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Berkeley's Natural Philosophy and Philosophy of Science

Although George Berkeley himself made no major scientific discoveries, nor formulated any novel theories, he was nonetheless actively concerned with the rapidly evolving science of the early eighteenth century. Berkeley's works display his keen interest in natural philosophy and mathematics from his earliest writings (*Arithmetica*, 1707) to his latest (*Siris*, 1744). Moreover, much of his philosophy is fundamentally shaped by his engagement with the science of his time. In Berkeley's best-known philosophical works, the *Principles* and *Dialogues*, he sets up his idealistic system in opposition to the materialist mechanism he finds in Descartes and Locke. In *De Motu*, Berkeley refines and extends his philosophy of science in the context of a critique of the dynamic accounts of motion offered by Newton and Leibniz. And in *Siris*, Berkeley's flirtation with neo-Platonism draws inspiration from the fire theory of Boerhaave as well as Newton's aetherial speculations in the Queries of the *Optics*. In examining Berkeley's critical engagement with the natural philosophy of his time, we will thus improve our understanding of not just his philosophy of science, but of his philosophical corpus as a whole.[1]

[1]Of course one should also mention here Berkeley's works on vision, treated elsewhere in this volume, which are certainly philosophical and are inspired in part by Berkeley's opposition to the geometrical theories of vision he found in Descartes and Malebranche.

I. Berkeley and mechanism

> ffall of Adam, rise of Idolatry, rise of Epicurism & Hobbism dispute about divisibility of matter &c expounded by material substances
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> Extension a sensation, therefore not without the mind.
>
> In y^{e} immaterial hypothesis the wall is white, fire hot etc
>
> Primary ideas prov'd not to exist in matter, after the same manner y^{t} secondary ones are prov^{d} not to exist therein. (PC 17-20)[2]

Berkeley's immaterialist hypothesis was developed and formulated in opposition to materialist mechanism, as these early entries from his philosophical notebooks make clear. Berkeley aims his criticisms most frequently at Locke and Descartes, but the view he attacks was held, in one version or another, by most of the leaders of the new science of the seventeenth century, including Galileo, Hobbes, Gassendi, and Boyle. At the risk of obscuring important theoretical divisions among these natural philosophers, the core doctrines of materialist mechanism might be sketched as follows: In perception, human beings have ideas which are caused by material objects. The existence of these material objects is not dependent upon human beings or their acts of perception. Material objects are composed of submicroscopic particles

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[2]All references to Berkeley are to the Luce-Jessop edition of Berkeley's works: George Berkeley, *The Works of George Berkeley, Bishop of Cloyne*, edited by A.A. Luce and T.E. Jessop (London, 1948-57), 9 vols. I have used the following abbreviations for Berkeley's works:

PC	Philosophical Commentaries (Berkeley's early notebooks)
PHK	*Principles of Human Knowledge*
3D	*Three Dialogues*
DM	*De Motu*
S	*Siris*

References to these works are by section number, except for 3D, where they are by page number. Quotations from *De Motu* are from Luce's translation, which I have occasionally altered slightly for the sake of accuracy. I have also benefited from Douglas Jesseph's translation in George Berkeley, *"De Motu" and "The Analyst": A Modern Edition with Introduction and Commentary*, trans. and ed. Douglas M. Jesseph, The New Synthese Historical Library vol. 41 (Dordrecht: Kluwer Academic Publishers, 1992).

possessing only a limited range of properties: size, shape, motion, and perhaps solidity. These properties are the primary qualities of bodies. Other properties (secondary qualities) which appear to belong to bodies, such as color, taste, sound, or smell, can be accounted for in terms of the effects of primary qualities upon our sensory systems. Nothing which *resembles* our ideas of color, taste, etc. belongs to the bodies themselves.[3] As the secondary qualities of bodies are explained in terms of primary qualities, so all physical events ought to be explained in terms of the motions and collisions of these tiny particles or corpuscles.

An examination of Berkeley's arguments against materialism is beyond the scope of this chapter, but we do need to consider here just what it is about materialist mechanism to which Berkeley is fundamentally opposed. Throughout the *Principles* and *Dialogues*, Berkeley attacks the mechanists' identification of physical bodies with mind-independent material objects. He rejects the claim that such objects (or their primary qualities) serve as causes of our ideas, or indeed, as any sort of causes. (PHK 19, 25, 50, 3D 216) And he aims to subvert the ontologically loaded version of the primary/secondary quality distinction, according to which physical bodies are systematically and radically different from the way they appear to us (PHK 9-15, 3D 187-9). These are the doctrines which appear to Berkeley to lead inexorably to skepticism and atheism.

On the other hand, Berkeley does not specifically take issue with the core mechanist claim about explanation: that physical events should be explained in terms of the motions of corpuscles possessing primary qualities. Berkeley himself has no problem with the existence of a microworld; he clearly holds that

[3]Of course, this does not require the mechanist to deny that bodies are colored. Rather, as in Locke, color in bodies may be identified with powers (grounded in the body's primary qualities) to produce certain kinds of ideas.

its often appropriate to explain macroscopic events in terms of microscopic mechanisms. This is evident from the seriousness with which he addresses a broadly mechanist objection to immaterialism in PHK 60:

> ...it will be demanded to what purpose serves that curious organization of plants, and the admirable mechanism in the parts of animals; might not vegetables grow, and shoot forth leaves and blossoms, and animals perform all their motions, as well without as with all that variety of internal parts so elegantly contrived and put together, which being ideas have nothing powerful or operative in them, nor have any necessary connexion with the effects ascribed to them? If it be a spirit that immediately produces every effect by a *fiat*, or act of his will, we must think all that is fine and artificial in the works, whether of man or Nature, to be made in vain. ...how comes it to pass, that whenever there is any fault in the going of a watch, there is some corresponding disorder to be found in the movements, which being mended by a skilful hand, all is right again? The like may be said of all the clockwork of Nature, great part whereof is so wonderfully fine and subtle, as scarce to be discerned by the best microscope. In short, it will be asked, how upon our principles any tolerable account can be given, or any final cause assigned of an innumerable multitude of bodies and machines framed with the most exquisite art, which in the common philosophy have very apposite uses assigned them, and serve to explain abundance of phenomena. (PHK 60)

We might be tempted to sum up Berkeley's opposition to materialist mechanism by saying that what Berkeley rejects is the metaphysical side of such mechanism, rather than its scientific side. There is a danger of anachronism here, but we can avoid it by identifying the distinction that *Berkeley himself* seeks to impose between natural philosophy and metaphysics. We may begin by examining Berkeley's response to the mechanist challenge quoted above:

> But to come nearer the difficulty, it must be observed, that though the fabrication of all those parts and organs be not absolutely necessary to the producing any effect, yet it is necessary to the producing of things in a constant, regular way, according to the Laws of Nature. There are certain general laws that run through the whole chain of natural effects: these are learned by the observation and study of Nature, and are by men applied as well to the framing artificial things for the use and ornament of life, as to

> the explaining the various phenomena: which explication consists only in shewing the conformity any particular phenomenon hath to the general Laws of Nature, or, which is the same thing, in discovering the *uniformity* there is in the production of natural effects; as well be evident to whoever shall attend to the several instances, wherein philosophers pretend to account for appearances. (PHK 62)

Though God could cause a watch to run with no internal mechanism, he will not typically do so, because he causes ideas according to set laws of nature, which he follows in order that nature should be intelligible to finite perceivers. Thus, a perceived disorder in the motions of a watch will be accompanied, given the appropriate circumstances, by a perceived disorder in the internal mechanism.

Here and elsewhere in the *Principles,* Berkeley gives us not just a response to an objection, but a developed account of the nature of scientific explanation and the status of laws of nature. Berkeley holds that laws of nature are regularities in the phenomena, regularities which "we learn by experience, which teaches us that such and such ideas are attended with such and such other ideas, in the ordinary course of things" (PHK 30). According to Berkeley's metaphysics, these are *mere* regularities, since physical phenomena are constituted by our perceptions and so caused directly by God. By observation we discover these regularities, which then permit us to explain phenomena. It seems, further, that any simple inductive generalization describes a law of nature for Berkeley, and that a phenomenon is explained when it is included in such a generalization:

> So that any one of these or the like Phenomena, may not seem strange or surprising to a man who hath nicely observed and compared the effects of Nature. For that only is thought so which is uncommon, or a thing by it self, and out of the ordinary course of our observation. (PHK 104)

> If therefore we consider the difference there is betwixt natural philosophers and other men, with regard to their knowledge of the phenomena, we shall find it consists, not in an exacter knowledge

> of the efficient cause that produces them, for that can be no other than the *will of a spirit*, but only in a greater largeness of comprehension, whereby analogies, harmonies, and agreements are discovered in the works of Nature, and the particular effects explained, that is, reduced to general rules. . . . (PHK 105)

Here we can see the distinction that Berkeley wants to draw between natural science and metaphysics. The role of the natural philosopher, for Berkeley, is to locate patterns in our ideas, not to examine the causes of those ideas, which are spiritual and properly treated by the metaphysician.[4] We can now return to the question raised earlier: Could Berkeley endorse mechanism as properly physical theory? Prima facie, it seems that the answer should be yes. If materialist mechanism can be stripped of its metaphysics (i.e. its claims about the ontological status of physical bodies and their causal powers) and converted into an account of the succession of ideas, then Berkeley has no principled objection to it.[5] It seems that Berkeley has room for an idealistic corpuscularianism, as long as corpuscles are not held to be unperceivable in some very strong sense.[6] In fact, there's no reason why Berkeley could not endorse an idealistic version of the primary/secondary quality distinction, according to which the secondary

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[4]See also DM 71, 72.

