

EDWARD B. DAVIS**Newton's Rejection of the 'Newtonian World View': The Role of Divine Will in Newton's Natural Philosophy¹**

The typical picture of Isaac Newton as the paragon of Enlightenment deism, endorsing a remote divine clockmaker and the separation of science from religion, is badly mistaken. In fact Newton rejected both the clockwork metaphor and the cold mechanical universe upon which it is based. His conception of the world reflects rather a deep commitment to the constant activity of the divine will, unencumbered by the 'rational' restrictions that Descartes and Leibniz placed on God, the very sorts of restrictions that later appealed to the deists of the 18th century.

Key Words: Descartes Deism, Divine upholding, Enlightenment, 'laws' of nature, Leibnitz, Mechanistic view, Newton, Newtonian world-view.

'With Aristotle's laws of motion overthrown, no role remained for a Prime Mover, or for Moving Spirits. The hand of God, which once kept the heavenly bodies in their orbits, had been replaced by universal gravitation. Miracles had no place in a system whose workings were automatic and unvarying. Governed by precise mathematical and mechanical laws, Newton's universe seemed capable of running itself.'²

'That Things could not be at first produced by Mechanism, is expressly allowed: And, when this is once granted; why, after That, so great Concern should be shown, to exclude God's actual Government of the World, and to allow his Providence to act no further than barely in concurring (as the Phrase is) to let all Things do only what they would do of themselves by mere Mechanism; and why it should be thought that God is under any Obligation or Confinement either in Nature or Wisdom, never to bring about any thing in the Universe, but what is possible for a corporeal Machine to accomplish by mere mechanick Laws, after it is once set a going; I can in no way conceive.'³

1 This essay is based rather closely on a chapter from my doctoral dissertation, 'Creation, Contingency, and Early Modern Science: The Impact of Voluntaristic Theology on 17th Century Natural Philosophy,' completed at Indiana University in 1984 with the kind assistance of a Dissertation Year Fellowship from the Charlotte W. Newcombe Foundation. I am grateful for the comments of Richard S. Westfall on the original dissertation, and for those of my colleague William V. Trollinger on a draft of this paper. It was previously published in *Fides et Historia* 22 (1990) and is reprinted with permission and minor editorial changes.

2 Thomas H. Greer, *A Brief History of the Western World*, fourth edition (New York: Harcourt Brace Javonovich, 1982), p. 364.

3 From the fifth reply that Newton's disciple and go-between Samuel Clarke wrote to

In much traditional historiography, the relationship between science and Christianity has been described in terms of conflict, with Galileo's encounter with the Holy See serving as the paradigmatic example: reason versus authority, progressive science overcoming obscurantist theology. In recent years however historians in growing number have discarded the rhetoric of confrontation when describing the relationship between religion and science. Metaphors of interaction have begun to replace the language of the battlefield.⁴ This new direction in historiography is wholly appropriate for understanding Isaac Newton, who did not practice the radical separation of science from theology that has come to characterize the modern world, and in terms of which he himself is so often depicted. Indeed the typical textbook for a course in Western Civilization—supposing that there is such a thing⁵—presents Isaac Newton as the grand synthesizer of terrestrial and celestial motion whose reduction of the physical universe to a concise set of mathematical laws set the stage for Enlightenment philosophes to remove God wholly out of the present order of things. Although Newton is described in some texts as a deeply theological person, the method he used in his science and the successes it attained are seen as the epitome of the triumph of a new rationalism over an older, essentially medieval, theocentric world view. Sometimes it is even noted that Newton personally played no part in creating the 'Newtonian world view' of the Enlightenment secularists. Whether or not this point is made explicitly, students are all too often left implicitly with the impression that Newton was himself an Enlightenment man whose theological views were incidental to his science, or even held in contradiction to it. If in our own teaching we also ignore or gloss over the vast theological gulf between Newton and the philosophers who reinterpreted his physics, we encourage the very opinion the Enlightenment deists wanted us to share: that theology and modern science

Gottfried Leibniz in the winter of 1715–16, which Clarke published as *A Collection of Papers, Which passed between the late Learned Mr. Leibnitz, and Dr. Clarke, In the Years 1715 and 1716. Relating to the Principles of Natural Philosophy and Religion* (London, 1717), p. 365. Here, as in all citations from this book (which will subsequently be called 'LCC'), I have not retained the frequent use of italics found in the original. A modern reprint edition prepared by H.G. Alexander, *The Leibniz-Clarke Correspondence* (Manchester: University of Manchester Press, 1956), is also available.

4 For a more extensive discussion see my essay review, 'Blessed are the Peacemakers: Rewriting the History of Christianity and Science,' *Perspectives on Science and Christian Faith* 40 (1988), 47–52, and the references cited there.

