“Popper versus Kirk,” p. 37) is well-taken and this paper is undertaken in that spirit.
The aim of this paper is to cast doubt upon this strong “counter-empiricist” reading of Anaximander. I start with a somewhat surprising comparison: Thomas Hobbes’s demonstration of the Law of Inertia (Inertia). Consideration of this argument reveals that there is a place for a priori principles in physical explanations that respect empirical adequacy as a going concern, for a priori principles can be regarded as part of the conceptual apparatus of an empirical theory.

With this point in hand, I turn to Anaximander’s argument. I argue that it does plausibly depend on empirical facts, despite the invocation of the PSR and the surprising cosmology it supports. Insofar as the fragments and testimonia tell us anything about Anaximander’s views on method, they are consistent with the conclusion that observation and empirical adequacy are important to his method.5

II

Let us consider Hobbes’s argument for Inertia.6 This argument comes from the second part of De corpore (1655/56), wherein he provides a relatively well-articulated presentation of first philosophy as he understands it, purporting to show how to derive universal theorems concerning the qualities of bodies from the definitions of “time,” “space,” “body,” etc.7 These theorems are supposed to constitute an explication of the concept of “material body.” Here is a summary of the argument: Let a be a body at rest in empty space; if a begins to move begins to move, it must move in some direction and there must be some reason that determines it to move that way; that reason cannot be internal to a; therefore there must be some reason external to a that determined

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5 My position agrees with R.J. Hankinson Cause and Explanation, pp. 14-16. Hankinson recognizes the importance of observation and empirical adequacy to Anaximander’s position, as well as the importance of general laws to the argument. I am also in agreement with Hankinson’s points regarding the PSR as a regulative principle (Cause and Explanation, pp. 14-16 and p. 228).

6 Text B. Hobbes gives arguments for both halves of Inertia: a body at rest stays at rest unless acted upon by external forces and a body in motion will continue in motion unless acted upon by external forces. I focus here only his argument for the left-hand conjunct.

7 For the purposes of this discussion, I ignore controversies concerning the accuracy of the 1656 English translation of the Latin text of De corpore and refer to the work by its Latin title, while citing the English text.
its velocity; but $a$ is in empty space, so any reason sufficient to determine $a$ to move that way is a sufficient reason for $a$ to move any other way; nothing can move in all directions at once; therefore, etc.

This is an *a priori* argument for Inertia. Hobbes does not base Inertia on an inductive generalization, but derives it as a theorem from the definitions laid down earlier in *De corpore* part II. Despite the way he sometimes comes across, Hobbes does not believe in the madcap rationalist ideal of physics as a purely *a priori* system of analytic and necessary truths. Broadly speaking, Hobbes is an empiricist with a positivistic outlook characterized by a resolute hostility to metaphysics, particularly to scholastic realism. Philosophy, according to Hobbes, is “*the Knowledge acquired by Reasoning, from the Manner of the Generation of any thing, to the Properties; or from the Properties, to some possible Way of Generation of the same; to the end to bee able to produce, as far as matter, and humane force permit, such Effects, as humane life requireth*” (*Lev.* XLVI. 1052: 1-8). Science—*Scientia* in the Aristotelian sense—is given a deflationary spin: science is the knowledge of universal, hypothetical statements and their deductive consequences. To have scientific knowledge of a given proposition is to know how to correctly derive that proposition from theorems and definitions, which explicate the terms concerning the subject of the proposition. In this way, Hobbes connects science, or the knowledge of the consequences of universal names in propositions, derived by demonstrative syllogism, with philosophy, or the knowledge of causes and effects. Natural philosophy shows how one fact depends on another by showing how propositions expressing these facts can be deduced from universal truths. Insofar as he thinks there even is such a thing as metaphysics, Hobbes thinks of it as nothing more than a propaedeutic to science in the above sense:
metaphysics, or “first philosophy,” is just an explication of the terms used in natural philosophy. These definitions play the role of “meaning postulates” in construction of the language-system of natural science—what Carnap might call a “thing language”—and first philosophy does not pretend to be a science of being qua being.

According to Hobbes, the goal of the *a posteriori* part of natural philosophy is to seek out the *possible* causes of the phenomena of nature and the procedure he envisions is the method of hypothesis: when seeking the causes of natural phenomena, the scientist can only posit a cause that, assuming certain definitions and theorems hold true, would be sufficient to determine the effect. These hypotheses posit the existence of bodies that satisfy the definitions and postulates concerning “body.” The natural scientist seeks a model that saves the phenomena; the only constraints are that the hypotheses be intelligible according to an empiricist criteria of significance, and that the phenomena in question can in fact be validly deduced from the proposed hypothesis. *A priori* we can show that if there is a body of such and such a quantity and motion, *then* these effects must follow; whether, *in point of fact* the hypothesis is true is beyond the scope of demonstrable knowledge. It is a conjecture rendered more probable by confirmatory experience and can only be assumed until disconfirmed by experience. Experimental results are relevant insofar as they bear on the empirical adequacy of the proposed explanatory conjecture.

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9 See “Empiricism, Semantics, and Ontology,” in *Meaning and Necessity*, pp. 205-221. I note a few differences between the Carnap’s position and Hobbes’s. First, the syntactical rules of the language-system (i.e. logic) are established in Hobbes’s view prior to first philosophy (following the order of presentation in *De corpore*), whereas for Carnap, part of what it is to construct a language-system is to specify the syntax and the semantics of the language; second, although Hobbes likely does not share Carnap’s ecumenicalism, which extends to language-systems that refer to abstract objects, he does allow that we can construct names for “useful fictions” in mathematics and science. These “feigned beings” have no “being in nature” but may be counted as beings “for the sake of doctrine” (*De corpore* II.6). For a discussion of the role of positiv in Hobbes’s philosophy of religion and science see my “Concerning men’s affections to Godward” *Journal of the History of Philosophy*, (forthcoming).
10 See, e.g., *De hom.* X.15; *De corpore* XXV.1, XXX.15; *Dec. Phys.* Ch. 1, pp. 78-80 and Ch. 2, pp. 82-82, 87-88. 
The \textit{a priori} deduction of Inertia proceeds \textit{relative} to the definitions of the language-system Hobbes builds in earlier sections of \textit{De corpore}. Let $\theta$ be the collection of all the definitions Hobbes lays down in these earlier sections. Hobbes’s position is that $\theta$ implies the proposition: \textit{a body at rest will stay at rest unless acted upon by external causes}. He is clear that one does not \textit{have} to accept his definitions and so could reject any theorems that follow from them.\footnote{For example, in the introduction to the part of \textit{De corpore} that concerns physics he writes: “if I am not deceived, I have [in the foregoing chapters on logic, metaphysics, and geometry] affirmed nothing, saving the definitions themselves, which hath not good coherence with the definitions I have given; that is to say, which is not sufficiently demonstrated \textit{to all those, that agree with me in the use of words and appellations}” (\textit{De corpore} XXV.1; my emphasis). See also \textit{De corpore} I.10.} All that he claims for his metaphysical system is that if you accept his definitions and postulates \textit{then} you should accept his theorems. Inertia is guaranteed to hold—assuming Hobbes’s proof is good—of anything that meets the definition of “body.” So, assuming there is some $x$ such that $x$ is “a body,” then $x$ will remain at rest, unless acted upon by some external cause; however, whether there \textit{exists} anything that satisfies the relevant definitions is, Hobbes is clear, an empirical matter.\footnote{E.g. \textit{Anti-White} XXVI.2, fol. 287: “…demonstrable truth lies in logical inferences; and in every demonstration the term that forms the subject of the conclusion demonstrated is taken as a name, not of a thing that exists, but of one supposed to exist. … For someone to prove that something exists, there is need of the senses, or experience.”} Science concerns universal propositions only; matters of fact and existence are expressed in singular propositions. Inertia is an \textit{a priori}, necessary proposition in that, assuming the concept of “body” as defined by $\theta$, it must be true. But it is important to note that Inertia is then part of the conceptual apparatus of $\theta$. That is, Inertia does not itself explain anything; rather, it \textit{deploy} in explanations of empirical phenomena.\footnote{Jesseph, “Experimentation,” p. 37. Hobbes refers to Inertia as an “axiom,” or a “principle of ratiocination,” for example, in \textit{Dec. Phys.} Ch. 2, p. 85.} That is part of what \textit{giving an explanation according to $\theta$} amounts to.
What about the PSR? Following Leibniz, I take the PSR to be the general principle that every event or fact has a cause or reason that explains why it is just so and not otherwise. Clearly the argument in De corpore invokes the PSR, since a key premise in the argument demands “reasons” for a body’s velocity and so Hobbes must be assuming that every motion has a cause that determines its velocity. However, if Hobbes’s proof is valid, each premise in the argument must be either a definition or else it must be a theorem derivable from the definitions. The trouble is that the PSR does not appear to be contained in any of the definitions of θ and it does not appear to be implied by them as a theorem. But the PSR actually is a presupposition of Hobbes’s system. It is a methodological assumption, built right into the definition of philosophy. This can be seen in the definition of philosophy from Leviathan: philosophy just is the knowledge of causes of phenomena and this presupposes that there are causes of the phenomena. There is, in fact, good evidence to suggest that Hobbes thinks that this presupposition that every phenomenon has a cause is hardwired into human psychology. It is a fundamental fact about us that we are prone to seek out causes. This natural tendency is motivated by our fear and anxiety over our future security and also by curiosity. Philosophy introduces order and method to what is an original human instinct. The PSR—an expression of these natural, unavoidable human passions—is an a priori proposition, which we accept as a regulative principle, for it is codified in the very practice of philosophy. On these grounds, Hobbes may consider himself justified in assuming the PSR in the above proof. We are warranted on pragmatic grounds in assuming that every motion is determined by a prior cause because insofar as we are trying to give a scientific