[5]Here I agree with Daniel Garber, "Locke, Berkeley, and Corpuscular Scepticism," in *Berkeley: Critical and Interpretive Essays*, ed. Colin Turbayne (Minneapolis: University of Minnesota Press, 1982), 174-196; Kenneth Winkler, *Berkeley: An Interpretation* (Oxford: Clarendon Press, 1989), 238-275; and Margaret Atherton, "Corpuscles, Mechanism and Essentialism in Berkeley and Locke," *Journal of the History of Philosophy* 29 (1991): 47-67.

[6]If corpuscles are unperceivable, then treating corpuscularianism as a description of regularities in our ideas becomes problematic, or, to put it another way, questions arise about the compatibility of the existence of corpuscles with Berkeley's *esse est percipi* principle. Here one must ask in what sense corpuscles are unperceivable; if, for example, they could be perceived with powerful microscopes (even if those microscopes are unlikely to be invented), then there doesn't seem much of a problem. For a more detailed discussion of this issue, see Margaret Wilson, "Berkeley and the Essences of the Corpuscularians," in *Essays on Berkeley: A Tercentennial Celebration*, ed. John Foster and Howard Robinson (Oxford: Clarendon Press, 1985), 131-148; Winkler, *Berkeley*, 263-275; and Lisa Downing, "*Siris* and the Scope of Berkeley's Instrumentalism," *British Journal for the History of Philosophy* 3 (September 1995), 279-300. Wilson also raises the interesting question of whether an acknowledgment of the scientific importance of the microworld is compatible with Berkeley's inclination to proclaim that according to his philosophy, we perfectly comprehend physical things (Wilson, 146).

qualities of observable bodies can be correlated in a law-like way with the primary qualities of smaller particles.[7]

But does Berkeley *endorse* an idealistic corpuscularianism in the *Principles* or *Dialogues*? Its pretty clear that the answer is 'no'.[8] While it presumably could turn out that the most useful regularities for natural science involve correlations between primary qualities of tiny bodies and other qualities and events, Berkeley shows little enthusiasm for the full mechanist program in natural philosophy in these works:[9]

> Some have pretended to account for appearances by occult qualities, but of late they are mostly resolved into mechanical causes, to wit, the figure, motion, weight, and such like qualities of insensible particles; whereas in truth, there is no other agent or efficient cause than *spirit*, it being evident that motion, as well as all other *ideas*, is perfect inert. See *Sect*. 25. Hence, to endeavour to explain the production of colours or sounds, by figure, motion, magnitude and the like, must needs be labour in vain. And accordingly, we see the attempts of that kind are not at all satisfactory. Which may be said, in general, of those instances, wherein one idea or quality is assigned for the cause of another. I need not say, how many *hypotheses* and speculations are left out, and how much the study of Nature is abridged by this doctrine. (PHK 102)

While Berkeley's primary target here is again mechanist pretenses to *causal* explanation, his dismissive attitude towards "attempts of that kind" does not seem compatible with a personal commitment to an idealistic corpuscularianism. Moreover, despite Berkeley's reservations about Newtonianism, he clearly finds it much more promising, as a species of natural philosophy, than the corpuscularianism of Descartes or Boyle.[10]

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[7]This comes in handy for interpreting *Siris* 266. See Winkler, *Berkeley*, 260-262.
[8]Thus I agree with Wilson that Garber overreads PHK 60-6 somewhat. See Wilson, 134-138 and Garber, "Corpuscular Scepticism," 182-187.
[9]This of course does not prevent him from endorsing some obvious "mechanistic" claims about the behavior of plants and animals being correlated with an internal mechanical structure.
[10]This is most explicit in *Siris* 243, but also seems evident in Berkeley's tendency, from the *Principles* onwards, to reserve his praise in the area of natural philosophy for Newton.

II. Berkeley and dynamics

A. Berkeley's *Principles* and Newtonian dynamics

Berkeley's philosophical engagement with Newton's *Principia Mathematica* began early in his career.[11] In the *Principia*, Newton had successfully reunited mechanics and astronomy by means of his laws of motion and theory of gravity. Berkeley's appreciation for Newton's achievement was profound. In the *Principles*, Berkeley cites Newton's mechanics as "the best key for . . . natural science" (PHK 110). His enthusiasm, does not, however, prevent him from attempting to impose conceptual reforms upon the theory: he goes on to maintain that Newton's doctrine of absolute space and motion must be abandoned. Berkeley argues that conceiving of motion requires conceiving of two bodies; thus, absolute motion is inconceivable (PHK 112-114). Having declared absolute motion to be incomprehensible, there is no need to posit absolute space. Furthermore, pure space, independent of all body, is likewise inconceivable (PHK 116).[12]

Berkeley thus dismisses Newton's distinction between absolute and relative motion, suggesting that Newton has no real need for absolute motion, for relative motion will serve his purposes just as well.[13] Nevertheless, Berkeley

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[11]Berkeley worries about the implications of Newton's doctrine of absolute motion as early as PC 30.

[12]Space does not permit a critical treatment of these claims. For further discussion see W.A. Suchting, "Berkeley's Criticism of Newton on Space and Time," *Isis* 58 (1967): 186-97; Gerd Buchdahl, *Metaphysics and the Philosophy of Science* (Cambridge: M.I.T. Press, 1969), 317-324; and Richard J. Brook, *Berkeley's Philosophy of Science*, Archives Internationales d'Histoire des Idées 65 (The Hague: Martinus Nijhoff, 1973), 125-145.

[13]It is presumably because Berkeley thinks that our clear conceptions of relative motion and space will stand in for Newton's unintelligible notions that he never raises the possibility of an

wants to avoid concluding that whenever two bodies are in motion relative to one another, both bodies have an equal claim to be termed "moved". That is, he seeks to preserve the intuitive distinction between true and apparent motion (e.g. when I look out the window of a speeding train and see trees rushing past, I want to say that their motion is merely apparent). It is in this context that one encounters the following striking passage:

> For to denominate a body *moved*, it is requisite, first, that it change its distance or situation with regard to some other body: and secondly, that the force or action occasioning that change be applied to it. If either of these be wanting, I do not think that agreeably to the sense of mankind, or the propriety of language, a body can be said to be in motion. I grant indeed, that it is possible for us to think a body, which we see change its distance from some other, to be moved, though it have no force applied to it (in which sense there may be apparent motion), but then it is, because the force causing the change of distance, is imagined by us to be applied or impressed on that body thought to move. Which indeed shews we are capable of mistaking a thing to be in motion which is not, but does not prove that, in the common acceptation of *motion*, a body is moved meerly because it changes distance from another; since as soon as we are undeceiv'd, and find that the moving force was not communicated to it, we no longer hold it to be moved. So on the other hand, when one only body (the parts whereof preserve a given position between themselves) is imagin'd to exist; some there are who think that it can be moved all manner of ways, tho' without any change of distance or situation to any other bodies; which we shou'd not deny, if they meant only that it might have an impressed force, which, upon the bare creation of other bodies, wou'd produce a motion of some certain quantity and determination. But that an actual motion (distinct from the impressed force, or power productive of change of place in case there were bodies present whereby to define it) can exist in such a single body, I must confess I am not able to comprehend. (PHK 115, 1710 ed.)

This passage is very surprising on two counts. First, Berkeley indicates that one body alone in the universe might have a force impressed upon it. Forces, then,

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instrumentalist treatment of absolute space, along the lines of his instrumentalist treatment of force. Berkeley argues that we implicitly rely on a relative conception of motion even when we suppose ourselves to be appealing to absolutes. See PHK 114, DM 64.

must be distinct from all sensible effects, such as motions. Nor can a force be a mere disposition to motion if *it* would *produce* motion. Lacking the slightest caveat here, one must assume that Berkeley thought forces *existed*. Second, he defines impressed force as "*power productive* of change of place" (my emphasis). He thus appears to grant forces causal status.

This understanding of force conflicts, of course, with one of Berkeley's central metaphysical tenets, argued for in the *Principles* and elsewhere, that physical things (bodies) are inactive and only spirits have causal efficacy. It's reassuring to learn that Berkeley struck the second half of the section quoted above (from "but does not prove" forward) from the second edition of the *Principles* (published in 1734, 13 years after *De Motu*). Pretty clearly, it was sometime between 1710 and 1721 that Berkeley began to reflect on the problematic status of physical forces.[14] While the 1710 edition of the *Principles* includes, as we have seen, an uncritical reference to physical forces, the 1734 edition appears merely to rely on our everyday concept of force or action (rather

[14]This position is, of course, necessarily somewhat speculative, but it is supported by the fact that Berkeley's pre-1721 writings include few remarks on physical force and show no signs of significant philosophical reflection on the status of dynamics. The only dynamic entry in his philosophical notebooks is PC 456, where Berkeley appeals to the notion of a vis impressa in what is apparently an attempt to defuse Newton's bucket argument as an argument for absolute space. (It may be that an allusion to a force-based response to the bucket experiment is preserved at the very end of PHK 114, in both the first and second editions. Berkeley is extremely cryptic here, however, so I do not take this as indicating a commitment to the existence of forces. See Suchting, 193. Neither the *New Theory of Vision* (1709) nor the *Three Dialogues* (1713) contain any significant use of dynamic concepts.

More convincing (if still indirect) evidence that Berkeley, in this early stage of his career, had no well thought out philosophical attitude towards physical forces is provided by a look at the manuscript version of the *Principles*. (George Berkeley, ADD. MS. 39304 fol. 70r-78r, Department of Manuscripts, British Museum, London.) The relevant portion of the manuscript covered with deletions and insertions. Most tellingly, PHK 115 (including the problematic section) has no real ancestor in the manuscript version. It would seem, then, that PHK 115 represents a late decision by Berkeley to recapitulate his conclusions from 113 and to elaborate upon the application of the notion of force to the problem at hand. Berkeley later came to regret the elaboration, and so dropped it from the second edition of the *Principles*. (I am indebted to Douglas Jesseph for suggesting to me the possible interest of this manuscript material.)

than the dynamicists unintelligible notion) to ground a merely pragmatic distinction between real and apparent motion.[15]

B. Berkeley's motivations for writing *De Motu*

We have already touched on some reasons why Berkeley, qua metaphysician, would have been pushed to consider the ontological status of physical forces. The existence of active corporeal forces contradicts Berkeley's doctrine that only spirits are causally active.[16] Moreover, Berkeley makes clear that his idealism directly implies that bodies, as bundles of ideas, are causally inactive:

> All our ideas, sensations, or the things which we perceive, by whatsoever names they may be distinguished, are visibly inactive, there is nothing of power or agency included in them. So that one idea or object of thought cannot produce, or make any alteration in another. To be satisfied of the truth of this, there is nothing else requisite but a bare observation of our ideas. For since they and every part of them exist only in the mind, it follows that there is nothing in them but what is perceived. But whoever shall attend to his ideas, whether of sense or reflection, will not perceive in them any power or activity; there is therefore no such thing contained in them. A little attention will discover to us that the very being of an idea implies passiveness and inertness in it, insomuch that it is impossible for an idea to do any thing, or, strictly speaking, to be the cause of any thing. . . . (PHK 25)

Interestingly, however, Berkeley makes no such arguments from metaphysics in *De Motu*. On the contrary, he seems to go out of his way to keep his immaterialism firmly under wraps. This is not so surprising given his intended

[15]For different interpretations of this passage and the import of the changes in the second edition, see Kenneth Winkler, "Berkeley, Newton and the Stars," *Studies in History and Philosophy of Science* 17 (1986): 23-42 and Warren O. Asher, "Berkeley on Absolute Motion," *History of Philosophy Quarterly* 4 (1987): 447-466.

[16]At 3D 217, for example, Philonous seeks to convince Hylas that "to suppose any efficient or active cause of our ideas, other than *spirit*, is highly absurd and unreasonable".

audience. Berkeley wrote *De Motu* as a contribution to an ongoing debate among natural philosophers; he could not and did not expect a tract on the scientific consequences of immaterialism to be taken seriously by such an audience.[17] Moreover, Berkeley's first biographer tells us that *De Motu* was submitted to the Paris Academy of Sciences, which had inaugurated its illustrious series of essay prize competitions by offering a prize for the best essay on motion.[18] The judges, of course, would have been generally Cartesian in orientation and Berkeley clearly crafts his work with this in mind.[19]

Despite the absence of idealism-based arguments against the existence of forces in *De Motu*, it is clear that Berkeley's attack on realism about dynamics is in part motivated by metaphysical concerns. Indeed, these concerns are made quite explicit in *Siris*:

> In strict truth, all agents are incorporeal, and as such are not properly of physical consideration. The astronomer, therefore, the mechanic, or the chemist, not as such, but by accident only, treat of real causes, agents, or efficients. Neither doth it seem, as is supposed by the greatest of mechanical philosophers, that the true way of proceeding in their science is, from known motions in nature to investigate the moving forces; forasmuch as force is neither corporeal nor belongs to any corporeal thing. . . .(S 247)

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[17]Thus I strongly disagree with Luce's assessment of *De Motu* as "the application of immaterialism to contemporary problems of motion." A.A. Luce, "Editor's Introduction to *De Motu*," *Works* 4: 3-4.

[18]Joseph Stock, *An Account of the Life of George Berkeley, D.D. Late Bishop of Cloyne in Ireland*, in *George Berkeley: Eighteenth Century Responses*, ed. David Berman (New York: Garland, 1989), 1: 19. While no records of the submission remain (see Jesseph's "Editor's Introduction", in Berkeley, *"De Motu" and "The Analyst": A Modern Edition*, 3), certainly the timing of the essay and Berkeley's decision to write in Latin support this contention.

[19]For example, in DM 25, Berkeley endorses a dualism of corporeal things and thinking things, not adding that in his own view corporeal things turn out to be bundles of ideas which are fundamentally ontologically dependent upon thinking things. Also in DM 53 Berkeley speaks somewhat uncharacteristically of a faculty of pure intellect (which, as it turns out, has spirit and the actions of spirits as its sole objects). Of course, here Berkeley is not saying anything which *contradicts* his own considered position, but he is certainly emphasizing his points of agreement with Cartesianism to the point that the reader might rashly assume more agreement than actually exists. The only passage in which it seems that Berkeley carries this strategy to the point of being disingenuous is DM 29, where Berkeley appears to suggest that the corpuscularian conception of body exhausts the real qualities of bodies. Of course, Berkeley himself holds that all the sensible qualities, including color, taste, sound, etc., are alike real qualities of bodies (a possibility that is left open by Berkeley's more cautious phrasing in DM 22).

> Natural phenomena are only natural appearances. They are, therefore, such as we see and perceive them. Their real and objective natures are, therefore, the same-- passive without anything active. . . . (S 292)

Berkeley found these doctrines threatened by the dynamic theories of motion put forward, most influentially, by Newton (in the *Principia Mathematica*) and Leibniz (in the *Specimen Dynamicum*, as well as other essays). In particular, Berkeley was concerned with a position that I will call dynamic realism: the view that forces are properly attributed to bodies and that these forces are active, i.e. they are efficient causes of motion.[20] Leibniz was certainly the most forthright of dynamic realists, and so, unsurprisingly, he comes in for the lion's share of Berkeley's abuse in *De Motu*. Newton's attitude vis-a-vis dynamic realism is, of course, more problematic. Newton's *official* position in the *Principia* was to remain stubbornly neutral about what realities might underlie his mathematical laws, and indeed Berkeley himself frequently invokes Newton in support of his own position. Nevertheless, Berkeley was concerned that the success of Newtonian dynamics might be taken to support a dynamic conception of nature. His concern was not unwarranted, as is shown by the history of Newtonianism.[21]

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[20]Thus, while, as we will see, Berkeley attacks views which would invest bodies with spiritual powers or would merge body and spirit so as to activate the natural world, he does not directly address views which would attribute force only to spiritual substances entirely distinct from matter. Doubtless he assumes that the only sensible way of understanding the claim that there are spiritual forces is as merely stating that minds cause the motions of bodies. He ultimately held, of course, that God's mind was the universal cause of such motions.

[21]And indeed Cotes' preface to the second edition of the *Principia* (1713), wherein he speaks of gravity as a primary quality of matter, might well have fueled Berkeley's concern. Sir Isaac Newton, *Mathematical Principles of Natural Philosophy*, translated by Andrew Motte, revised by Florian Cajori (Berkeley: University of California Press, 1962), xxvii. For relevant material on the history of Newtonianism see, e.g., Robert E. Schofield, *Mechanism and Materialism: British Natural Philosophy in an Age of Reason* (Princeton: Princeton University Press, 1970) and P.M. Heimann and J.E. McGuire "Newtonian Forces and Lockean Powers: Concepts of Matter in Eighteenth-Century Thought," *Historical Studies in the Physical Sciences* 3 (1971): 233-306.

C. Berkeley's case against dynamic realism

Berkeley pursues a two-pronged assault against the dynamic realist: In the first place, he invokes a number of loosely related philosophical views, each of which he takes to be widely held and to in some way cast doubt on the plausibility of dynamic realism. Berkeley's strategy here is to point out some of the conceptual difficulties occasioned by attributing active (i.e. efficient causal) qualities to corporeal bodies. The principles Berkeley invokes are carefully chosen so as both to cohere with Berkeley's metaphysical views and to secure the widest possible agreement. In the second place, Berkeley constructs a sustained argument which aims to show that dynamic realism is nonsensical. We will now look briefly at each aspect of Berkeley's campaign against realism about dynamics.

1. Challenge from common philosophical principles

Anti-scholasticism

Perhaps the most widely held view which Berkeley appeals to in this context is anti-scholasticism. Berkeley accuses dynamicists of invoking occult qualities, using obscure terms, and in general falling back upon scholastic ways of thinking (DM 8, 19, 40). Berkeley specifically cites Leibniz in this context, and of course his accusations are well-grounded, since Leibniz himself forthrightly links his dynamics to the validity of certain scholastic notions.[22] However, as it stands these charges seem rather superficial, for it is not clear exactly what features are shared (other than obscurity) by the theories Berkeley stigmatizes as

[22]See G.W. Leibniz, "A New System of Nature," in *Philosophical Essays*, trans. and ed. Roger Ariew and Daniel Garber (Indianapolis: Hackett Publishing Co., 1989), 139.

neo-scholastic, nor why they are objectionable. Fortunately, Berkeley's critique does not stop at this relatively superficial level.