5 I am sympathetic with readers who may argue that I am creating a straw man: that textbooks on Western history are far too diverse to be covered by my blanket statement. When it comes to the treatment of Newton, however, there is in fact very little diversity. If he is treated at all, it is almost always in such a way as to connect him, either implicitly or explicitly, with the rationalist world view that he rejected. For some 'typical' texts, see those by Greer, cited above; Donald Kagan, Steven Ozment, and Frank M. Turner, *The Western Heritage*, second edition (New York: Macmillan, 1983); and Edward McNall Burns, Robert E. Lerner, and Standish Meacham, *Western Civilizations: Their History and Their Culture*, tenth edition (New York: Norton, 1984). The text by Marvin Perry, Myrna Chase, James R. Jacob, Margaret C. Jacob, and Theodore H. Von Laue, *Western Civilization: Ideas, Politics & Society*, third edition (Boston: Houghton Mifflin, 1989), is a rare exception to the generally poor treatment of Newton and his science found in other standard texts.

are fundamentally at odds. To correct this it is not enough merely to mention (as some texts do) that Newton was a religious man who saw his work as a fundamental contribution to the argument from design; or simply to state that he wrote much more about Biblical prophecy and church history than he did about either physics or mathematics. What is needed is a fresh interpretation of the central role of theology within Newton's own science, which lies at the foundation of modern science. Only then will we be able to fill in the nuances that will allow us to do justice to the complex man that was Newton, let alone the complex relationship of science and theology both in his day and subsequently.

It is of course impossible for me to give even a reasonably complete account of Newton's theology in the space allowed to me here. His private theological writings contain over a million words devoted primarily to prophecy, sacred history, and doctrine. Though far less extensive, his public utterances leave no doubt that natural theology also received its fair share of attention.⁶ Yet in spite of substantial recent study, the relationship between Newton's public scientific life and his private religious life remains, like almost all facets of this complex man, enigmatic.⁷ I do not propose completely to clarify that relationship. Rather it is my intention to focus on one aspect of Newton's theological thought, his emphasis on the dominion of a free and powerful God, in order to show how his concept of God underlay his rejection of the rationalistic approach to natural philos-

6 Modern scholarship of Newton's religion began with Louis Trenchard More, *Isaac Newton, A Biography* (New York: Scribner's 1934), the first work to accept at face value the Arianism which so permeates Newton's private papers. Herbert McLachlan, hardly a disinterested party as a Unitarian himself, poorly edited a collection of unpublished papers bearing on soteriology and polity in *Isaac Newton: Theological Manuscripts* (Liverpool: University of Liverpool Press, 1950). Richard S. Westfall, 'Newton's Theological Manuscripts,' in *Contemporary Newtonian Research*, ed. Zev Bechler (Boston: Reidel, 1982), pp. 129-43, surveys all the accessible collections and attempts an overview of their contents. Prophecy is the focus of Leonard Trengove, 'Newton's Theological Views,' *Annals of Science* 22 (1966), 277-94. Natural religion receives special attention in 'Isaac Newton's *Theologiae Gentilis Origines Philosophicae*,' Westfall's contribution to *The Secular Mind*, ed. W. Warren Wagar (New York: Holmes & Meier, 1982), pp. 15-34.

7 Westfall's basic thesis, that Newton was a precursor of the Enlightenment, is developed in the final chapter of *Science and Religion in Seventeenth-Century England* (New Haven: Yale University Press, 1958), in 'Isaac Newton: Religious Rationalist or Mystic?' *Review of Religion* 22 (1958), 155-70, and in his justly praised *Never at Rest, A Biography of Isaac Newton* (Cambridge: University Press, 1980), which will be cited hereafter by its short title alone. I am inclined to agree more with Frank E. Manuel, whose study of *The Religion of Isaac Newton* (Oxford: Clarendon Press, 1974) stresses those aspects which remind us that Newton was not a modern man. Neither Westfall nor Manuel sees a significant interaction between Newton's science and his religion, apart from his pursuit of natural theology. William H. Austin, 'Isaac Newton on Science and Religion,' *Journal of the History of Ideas* 31 (1970), 521-42, denies that Newton's theology derived from his science; E.W. Strong, 'Newton and God,' *Journal of the History of Ideas* 13 (1952), 147-67, denies the reverse. Varying degrees of synthesis are attempted with varying degrees of success by Klaus-Dietwardt Buchholtz, *Isaac Newton als Theologe; ein Beitrag zum Gespräch zwischen Naturwissenschaft und Theologie* (Witten: Luther-Verlag, 1965); and David Castillejo's unusual book, *The Expanding Force in Newton's Cosmos* (Madrid: Ediciones de Arte y Bibliofilia, 1981), which discovers unity in a numerical scheme that Newton almost certainly did not believe.

ophy advocated by Rene Descartes and Gottfried Leibniz—the very sort of natural philosophy that was, ironically, to become so popular with Enlightenment writers.⁸

The notion of dominion lay at the heart of Newton's theology. It is 'on account of his dominion,' we read in the famous General Scholium to the second (1713) edition of the *Principia*, that God 'is wont to be called "Lord God" PANTOKRATOR, or "Universal Ruler"...' "The Supreme God," Newton continued, 'is a Being eternal, infinite, absolutely perfect, but a being, however perfect, without dominion, cannot be said to be "Lord God"...'⁹ Indeed for Newton divine perfection was virtually equated with dominion, which he understood to be manifest in the constant activity of the divine will. The highest idea of a perfect entity, he wrote in a private manuscript,

is that it should be one substance, simple, indivisible, living and life-giving, always everywhere of necessity existing, in the highest degree understanding all things, freely willing good things; by his will effecting things possible; communicating as far as is possible his own similitude to the more noble effects; containing all things in himself as their principle and location; decreasing and ruling all things by means of his substantial presence (as the thinking part of a man perceives the appearances of things brought into the brain and thence rules its own body); and constantly co-operating with all things according to accurate laws, as being the foundation and cause of the whole of nature, except where it is good to act otherwise.¹⁰

