Studies in History and Philosophy of Science 105 (2024) 165–174

Contents lists available at ScienceDirect

Studies in History and Philosophy of Science

journal homepage: www.elsevier.com/locate/shpsa

Berkeley on true motion

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ARTICLE INFO

Keywords:
Absolutism
Relativism
True motion
George Berkeley
Instrumentalism

ABSTRACT

Studies of the Early Modern debate concerning absolute and relative space and motion often ignore the significance of the concept of true motion in this debate. Even philosophers who denied the existence of absolute space maintained that true motions could be distinguished from merely apparent ones. In this paper, I examine Berkeley's endorsement of this distinction and the problems it raises. First, Berkeley's endorsement raises a problem of *consistency* with his other philosophical commitments, namely his idealism. Second, Berkeley's endorsement raises a problem of *adequacy*, namely whether Berkeley can provide an adequate account of what grounds the distinction between true and merely apparent motion. In this paper, I argue that sensitivity to Berkeley's distinction between what is true in the metaphysical, scientific, and vulgar domains can address both the *consistency* and the *adequacy* problems. I argue that Berkeley only accepts true motion in the scientific and vulgar domains, and not the metaphysical. There is thus no inconsistency between his endorsement of true motion in science and ordinary language, and his metaphysical idealism. Further, I suggest that sensitivity to these three domains shows that Berkeley possesses resources to give an adequate account of how true motions are discovered in natural science.

1. Introduction

The development of classical mechanics brought with it a renewed interest in the metaphysics of space and motion. Most studies of the early modern debates over the nature of space and motion have focused on the division between *absolutism* and *relativism,* with Newton the quintessential absolutist and Leibniz the quintessential relativist. An almost exclusive focus on this division has elided another distinction which was equally important to the early modern philosophers involved in the controversy over the metaphysics of motion and space. This is the distinction between *true* and *merely apparent* motion. Most natural philosophers in the period, whether they believed in absolute space or not, nevertheless contended that there is a fact of the matter as to what a body's *true* motion is, to be distinguished from the way it might appear from a particular vantage point.[1] A classic problem considered in the early modern period illustrates the importance of the distinction: one could say that the earth is at rest and that the sun and planets truly move around it, or that the sun is at rest and that the earth and other planets truly move around it. As the evidence for heliocentrism mounted, even philosophers who denied absolute space and motion nevertheless affirmed that the earth truly moves around the sun, and not *vice versa*. George Berkeley is one of these philosophers, and thus is committed to the distinction between true and merely apparent motion.[2]

The rejection of absolute space raises difficulties for philosophers who wish to affirm that there are true motions. Foremost is the difficulty of specifying by what criterion true motions are distinguished from merely apparent or relative motions. For absolutists about space, the solution is simple: true motion is motion in absolute space.[3] For relativists about space, there is some difficulty in specifying an appropriate reference frame which does not depend on absolute space but is nevertheless capable of grounding true motion. Indeed, Marius Stan has argued that in the early modern period, *only* the absolutists provided an

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[1] Examples of natural philosophers who accepted the distinction between true and merely apparent motion include Descartes, Leibniz, and Newton. Indeed, among the early moderns it was perhaps only Christian Huygens who denied true motion in favor of a strict relativism (Stan 2016b, pp. 281–282).

[2] Examples of those who recognize that Berkeley endorses true motion (in those terms) are Stan (2016a, p. 261), Rynasiewicz (2000, p. 74), Winkler (1986, p. 29), and Brook (1973, pp. 141–142). Downing (2005, p. 237) acknowledges that Berkeley endorses a distinction between "real and apparent motion," but claims the distinction is "merely pragmatic." Similar terminology is used to describe the distinction by Asher (1987, pp. 452–453). While it is not always put in terms of "true motion," these commentators all recognize that Berkeley attempts to salvage some distinction between the merely apparent motion of a body and the actual motion of a body.

[3] Of course, the absolutist faces the related epistemological problem of accounting for how we can know the true motions of bodies given that we can not perceive absolute space.

https://doi.org/10.1016/j.shpsa.2024.05.015
Received 30 April 2023; Received in revised form 9 May 2024; Accepted 14 May 2024
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adequate criterion for true motion.[4] If Stan is correct, then Berkeley will have failed to provide an adequate criterion for true motion.

The issue of providing an extensionally adequate criterion for true motion was felt by the critics of absolutism, and Berkeley is no exception. In the *Principles* and *De Motu*, Berkeley spends almost as much time sketching a solution to the issue as he does arguing against the absolutism of Newton's *Principia*.[5] Berkeley's attempt to address the issue is both interesting and riddled with its own puzzles, which can be broken down into problems of *consistency* and problems of *adequacy*. Regarding consistency, there are two questions. First, there is the question of whether Berkeley's metaphysical commitments are consistent with his claims about true motion, since Berkeley's idealist concept of motion appears to be inconsistent with the existence of true motions.[6] Second, Berkeley adopts Newton's own criterion for identifying true motions, which claims that true motion is motion that is the result of the application of a force. This appears to be in tension with Berkeley's rejection of the existence of physical forces in *De Motu.* Thus by endorsing true motion, Berkeley appears to make commitments that are at odds with other important tenets of his philosophy, namely his idealism and his dynamical anti-realism. Grouped together, these two questions form for Berkeley what I will call the *consistency problem*. Additionally, the question arises whether Berkeley actually provides an adequate criterion for true motion. According to Stan, because Berkeley rejects absolutism, he must provide an alternative account of what grounds true motion (which is particularly crucial because Newton's mechanics depends on the concept of true motion). Call this the *adequacy problem.*[7]