Anti-vitalism and heterogeneity thesis

If we examine some closely-related passages, we begin to see more clearly what it is that Berkeley objects to in those dynamic theories which he stigmatizes as neo-scholastic:

> *Solicitation* and *effort* or *conation* [striving] belong properly to animate beings alone. When they are attributed to other things, they must be taken in a metaphorical sense; but a philosopher should abstain from metaphor. (DM 3)

> All those who, to explain the cause and origin of motion, make use of the hylarchic principle, or of a nature's want or appetite, or indeed of a natural instinct, are to be considered as having said something, rather than thought it. And from these they are not far removed who have supposed 'that the parts of the earth are self-moving, or even that spirits are implanted in them like a form' [Borelli] in order to assign the cause of the acceleration of heavy bodies falling. So too with him [Leibniz] who said 'that in the body besides solid extension, there must be something posited to serve as starting-point for the consideration of forces.' All these indeed either say nothing particular and determinate, or if there is anything in what they say, it will be as difficult to explain as that very thing it was brought forward to explain. (DM 20)

In effect, Berkeley accuses certain dynamic theorists of vitalism, i.e. of supposing that ordinary physical bodies are animate or ensouled. Berkeley maintains that vitalism is a thesis which withers under the light of philosophical scrutiny.

Berkeley's specific targets in DM 20 do appear to be open to charges of vitalism. In his first sentence, Berkeley seems to allude to the views of the Cambridge Platonists. Cudworth, for example, is willing to suppose that matter is moved by a "Subordinate Hylarchical Principle" or soul, "vitally united" with bodies.[23] Giovanni Borelli, in his *De Vi Percussionis*, holds that the descent of

[23]More specifically, Ralph Cudworth had argued in his *True Intellectual System of the Universe* that the general cause of motion in the world is "*...an Inferiour Created Spirit, Soul*, or *Life of Nature*, that

heavy bodies is caused by an internal agent, and he supposes, as Berkeley reports, that particles of matter are self-moving or have self-moving spirits.[24] Leibniz sees his dynamics as tied to his metaphysical thesis that bodies are, in a sense, ensouled:

> . . . I admit an active and, so to speak, vital principle superior to material notions everywhere in bodies. . . . [25]

> Secondary matter is, indeed, a complete substance, but it is not merely passive; primary matter is merely passive, but it is not a complete substance. And so, we must add a soul or a form analogous to a soul. . . . Something constitutive, substantial, enduring, what I usually call a *monad*, in which there is something like perception and appetite.[26]

Berkeley was not alone in finding Leibniz' position, for example, obviously absurd; in a paper published in the *Philosophical Transactions* of the Royal Society, Samuel Clarke mocks Leibniz for supposing "some *living Soul* essentially belonging to *every Particle of Matter*".[27]

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is, a *Subordinate Hylarchical Principle*, which hath a Power of *Moving Matter Regularly*, according to the Direction of a *Superiour Perfect Mind*". This hylarchic principle, AKA the Plastick Life of Nature, though a spiritual substance, was held by Cudworth to be "vitally united" to matter in the same way as animal souls are united with animal bodies. He compares the action of the Plastick Life of Nature, which he held to be goal-directed but not knowledge-guided, to the natural instinct of animals. Ralph Cudworth, *Collected Works of Ralph Cudworth*, vol. 1, *The True Intellectual System of the Universe* (Hildesheim: Georg Olms Verlag, 1977; reprint London: for Richard Royston, 1678), 668-9. See also Douglas Jesseph, in George Berkeley, *"De Motu" and "The Analyst": A Modern Edition*, ed. Douglas Jesseph (Kluwer Academic Publishers, Dordrecht, 1992), 81.

In *The Immortality of the Soul*, Henry More had theorized similarly about the Spirit of Nature, an incorporeal but senseless substance which served as "the *Vicarious power of God* ... upon the Universal Matter of the World," moving and organizing that matter. Henry More, *The Immortality of the Soul*, ed. Alexander Jacob (Dordrecht: Martinus Nijhoff, [1662] 1987), 267. Arguably, to the extent that the spirit of nature or hylarchical principal was intended to be a substance entirely *distinct* from matter, the charge of vitalism is misleading, for matter *itself* is not animated. See footnote 20 above.

[24]Giovanni Alfonso Borelli, *De vi percussionis liber* (Bononiae: Jacob Montij, 1667), 180-1. See R.S. Westfall's discussion in his *Force in Newton's Physics* (New York: American Elsevier Publishing Co., 1971), 228-9.

[25]Leibniz, "A Specimen of Dynamics," *Philosophical Essays*, 125.

[26]Leibniz, "On Nature Itself," *Philosophical Essays*, 162-3.

[27]Letter Occasion'd by the present Controversy among Mathematicians, concerning the Proportion of Velocity and Force in Bodies in Motion," *Philosophical Transactions* 35 (1728), 381-88. Moreover, the second section (No. 2) of Clarke's appendix to the Leibniz-Clarke correspondence is clearly crafted to highlight what Clarke too sees as vitalism and neo-scholasticism in the

But why exactly is it manifestly mistaken to suppose that bodies in general are ensouled or endowed with an active principle? Berkeley sheds some further light on this issue in a passage in which he uncharacteristically cites Descartes as an authority:

> A thinking, active thing is given which we experience as the principle of motion in ourselves. This we call *soul*, *mind*, and *spirit*. Also given is a thing extended, inert, impenetrable, moveable, totally different from the former and constituting a new genus. Anaxagoras, wisest of men, was the first to grasp the great difference between thinking things and extended things, and he asserted that the mind has nothing in common with bodies, as is established from the first book of Aristotle's *De Anima*. Of the moderns Descartes has put the same point most forcibly. What was left clear by him others have rendered involved and difficult by their obscure terms. (DM 30)

Berkeley here praises Cartesianism for its dualism, which makes body and mind heterogeneous. Berkeley clearly endorses the heterogeneity thesis, despite the fact that his underlying ontology differs greatly from Descartes. The heterogeneity thesis explains the problem with vitalism-- vitalism conflates two categories which ought to be kept distinct. Descartes, too, holds that certain sorts of dynamic realism violate the heterogeneity thesis; in the Sixth Set of Replies, Descartes cites the conflation of mind and body as the source of an illegitimate conception of gravity.[28]

Of course, for Descartes the heterogeneity thesis is grounded in a particular account of nature of body and mind, according to which all properties of body are modifications of extension, and all properties of mind are

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underpinnings of Leibniz' dynamics. Samuel Clarke and G.W. Leibniz, *The Leibniz-Clarke Correspondence*, ed. H.G. Alexander (Manchester: Manchester University Press, 1956) 127-131.

[28]Rene Descartes, "Author's Replies to the Sixth Set of Objections," in *The Philosophical Writings of Descartes*, translated by John Cottingham, Robert Stoothoff, Dugald Murdoch (Cambridge: Cambridge University Press, 1984), 2:297-8. Murray Miles argues that Descartes' general opposition to positing underived forces in matter stems from his conviction that to do so "involves an illicit conflation of the mental with the physical". Murray Miles, "Descartes' Mechanism and the Medieval Doctrine of Causes, Qualities, and Forms," *The Modern Schoolman* 65 (1988): 101, 111.

modifications of thought.[29] Thus, Descartes holds that bodies can possess only a very limited range of intrinsic qualities, and force, it would appear, cannot number among them. Louis de la Forge argues explicitly that because the concept of force does not include the concept of extension, force cannot belong to matter.[30]

Here, Berkeley is very much in accord with Descartes' conclusions, but, ultimately, for his own reasons. Berkeley too holds that bodies possess only a limited range of properties, although for him those properties include all the sensible qualities, not just the purely geometrical qualities of Cartesian mechanism. In DM 30, Berkeley focuses on Descartes' conclusions, and effectively underlines the fact that the conception of body put forward by his influential mechanical philosophy seems to leave no room for active force.

However, the fact that answering these further questions requires appeal to a more detailed metaphysical system limits the scope of Berkeley's objection. We might ask, for example, whether a Newtonian need be affected by Berkeley's appeal to the heterogeneity of mind and body. As was noted above, the Newtonian Samuel Clarke obviously rejects Leibniz' blatant attribution of a soul-like form to matter. Clarke is certainly disturbed by the prospect of conflating spirits with bodies. The question, however, is whether attributing forces to bodies *thereby* spiritualizes them. For the Cartesians and for Berkeley, this is clearly the case, since their ontologies dictate that only spirits are active. It is not clear, however, that this claim need secure general agreement.[31]

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[29]Strictly speaking, this formulation must be qualified to take note of the fact that duration, existence, unity and number are properties of both mind and body. Garber handles this by saying that all properties of body must be ways of being an extended substance. Daniel Garber, *Descartes' Metaphysical Physics* (Chicago: University of Chicago Press, 1992), 67-68.

[30]Louis de la Forge, *Traité de l'esprit* (Amsterdam: Abraham Wolfgang, 1666; reprint Hildesheim: Georg Olms Verlag, 1984), 251-2.

[31]Of course, one might also simply reject the heterogeneity thesis altogether as did Anne Conway in her *Principles of the Most Ancient and Modern Philosophy*, first published in Latin in 1690, eleven

Inertia and the passivity principle

In addition, Berkeley provides us with one other way of spelling out what's wrong with animating bodies as some dynamicists do:

> But those who attribute a vital principle to bodies are imagining an obscure notion and one ill suited to the facts. For what is meant by being endowed with the vital principle, except to live? And to live, what is it but to move oneself, to stop, and to change one's state? (DM 33)

To suppose that bodies may contain a vital principle, Berkeley claims, is to suppose that they can move themselves, which violates the widely accepted principle that body is passive in the sense of being incapable of originating new motion. (This principle is obviously in harmony with Berkeley's metaphysical views, since it follows from the claim that bodies cannot be causes at all.)

I call this a widely accepted principle; it was not universally accepted: for example, Gassendi, the influential seventeenth century atomist had rejected it.[32] I do want to claim, however, that in asserting that body cannot be self-moving, Berkeley was in accord with a spectrum of natural philosophers ranging well-beyond the Cartesian camp. Robert Boyle, for example, held that material bodies cannot be conceived of as self-moving or as the origins of motions and, moreover, associated the opposing view with vitalism.[33] In his study of materialism in eighteenth-century Britain, John Yolton cites a number of British natural philosophers in the early to mid-eighteenth century who maintained that bodies are passive in the sense of not intrinsically possessing any power to move

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years after her death. Anne Conway, *The Principles of the Most Ancient and Modern Philosophy*, ed. Peter Loptson (The Hague: Martinus Nijhoff, 1982).

[32]Even Gassendi, however, held that matter is not essentially self-moving, but that this attribute is bestowed on it by God at creation. Pierre Gassendi, *The Selected Works of Pierre Gassendi*, ed. and trans. Craig B. Brush (New York: Johnson Reprint Corporation, 1972), 399.

[33]See Robert Boyle, "A Free Enquiry into the Vulgarly Received Notion of Nature," in *Selected Philosophical Papers of Robert Boyle*, ed. M.A. Stewart (Indianapolis: Hackett, 1991), 181-2.

themselves or to originate motion, including Samuel Colliber, Humphrey Ditton, Andrew Baxter, and William Porterfield.[34]

In assessing the scope of this challenge, however, its crucial to notice that the sort of passivity that Berkeley appeals to here does not amount to *total* passivity, i.e. complete causal inactivity. Those who maintained that bodies lacked active powers (to move themselves, to originate motion) often *contrasted* those powers with the *passive* powers that bodies evidently *have* (to move other bodies via impact, to transfer motion). Locke, for example, contrasts active with passive powers, and suggests that the power to transfer motion is not properly denominated an active power. Thus, the passivity principle does not by itself support the thesis that bodies have no causal powers, and so it does not ground a completely general worry about all attributions of force to body. (Positing impact forces, for example, does not conflict with this understanding of the passivity of body.)

Interestingly, Berkeley never charges *Newton* with the error of making bodies active in this sense, i.e. making them sources of new motion; rather, he cites Newton as an authority who implicitly acknowledges the passivity of body:

> All heavy things by one and the same certain and constant law seek the centre of the earth, and we do not observe in them a principle or any faculty of halting that motion, of diminishing it or increasing it except in fixed proportion, or finally of altering it in any way. They behave quite passively. Again, in strict and accurate speech, the same must be said of percussive bodies. Those bodies as long as they are being moved, as also in the very moment of percussion, behave passively, exactly as when they are at rest. Inert body so acts as body moved acts, if the truth be told. Newton recognizes that fact when he says that the force of inertia is the same as

[34]John Yolton, "Matter: Inert or Active," chap. in *Thinking Matter: Materialism in Eighteenth-Century Britain* (Minneapolis: University of Minnesota Press, 1983), 90-106. Even Cudworth and More affirmed that matter itself is passive and unable to move itself. In their view spiritual principles must be introduced to explain activity. The result is the flagrant vitalism disparaged by Berkeley and Clarke.

> impetus. But body, inert and at rest, does nothing; therefore body moved *does nothing*. (DM 26, my emphasis)

In this passage,[35] Berkeley alludes to Definition III of the *Principia*, where Newton defines the vis insita or innate force of matter as "a power of resisting, by which every body, as much as in it lies, continues in its present state, whether it be of rest, or of moving uniformly forwards in a right line."[36] From DM 26 it appears that Berkeley is appealing to Newton as support for his claim that bodies are passive in the sense of lacking all causal powers. Now, it's clear that in *some* sense Newton acknowledges the passivity of bodies in Definition III, for he attributes a "force of inactivity" to all bodies. However, it's equally clear that this force of inactivity does not rule out causal interactions between bodies; rather, it appears to *govern* such causal interactions-- as impulse, for example, it "endeavors to change the state" of other bodies. Newton provides a more explicit statement of his understanding of the passivity of body in a draft variant relating to Query 31 of the 1717-18 English edition of the *Optics*:

> For Bodies (alone considered as long, broad & thick . . .) are passive. By their vis inertiae they continue in their state of moving or resting & receive motion proportional to ye force impressing it & resist as much as they are resisted; but they cannot move themselves; & without some other principle than the vis inertiae there could be no motion in the world.[37]

Newton's understanding of the basic nature of body thus seems in accord with the passivity principle.[38] But that view, as was noted previously, does not rule out causal interactions between bodies at impact. In Newton's view the *vis inertia*, although a *passive* principle in the sense that it does not permit bodies to

[35]See also DM 51.
[36]Newton, *Mathematical Principles*, 2.
[37]Sir Isaac Newton, Add. 3970, fol. 620r, Cambridge University Library, quoted in J.E. McGuire, "Force, Active Principles, and Newton's Invisible Realm," *Ambix* 15 (1968), 170-1.
[38]Here I am in agreement with Ernan McMullin, who argues that the core of Newton's conception of the passivity of matter is captured by the principle that matter cannot of itself be the source of new motion. Ernan McMullin, *Newton on Matter and Activity* (Notre Dame: University of Notre Dame Press, 1978), 35, 101-106.

originate motion, explains the causal interactions among bodies in accordance with his first three laws of motion.[39]

On the other hand, the considerations which Berkeley raises here do pose a grave problem for a certain type of dynamic realism. It seems that Newton's own understanding of passivity rules out the view that *gravity*, *attraction*, or *repulsion* are intrinsic qualities of body.[40] Of course, this then raises a pressing problem about the status of such forces. Many early Newtonians were concerned to reconcile Newton's theory of gravity with their belief that body itself is not self-activating and cannot *originate* motion. Richard Bentley, for example, echoes Newton's view that "brute matter", as inanimate, can only transfer motion and cannot originate it.[41] Likewise, Benjamin Worster maintains that "the inertia of matter consists in its not being able to produce or destroy Motion in itself" and that "all Matter is sluggish and inactive, and unable to move itself".[42] One solution that was frequently proposed was to attribute such forces to God's activity-- a move that Berkeley himself would certainly applaud as a step in the right direction. Samuel Clarke, for example, seems to make such a move,[43] as does Worster.[44]

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[39]See Alan Gabbey, "Force and Inertia in the Seventeenth Century: Descartes and Newton," in *Descartes: Philosophy, Mathematics and Physics*, ed. Stephen Gaukroger (Brighton: Harvester Press, 1980), 279 & 284.

[40]Some of Newton's critics accused him of having such a view of gravity, although he apparently rejected it in his now well-known letter to Bentley. Sir Isaac Newton, *Newton's Papers and Letters on Natural Philosophy*, ed. I. Bernard Cohen (Cambridge: Harvard University Press, 1958), 302-303. To what extent this letter represented Newton's own view, as opposed to his desire to escape controversy, is, of course, a difficult question. For an interesting and unconventional interpretation of Newton's correspondence with Bentley, see John Henry, "'Pray Do Not Ascribe that Notion to Me': God and Newton's Gravity," in *The Books of Nature and Scripture*, ed. James E. Force and Richard H. Popkin (Dordrecht: Kluwer Academic Publishers, 1994), 123-147.

[41]Richard Bentley, "Sermon VII," in *Eight Sermons* (Cambridge: for Cornelius Crownfield, 1724) , 277-81.

[42]Benjamin Worster, *A Compendious and Methodical Account of the Principles of Natural Philosophy* , 2d. ed. (London: for Stephen Austen, 1730), xvi, 5.

[43]Samuel Clarke, "A Discourse Concerning the Unalterable Obligations of Natural Religion," in *The Works of Samuel Clarke* (London: printed for J. and P. Knapton, 1738), 2:601.

[44]". . . [it] is most evident and certain, that either these active Principles [attraction and repulsion] themselves, or at least that more general one from whence they result, is altogether immechanical

Thus, while appealing to the principle that matter cannot move itself does not secure the conclusion that Berkeley ultimately wanted-- that matter is passive in the sense of lacking any causal power-- Berkeley's appeal does highlight a widespread worry about the status of attractive and repulsive forces that rendered outright realism about Newtonian dynamics unattractive.

God's relation to the physical world

This leads us to Berkeley's final line of attack, which is designed to undermine dynamic realism generally. In DM 34, Berkeley seems to imply that while the Newtonian conception of inertia *suggests* that bodies are causally inactive, a proper conception of God's relation to bodies leaves no doubt about their status:

> Modern thinkers consider motion and rest in bodies as two states of existence in either of which every body, without pressure from external force, would naturally remain passive; whence one might gather that the cause of the existence of bodies is also the cause of their motion and rest. *For no other cause of the successive existence of the body in different parts of space should be sought, it would seem, than that cause whence is derived the successive existence of the same body in different parts of time.* But to treat of the good and great God, creator and preserver of all things . . . is, however, rather the province of first philosophy or metaphysics and theology. (DM 34, my emphasis)

In this passage, Berkeley alludes to a well-known argument of Malebranche's designed to show that a proper conception of the dependence of the world on God entails that bodies are causally inactive. Malebranche's overall argument may be summarized as follows: Every body is perpetually causally dependent on God's conservation. (Thus, God is always a necessary cause of each body's existence.) But conservation is just continuous creation. (Thus, God is always a sufficient cause of each body's existence.) But, in causing a body's

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and independent from Matter, and can only proceed from the first Cause and Author of all things. . . ." Worster, *Principles of Natural Philosophy*, 10.

existence, necessarily God causes it to exist in a determinate state (e.g. in a particular place). Therefore, God, is the necessary and sufficient cause of all states of all bodies. In this picture, bodies are left with no causal role to play, except as the "occasional causes" of God's actions.[45]

This picture of the dependence of the physical world on God does, then, effectively motivate an occasionalist understanding of the passivity of body. It justifies Berkeley's assertion in DM 36 that God, qua conserving cause, is the true and efficient cause of all things. It thereby rules out attributing any (active) forces to body and so rules out the sort of dynamic realism which Berkeley seeks to undermine in *De Motu*. The picture is a Cartesian one, traceable to Descartes' views on conservation and creation and found in the work of other prominent Cartesians, most notably Louis de la Forge.[46] It is also fully in harmony with Berkeley's metaphysics, since in Berkeley's view the ideas which make up physical bodies are caused by God. In causing their existence, he causes their properties and relations. There is thus no room left for bodies to cause motion among themselves.

In analyzing this aspect of *De Motu*, we have seen the remarkable extent to which Berkeley identifies some of the important philosophical tensions engendered by the emergence of force-based theories of motion in the 17th century. Most significantly, dynamic theories conflicted with a strict dualism

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[45]Nicolas Malebranche, "Dialogue VII," in *Dialogues on Metaphysics*, trans. Willis Doney (New York: Arabis, 1980), 157.

[46]Louis de la Forge, *Traité de l'Esprit de l'Homme*, in *Œuvres Philosophiques*, ed. Pierre Clair (Paris: Presses Universitaires de France, 1974), 242-3. It is, of course, a disputed question whether Descartes himself was committed to occasionalism. It suffices for my purposes that this be one obvious interpretation of certain of Descartes' tenets. Malebranche and de la Forge, among others, interpreted him in this way. More recently Gary Hatfield has argued forcefully that Descartes does not, in the final analysis, attribute true forces to bodies, but rather holds that God is the source of the motions of bodies. Gary Hatfield, "Force (God) in Descartes' Physics," *Studies in the History and Philosophy of Science* 10 (1979): 113-40.

according to which only minds or spirits could be characterized as active, with the widespread view that matter could not be self-moving or originate new motion, and with theological claims about the total dependence of the created world upon God. Furthermore, it was among the Cartesians that these doctrines were most strictly and firmly held. Thus, *De Motu* reveals an interesting affinity between Berkeley and the Cartesians at the intersection of physics and metaphysics, despite the deep ontological differences between them. In all these respects, Berkeley's *De Motu* is a crucial document for the history and philosophy of science.

2. The argument from unimaginability

In addition to the philosophical challenges detailed in the previous section, Berkeley also puts forward a sustained argument designed to show that dynamical realism in untenable. The core of the argument is put forward in DM 22-24:[47]

> All that which we know to which we have given the name *body* contains nothing in itself which could be the principle of motion or its efficient cause; for impenetrability, extension, and figure neither include nor connote any power of producing motion; nay, on the contrary, if we review singly those qualities of body, and whatever other qualities there may be, we shall see that they are in fact passive and that there is nothing active in them which can be understood as the source and principle of motion . . . .
>
> And so about body we can boldly state as established fact that it is not the principle of motion. But if anyone maintains that the term *body* covers in its meaning occult quality, virtue, form, and essence, besides solid extension and its modes, we must just leave him to his useless disputation with no ideas behind it, and to his abuse of names which express nothing distinctly. But the sounder philosophical method, it would seem, abstains as far as possible from abstract and general notions (if *notions* is the right term for things which cannot be understood).

[47]See also DM 29-31.

> The contents of the idea of body we know; but what we know in body is agreed not to be the principle of motion. But those who as well maintain something unknown in body of which they have no idea and which they call the principle of motion, are in fact simply stating that the principle of motion is unknown, and one would be ashamed to linger long on subtleties of this sort. (DM 22-4)

Berkeley's argument here may be summarized as follows:

(1) Physical forces are supposed to be active qualities of body.

(2) But all the known qualities of body are passive.

Thus, (3) Force is an unknown quality of bodies.

And therefore, (4) The term 'force' is empty, i.e., it does not refer.

The real grounds for Berkeley's argument are somewhat obscured by his presentation. It is crucial to notice that by 'known quality' here, Berkeley in effect means 'sensed quality' (or, better, 'quality as sensed'), for in recommending that we "review . . . those qualities of body," he is directing us to recollect our sensory experiences, not to attempt to consult intellectual or abstract concepts. Thus, (2) and (3) are relatively unproblematic; the major difficulty lies in justifying the leap to (4). Berkeley supplies the missing links elsewhere in *De Motu*, arguing in effect that (a) we cannot name what we cannot conceive and (b) conceiving of something corporeal requires having a sense-based idea of it (either an idea of sense or an idea of imagination, which in turn must have its origin in sense).[48] Thus, Berkeley grounds this argument against dynamic realism in a restrictive empiricist epistemology and a claim about the conditions required for a term to refer. Because forces cannot be imagined (activity not being a sensible quality), they cannot be conceived. Dynamic terms are therefore not referential and dynamic realism is untenable.

[48]See DM 21 and 53, in addition to DM 22-24 and DM 29-31. For more detailed analysis of this argument, see Lisa Downing, "Berkeley's Case Against Dynamical Realism," in *Berkeley's Metaphysics*, ed. Robert Muehlmann (Penn State Press, 1995), 197-214. Clearly (b) is the argument's weakest link.

D. Berkeley's solution

Berkeley's conclusion, then, is that dynamic terms ('force', 'gravity', 'impetus', etc.) do not refer to any active qualities of bodies, and thus we cannot suppose that dynamic theory provides us with a true description of the world. One response to this conclusion would be to suggest that since dynamics fails to describe the world, we ought to look for another theory of motion. This is not Berkeley's response, however. Berkeley clearly regards Newtonian dynamics, as presented in the *Principia Mathematica*, as an adequate and well-demonstrated mechanical theory, for he goes so far as to cite Newton's laws and corollaries as paradigmatic of scientific principles (DM 69). It is clear, then, that Berkeley must have held some sort of anti-realist understanding of Newton's dynamics. Indeed Berkeley's primary positive aim in *De Motu* is to advocate such an understanding of dynamics. We turn now to a closer examination of Berkeley's own view of the status of dynamics.

We should begin by examining some relevant passages:

> *Force, gravity, attraction*, and terms of this sort are useful for reasonings and computations about motion and bodies in motion, but not for understanding the simple nature of motion itself or for indicating so many distinct qualities. As for attraction, it was certainly introduced by Newton, not as a true, physical quality, but only as a *mathematical hypothesis*. (DM 17, my emphasis)

> A similar account must be given of the composition and resolution of any direct forces into any oblique ones by means of the diagonal and sides of the parallelogram. They serve the purpose of mechanical science and computation; but to be of service to computation and mathematical demonstrations is one thing, to set forth the nature of things is another. (DM 18)[49]

[49]Berkeley is referring to Newton's Corollaries I and II. See Newton, *Mathematical Principles*, 14-15.

> Action and reaction are said to be in bodies, and that way of speaking suits the purposes of mechanical demonstrations; but we must not on that account suppose that there is some real virtue in them which is the cause or principle of motion. For those terms are to be understood in the same way as the term *attraction*; and just as attraction is only a *mathematical hypothesis*, and not a physical quality, the same must be understood also about action and reaction, and for the same reason. For in mechanical philosophy the truth and use of theorems about the mutual attraction of bodies remain firm, as founded solely in the motion of bodies. . . . (DM 28, my emphasis)

The instrumentalist *tone* of these passages is unmistakable. Berkeley repeatedly emphasizes the utility of dynamics for calculations about the motions of bodies as contrasted with its unsuitability as a literal description of physical reality.

These passages raise two related questions, however, which are central to an adequate interpretation of Berkeley's position: *How* are the theorems of dynamics founded in the motion of bodies? What is a mathematical hypothesis? Berkeley provides the key to answers in sections 38 and 39 of *De Motu*:

> In mechanics also notions are premised, *i.e.* definitions and first and general statements about motion from which afterwards by mathematical method conclusions more remote and less general are deduced. And just as by the application of geometrical theorems, the sizes of particular bodies are measured, so also by the *application* of the universal theorems of mechanics, the movements of any parts of the mundane system, and the phenomena thereon depending, become known and are determined. And that is the sole mark at which the physicist must aim. (DM 38, my emphasis)

> . . . the mechanician makes use of certain abstract and general terms, supposing in bodies force, action, attraction, solicitation, *etc. which are of first utility for theories and formulations, as also for computations about motion*, even if in the truth of things, and in bodies actually existing, they would be looked for in vain, just like the geometers' *fictions* made by mathematical abstraction. (DM 39, my emphasis)

The theorems of mechanics are founded in the motions of bodies in that they are justified by their application to "the mundane system," by their ability to

"determine" or predict the motions of bodies. From the universal "theorems" we can deduce concrete predictions. Mathematical hypotheses (force, attraction, etc.) are fictions. The dynamic terms ('force', 'attraction', etc.) function purely formally in the theory, like formal variables. The theory as a whole serves as an instrument or calculating device for kinematic predictions. Berkeley's anti-realism is thus full-fledged instrumentalism.[50]

Berkeley's recommended attitude towards dynamics is indeed modern-sounding, and it is not without provocation that some have characterized Berkeley as a proto-positivist. However, these sorts of descriptions run the risk of two sorts of problems. On the one hand, they tend to obscure the contextual motivation and significance of Berkeley's project as a contribution to an ongoing debate about the status of forces in mechanics and, more generally, about the activity/passivity of the natural world. And on the other, by encouraging a narrow focus on the modern-sounding aspects of Berkeley's philosophy of

[50]Many commentators have interpreted Berkeley as a reductionist (Hinrichs, Myhill, and Brook), rather than an instrumentalist, or as vacillating between the two (Buchdahl and Newton-Smith). On the reductionist interpretation, Berkeley would hold that dynamics is reducible to kinematics, that is, he would be committed to the possibility of translating any statement apparently invoking forces into a statement merely about the motions of bodies. Instrumentalism, on the other hand, avoids any claims about translatability by regarding the theory as a whole as a calculating device. In my view, several considerations militate against the reductionist interpretation, the most important being that Berkeley always *justifies* the use of mathematical hypotheses by the *utility* of dynamics, never by the *translatability* of dynamic terms into kinematic ones, nor does Berkeley offer anything like a manual for translation. Although certain passages of *De Motu* have a reductionist ring (DM 6, 7, 11, 22), one must keep in mind Berkeley's target. A realist Newtonian mechanist of the sort Berkeley is attacking holds that forces are distinct from all sensible effects. Berkeley supposes, however, that when such a person imagines that she has a non-vacuous concept of force, it can only be that she's (illegitimately) thinking of motion or the sensation of effort. Consequently, Berkeley repeatedly emphasizes that dynamical terms don't denote *anything other* than motion, felt impact, etc.; in this context, to say that forces can't be separated from motions is just to say that *there aren't any distinct entities that are forces*. In *Siris*, it is still more clear that Berkeley is no reductionist, for he straightforwardly declares that motion, but not force, belongs to bodies (S 234, S 250). For reductionist or quasi-reductionist interpretations of Berkeley see Gerard Hinrichs, "The Logical Positivism of Berkeley's *De Motu*," *Review of Metaphysics* 3 (1950): 492; John Myhill, "Berkeley's *De Motu*--An Anticipation of Mach," in *George Berkeley*, ed. S.C. Pepper, Karl Aschenbrenner, Benson Mates, University of California Publications in Philosophy vol. 29 (Berkeley: University of California Press, 1957), 147; Brook, 117-118; Buchdahl, 287-8; W.H. Newton-Smith, "Berkeley's Philosophy of Science," in *Essays on Berkeley: A Tercentennial Celebration*, ed. John Foster and Howard Robinson (Oxford: Clarendon Press, 1985), 152.

science, they obscure the connections between that philosophy of science and other aspects of his philosophy. In other words, they promote the neglect of both the historical and philosophical context of Berkeley's instrumentalism. As I've tried to show, both contexts are crucial to understanding Berkeley's case against dynamic realism and his intended alternative.[51]

E. Instrumentalism and the revised view of explanation

In Part I, we took note of Berkeley's account of laws of nature and explanation in the *Principles*; this account undergoes significant development in *De Motu*. Berkeley's *Principles* account (according to which any simple inductive generalization counts as a law of nature and phenomena are explained by inclusion in such generalizations) faces two major problems. The first is rather basic: Satisfactory scientific theorizing seldom stops with simple inductive generalizations. If, for example, I observe that the copper roof of a newly-built building has begun to turn greenish, my generalization that this always seems to happen to copper that's exposed to the elements clearly does not provide an adequate *scientific* explanation of my observation. The second difficulty is more specific: In the *Principles*, Berkeley describes Newton's *Principia Mathematica* as "the best key" for natural science (PHK 110). Yet Newton's laws of motion, the foundation of his mechanical system, are not the products of simple inductive generalization, and they do not each correspond to a simple regularity in the

[51]I have room here only to gesture at one other important aspect of the philosophical context of Berkeley's instrumentalism. In the seventh dialogue of *Alciphron*, Berkeley develops an theory of significance according to which language can be significant, despite not suggesting ideas, by guiding or inspiring action. (This account is foreshadowed to some extent in the Draft Introduction to the *Principles*.) He specifically applies his account of action-guiding language to the case of dynamics, suggesting that dynamic terms acquire a sort of significance through their role in a system of action-guiding rules. Thus, Berkeley's views about language help to give further content to the instrumentalism he defends in *De Motu*.

phenomena. Thus, in the *Principles*, it's unclear how Berkeley could regard Newton's laws as laws of nature which explain the motions of bodies.

In *De Motu*, Berkeley refines his account of natural laws and explanation in a way which alleviates the two difficulties just diagnosed and supports his dynamical instrumentalism. The key change in *De Motu* is Berkeley's new emphasis on the importance of the *generality* of scientific laws in properly scientific explanation:

> Similarly in mechanical philosophy those are to be called principles, in which the whole discipline is grounded and contained, those primary laws of motions which have been proved by experiments, elaborated by reason and rendered universal. These laws of motion are conveniently called principles, since from them are derived both general mechanical theorems and particular explanations of the phenomena.
>
> A thing can be said to be explained mechanically then indeed when it is reduced to those most simple and universal principles, and shown by accurate reasoning to be in agreement and connection with them. For once the laws of nature have been found out, then it is the philosopher's task to show that from the constant observance of these laws, that is from these principles, any phenomena necessarily follow. In that consist the explanation and solution of phenomena. . . . (DM 36-37)

Thus, in *De Motu*, Berkeley develops a specialized sense of 'law of nature', according to which the laws of nature are the most general principles from which observed regularities in the phenomena can be deduced. A phenomenon is scientifically explained, then, when it is shown to follow from these most general principles.

In keeping with this revised conception of laws of nature, Berkeley no longer describes the scientist as merely inductively collecting laws from observation, rather the laws are "proved by experiments, elaborated by reason and rendered universal." Likewise, in *Siris* Berkeley states that "the natural or mechanic philosopher endeavours to discover those laws by experiment and reasoning"(S 234).

Since laws of nature may transcend simple inductive generalizations, Newton's laws become legitimate candidates for natural laws. Berkeley's *De Motu* view of laws of nature and scientific explanation permits him to confer this status upon Newton's laws, since we can deduce from them innumerable regularities in the motions of bodies and observed motions can be explained by being shown to follow from Newton's laws (given initial conditions). Berkeley maintains that Newton's laws can play this role without having to be regarded as factual statements, for their importance lies in their applicability, not in descriptive content (which Berkeley ultimately thinks they lack). Thus Berkeley's *De Motu* view of laws of nature and scientific explanation legitimates his instrumentalist attitude towards Newtonian dynamics by dictating that Newton's laws, construed instrumentally, do count as laws of nature and do provide scientific explanations of kinematic phenomena. Moreover, the revised notions of laws of nature and scientific explanation that Berkeley puts forward in *De Motu* more accurately reflect the actual practice of science, which values generality in its theories, than his *Principles* view, which allowed that any inductive generalization explains its instances.

Although Berkeley's *De Motu* view of the aims of science clearly represents an improvement over his view in the *Principles*, it nevertheless provokes further questions. In particular, while Berkeley's *De Motu* view does capture the *fact* that science aims at general theories, one might well ask how Berkeley explains *why* science should seek generality, why more general laws provide more adequate scientific explanations. One response that might seem to be open to Berkeley is to assert that more general laws are more likely to accurately reflect God's volitions, since God's nature leads him to work in simple ways. However, this is not a response that Berkeley actually gives; in general, he

seems reluctant to suppose that we can conclude much from our limited knowledge of God's nature.[52]

The response that seems most in accord with Berkeley's stated views is the following: General laws are preferable for pragmatic reasons; we can do more with them--make more predictions, correlate more data, etc. The nature of this response brings out the fact that Berkeley's notion of scientific explanation is a highly pragmatic one, so much so that one might wonder whether it really deserves to be called a notion of *explanation* at all. Certainly, Berkeley himself acknowledges a more full-bodied sort of explanation, causal explanation, which he holds to be the province of metaphysics or theology, rather than science:

> Physically, therefore, a thing is explained *not by assigning its truly active and incorporeal cause*, but by showing its connection with mechanical principles. . . . (DM 69, my emphasis)

> Only by meditation and reasoning can truly active causes be rescued from the surrounding darkness and be to some extent known. To deal with them is the business of first philosophy or metaphysics. And if each science were allotted its own province, its bounds assigned, the principles and objects belonging to it accurately distinguished, it would be possible to treat each with greater ease and clarity. (DM 72)[53]

Moreover, Berkeley holds that in order to truly and completely "account for the phenomena," we *must* treat their efficient cause:

> We cannot make even one single step in accounting for the phenomena without admitting the immediate presence and immediate action of an incorporeal Agent, who connects, moves, and disposes all things according to such rules, and for such purposes, as seem good to Him. (S 237)

Although Berkeley describes himself as analyzing how science explains, it might be less misleading to describe him as putting forward a new view of the

[52]Although he assumes that we can know that God is benevolent and rational, and he maintains that this should give us confidence in our laws of nature.
[53]See also S 231.

aims of science, rather than a new view of scientific explanation. Berkeley's position, under this description, is that science does not aim at *explanation* (which makes reference to causes) but rather at a certain sort of useful *understanding* of nature (which he is happy to call 'explanation'), akin to the sort of understanding of a language that we gain from studying its grammar:

> There is a certain analogy, constancy, and uniformity in the phenomena or appearances of nature, which are a foundation for general rules: and these are a grammar for the understanding of nature, or that series of effects in the visible world whereby we are enabled to foresee what will come to pass in the natural course of things. (S 252)

Newton's dynamics, construed instrumentally, provides precisely the sort of understanding that Berkeley takes to be the ultimate aim of science. Thus, Berkeley's considered view of the aims and workings of natural science complements and supports his instrumentalism about dynamics.