Hence, as he wrote in another manuscript, 'the wisest of beings required of us to be celebrated not so much for his essence as for his actions, the creating, preserving, and governing of all things according to his good will and pleasure.'¹¹

Hand in hand with Newton's belief in the dominion of God was his suspicion of pure reason. His Arian Christ was the Christ of unadorned scripture, the Christ whom God had revealed to men, not the Christ of idolatrous reason. It was not enough to say that an article of faith could be

8 Many scholars have recognized the importance of the divine will in Newton's natural philosophy, but few have written at length on this. Exceptions include Alexandre Koyré, 'Newton and Descartes,' in his own *Newtonian Studies* (Cambridge: Harvard University Press, 1965), pp. 53–114; J.E. McGuire, 'Force, Active Principles, and Newton's Invisible Realm,' *Ambix* 15 (1968), 154–208, hereafter cited as 'FAN'; and Martin Tamny, 'Newton, Creation, and Perception,' *Isis* 70 (1979), 48–58.

9 *Mathematical Principles of Natural Philosophy*, trans. Andrew Motte and revised by Florian Cajori (Berkeley: University of California Press, 1934), p. 544. Reprinted by permission of the University of California Press. Hereafter this edition will be cited as 'Cajori'.

10 Royal Society, Gregory MS. 245, folio 14a, translated from the Latin by J.E. McGuire, 'FAN,' p. 190. McGuire has published an almost identical statement (from University Library Cambridge Add. MS. 3965.13) on p. 123 of 'Newton on Place, Time, and God: An Unpublished Source,' *British Journal for the History of Science* 11 (1978), 114–29.

11 Yahuda MS. 21, folio 1r, quoted by Manuel, *Religion*, pp. 21f.

deduced from scripture. 'It must be express in the very form of sound words in which it was delivered by the Apostles,' for men were apt to 'run into partings about deductions. All the old Heresies lay in deductions; the true faith was in the text.'¹² Although he thought that true religion was indeed reasonable, rationalism in religion is something Newton never sought, claiming that it was 'contrary to God's purposes that the truth of his religion should be as obvious and perspicuous to all men as a mathematical demonstration.'¹³

Given his emphasis on divine dominion as revealed in God's actions rather than his essence, it is hardly surprising that Newton much preferred the teleological argument to the ontological. 'The dominion or Deity of God,' he wrote in a draft of the General Scholium, 'is best demonstrated not from abstract ideas but from phenomena, by their final causes.'¹⁴ Unlike the rationalists, who sought to prove the existence of God from arguments about the necessity of his being or the force of innate ideas, Newton looked to the clear evidence of his willful actions in nature, evidence to which Newton believed he had contributed in no small measure. 'When I wrote my treatise about our Systeme,' he told Richard Bentley in 1692, 'I had an eye upon such Principles as might work with considering men for the believe of a Deity & nothing can rejoice me more then to find it usefull for that purpose.'¹⁵ The only possible cause of the frame of the world and the diversity of creatures was the will of a sovereign God. The six planets, Newton observed, all revolve about the sun in concentric circles in the same direction and almost in the same plane; the ten moons show a similar regularity. Though their orbits might continue 'by the mere laws of gravity, yet they could by no means have at first derived the regular position of the orbits themselves from those laws.' It was inconceivable that 'mere mechanical causes could give birth to so many regular motions. . . .' Such a beautiful system 'could only proceed from the counsel and dominion of an intelligent and powerful Being.'¹⁶ If regularity pointed to choice rather than chance, variety pointed to will rather than necessity. 'Blind metaphysical necessity,' argued Newton in the General Scholium, 'could produce no variety of things. All that diversity of natural things which we find suited to different times and places could arise from nothing but the will of a Being

12 Here Newton was commenting on 2 Timothy 1:13, 'Hold fast to the form of sound words, which thou hast heard of me . . .' Yahuda MS. 15.1, folio 11r, quoted by Manuel, *Religion*, pp. 54f.

13 Fragments from a treatise on Revelation, Yahuda MS. 1, folio 194, reprinted as an appendix to Manuel, *Religion*, p. 124.

14 *Unpublished Papers of Isaac Newton*, ed. and trans. by A. Rupert Hall and Marie Boas Hall (Cambridge: Cambridge University Press, 1962), p. 363. In future this work will be cited as 'Halls'.

15 Letter of 10 December 1692, in *The Correspondence of Isaac Newton*, ed. H.W. Trumbull et al., 7 Vols. (Cambridge: Cambridge University Press, 1959-77) III, 233. Reprinted with permission from the President and Council of the Royal Society. All future references to this set will be given as *Corres*.

16 Carjori, pp. 543f. For similar comments to Bentley, see *Corres* III, 235 and 254f. Cf. the drafts of the General Scholium in Halls, pp. 353, 360, and 362f.

necessarily existing.¹⁷ Thus Newton found it 'unphilosophical to seek for any other Origin of the World, or to pretend that it might arise out of a Chaos by the mere laws of Nature'¹⁸—as Descartes had done in several places, most notably in his posthumously published treatise *Le Monde*.¹⁹ Descartes had also banished final causes from natural philosophy, a position Newton likewise rejected with vigor. Indeed Newton wrote in Query 28 of the *Opticks* that

the main Business of natural Philosophy is to argue from Phaenomena without feigning Hypotheses, and to deduce Causes from Effects, till we come to the very first Cause, which certainly is not mechanical; and not only to unfold the Mechanism of the World, but chiefly to resolve . . . [ultimate] Questions.²⁰

Clearly, then, Newton's understanding of God's dominion shaped the metaphysical perspective in which he placed his science. More than this, however, it also affected the actual content of this science, leading him to reject what he viewed as the materialism of both his predecessor Rene Descartes and his contemporary Gottfried Leibniz. Neither one, as Newton saw it, allowed God to exercise dominion over the creation he had made. In the unpublished treatise *De gravitatione et equipondo fluidorum*, which was probably written about 1684–5,²¹ just as he was beginning to draft the *Principia*, Newton spelled out his objections to the Cartesian concept of matter, which he took for a path to atheism. Unable to separate the concept of matter from that of space in his mind, Descartes had concluded that matter and extension were necessarily indistinguishable. His universe was therefore devoid of void; all motion took place in closed loops, and all changes in motion were caused by direct contact, not by forces acting at a distance. Arguing against Descartes, Newton claimed that matter 'does not exist necessarily but by divine will.' Our notion of it was therefore uncertain, 'because it is hardly given to us to know the limits of the divine power, that is to say whether matter could be created in one way only, or whether there are several ways by which different beings similar to bodies could be produced.' Newton went on to propose a thought experiment in which he appealed to God's power to create pieces of empty space containing no matter, and then to move them around as if they were pieces

17 Cajori, p. 546. This passage was added in the third (1726) edition. Cotes expressed a similar view in his preface to the second edition (Cajori, pp. xxxi–xxxii). Cf. the selection from University Library Cambridge Add. MS. 3965.13, printed by McGuire in 'Newton on Place, Time, and God,' p. 123.

18 From Query 31 in the *Opticks*, fourth edition (New York: Dover), p. 402. Hereafter this will be cited as *Opticks*.

19 See, for example, chapter 6 of *Le Monde, ou Traite de la lumiere*, trans. Michael Sean Mahoney (New York: Abaris Books, 1979).

20 *Opticks*, p. 369.

21 The generally accepted date for its composition (ca. 1670) is probably wrong, according to a letter I have received from Betty Jo Dobbs. She has recently found strong evidence that places it in the mid 1680s. The Latin text of *De gravitatione* is printed with an English translation in Halls, pp. 89–156.

of matter. The analogy upon which he relied was the human ability to move the body at will, by thought alone. The same 'free power of moving bodies at will can by no means be denied to God, whose faculty of thought is infinitely greater and more swift.' By 'the sole action of thinking and willing,' God could 'prevent a body from penetrating any space defined by certain limits.' If by his power God should cause some part of space to be impenetrable, to reflect light, and to resonate when struck, it would be impossible to distinguish that space from true body. If God should in addition transfer those properties to other parts of space 'according to certain laws, yet so that the amount and shape of that impenetrable space are not changed,' then even the property of motion would be created. Finally, God could cause us to perceive such a piece of space, 'For it is certain that God can stimulate our perception by his own will, and thence apply such power to the effects of his will.'²² If the whole world were constituted of only such spaces, Newton concluded, 'it would seem hardly any different.' Thus 'we can define bodies as *determined quantities of extension which omnipresent God endows with certain conditions.*'²³ But if such a world would not differ from the one we know, why think of it in this way? 'I have deduced a description of this corporeal nature from our faculty of moving our bodies,' Newton added, 'so that God may appear . . . to have created the world solely by the act of will, just as we move our bodies by an act of will alone. . .' The point of this voluntarist conception of matter, as Newton was not reluctant to say, was that 'we cannot postulate bodies of this kind without at the same time supposing that God exists, and has created bodies in empty space out of nothing. . .' The Cartesian identification of matter and extension, on the other hand, was manifestly 'a path to Atheism, both because extension is not created but has existed eternally, and because we have an absolute idea of it without any relationship to God,' which would make it 'possible for us to conceive of extension while imagining the non-existence of God.'²⁴

God's relation to the frame of time and space was indeed an intimate one for Newton. Because God had 'a propensity to action,' it concerned his glory and majesty 'that he should never and nowhere be idle.'²⁵ The omnipresent, eternal God 'is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our

22 Halls, pp. 138f.

23 *Ibid.*, pp. 139f, emphasis his.

24 *Ibid.*, pp. 141-43. Cf. pp. 132 and 145. This argument is very similar to one used by Robert Boyle, who compared God's ability to move the bodies in his world to a man's ability to move his own shadow by an act of pure volition. See his essay 'Upon the sight of one's shadow cast upon the face of a river,' one of the *Occasional Reflections*, in *The Works of the Honorable Robert Boyle*, ed. Thomas Birch, second edition, 6 Vols. (London, 1772), II, pp. 401-406, where Boyle styles the world as 'God's shadow.'