In this paper, I develop an interpretation of Berkeley's views on motion that responds to the consistency problem and the adequacy problem. Central to my interpretation is the distinction between three "domains" in Berkeley's philosophy, each with its own truth conditions. These domains are the metaphysical, the scientific, and the vulgar.[8] Given that in Berkeley's view the aims of these domains diverge, we can expect to find that what is true according to each will also diverge. I argue that Berkeley is best understood to be denying that, metaphysically speaking, there are any true motions. When Berkeley claims there are true motions, I argue he intends this to be true only scientifically and vulgarly speaking. This distinction solves the consistency problem because it shows that Berkeley's metaphysical views on motion are not inconsistent with the existence of true motion according to science or ordinary language. Furthermore, the force criterion is unproblematic, because neither forces nor true motions actually exist, rather they are only adopted for their usefulness in science and ordinary language. Regarding the adequacy problem, on my interpretation Berkeley is not constrained to provide an answer to the metaphysical question of what *grounds* true motion, because he does not think there is true motion metaphysically speaking. This leaves only the problem of offering a practical method in science for distinguishing between true and merely apparent motions. Given that Berkeley claimed to distinguish true and apparent motions in science in exactly the same manner as Newton, Berkeley took himself to have given an adequate theory of true motion.

Throughout the paper, I adopt the helpful taxonomy of positions introduced by Marius Stan, aimed at correcting ambiguities in previous work on absolute and true motion throughout the history of philosophy:

> **Completism:** There is a fact of the matter as to what the velocity of a body is, called its "true motion."
>
> **Absolutism:** Absolute space exists; a body's true motion is its velocity in absolute space.
>
> **Relationism:** Absolute space does not exist; a body's true motion is its velocity in relation to some other privileged body or reference frame.
>
> **Relativism:** Absolute space does not exist; bodies do not have true motions, and all apparent motions from various reference frames are equally legitimate descriptions of the body's motion.[9]

Cast this way, absolutism and relationism are competing hypotheses about how completism is to be explained, and the subject of their disagreement concerns whether absolute space exists and can play the role of conceptually distinguishing true motions from merely apparent ones. Relativism is the denial of completism, and is on the face of it the more radical position, since it denies that there is a fact of the matter as to whether a body moves or is at rest.[10] It agrees with relationism in that it denies that absolute space can distinguish true motions from apparent ones, but disagrees in that it denies that there is any *other* way to distinguish true motions from apparent ones.

What follows is a roadmap for the paper. In section II, I present evidence which pushes Berkeley towards relativism. Section III delineates three different sorts of completism (metaphysical, scientific, and vulgar), and makes the case that although Berkeley denies metaphysical completism, he nevertheless endorses scientific and vulgar completism. Sections IV and V deploy the distinction between metaphysical and scientific completism to solve the remaining consistency problem (IV) and adequacy problem (V). Section IV argues that Berkeley's acceptance of Newton's force criterion is consistent with his dynamic antirealism, and Section V argues that Berkeley avoids Stan's challenge of providing a ground for inertial mechanics with an adequate criterion for true motion.

[4] Stan (2021, pp. 4–5).

[5] In the *Principles,* Berkeley uses sections §113–115 to explain his solution, and only section §116 to argue against Newton's absolutism. In *De Motu*, he uses sections §64–65 to explain his solution, and sections §54–63 to argue against absolutism.

[6] By "idealist concept of motion" I intend to signal that Berkeley thinks that motion must be perceivable as an idea. If one prefers the term "empiricist" or "phenomenalist," there is no significant difference in implication for Berkeley's views on true motion; all intimate the problem of the perceivability of true motion caused by Berkeley's philosophical commitments.

[7] While Berkeley's theory of motion has inspired a significant amount of commentary, the consistency and adequacy problems have not received much attention. Instead, commentators have largely been occupied with Berkeley's arguments against absolute space and absolute motion: most prolifically in his critique of Newton's bucket experiment in *Principles* §114 and *De Motu* §60–62. This focus is on display in, for example, Popper (1953), Whitrow (1953), Suchting (1968), Brook (1973), Grey (1973), Winkler (1986), and Asher (1987). As noted above in fn. 2, some of these authors have at least recognized Berkeley's attempts to give a theory of true motion, but this theory has not been given sustained treatment - Winkler (1986) perhaps comes closest to giving an account of true motion, but his primary focus is on the role of the fixed stars in Berkeley's philosophy. The part of Berkeley's theory of true motion that has received the most attention is his endorsement of the force criterion (i.e., the second component of the consistency problem), which has been explored by Winkler (1986), Asher (1987), and Downing (2005). However, no one has made explicit the apparent tension between Berkeley's metaphysical concept of motion and the endorsement of completism, and thus no one has responded to this apparent worry. