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Metaphysics and Natural Philosophy in Descartes and Newton

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Abstract This paper compares Newton's and Descartes's conceptions of the complex relationship between physics and metaphysics.

Keywords Newton · Descartes · Metaphysics · Physics · Space

1 Introduction

It is sometimes said that "natural philosophy" in the seventeenth century was really a version of what we would now call "physics." But this is somewhat misleading. In fact, natural philosophy was typically understood as the science of nature as a whole, including those parts of nature that are animate. Hence natural philosophy included some aspects of biological and psychological phenomena, since human bodies and the human being are part of nature.[1] Given this very wide scope of natural philosophy, it is not possible for a single paper to articulate its relation to metaphysical questions, even when focusing specifically on Descartes and Newton (see Janiak 2008). Instead, I plan to analyze the way in which this

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[1] Many thanks to Gary Hatfield for a memorable discussion of these issues. For more details on the scope of seventeenth century natural philosophy, see my (forthcoming) and Blair (2006); on the history of natural philosophy more generally, see Grant (2007). For a useful discussion of *physics* in the seventeenth century, see Heilbron (1982, 1–5).

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relationship sheds light on two issues: first, Newton's complex reaction to various Cartesian ideas within both metaphysics and physics; and second, how the relation between natural philosophy and metaphysics in the late seventeenth century connects with questions about the scope of revealed theology in that era. In what follows, we will see how Newton's rejection of Cartesian metaphysical views is intimately connected with his adoption of several key anti-Cartesian views within natural philosophy, and also how that rejection illuminates the distinction between natural philosophy and revealed theology in Newton's mature work. As in many other domains, Newton's specific means of distinguishing treatments of the divine that involve revealed theology from those that remain squarely within natural philosophy is intriguing, if not unique.[2]

When we think of seventeenth century conceptions of space, time and motion, we do not tend to think of Descartes as making a crucial contribution; and when we think of Descartes's philosophy, we do not tend to think of his understanding of space, time and motion as central. But Descartes's views—as part of what has aptly been called his *metaphysical physics* (Garber 1992)—are essential for understanding Newton's conception of space and motion.[3] This is especially evident from the now famous unpublished anti-Cartesian tract among Newton's papers, known simply as *De Gravitatione* after its first line. Newton rejected nearly every defining aspect of Cartesian physics: the derivation of the first two laws of nature from God's property of immutability; the conception of space, time and motion implied by the Cartesian identification of body and space; the theory of vortices as the central explanatory tool for understanding the planetary orbits; and so on. Newton titled his *magnum opus* to suggest that it ought to replace Descartes's *Principia philosophiae*, first published in Amsterdam in 1644 (French translation, 1647), a text that Newton read carefully and kept in his personal library (Harrison 1978). On occasion, Newton even referred to the *Principia* as his "*Principia Philosophiae*". It seems reasonable, then, to probe the relation between metaphysics and natural philosophy in Newton's oeuvre by considering it within a Cartesian historical context.

2

In *Principia Philosophiae*, Descartes distinguishes the "vulgar" from the "proper" conception of motion, where the proper, or strict, conception is classically relationalist. Descartes tells us (Descartes 1964–1974, Latin: AT VIII-1:53 | French: AT IX-2:75) that motion in the

[2] Throughout this paper, when I write of *theology*, I mean what is typically called *revealed theology*, rather than *natural theology*. Hence I mean some view that is self-consciously regarded as a reflection of one's faith, or of one's interpretation of Scripture. If *natural theology* involves instead an appeal to reason, and to rational argument, then it is outside the scope of my inquiry. For a helpful discussion of English natural theology in the seventeenth century, see Mandelbrote (2007). Thanks to Michael Friedman for discussion of this point.

[3] In this, Newton was not alone: as Heilbron puts it, as of the mid-seventeenth century, "Descartes then replaced Aristotle as the foil against which British physics tested its metal" (1982, 30). For various perspectives on Newton's relation to Descartes and Cartesian ideas, see, *inter alia*, Koyré (1968), Gabbey (1980); Cohen (1990), Stein (2002), and Janiak (2010). Newton's relation to Cartesianism was mediated through the Cambridge Platonist Henry More's well-known criticisms of Descartes's views in natural philosophy and metaphysics. More was originally a strong supporter of Cartesian natural philosophy, calling its competitors in the 1640s mere "shrimps" (Heilbron 1982, 30); he later changed his mind. Newton had eleven of More's works in his personal library (see Harrison 1978), including More (1655, 1659, 1662). More's celebrated correspondence with Descartes in 1649 is an important source for understanding some of Newton's reactions to Cartesian metaphysics—see Geneviève Lewis's edition of the correspondence, Descartes (1953). Indeed, More's correspondence with Descartes is akin in many ways to his correspondence with Elisabeth (see Shapiro 2007): each writer pressured Descartes into dealing with issues, such as mind-body interaction and divine-matter relations, that he largely bracketed in the published works.

ordinary sense is "nothing other than *the action by which a body passes from one place to another*."[4] Apparently, Descartes views this ordinary understanding of motion as problematic because it uses a notion of *place* that involves difficulties, and more importantly, because it treats motion as the *action* by which a body is transferred from place to place, which may conflict in some ways with the principle of inertia articulated in the first two laws of the *Principles* (see below).[5] In the next section of the text, Descartes jettisons the problematic notions of *place* and *action*, defining true motion as follows:

> If, on the other hand, we consider what should be understood by *motion*, not in common usage but in accordance with the truth of the matter, and if our aim is to assign a determinate nature to it, we may say that *motion is the transfer of one piece of matter, or one body, from the vicinity of the others which immediately touch it, and which we consider to be at rest, to the vicinity of others* [*ex vicinia eorum corporum, quoe illud immediate contingent & tanquam quiescentia spectantur, in viciniam aliorum*] (Descartes 1964–1974, AT VIII-1:53–4).

This distinction between the "vulgar" and the "proper" conception of motion may be demanded by Descartes's metaphysics. The "vulgare" conception presumably reflects our ordinary ideas about motion, and can employ notions that are imprecise or inherently problematic. But if one thinks that extension is the essence of body, and therefore that there cannot be any empty space, then wherever there is a place, there is a body (or bodies). Any travel from place to place will necessarily involve a change in the traveling body's relation to other bodies. And any body will necessarily be surrounded by other bodies—its "vicinity"—at every instant of its existence.

Many of Newton's objections to *Principia Philosophiae* in *De Gravitatione* reflect an overarching attitude toward Cartesian proper motion, viz. that it fails to reflect facts about motion expressed by Descartes's own laws of nature. Hence Newton engages in a systematic internal critique of Cartesian natural philosophy. Descartes's first two laws of nature in *Principia Philosophiae* are introduced as follows (Descartes 1964–1974, Part Two, §§ 37–9; AT VIII-1: 62–3):

> The first law of nature [*lex naturae*]: that each and every thing, in so far as it can [*quantum in se est*], always perseveres in the same state, and thus what is once in motion always continues to move . . . The second law of nature: that all motion is in itself rectilinear; and hence any body moving in a circle tends always to move away from the center of the circle it describes.[6]

Newton's analysis is extremely detailed, so a few aspects of it will have to suffice here. He claims, for instance, that Descartes is inconsistent regarding the ever-important issue of the earth's motion. On the one hand, Descartes's conception of "proper" motion implies that a body B moves if two conditions are met: first, B is transferred from one group of surrounding bodies to another group; and second, B's original group of surrounding bodies is regarded as

[4] That is: "nihil aliud est quàm *actio*, *quâ corpus aliquod ex uno loco in alium migrat*." The italics are in the original Latin and in the original French.

[5] For an illuminating discussion, see Garber (1992, 159–62). It may also conflict with section 26 of Part Two, which indicates that despite appearances to the contrary, the motion of a body does not require more action than rest.

[6] Descartes's understanding of the laws of nature is complex. For instance, although he takes God to be the "primary" cause of motion (section 36), he considers the laws to be secondary causes of it. For an illuminating treatment of this possibly confusing notion, see Schmaltz (2008, 105–16).

not moving. Since the earth is carried around its solar orbit by a vortex that entirely surrounds it, Descartes concludes that the earth does not *truly* move. On the other hand, Descartes says that the earth has a tendency to recede from the sun (Newton cites the *Principles*, Part 3: §140). But by Descartes's laws, if the earth were at rest, it would remain at rest and would *not* tend to recede from the sun—it would only have such a tendency if it were following a curvilinear trajectory.

According to Newton (2004, 15–16), Descartes's view that each body has only one "proper" motion also conflicts with his definition of such motion. Imagine two observers in separate spacecrafts watching the earth and its vortex flow through the solar system (imagine, for the sake of argument, that the vortex is perceptible). One observer maintains an unchanging position external to the vortex surrounding the earth, and regards the vortex as being at rest. From her point of view, if the earth remains surrounded by the vortex, it *does not move*, properly speaking; but if the earth is transferred away from this vortex, it *does move*, since she regards the vortex as being at rest. If a second observer is placed such that he regards the vortex surrounding the earth at time_1 as moving, then given the definition above, *he cannot regard the earth as moving, even if it is transferred to the vicinity of other bodies at* time_2. The reason is that the earth cannot move beginning at time_1 if at time_1 the vortex surrounding it is *not* regarded as at rest. So these observers will disagree if they each take the earth to be transferred away from the vicinity of the vortex that surrounds it at time_1.

Newton also objects to the fact that Descartes renders a body's proper motion relative to its position with respect to other bodies. Newton makes his case as follows: suppose that the vortex surrounding the earth were moving according to Descartes's view of proper motion—i.e., the vortex is transferred from the bodies surrounding it, which we regard as being at rest. This means the earth must be at rest. If God were to render the vortex surrounding the earth motionless, without interacting with the earth in any way, then a formerly stationary earth would begin moving (as long as we regarded the vortex as being at rest). God could therefore move the earth without applying a force to it, or interacting with it in any way. Once again, we find a tension with Descartes's laws, since the first law indicates that a body at rest will remain at rest unless acted upon—to explain the first law, Descartes writes: "If it is at rest, we hold that it will never begin to move unless it is pushed into motion by some cause" (Part 2: §37). From Newton's point of view, it is a mistake to sever the tie between true motion and external action, *a tie implied by Descartes's own laws*. The other side of the coin can be put in this way: Descartes's definition of proper motion does not connect a body's true motion with any external cause acting on that body, hence we might say that the definition is not dynamically tractable, even when viewed from the perspective of Descartes's own first two laws.

These criticisms shed light on Newton's view of space in the *Principia*. A Scholium follows the definitions at the text's beginning, before Book I begins. Newton notes that he will not *define* space, time and motion, as he did such quantities as centripetal force, mass, and the quantity of motion:

> Thus far it has seemed best to explain the senses in which less familiar words are to be taken in this treatise. Time, space, place, and motion are familiar to everyone. But it must be noted that these quantities are commonly conceived not otherwise than in relation to the perceivable. And this is the origin of certain prejudices; to eliminate them it is useful to distinguish these quantities into absolute and relative, true and apparent, mathematical and common. (Newton 1972, vol. 1: 46; Newton 1999, 408)

Although Newton thinks the common conception of space, time and motion leads to problematic "prejudices," the fact that he does not define space, time and motion here is crucial, for he begins with the common understanding of these quantities, and then introduces the idea that the common point of view actually presents us with measures of the quantities that are presented directly within the mathematical point of view. For instance, from the common point of view, we take some (relative) space delimited by object relations to be space itself: we might (say) take the space of our air to be space itself, which could be reasonable for some practical purposes. This is a *measure* of space itself, as if one were measuring a college campus by walking through one of its quads, just as a clock's ticking away the hours will give us a measure of the quantity, time. The true or mathematical point of view, however, considers these quantities themselves, and not merely some measures of them. This obviously raises numerous questions, some of which will become particularly salient below.

After distinguishing absolute and relative space, Newton distinguishes between absolute (or true) and merely relative motion: "Absolute motion is the translation of a body from absolute place to absolute place; relative motion is the translation from relative place to relative place" (Newton 1972, vol. 1.: 47; Newton 1999, 409). But why do we require absolute motion? Why isn't it sufficient to think of each body's motion as involving changes in its relations to other bodies, or perhaps to relative places that are defined in terms of such relations?

Newton provides us with at least three salient reasons to jettison the view that we can understand a body's true motion in terms of changes in its relations to other bodies (Descartes gives one construal of this overarching view). First, he notes an empirical fact, namely that there may be no body that is truly at rest anywhere in the universe to which we could refer the relative motions of all other bodies (Newton 1972, vol. 1: 48–9; Newton 1999, 411). Second, he notes that although there may in fact *be* a body that is truly at rest, it is perfectly possible that we will be unable to determine *which* body is at rest, and that some other body within the reach of our senses—say within our solar system, if we count astronomical observation—maintains a fixed position with respect to the truly resting body.

With his third point, Newton echoes the idea in *De Gravitatione* that if we take true motion to involve a change in object relations, we will sever the tie between motion and its causes. He writes in the Scholium:

> The causes which distinguish true from relative motions are the forces impressed on bodies to generate motion. True motion is neither generated nor altered except by forces impressed on the moving body itself, but relative motion can be generated and altered without forces impressed on this body. (Newton 1972, vol. 1: 50; Newton 1999, 412)

The idea is that a body's relations to other bodies do not bear the right relationship to impressed forces, for as Newton indicates in *De Gravitatione*, we can alter the relations of a body *without impressing any force on it*; and even if we impress a force on a given body, if we impress forces on the bodies that bear a relation to it, their relations might remain unchanged. Therefore, in order to understand the relation between true motion and impressed force, we should not understand true motion in terms of a body's relations with other bodies. This helps to place Newton's move to absolute space in the right light: in order to understand the relationship between true motion and impressed force, we construe true motion in terms of a body's relation to places within absolute space, rather than in terms of its relation to other bodies.

Descartes's rhetoric suggests that natural philosophy, or anyway physics, must rest on a metaphysical foundation—its trunk must be held up by metaphysical roots.[7] But Newton does not react to this viewpoint as some twentieth century commentators have said; in particular, he does not focus primarily on the claim that it is dangerous or unwise to rest physics on a metaphysical foundation. He has a much more decisive rejection in mind: Descartes's problem is that his metaphysical views push him to adopt ideas about space, time and motion that are in fact inconsistent with what his own laws tell us about space, time and motion. Thus Newton's analysis indicates a kind of bifurcation of Cartesian views on physics into two distinct sectors, one of which is indeed founded on metaphysical notions and the other of which is relatively autonomous. On the one hand, in Part Two of the *Principles*, Descartes articulates basic concepts of space, time and motion that reflect, or are demanded by, his metaphysical commitments, especially his plenist view and his identification of body and extension. On the other hand, in the same section of the text, Descartes articulates three laws that are relatively autonomous from these concerns, for what they indicate about space, time and motion is inconsistent with the explicit discussion of these concepts in the part of physics that rests on a metaphysical foundation.

Newton's criticism of Descartes may seem trivial, or merely clever. (Those who regard *De Gravitatione* as a juvenile work often consider it the latter.) But it is not. It points to a *prima facie* difficulty inherent within Descartes's project of resting physics, or natural philosophy, on a metaphysical foundation. To see this problem, consider, first of all, the structure of Part Two of the *Principles*. After ten sections that consider various issues, including the nature of body and of rarefaction, section 10 begins a broad discussion of space—one that includes discussions of various issues, such as the vacuum—that continues until section 23, when the issue of motion is introduced; the discussion of motion continues until section 33. After section 36, which presents the idea that God is the "primary cause" of motion, preserving the quantity of motion in the universe, the three laws of nature are introduced and discussed in the next eight sections. Of course, Descartes thinks that the three laws of nature articulated in Part Two of the *Principles* rest on the metaphysical views that undergird the notions of space, time and motion found within that same text. Descartes argues, in particular, that the three laws are derived from God's immutability and from the identification of space and body. A full analysis of this situation is beyond the scope of this paper, but here is a suggestion. It is possible that whereas Descartes's view of true or proper motion rests specifically on his identification of space and body, his *first two* laws rest specifically on the notion of God's immutability (here I bracket the third law). If these two aspects of Cartesian metaphysics entail mutually incompatible ideas of motion, they may be in some tension with one another. Or more precisely, the specific way in which Descartes understands the implications of God's immutability seems to conflict with the specific way in which he understands the implications of his identification of body and space. Since each of these views constitutes a key piece of Cartesian metaphysics, it is not obvious how Descartes ought to resolve this tension. This is not to say that there is in fact such a tension, or that it is irresolvable; rather, the point is merely that these are the concerns that Newton's analysis raises for the Cartesians.