25 University Library Cambridge Add. MS. 3965.13, folio 541v, quoted by McGuire, 'FAN,' p. 201.

own Bodies.²⁶ Influenced by Henry More's Christian Neoplatonism, his own extensive alchemical investigations, and his own commitment to a voluntarist notion of divine activity, Newton rejected the brute mechanisms of traditional mechanical philosophies, infusing the inert world of matter with the activity of the divine will—either directly through the hand of God or indirectly through active principles, which gave the world a structure and order that evinced providential choice rather than blind mechanical necessity. In the end, if Betty Jo Dobbs is correct, Newton assigned to Christ control over the short range forces of alchemical, electrical, and vital phenomena, leaving the cosmic force of gravitation to God himself.²⁷ A number of Newton's contemporaries certainly understood the latter to have been the case.²⁸ According to a memorandum written by David Gregory in May 1694, Newton also gave God the responsibility of preventing the stars from collapsing together under the very attraction which he caused.²⁹ This is probably what Newton had had in mind fifteen months before when he had agreed with Bentley that if 'all the matter were at first divided into several systems & every system by a divine power [were] constituted like ours: yet would the outward systemes descend towards the middlemost so that this frame of things could not always subsist without a divine power to conserve it.'³⁰ Thus in Query 31 Newton described Nature as

very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attractive and repelling Powers which intercede the Particles. The *Vis inertiae* is a passive Principle by which Bodies persist in their Motion or Rest, receive Motion in proportion to the Force

26 Query 31 (*Opticks*, p. 403). Cf. Query 28 (p. 370). On Newton's belief in space as the literal sensorium of God, a position which he later tried to hide, see Koyré and Cohen, 'The Case of the Missing Tanquam: Leibniz, Newton & Clarke,' *Isis* 52 (1961), 555–66, and *Never at Rest*, pp. 646–48.

27 'Newton's Alchemy and His Theory of Matter,' *Isis* 73 (1982). Her study of *The Foundations of Newton's Alchemy* (Cambridge: Cambridge University Press, 1975) has already become a classic. Other outstanding contributions to this aspect of Newtonian thought are McGuire's article 'FAN' and Ernan McMullin, *Newton and Matter and Activity* (Notre Dame: University of Notre Dame Press, 1978), a model of clarity.

28 This would include Locke, Wren, Gregory, and Whiston. See *Never at Rest*, pp. 510 and 647, and Westfall, *Force in Newton's Physics* (New York: American Elsevier, 1971), pp. 395–400. Leibniz, another who understood this, will be discussed below. Newton's support for an aether as the cause of gravitation at the end of his life, as seen in *Queries* 17–24, must not be mistaken for a return to traditional mechanical explanation. See *Never at Rest*, p. 794. For an account of Newton's changing views on the cause of gravitation and other forces, see McGuire, 'FAN.'

29 *Corres* III, 336.

30 Letter of 25 February 1693 (*ibid.*, 255). In Query 28 (*Opticks*, p. 369), published first in 1706, Newton implied that God was 'what hinders the fix'd stars from falling upon one another'. In the General Scholium, however, we find only the following phrase, added to the third (1726) edition: 'and lest the systems of the fixed stars should, by their gravity, fall on each other, he [God] hath placed those systems at immense distances from one another.' (*Carjori*, p. 544). Apparently the continuous action of God was no longer thought to be required for this.

impressing it, and resist as much as they are resisted. By this Principle alone there never could have been any Motion in the World. Some other Principle was necessary for putting Bodies into Motion; and now they are in Motion, some other Principle is necessary for conserving the Motion.³¹

On the following pages, Newton elaborated on the inadequacies of a purely mechanical world. Without active principles, he argued, the quantity of motion in the world would decrease. What he had in mind here—that collisions are rarely elastic and that rotating vortices quickly slow down—fails to distinguish between what we now call momentum and energy. But it would not be misleading to suggest that his insight, despite serious difficulties, captured the essential thrust of the law of entropy: the universe is running down. 'Seeing therefore the variety of Motion which we find in the World is always decreasing,' he concluded,

there is a necessity of conserving and recruiting it by active Principles, such as are the cause of Gravity, by which Planets and Comets keep their Motions in their Orbs, and Bodies acquire great Motion in falling; and the cause of Fermentation, by which the Heart and Blood of Animals are kept in perpetual Motion and Heat: the inward Parts of the Earth are constantly warm'd, and in some Places grow very hot; Bodies burn and shine, Mountains take fire, the Caverns of the Earth are blown up, and the Sun continues violently hot and lucid, and warms all things by his Light. For we meet with very little Motion in the World, besides what is owing (either) to these active Principles (or to the Dictates of a Will). And if it were not for these Principles the Bodies of the Earth, Planets, Comets, Sun, and all things in them would grow cold and freeze, and become inactive Masses; and all Putrefaction, Generation, Vegetation, and Life would cease, and the Planets and Comets would not remain in their Orbs.³²

The end of this passage, added in the 1717 edition, suggests a further, more cosmic, sense in which Newton believed the universe was running down. By virtue of their great masses, Jupiter and Saturn noticeably perturb one another's orbits and those of passing comets, which in turn perturb the rest of the planets. Eventually these perturbations would accumulate, Newton thought, 'till this System wants a Reformation.'³³ A few years before his death Newton confided to John Conduitt what may have been the full meaning of this cryptic remark. It was Newton's conjecture, Conduitt recorded, 'that there was a sort of revolution in the heavenly bodies.' Vapors and light from the sun 'had gathered themselves by degrees into a body and then attracted more matter from the planets,' at length forming a

31 *Opticks*, p. 397.

32 Pages 399f. The words in brackets were deleted from the 1717 edition, in which the last sentence was added.

33 Page 402.

new planet and then a comet, which eventually fell into the sun and replenished its matter. The comet of 1680, Newton thought, would someday meet the same fate, at which time 'this earth would be burnt' and all animals would perish. Apparently he believed that something like this had happened previously, for the earth bore 'visible marks of ruin upon it which could not be effected by a flood only.' When Conduitt asked how the earth could have been re-peopled if this had ever happened, Newton replied that 'the power of a creator' was required.³⁴

It was these very questions about the cause of gravitation and the stability of the cosmos that were fundamental to Newton's dispute with Leibniz about the nature of God's ongoing relation to the world. And once again, just as in his disagreement with Descartes, Newton's theology moulded his position. Leibniz spelled out his differences with Newton in a letter to Johann Bernoulli from December 1715. What Newton thinks, the German complained, 'seems plainly absurd to me, namely that the motion of the world-machine will come to cease unless from time to time restored by God. Thus miracles are necessary to him, and he will prove unable to explain his attraction without perpetual miracles.'³⁵ Leibniz debated these issues with Samuel Clarke, a friend and disciple of Newton's who acted as his spokesman in the debate, starting in late 1715 and ending a year later with Leibniz' death. Although Clarke was a capable theologian who could have debated Leibniz entirely on his own, surviving manuscript evidence indicates that Newton was intimately familiar with Clarke's arguments, perhaps in some cases even suggesting them himself. There can be little doubt that Newton endorsed what Clarke wrote.³⁶

Leibniz opened his attack on Newton's views by questioning Newton's belief that the world is running down. If God had 'to wind up his Watch from Time to Time,' Leibniz claimed, then he lacked 'sufficient Foresight to make it a perpetual Motion.' The Newtonians, on the other hand, obliged God 'to clean it now and then by an extraordinary Concourse, and even to mend it, as a Clockmaker mends his Work . . .' Against this, Leibniz held that God worked miracles not 'in order to supply the Wants of Nature, but

34 King's College, Conduitt Papers, Keynes MS. 130.11, quoted by Castillejo, *The Expanding Force*, pp. 95-97. According to Gregory's memorandum of May 1694 (*Corres III*, 336), Newton believed that 'The Satellites of Jupiter and Saturn can take the places of the Earth, Venus, Mars, if they are destroyed, and be held in reserve for a new Creation.' Cf. Newton's letter to Bentley of 25 February 1693 (*ibid.*, 253). Whether Newton believed in pre-Adamite men, I do not know and do not care to speculate.

35 *Corres VI*, 261.

36 The relevant evidence, which is quite extensive, is evaluated in Alexandre Koyré and I.B. Cohen, 'Newton and the Leibniz-Clarke Correspondence with Notes on Newton, Conti, and Des Maizeau,' *Archives internationales d'histoire des sciences* 15 (1962), 63-126. In an earlier work, *From the Closed World to the Infinite Universe* (Baltimore: Johns Hopkins University Press, 1957), Koyré had remarked (p. 301) that he was 'morally certain that Clarke communicated to Newton both Leibniz's letters and his own replies to them.' In the article just cited, Koyré and Cohen observe (p. 67) that from their 'study of the Newtonian manuscripts, the 'moral' conviction has been transformed into a demonstrable one.' For the correspondence itself, see note 3.

those of Grace. Whoever thinks otherwise, must have a very mean Notion of the Wisdom and Power of God.³⁷ Clarke (and Newton) did not agree. God was not a watchmaker, for the world was not a watch: it was utterly incapable of running on its own. God was rather 'himself the Author and continual Preserver' of the forces in the world, so that 'nothing is done without his continual Government and Inspection.' What follows then is a remarkable passage—remarkable, that is, because in it Clarke (on behalf of Newton) explicitly rejects the clockwork metaphor that is so often associated with Newtonian science:

The Notion of the World's being a great Machine, going on without the Interposition of God, as a Clock continues to go without the Assistance of a Clockmaker; is the Notion of Materialism and Fate, and tends, (under pretence of making God a Supra-mundane Intelligence,) to exclude Providence and God's Government in reality out of the World.³⁸

Just as Newton had objected to the Cartesian notion of matter because it did not explicitly require a creator, for the same reason Clarke objected to the Leibnizean notion of the world machine. Casting away the clockwork metaphor, Clarke turned to the much more truly Newtonian image of the world as under the constant supervision and governance of a God who works out his perfect plan. The wisdom of God, he argued, does not involve 'making Nature (as an Artificer makes a Clock) capable of going on Without him: (for that's impossible; there being no Powers of Nature independent upon God, as the Powers of Weights and Springs are independent upon Men);. . .' The wisdom of God involves rather 'framing Originally the perfect and complete Idea of a work, which begun and continues, according to that Original perfect Idea, by the Continual Uninterrupted Exercise of his Power and Government.'³⁹ Clarke had gone straight to the heart of the matter. God is no absentee landlord, a perfect watchmaker whose work never needs adjustment; he is instead an omnipotent governor who exercises his dominion directly and continually as active cause of all that comes to pass. '[W]ith regard to God,' Clarke observed, there are 'no powers of Nature at all, that can do any Thing of themselves . . .'⁴⁰ The whole order of nature was thus a constant divine work, unfolding the original perfect design. Where Leibniz insisted on limiting God to what intelligible mechanisms could accomplish, Clarke allowed God the freedom to act in any way for reasons known only to him:

For why was not God at Liberty to make a World, that should continue in its present Form as long or as short a time as he thought fit, and should then be altered (by such Changes as may be very wise and fit, and yet Impossible perhaps to be performed by Mechanism,) into whatever other Form he himself pleased?⁴¹

37 From his first paper to Clarke (LCC, pp. 5–7).

38 Clarke's first reply (LCC, p. 15).

39 Clarke's second reply (LCC, p. 45).

40 *Ibid.*, p. 47.