At this point, we are in a position to appreciate another problem with applying the proto-positivist tag to Berkeley, namely, it suggests a serious misreading of Berkeley's reformist project in *De Motu*. Berkeley's aim in *De Motu* is not, as the positivist label implies, to free physics from the tyranny of metaphysics. Indeed, Berkeley's aim is more nearly the reverse: clearly Berkeley wishes to insulate metaphysics, and in particular, his idealist metaphysics, from the new science. As the passages quoted above illustrate, Berkeley's prescription privileges metaphysics by placing causal explanation within its domain. Berkeley is quite blunt about this result in *Siris*:

> Certainly, if the explaining a phenomenon be to assign its proper efficient and final cause, it should seem the mechanical philosophers never explained anything; their province being only to discover the laws of nature, that is, the general rules and methods of motions, and to account for particular phenomena by reducing them under, or shewing their conformity to, such general rules. (S 231)

Of course this should not be taken to suggest that Berkeley can be depicted as some sort of anti-science reactionary. On the contrary, he was a sincere and enthusiastic Newtonian precisely because his instrumentalist prescription for dynamics allowed him to be: If dynamics can be given an instrumentalist reading, than we have no a priori reason to prefer Newtonian physics to Cartesian physics-- the theories must be judged by their results. Its clear what Berkeley thought the verdict should be:

> Nature seems better known and explained by attractions and repulsions than by those other mechanical principles of size, figure, and the like; that is, by Sir Isaac Newton than Descartes. (S 243)

III. Berkeley and the aether

> This aether or pure invisible fire, the most subtle and elastic of all bodies, seems to pervade and expand itself throughout the whole universe. If air be the immediate agent or instrument in natural things, it is the pure invisible fire that is the first natural mover or spring from whence the air derives its power. This mighty agent is everywhere at hand, ready to break forth into action, if not restrained and governed with the greatest wisdom. Being always restless and in motion, it actuates and enlivens the whole visible mass, is equally fitted to produce and to destroy, distinguishes the various stages of nature, and keeps up the perpetual round of generations and corruptions, pregnant with forms which it constantly sends forth and resorbs. So quick in its motions, so subtle and penetrating in its nature, so extensive in its effects, it seemeth no other than the vegetative soul or vital spirit of the world. S 152

Siris, published in 1743, was Berkeley's last major work. It is undeniably an odd book, at least from the perspective of a student of Berkeley's early philosophical works; there are discontinuities of both style and substance between *Siris* and

the *Principles*. The continuities, however, are also striking, and merit more scholarly attention that they have heretofore received.[54]

In particular, *Siris* exhibits very strongly Berkeley's lifelong interest in natural philosophy and, more specifically, his interest in Newton's works. Nevertheless, the result is a work of a very different character from *De Motu*. Whereas in *De Motu*, Berkeley constructs a (narrowly) philosophical critique of the Newtonianism of the *Principia*, in *Siris* Berkeley produces a (broadly) philosophical meditation inspired by the Newtonianism of the Queries to the *Optics*.

At the heart of *Siris* is the aether or invisible fire described above. Berkeley's enthusiasm for the aether clearly owes much to Newton, but his characterization of it is more directly inspired by the work of Hermann Boerhaave, the Dutch chemist, botanist, and physician whose teachings were highly influential in mid-eighteenth century Britain.[55] Boerhaave, along with other Dutch natural philosophers cited by Berkeley, assigned a central role in accounting for physio-chemical activity to fire, a subtle, insensible particulate substance, sometimes identified with light.[56]

In order to understand why Berkeley accords this aether such a central role in *Siris*, we must take into consideration the aims of the book, which were

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[54]My own *general* interpretive attitude towards *Siris*, which I cannot defend at any length here, is that it can for the most part be rendered consistent with the metaphysics of Berkeley's early works (as indeed Berkeley thought it could be), although the results are not always appealing. And, while Berkeley had not given up his idealism when he wrote *Siris*, he *had* abandoned some of his former motivations for it--strict empiricism and a desire to uphold common sense against skepticism, for example.

[55]On Berkeley's debt to Boerhaave, see Jessop's introduction to *Siris*, *Works*, Vol. V, 11. Jessop also collects relevant passages from the *Elementa Chemiae* as Appendix II to *Siris*. See also I.C. Tipton, 'The "Philosopher by Fire" in Berkeley's *Alciphron*,' in *Berkeley: Critical and Interpretive Essays*, ed. Colin Turbayne (Minneapolis: University of Minnesota, 1982), 161. On Boerhaave's views and his influence in Britain, see Schofield, 134-157. The *Elementa Chemiae* was published in 1732 and translated into English in 1735 and again in 1741. An unauthorized edition compiled from student lecture notes had been published in 1724 and translated into English in 1727.

[56]Berkeley also mentions Nieuwentyt and Homberg, S 189-90.

three-fold: "to communicate to the public the salutary virtues of tar-water,"[57] to provide scientific background supporting the efficacy of tar-water as a medicine, and to lead the mind of the reader, via gradual steps, toward contemplation of God.[58] The latter two aims shape Berkeley's extensive use of contemporary natural science in *Siris*: the "activity" of the aether, in his view, can both explain the miraculous virtues of a certain medicine, i.e. tar-water, and reveal God's divine order (S 237-9).

Limitations of space prevent us from following out the "chain of philosophical reflexions" that constitute *Siris*; but we should touch briefly on the relations of *Siris'* philosophy of science to Berkeley's earlier views. In this area, the continuities with Berkeley's earlier work are very strong indeed.[59]

Berkeley makes heavy use of dynamic notions such as forces, attractions, and repulsions in *Siris*, most notably in his description of the aether, which is supposed to "operate" by means of forces (S 162). However, Berkeley also makes clear that the dynamic elements of his theorizing are to be understood instrumentally, not as literal attributions of real forces to particles; to say that certain particles attract or are attracted is just to say that their movements agree with certain laws (S 231). Indeed, some of Berkeley's most explicit declarations that physical bodies are not and cannot be invested with force are to be found in *Siris* (S 234).

Moreover, Berkeley makes clear that his tendency to dignify the aether with titles such as "mighty agent" should likewise not be taken at face value. The

[57]*Siris*, Berkeley's introductory paragraph, *Works* , Vol. V, p. 31.
[58]On the last, see S 297, 303.
[59]For a detailed treatment of aspects of Berkeley's natural philosophy in *Siris*, see Gabriel Moked, *Particles and Ideas: Bishop Berkeley's Corpuscularian Philosophy*. (Clarendon Press, Oxford, 1988).

aether is, despite its subtlety, corporeal, and Berkeley remains firm in his conviction that no corporeal things can be true efficient causes:[60]

> We have no proof, either from experiment or reason, of any other agent or efficient cause than mind or spirit. When, therefore, we speak of corporeal agents or corporeal causes, this is to be understood in a different, subordinate, and improper sense. (S 154)

> Therefore, though we speak of this fiery substance as acting, yet it is to be understood only as a mean or instrument, which indeed is the case of all mechanical causes whatsoever. They are, nevertheless, sometimes termed agents and causes, although they are by no means active in a strict and proper signification. . . . In compliance with established language and the use of the world, we must employ the popular current phrase. But then in regard to truth we ought to distinguish its meaning. It may suffice to have made this declaration once for all, in order to avoid mistakes. (S 155)

What is more deeply puzzling about *Siris*, from this perspective, is Berkeley apparent realism about the aether: he seems to treat the aether as something known to exist rather than as a "mathematical hypothesis" (S 281). This puzzle may be partially resolved by noting that Berkeley's reasons for treating forces as mere mathematical hypotheses center on their purported activity. Since the aether is not truly active, a realistic treatment of aether is not ruled out.[61] More specifically, accepting the existence of aether does not give rise to the sort of conceptual problems diagnosed by Berkeley in *De Motu*. Nor does it violate the epistemological and semantic doctrines appealed to in Berkeley's argument from unimaginability, for the aether is corporeal and particulate, i.e. it possesses parts with size, shape, weight etc. (S 162, 207). Because the aether

[60]By 'corporeal,' Berkeley still ultimately means 'ideal,' as is made clear in S 251, quoted below, and S 292.

[61]The question of the compatibility of the actual existence of the aether with Berkeley's *esse est percipi* principle is, however, a delicate one. See Wilson, 131-148; Winkler, *Berkeley*, 263-275; and Downing, "*Siris* and the Scope of Berkeley's Instrumentalism."

possesses qualities of a sensible kind, it is imaginable and hence conceivable. Realism about aether is thus tenable in a way that realism about forces is not.

Thus, Berkeley's use of natural philosophy in *Siris* is not obviously in conflict with his philosophy of science laid out in *De Motu*. Moreover, aspects of that philosophy of science find their fullest and finest articulation only in *Siris*:

> It passeth with many, I know not how, that mechanical principles give a clear solution of the phenomena. The Democritic hypothesis, saith Dr. Cudworth, doth much more handsomely and intelligibly solve the phenomena than that of Aristotle and Plato. But, things rightly considered, perhaps it will be found not to solve any phenomenon at all; for all phenomena are, to speak truly, appearances in the soul or mind; and it hath never been explained, nor can it be explained, how external bodies, figures, and motions, should produce an appearance in the mind. Those principles, therefore, do not solve, if by solving is meant assigning the real, either efficient or final, cause of appearances, but only reduce them to general rules. (S 251)

> We know a thing when we understand it; and we understand it when we can interpret or tell what it signifies. (S 253)

> ...the phenomena of nature, which strike on the senses and are understood by the mind, form not only a magnificent spectacle, but also a most coherent, entertaining, and instructive Discourse; and to effect this, they are conducted, adjusted, and ranged by the greatest wisdom. This Language or Discourse is studied with different attention, and interpreted with different degrees of skill. But so far as men have studied and remarked its rules, and can interpret right, so far they may be said to be knowing in nature. A beast is like a man who hears a strange tongue but understands nothing. (S 254)