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15 Monadology 32. I note that there really is no such thing as the PSR; Leibniz himself does not stick to one uniform expression.
16 See the discussion of curiosity at Lev. VI 86: 15-22 and “admiration” at Lev. VI 86: 32-33. These, Hobbes is clear, are peculiarly human passions. See also Lev. XII. For a discussion of the ways in which fear and curiosity determine religious belief see my “Concerning ‘men’s affections to Godward’” Journal of the History of Philosophy, (forthcoming).
17 De corpore I.1.
account, we are committed to this assumption. Without assuming that, generally, for any given phenomena there is some cause that is explicable to reason, it is difficult to understand what scientific investigation (defined as Hobbes has defined it) is aiming at. To abandon the PSR is to abandon the game; there is not much point in playing a game that, in principle, you have no hope of winning.

III

Let us turn to Anaximander’s argument.¹⁸ The argument is not supposed to establish that the Earth is at rest; rather, it supposed to explain why the Earth is at rest. The context of Aristotle’s report indicates this. As Aristotle understands the argument, Anaximander says it is at rest necessarily because of “equality.” The argument presupposes that the Earth is at rest and at the center of the cosmos, since the appearances attest to this, and so the important work in the argument is done by the principle, which I shall call the “Equidistance Principle,” that it is “no more fitting” for something “equally far from the extremes” to move one way, rather than the opposite way. The assumption that the Earth’s being “equally far” from the edges of the cosmos implies that it is “no more fitting” for the Earth to move one way, rather the opposite is an instance of the Equidistance Principle.

The Equidistance Principle looks superficially like the PSR, but they are not equivalent. Anaximander’s argument is intended to show that given that the Earth is at rest, it must stay at rest; showing why this must be the case constitutes the explanation of that fact. The PSR is implicit in the argument. It shows up in the assumption that if an object moves, then there must be some reason or cause for it to move one way, rather than the opposite way. The PSR says that every event has a cause; the motion of a body is an event and so that motion must have a cause.