My (very) brief discussion of Descartes's idea of motion in the ordinary and the true senses suggests a slightly different perspective on these issues. As we saw above, one reason for Descartes to jettison the (ordinary) idea that motion is the *action* by which a body travels

[7] In the preface to the French edition of the text (1647), he writes (AT IX-2: 14): "Ainsi toute la Philosophie est comme un arbre, dont les racines sont la Metaphysique, le tronc est la Physique, & les branches qui fortent de ce tronc sont toutes les autres sciences, qui se reduisent à trois principales, à scauoir la Medecine, la Mechanique & la Morale, j'entens la plus haute & la plus parfait Morale, qui, presupposant une entire connoissance des autres sciences, est le dernier degree de la Sagesse."

from place to place is that this idea may conflict with the first two laws of nature. These laws tell us that a body will remain in its state of motion—whether it is at rest or moving rectilinearly—unless acted upon by something external. Hence the laws seem to imply that a body moving rectilinearly need not be thought of as acted upon by anything at all. This may conflict with the ordinary idea that motion *just is an action*. So in this specific sense, Descartes's definition of true motion captures an important aspect of the view of motion expressed in the first two laws of nature. From Newton's point of view, however, it did not capture enough.

Yet this cannot be the end of the story. Newton's contention that Descartes fails to present conceptions of space, time and motion that reflect the laws of nature presented in *Principia Philosophiae* has an echo in Newton's *own* work. Broadly stated, there is a significant tension between Newton's own conception of true space and motion, on the one hand, and his three laws of motion, along with their corollaries, on the other. The notion of absolute space implies that each body has a velocity relative to space at any given instant. But the laws of motion indicate that the forces acting on a body are independent of its velocity—hence two bodies bumping into each other exert forces on one another that are proportional to their accelerations (and masses), but this is independent of whether these bodies are at absolute rest or are moving inertially with any velocity whatever. As Newton himself notes, the laws of motion imply corollary five, which indicates that no experiment could determine whether any closed system of bodies is at absolute rest or moving inertially—for all the forces and accelerations are independent of velocity in absolute space (Newton 1972, vol 1.: 63–4; Newton 1999, 423). But this indicates that the notion of absolute space gives rise to a quantity—the true velocity of each object—that can never be measured. Hence it indicates that Newton defines true motion *not in terms of his own laws*, but rather in terms of changes in absolute place (DiSalle 2006). What this indicates is that it is far from trivial, in the mid to late seventeenth century, to develop concepts of space, time and motion that reflect the laws of nature as either Descartes or Newton understood them.

Nonetheless, there is a strong reason to resist the tempting conclusion that Newton could have in fact jettisoned the notion of absolute or mathematical space from his work in natural philosophy, as some of his eighteenth century followers, such as Kant, seem to have done (Friedman 1990). Of course, in order to jettison this notion, he would have needed a suitable alternative that was conceptually possible within his historical context, and it seems reasonably clear that the notion of a frame of reference, and the allied notion of an inertial frame, were simply unavailable to Newton (DiSalle 2006). But just as importantly, the very concept of mathematical space found in the Scholium to the *Principia* plays another crucial role within Newton's natural philosophy, as I argue below.

3

Just as Newton develops his conception of mathematical space in order to replace what he regards as the faulty views articulated by Descartes in natural philosophy, his other motivation for introducing that conception to his readers can be understood as part of an overarching rejection of Cartesian metaphysics. Newton's discussion in *De Gravitatione* is not limited to highlighting the failures of Cartesian physics; it also tackles Descartes's conception of God, infinity, the distinction between mind and body, and other topics. Newton notes that in the *Principles*, as in the *Meditations*, Descartes "seems to have demonstrated that body does not differ at all from extension." He adds:

> I shall reply to this argument by saying what extension and body are, and how they differ from each other. For since the distinction of substances into thinking and extended, or rather into thoughts and extensions, is the principal foundation of Cartesian philosophy, which he contends to be known more exactly than mathematical demonstrations: I consider it most important to overthrow [that philosophy] as regards extension, in order to lay truer foundations of the mechanical sciences. (1962, 98–99; 2004, 21)

At the beginning of the very next paragraph, Newton analyzes what we might think of as a Cartesian presupposition, viz. the view that any item within our ontology must be considered either a substance in its own right, or else a *property* (or *mode* of some property) of some substance. Newton fundamentally rejects this view, contending that space is ontologically unique: it is neither a substance, nor a property of any substance, but something with "its own manner of existing."