41 Clarke's fifth reply (LCC, p. 347).

Implicit to Clarke's (and Newton's) view of the constant divine governance of the world is a blurring—or perhaps even the outright elimination—of the distinction between natural and supernatural events. Indeed Clarke took precisely this step, arguing that 'Natural and Supernatural are nothing at all different with regard to God, but distinctions merely in Our Conceptions of things.' When the sun moves across the sky every day, we call it natural; if its motion ceases for a day, we call it supernatural. But, says Clarke, 'the One is the Effect of no greater power, than the Other; nor is the One, with respect to God, more or less Natural or Supernatural than the other.' This is because God is present to the world 'as a Governor; Acting upon all Things, himself acted upon by nothing.' Deliberately echoing Newton's words in the General Scholium, Clarke added, 'He is not far from every one of Us, for in him We (and all Things) live and move and have our Beings.'⁴² With regard to God, no possible thing was more miraculous than any other. Miracles were simply unusual acts of God, but no more or less acts of God than ordinary events. The raising of a dead human body and the sudden stopping of the earth's motion were called miracles; the ordinary generation of a human body and the continual motion of the earth were called natural, 'for no other Reason, but because the Power of God effects one usually, the other unusually.'⁴³ This same understanding of miracles is implicit in several unpublished papers of Newton's. One of them reads as follows:

For Miracles are so called not because they are the works of God but because they happen seldom & for that reason create wonder. If they should happen constantly according to certain laws imprest upon the nature of things, they would no longer be wonders or miracles, but might be considered in Philosophy as part of the Phenomena of Nature (notwithstanding their being the effects of the laws impressed upon Nature by the powers of God) notwithstanding that the cause of their causes might be unknown to us.⁴⁴

What Newton assumed here, I contend, is that God does *all* things in nature, whether usual or unusual. Most things he does by laws he established, and these we consider natural. Some things, which happen seldom and therefore give us reason to marvel, he does without laws. The word 'miracle' is reserved for unusual events simply because ordinary events don't create the same degree of wonder. Newton's point about

42 Clarke's second reply (LCC, pp. 49–53). Newton also made reference to Acts 17:27f in the General Scholium. For really excellent discussions of the breakdown of the natural/supernatural distinction by Luther, Calvin, and the mechanical philosophers, see Keith Hutchinon, 'Supernaturalism and the Mechanical Philosophy,' *History of Science* 21 (1983), 297–333; and Gary B. Deason, 'Reformation Theology and the Mechanistic Conception of Nature,' in *God & Nature*, ed. David C. Lindberg and Ronald L. Numbers (Berkeley: University of California Press, 1986), pp. 167–191.

43 Clarke's fifth reply (LCC, p. 351).

44 From an uncatalogued MS at Lehigh University, quoted with permission. The words in brackets are crossed out. For similar statements, see the various manuscripts printed in Koyré and Cohen, 'Newton and the Leibniz-Clarke Correspondence,' pp. 72–75 and 108–115.

miracles not being so called because they are divine works is thus seen to be etymological: 'miracle' derives from the Latin verb 'mirari,' to create wonder or astonishment. Considering Newton's beliefs about divine activity in nature, he could hardly have meant that miracles are not acts of God; his point can only have been that they are simply extraordinary acts of God.

This is fully consistent with his reply to Leibniz' other charge, that he could not explain gravitation without making it a perpetual miracle. Behind Leibniz' claim is the assumption that the universe is essentially Cartesian, completely full of matter in vortical motion. On this view the planets were swept around the sun by the vast whirlpool of subtle matter that constitutes the region of space we call the solar system. Although planets had a tendency to recede from the center of the vortex (the sun) owing to their inertia, they were held in check by the press of all the other matter in the universe, which was a plenum. Thus for Descartes and Leibniz, there was (and could be) no 'attraction' between the sun and the planets, pulling them out of otherwise straight paths into elliptical orbits. There could indeed be no 'forces' at all; there was only matter and motion, with the direct contact of bodies as the only mechanism capable of changing motion. This is why Leibniz argued to Clarke that the revolution of a body about 'a certain fixed Centre, without any other Creature acting upon it' was something which 'could not be done without a Miracle; since it cannot be explained by the Nature of Bodies.'⁴⁵

Leibniz had first aired this complaint in a February 1711 letter to Nicolaus Hartsoecker which was published in the 5 May 1712 issue of the weekly *Memoirs of Literature*. There it was seen by Newton's disciple Roger Cotes, who called it to Newton's attention. Newton's reply took the form of a letter to the editor of the *Memoirs*. A surviving draft of the letter reveals the close link between Newton's insistence on the reality of gravitation and his acceptance of the given-ness of a world created by the will of God. Gravity should not be called a miracle just because no mechanical hypothesis had been offered to explain it, Newton said. We cannot give a mechanical explanation for the hardness, inertia, or extension of a body, yet we do not call these miraculous:

They are the natural real reasonable manifest qualities of all bodies seated in them by the will of God from the beginning of creation & perfectly incapable of being explained mechanically . . . And therefore if any man should say that bodies attract one another by a power whose cause is unknown to us or by a power seated in the frame of nature by the will of God, . . . I know not why he should be said to introduce miracles & occult qualities & fictions into the world. . . . But certainly God could create Planets that should move round of themselves without any other cause then [sic] gravity . . . For gravity without a Miracle may keep the Planets in.⁴⁶

45 Leibniz' third paper (LCC, pp. 69–71).

46 University Library Cambridge Add. MS. 3968.17, folio 257, as printed in *Corres* V, 300.

Newton had spelled out precisely his fundamental disagreement with his archrival: we cannot assume that mechanical explanation exhausts the range of natural phenomena. And this is so because we live in a universe created by the will of God, who governs the world in any manner he wishes, not necessarily as we would. If God chose to produce gravity mechanically, then let a mechanical cause be sought; if not, the phenomenon was no less real, and no less lawlike. 'Gravity must be caused by an agent acting constantly according to certain laws,' Newton had told Bentley, 'but whether this agent be material or immaterial is a question I have left to ye consideration of my readers.'⁴⁷ The readers he had in mind were those of the *Principia*, where he had refrained from discussing the actual cause of gravitation, preferring instead to focus on its reality as demonstrated from phenomena. This he did deliberately, intending his approach to be seen as the rejection of the kind of science advocated by his continental rivals, who sought to derive all of nature from a few principles arising from their own fertile imaginations. He summarized his position in a draft of a letter to Roger Cotes, the gifted mathematician who was supervising the publication of the second edition of the *Principia*:

Experimental philosophy reduces Phaenomena to general Rules & looks upon the Rules to be general when they hold generally in Phaenomena. . . . Hypothetical Philosophy consists in imaginary explications of things & imaginary arguments for or against such explications, or against the arguments of Experimental Philosophers founded upon Induction. The first sort of Philosophy is followed by me, the latter too much by Cartes, Leibnitz & some others.⁴⁸

The letter which Cotes actually received made no mention of those two gentlemen or their philosophies, but Cotes did not need to be told what he could see for himself. Natural philosophers may be reduced to three classes, he advised readers in his preface to the new edition. Some follow Aristotle and reduce the effects of bodies to natures and qualities, which is to tell us nothing. Others assume hypotheses as first principles of their speculations, forming an 'ingenious romance' with little resemblance to reality. The third class pursue experimental philosophy, assuming as a principle nothing not proved by phenomena. Cotes went on to reveal the religious foundation of this third kind of philosophy. Undoubtedly the whole world, with all its diversity of forms and motions, 'could arise from nothing but the perfectly free will of God directing and presiding over all.' Flowing from this fountain, the laws of nature show 'many traces indeed of the most wise contrivance, but not the least shadow of necessity. These therefore we must not seek from uncertain conjectures, but learn them from observations and experiments.' Anyone presumptuous enough to think that he can learn the laws of nature from pure reason 'must either suppose that the world exists by necessity, and by the same necessity follows the laws proposed; or if the order of Nature was established by the will of God,

47 Letter of 25 February 1693 (Corres III, 254).

48 University Library Cambridge, Add. MS 3984.14, folio 1, as printed in Corres V, 398f.

that himself, a miserable reptile, can tell what was fittest to be done.' Or, to put it another way, 'The business of true philosophy is to derive the natures of things from causes truly existent, and to inquire after those laws on which the Great Creator actually chose, to found this most beautiful Frame of the World, not those by which he might have done the same, had he so pleased.'⁴⁹

To be sure, Newton did not write this; nor did he read what Cotes had written before it went to press—although Clarke did.⁵⁰ But Cotes said nothing which Newton had not already expressed in his long and distinguished career. It was by divine will, not rational necessity, that matter existed and possessed the properties that it did. As Newton put it once in an unpublished manuscript, 'The world might have been otherwise then it is (because there may be worlds otherwise framed then this) Twas therefore noe necessary but a voluntary & free determination yt it should bee thus.'⁵¹ Divine will had ordered the universe and would renew it from time to time as he saw fit. Natural laws were actively imposed by that will and could differ from one part of the universe to another: by varying the proportions of matter and space, and perhaps even by varying the forces, Newton argued at the close of the *Opticks*, God is able 'to vary the laws of nature and make worlds of several sorts in several parts of the universe.'⁵²

Surely this is not the God of the Enlightenment. I can find no necessity in Newton's theology or in his natural philosophy, no trace of the rationalist God of Descartes and Leibniz, the God who became the absentee landlord of 18th century deists. But if Newton was not an Enlightenment man—if Newton was not a Newtonian—then why do we continue to treat him as if he were?

It has been a fundamental assumption of this paper that, contrary to what we are often told, theology and science were inextricably intertwined during the crucial, formative years of the modern scientific world view. At a much deeper level than the superficial disputes over scriptural interpretation that accompanied the reception of Copernican astronomy, theology exerted a subtle but significant influence on 17th century science, driving thinkers such as Newton⁵³ to reject what they perceived to be the presumptuous claims of continental rationalism, the very sorts of claims that would later be wrongly associated with his name.

Dr. Edward B. Davis is Associate Professor of Science and History at Messiah College in Grantham, Pennsylvania. During 1991–92 he is a Mellon Fellow in the Humanities at the University of Pennsylvania.

49 Carjori, pages xxxii and xxvii, respectively. John Locke had the same view of Newton's science. See Koyré, *Newtonian Studies*, pp. 154f.

50 See *Never at Rest*, p. 749.

51 Quoted with permission from MSS 1031B (formerly: Burndy 16), folio 4v, Dibner Library, Special Collections Branch, Smithsonian Institution Libraries, Washington, DC 20560. Jo Dobbs kindly called my attention to this passage.

52 Query 31 (pp. 403f).

53 Robert Boyle also comes to mind. See my dissertation (cited above) for details.