¹⁸ Text A.
But it is clear that the Equidistance Principle is not equivalent the PSR, because the former makes special reference to distances. It is a physical principle. The *equidistance* of the Earth to the extremes is the reason it must be at rest. But one must *first* establish that the fact that the Earth is equidistant from all the extremes implies that there can be no cause for Earth to move one way rather than another; only then is the application of the PSR to move from the absence of causes to absence of fact justified.

The Equidistance Principle is not an *a priori* truth, but the normative language—that it is not “fitting” for what is “equally far from the extremes” to move—provides us with a good clue to its source. It may derive, I suggest, from Anaximander’s *general* cosmological views. Specifically, Anaximander holds it because he views it as a consequence of a law of nature. We know that Anaximander used legalistic or moralistic terms to express the necessity with which natural processes are regulated by law.\(^1\) His view seems to be that opposites are in a state of conflict and motion that is governed by an impersonal, universal law of exchange keeping them in an equilibrium.\(^2\) If one element begins to “take more” than its “due share” it is then “punished” and its opposite element takes “compensation” in accordance with the law.

Plausibly, the law Anaximander has in mind is quite general: all pairs of opposites “contend” with one another, acting on one another, but must be in equilibrium over time. Call this law $E$. A common example of an instance of $E$ is the seasons: the seasons change in a regular cycle because the system defined by the hot-cold pair is kept in a state of dynamic equilibrium by $E$. However, it is also possible for a system to be in a state of *static* equilibrium. Like the arm of a balance supporting equal weights on both its ends, the opposed elements in such a system

\(^1\) One thing changes into another “according to necessity, for they pay the penalty and retribution to each other for their injustice in accordance with the ordering of time” (McKirahan, *Philosophy Before Socrates*, p.43).
would be in a constant state of equilibrium, equally “sharing” territory with one another. Neither element in the system takes more than its “due” from its opposite and so there is never a need for the law to extract penalties and retribution from either member of the pair.

If Anaximander recognizes a general law of equilibrium of opposites and if both dynamic and static systems are subsumed under it, then this may account for the premise in the argument that the Earth’s equidistance from the “extremes” implies that there is no reason or cause for it to move. The Equidistance Principle derives from $E$. It would not be “fitting” for the Earth to move from its present position, equidistant from the extremes of the cosmos, for the Earth and the extreme edges of the cosmos stand in a static equilibrium with respect to one another. Should the Earth move in any direction it would do something without reason, or “inappropriate,” infringing upon its opposite member—the extreme edges of the cosmos—and would have to be “made to pay the penalty” for this infraction. That is, the Earth must stay at rest in the center because any motion would be a violation of $E$. Hence, the premise that the Earth does not move because it would not be “fitting” for something at the center to move in any direction is not derived from the PSR; rather, it is a consequence of Anaximander’s general cosmological law, the law $E$.

“Equality” is a cause of rest in the sense that it is a consequence of $E$ that opposites must be in a state of equilibrium with one another. If that equilibrium is disturbed, it must be restored, with change and motion the inevitable result. But if opposites are “equally related” to one another, then they simply have to stay put and the system remains static. This is what $E$ dictates.

IV

From Hobbes we learned two lessons about the use of a priori principles in empirical physics that bear upon our analysis of Anaximander’s argument. The first is that a law, like Inertia, may have an a priori status relative to the definitions and postulates of the theory from which it is
derived. In this way a law might form part of the conceptual apparatus of a given theory and \textit{as such} it is deployed in explanations from within that theory. In an absolute sense, one cannot deduce particular facts from the theory as these are a matter of observation; however, one can explain particular facts by reference to the general laws of the theory. In Hobbes’s case, one would show how a given fact follows from \( \theta \), which includes Inertia as a theorem—that is just what \textit{giving an explanation according to} \( \theta \) would be—but this way of conceiving of physics is clearly compatible with a generally positivistic outlook toward the relevance of empirical data.

The second is that a natural philosopher might accept the PSR as a \textit{methodological} assumption and in so-doing accept it as an \textit{a priori} principle of his system.