Newton's rejection of Cartesian metaphysics is in fact even more thoroughgoing than this suggests. After discussing Descartes's conception of space in more depth, especially his thoughts about the possible infinity of space, Newton articulates a startling and controversial position:

> Space is an affection of a being just as a being. No being exists or can exist which is not related to space in some way. God is everywhere, created minds are somewhere, and body is in the space that it occupies; and whatever is neither everywhere nor anywhere does not exist. (1962, 103; 2004, 25)

This is as deep a rejection of Cartesian dualism as one is likely to find. Newton does not settle for the usual complaint that we cannot understand how the *mind*, a non-extended entity, can possibly interact with the *body*, an extended one. He presents that complaint, but then argues that there is a much more fundamental difficulty confronting the Cartesians: their *res cogitans* is literally nowhere—it is not extended—and *therefore does not exist*. Newton explicitly regards all entities as spatial, including human minds and even God. He does not reject Descartes's dualism by embracing monism in Spinoza's sense, for there are many substances, including God, ordinary objects, and human minds.[8] But there is only one *type* of substance, namely extended substance. Everything inhabits space and time.

Now we are close to the heart of Newton's metaphysics. We might read this passage in *De Gravitatione* as providing an analysis of *what it means to exist*. And the analysis is surprisingly far reaching. Newton apparently thinks *that for something to exist just is for that thing to occupy some space at some time*. That may sound unproblematic: after all, it may be reasonable to think that for this chair in front of me, or this building I am standing in, *to exist* just is for these things to be present in physical space at some time. What is remarkable about Newton's view is that he extends this analysis to two other, metaphysically crucial, entities: the mind and God. *Contra* Descartes, the mind is fundamentally akin to the body: it, too, exists just in case it occupies some place at some time. Newton is absolutely clear about this—he indicates that he has provided an analysis of existence when he says that if we deny his idea that the mind occupies space, then that is equivalent to denying that it exists. Perhaps even more shockingly, Newton applies this analysis even to the divine being.

So from Newton's perspective, Descartes's metaphysics has three crucial failures: first, it contends that there are two types of substance, *res cogitans* and *res extensa*, where only the latter occupies space; second, since *res cogitans* is not extended, its existence consists in something other than the occupation of a place at a time; and third, God's existence is

[8] Many thanks to Dan Garber for discussion of this point.

fundamentally distinct from that of *res cogitans* and *res extensa*. The identification of these failures leads Newton to embrace a very different picture: first, all entities are of the same type, for even the human mind and God are *extended*; second, all entities, including minds, exist just in case they occupy a place at a time; and third, as a result, God's existence is fundamentally akin to that of any other entity. These ideas entail the clearly anti-Cartesian view that two substances can be in the same place at the same time, since, e.g., God is present everywhere, even where (and when) other substances, such as ordinary material objects, are present.[9] Thus in the course of rejecting Descartes's conception of body and of space, his substance dualism, and his understanding of God's existence, Newton articulates a powerful, independent, philosophical picture of the world, one centered on God's relationship with the creation.

We find an echo of this picture in the second edition of the *Principia* in 1713, in a new section of the text called the *General Scholium*.[10] In this fascinating section (see Cohen 1969), Newton introduces his discussion of God by reiterating the understanding of the divine creation of the solar system mentioned in the first edition: "This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being" (Newton 1972, vol. 2: 759–60; Newton 1999, 940). This is then followed by a much broader, and substantially deeper, discussion (Newton 1972, vol. 2: 761–2; Newton 1999, 941–2, for both passages):

> He is eternal and infinite, omnipotent and omniscient, that is, he endures from eternity to eternity, and he is present from infinity to infinity; he is not eternity and infinity, but eternal and infinite; he is not duration and space, but he endures and is present. He endures always and is present everywhere, and by existing always and everywhere he constitutes duration and space. Since each and every particle of space is *always*, and each and every indivisible moment of duration is *everywhere*, certainly the maker and lord of all things will not be *never* or *nowhere*.

He continues:

> God is one and the same God always and everywhere. He is omnipresent not only *virtually* but also *substantially*; for action requires substance. . . It is agreed that the supreme God necessarily exists, and by the same necessity he is *always* and *everywhere*.

Here we find an echo of Newton's views in *De Gravitatione*. Newton applies his analysis of existence to the divine being, arguing that God must be understood as occupying space and time, just as any existing entity does. And indeed, the necessity of God's existence is construed in parallel terms: to exist contingently is to occupy some space at some time; to exist necessarily is to occupy all of space at all times. To deny that God occupies space just is to deny that God exists.

Newton's metaphysics leaves us with a question about the *Principia*: is there any conceptual connection between the notion of mathematical space in the Scholium and the view of God's spatiality in the General Scholium? Does the notion of mathematical space, which enables Newton to make sense of true motion in an anti-Cartesian fashion, also enable him

[9] One finds the same conception in More (1659), Bk I, Chap. 2, sections 10–11; Newton kept a copy of this work in his personal library (Harrison 1978).

[10] The text of the "Scholium Generale" is extremely dense and complex. It contains numerous allusions to theological and metaphysical issues that may not be evident at first glance. For an illuminating discussion of Newton's approach to religious and theological questions, including his heretical anti-Trinitarian views as they emerge in the General Scholium, see Snobelen (2001). For an erudite discussion of the philosophical—including the neo-Platonist—background of the text, see de Smet and Verelst (2001).

to articulate what he regards as the proper conception of God's presence in the world? Put another way, Newton may in fact employ the notion of mathematical space in his musings on the divine within texts like the General Scholium—but does he *require* that notion in any sense? Or would the ordinary or relative conception of space suffice? I tackle these interrelated questions in the next section.

4

If we look back at the very beginning of the *Principia*, at the Scholium on space and time, we find an important clue. In a passage found in all three editions of the text, Newton clarifies an aspect of his distinction between relative and true space (Newton 1972, vol. 1: 52; Newton 1999, 413–14):

> Relative quantities, therefore, are not the actual quantities whose names they bear, but are those sensible measures of them (true or erroneous) commonly used in place of the quantities measured. Yet if the meanings of words are to be defined by usage, then by the names 'time', 'space', 'place', and 'motion', these sensible measures should properly be understood; the manner of expression will be out of the ordinary and purely mathematical if the quantities being measured are understood here. Accordingly those who interpret these words as referring to the quantities being measured do violence to the Scriptures. And they no less corrupt mathematics and philosophy who confound true quantities with their relations and common measures.

Recall two aspects of Newton's discussion in the Scholium: (1) space, time and motion are "quantities;" and, (2) relative spaces, times and motions are "measures" of these quantities. When you look at your watch, wondering what time it is, you *measure* the quantity, *time*. These two ideas raise many significant questions; but what I want to focus on here is in fact another, possibly more confusing, aspect of Newton's view, namely his suggestion that one does violence to Scripture if one conflates the *measures* of space, time and motion with those *quantities themselves*. Determining why Newton makes this claim is crucial (see Cohen 1969).

The first thing to be said about the passage above is rather obvious. For Newton, Scripture is written in the language of the "common person"—thus, in interpreting any of its descriptions of space or motion, we ought to understand these as claims concerning *relative spaces*.[11] To understand these descriptions as holding of space and time themselves, according to Newton, does "violence" to the scriptures, because it undermines their *veracity*. Why should it undermine their veracity? Presumably for this reason: if Scripture proclaims (say) that the sun once miraculously stopped moving at some point in history, we should not understand this as a change in what Newton calls its "true" motion, which would have to be accompanied by various *dynamical effects*, but rather as a change in its *relative* motion, which need not be accompanied by such effects. Similarly, we should take the scriptural description as indicating how things appeared to ordinary observers, and not how they actually were.

But does this reading render Newton's view trivial? After all, the contention that Holy Scripture is written in a "*vulgare*" language, the language of the *commoner*, is a familiar aspect of the strategy of accommodation that many natural philosophers adopt in the

[11] Of course, the idea that Scripture is written in the language of the common person is not unique to Newton, to the seventeenth century, or even to Protestant theology more generally. It has a long and complex history that I cannot delve into here—for discussion, see Grant (2007, 269).

seventeenth century. Consider, for instance, the most famous attempt at accommodating religion and natural philosophy, Galileo's 1615 letter to the Grand Duchess Christina, written just one year before the Church officially censured Copernican astronomical doctrine. One of Galileo's overarching points, of course, is that genuine truths cannot conflict; thus if the Copernican conception of the earth-sun relationship is correct, it cannot conflict with the account of such matters found in Holy Writ. We can resolve any tension between the two by adopting a second fundamental attitude: namely, the idea that Holy Scripture—unlike mathematical astronomy—is written in the common language. Thus we can always search for a deeper, "*hidden*," meaning of any biblical passage if we seek to resolve its tension with any conclusion reached by natural philosophy.

It seems to me, however, that Newton is in fact making a distinct point here, one that is more philosophically robust and challenging. He is not merely parroting the well-known contention that the Bible is written in a "vulgare" language; he is in fact connecting his crucial distinction between absolute and relative space to that old idea in a novel way. This is not directly evident from the passage in the *Principia* that I quoted above. But we can uncover Newton's overall strategy of accommodation if we look elsewhere for his remarks on the relation between the interpretation of religious texts and the understanding of the physical world articulated in natural philosophy.

Toward the end of 1680, one of Newton's acquaintances from Cambridge, one Thomas Burnet, intended to publish a book in London with the title, *Telluris theoria sacra*, the *Sacred Theory of the Earth*. Before publishing the work, he sought the advice of the Lucasian Professor of Mathematics at Cambridge. Some of the correspondence is apparently lost, but we do know that in 1680, on Christmas Eve in fact, Newton wrote to Burnet with some criticisms of his attempt to accommodate the Biblical description of the creation of the Earth with the current teachings of what Burnet, in original English, simply calls "philosophy." On January 13th of 1681—the new year, by the new calendar—Burnet wrote a lengthy reply from his London home. One of his essential claims is that the Mosaic description of the creation—according to which, of course, the world was created within six days—cannot be squared with the teachings of philosophy, and that we must therefore regard Moses as providing us not with a description of what Burnet calls "physical reality," but rather with a *metaphorical* or *ideal* description. The business of philosophy, of course, *is* to provide a description of physical reality, according to Burnet.

One might expect Newton to endorse this point of view. After all, it enables Burnet to dissolve the deep tension between the Biblical view of the world and the philosophical one, and Burnet, who later became a doctor of divinity, certainly shows the kind of respect for the Hebrew Bible that someone like Newton would find *de rigeur*. Later that month, however, Newton strongly rejected Burnet's method of accommodation. He writes:

> As to Moses I do not think his description of the creation either philosophical or feigned, but that he described realities in a language artificially adapted to the sense of the vulgar. Thus where he speaks of two great lights I suppose he means their apparent, not real greatness. So when he tells us God placed those lights in the firmament, he speaks I suppose of their apparent not of their real place, his business being not to correct the vulgar notions in matters philosophical but to adapt a description of the creation as handsomely as he could to the sense and capacity of the vulgar [Newton to Burnet, January 1681, Newton 1959–1977, Vol. 2: 331].

Later in the same lengthy letter, Newton elaborates:

> Consider therefore whether any one who understood the process of the creation and designed to accommodate to the vulgar not an Ideal or poetical but a true description of it as succinctly and theologically as Moses has done, without omitting any thing material which the vulgar have a notion of or describing any being further than the vulgar have a notion of it, could mend that description which Moses has given us. If it be said that the expression of making and setting two great lights in the firmament is more poetical than natural: so also are some other expressions of Moses, as where he tells us the windows or floodgates of heaven were opened Gen 7 and afterwards stopped again Gen 8 and yet the things signified by such figurative expressions are not Ideal or moral but true. For Moses accommodating his words to the gross conceptions of the vulgar, describes things much after the manner as one of the vulgar would have been inclined to do had he lived and seen the whole series of what Moses describes (*ibid*, 333).

Newton thus forcefully argues, much to our surprise, that we *cannot* resolve the tension between the teachings of the *Bible* and those of *philosophy* by simply declaring the former to be written in a common language that employs various poetical or metaphorical descriptions. Instead, he makes the perhaps astonishing claim that Moses gives us a description of the creation that is not metaphorical or poetical, but *true*. What can he have in mind?

It is crucial to recognize that the Scholium's distinction between the *mathematical/absolute* perspective and the *common/relative* perspective should not be collapsed into the distinction between the *true* and the *false*. A Mosaic description of the world is *not* a *false* description. On the contrary, Newton's point is that if we understand Moses to be referring to *apparent* space, time and motion—which he more famously labels *relative* space, time and motion—then the truth of his descriptions can be rescued. Indeed, the Hebrew Bible and other sacred texts can in fact be *literally true* if interpreted in this way. Thus sacred texts are neither *false* nor only *metaphorically* true—as Newton tells Burnet, they are neither "philosophical" nor "feigned"—but are in fact literally true, if understood in the right way.[12]

But how could that be? To see what Newton has in mind, consider a simple statement, say, "The sun set last night in Brussels at 7 PM." The contention Newton makes is that this statement can be literally true, provided that it is interpreted *as a statement about apparent—or relative—space, time and motion*. When I say that the sun set last night, of course, I am not making any claim about what Newton would call the true (or mathematical, or absolute) motion of the sun; I know very well that the sun does not revolve around a stationary earth. Instead, I am making a claim about the *apparent* motion of the sun—and indeed, the sun *does apparently* move around a stationary earth. Notice, moreover, that we can apply the true/false distinction to statements about apparent or relative motions themselves: thus it may in fact be true—and in fact, *literally true*—that the sun set last night in Brussels at 7 PM, if we understand the fact that this statement concerns the apparent motion of the sun around the earth. Thus the Newtonian distinction between true and apparent motion is itself *distinct* from the ordinary distinction between the true and the false: there are true statements

[12] This is not to say that for Newton, all Scriptural discourse is literal or to be interpreted literally. To take one example, Newton clearly thinks that Scriptural descriptions of the divine should be understood as allegorical. In the General Scholium, for instance, we read (*Principia mathematica*, vol. 2: ; Cohen/Whitman, 942–3): "But God is said allegorically to see, hear, speak, laugh, love, hate, desire, give, receive, rejoice, be angry, fight, build, form, construct. For all discourse about God is derived through a certain similitude with things human, which while not perfect is nevertheless a similitude of some kind." Of course, in this case, the attempt to communicate facts about God with ordinary readers of Scripture requires the use of allegory and metaphor in a way that discussions of space, time and motion do not. For an intriguing connection between this Newtonian view and the views of Philo, see de Smet and Verelst (2001, 9).

about apparent motions and false ones as well. That is presumably why Newton writes (1972, vol. 1: 52; 1999, 413–14): "Relative quantities, therefore, are not the actual quantities whose names they bear, but are those sensible measures of them (true or erroneous) commonly used in place of the quantities measured." The parenthetical remark is crucial. For instance, we could falsely claim that the sun set last night in Brussels at 2 PM, or that it did not set, etc. More generally, literal claims concerning the apparent motions of bodies can be either true or false.

5

What, then, are the implications of my argument? There are two. The first implication is comparatively straightforward: from Newton's point of view, natural philosophy attempts to uncover the true motions of the objects that constitute our world; Scripture describes *those same* objects—the moon, the sun, the earth, the stars—but characterizes how they *appear to us*. Since it certainly *appears* as if the earth is a stationary body circled each day by the sun, Scripture sticks with precisely this appearance and does not deviate from it. It is the natural philosopher who discovers the true motions of the earth and the sun. As Newton indicates, the philosopher must discover the true motions of bodies, not merely their apparent motions, because that will lead to the discovery of the forces that cause those motions, and the discovery of forces, in turn, is one of the fundamental goals of Newtonian natural philosophy.[13]

The *second* implication is perhaps more surprising, and here I can tie together the strands of this paper. It is not merely the case that Newton thinks of the natural philosopher as legitimately investigating the nature of the divine being when analyzing the *phenomena*. If Newton were to limit himself to the kind of design argument we find in many authors in this period—the kind of argument he himself makes in the first edition of the *Principia*, in his correspondence with Bentley six years later, and in the General Scholium in 1713 (retained in 1726)—he would be implying that the natural philosopher can add *further arguments* for the existence of God. This would not alter the *knowledge* of the divine available to theologians. Instead, Newton transcends that familiar point of view in a fundamental way. He implies that even the most sophisticated interpretation of all of Holy Scripture will leave us without a complete understanding of the creator. For as we have seen, Holy Writ is always limited in its description of the creation to discussions of *apparent* motions, *common* measures of time, *relative* ideas of space. For Newton, there is a crucial aspect of the divine that we cannot understand if we limit ourselves to these resources of theology and of the interpretation of religious texts. As we have seen, God does not inhabit any merely apparent or relative or common space: God is an infinite being who inhabits an infinite and eternal mathematical space. One cannot learn that fact from reading the Bible. The philosopher knows the nature of God.

[13] In the preface to the first edition (1687) of the *Principia*, Newton writes (1972, vol. 1: 1999, 382): "For the whole difficulty of philosophy seems to be to discover the forces of nature from the phenomena of motions and then to demonstrate the other phenomena from these forces."

References

Blair, A. (2006). Natural philosophy. In L. Daston & K. Park (Eds.), *Cambridge history of science, Vol. 3: Early modern science*. Cambridge: Cambridge University Press.

Cohen, I. B., et al. (1969). Isaac Newton's *Principia*, the scriptures, and the divine providence. In S. Morgenbesser (Ed.), *Philosophy, science and method: Essays in honor of Ernest Nagel*. New York: St. Martin's Press.

Cohen, I. B., et al. (1990). Newton and descartes. In G. Belgioioso (Ed.), *Descartes, Il metodo e i saggi*. Rome: Istituto della Enciclopedia Italiana.

de Smet, R., & Verelst, K. (2001). Newton's scholium generale: The platonic and stoic legacy. *History of Science, 39*, 1–30.

Descartes, R. (1953). *Correspondance avec Arnauld et Morus*, texte Latin et traduction (G. Lewis, Ed., Trans.), Paris: Vrin.

Descartes, R. (1964–1974). *Oeuvres de Descartes*. (C. Adam & P. Tannery Eds., Trans). New edition. Paris: Vrin.

DiSalle, R. (2006). *Understanding space-time*. Cambridge: Cambridge University Press.

Friedman, M. (1990). Kant and Newton: Why gravity is essential to matter. In P. Bricker & R.I.G. Hughes (Eds.), *Philosophical perspectives on Newtonian science*. Cambridge, MA: MIT Press.

Gabbey, A. (1980). Force and inertia in the seventeenth century: Descartes and Newton. In S. Gaukroger (Ed.), *Descartes: philosophy, mathematics and physics*. Sussex: Harvester Press.

Garber, D. (1992). *Descartes' metaphysical physics*. Chicago: University of Chicago Press.

Grant, E. (2007). *A history of natural philosophy*. Cambridge: Cambridge University Press.

Harrison, J. (1978). *The library of Isaac Newton*. Cambridge: Cambridge University Press.

Heilbron, J. (1982). *Elements of early modern physics*. Berkeley: University of California Press.

Janiak, A. (2008). *Newton as philosopher*. Cambridge: Cambridge University Press.

Janiak, A. (2010). Substance and action in Descartes and Newton. *The Monist, 93*, 655–675.

Janiak, A. (Forthcoming) Natural philosophy. In D. Kaufman (Ed.), *Routledge companion to seventeenth century philosophy*. London: Routledge.

Koyré, A. (1968). *Newtonian studies*. Chicago: University of Chicago Press.

Mandelbrote, S. (2007). The uses of natural theology in seventeenth century England. *Science in Context, 20*, 451–480.

More, H. (1655). *An antidote against atheism*. London: J. Flesher.

More, H. (1659). *Immortality of the Soul, so farre forth as it is demonstrable from the knowledge of nature and the light of reason*. London: J. Flesher.

More, H. (1662). *A collection of several philosophical writings*. London: J. Flesher.

Newton, I. (unknown date) De Gravitatione et Aequipondio Fluidorum. University Library, Cambridge, MSS Add. 4003.

Newton, I. (1959–1977). *The correspondence of Isaac Newton*. H. W. Turnbull et al., (Eds.), Cambridge: Cambridge University Press.

Newton, I. (1962). *Unpublished scientific papers of Isaac Newton*. A. R. Hall & M. Boas Hall (Eds.), Cambridge: Cambridge University Press.

Newton, I. (1972). *Philosophiae naturalis principia mathematica*. A. Koyré I. Bernard Cohen, & A. Whitman (Eds.), The third edition with variant readings. Cambridge, MA: Harvard University Press.

Newton, I. (1999). *The principia: Mathematical principles of natural philosophy*. (I. Bernard Cohen, A. Whitman trans.). Berkeley: University of California Press.

Newton, I. (2004). *Philosophical writings*. A. Janiak (Ed.), Cambridge: Cambridge University Press.

Schmaltz, T. (2008). *Descartes on causation*. Oxford: Oxford University Press.

Shapiro, L. Ed., Trans. (2007). *The correspondence between Princess Elisabeth of Bohemia and René Descartes*. Chicago: University of Chicago Press.

Snobelen, S. (2001). God of gods, and lord of lords: The theology of Isaac Newton's general scholium to the *principia*. *Osiris* (2nd Series), *16*, 169–208.

Stein, H. (2002). Newton's metaphysics. In I. B. Cohen & G. Smith (Eds.), *The Cambridge companion to Newton*. Cambridge: Cambridge University Press.

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