The latter point reminds us that, given that we have no evidence regarding Anaximander’s views on the PSR and its status, his acceptance of the principle is not indicative of his outlook toward the relevance of observation to theory; his implicit adoption of the PSR points only to a commitment to a methodology that presupposes that, in general, every fact has some cause for why it is \textit{just so}. But that is just one way of “doing science.” I have also argued that Anaximander’s argument should be read as an explanation for the fact that the Earth is at rest: it is so, necessarily, as a consequence of \( E \). For all the fragments and \textit{testimonia} tell us, \( E \) could depend on inductive generalization. However, as Hobbes’s example reminds us, \textit{even if} \( E \) is an \textit{a priori} truth, that is still insufficient to declare Anaximander’s cosmology “counter-observational” or dependent on \textit{pure a priori} considerations. \( E \) could be an “immanent” \textit{a priori} truth, a conceptual truth of the “Anaximanderian system.” What it is to give an \textit{Anaximanderian explanation} of some fact would be to show how it follows from the Anaximanderian system. And, indeed, his argument proceeds by assuming an empirical fact—that the Earth \textit{is} at rest at the center of the cosmos—and showing us the wherefore of this fact through \( E \).
Anaximander is rightly to be praised for raising up physical and cosmological explanations beyond appeals to myth and the immediate hands of divinity. Certainly, the introduction of rational argument and natural law are real scientific advances. But even as we acknowledge his contribution, we must remember that a commitment to reason does not entail a commitment to Rationalism.²¹

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Hankinson, R.J. *Cause and Explanation in Ancient Greek Thought*. Oxford: Oxford University Press, 1998. [Cause and Explanation]


[“Hobbes and Method”]


[“Concerning ‘men’s affections to Godward””]


[“Wallification”]


Textual Appendix

Text A:

Some, like Anaximander … declare that the earth stays at rest because of equality. For it is no more fitting for what is situated at the center and is equally far from the extremes to move up rather than down or sideways. And it is impossible for it to move in opposite directions at the same time. Therefore, it stays at rest of necessity (Aristotle, De caelo 2.13 295b11-16 = DK 12A26).

Text B:

Whatsoever is at rest, will always be at rest, unless there be some other body besides it, which, by endeavouring to get into its place by motion, suffers it no longer to remain at rest. For suppose that some finite body exist and be at rest, and that all space besides be empty; if now this body begin to be moved, it will certainly be moved some way; seeing therefore there was nothing in that body which did not dispose it to rest, the reason why it moved this way is in something out of it; and in like manner, if it had been moved any other way, the reason of motion that way had also been in something out of it; but seeing it was supposed that nothing is out of it, the reason of its motion one way would be the same with the reason of its motion every other way, wherefore it would be moved alike all ways at once; which is impossible.

In a like manner, whatsoever is moved, will always be moved, except there be some other body besides it, which causeth it to rest. For if we suppose nothing to be without it, there will be no reason why it should rest now, rather than at another time; wherefore its motion would case in every particle of time alike; which is not intelligible (De corpore VIII.19).

Text C:

There is a certain Philosophia prima, on which all other Philosophy ought to depend; and consisteth principally, in right limiting of the significations of such Appellations, or Names, as are of all others the most Universal: Which … are commonly called Definitions; such as are the Definitions of Body, Time, Place, Matter, Forme, Essence, Subject, Substance, Accident, Power, Act, Finite, Infinite, Quantity, Quality, Motion, Action, Passion, and diverse others, necessary to the explaining of a mans Conceptions
concerning the Nature and Generation of Bodies. The Explication (that is, the settling of the meaning) of which, and the like Terms, is commonly in the Schools called *Metaphysiques*; as being a part of the Philosophy of Aristotle, which hath that for title: … But the Schools take them for *Books of supernaturall Philosophy*: … And indeed that which is there written, is for the most part so far from the possibility of being understood, and so repugnant to naturall Reason, that whosoever thinketh there is any thing to bee understood by it, must needs think it supernaturall (*Lev. XLVI.1076: 8-18*).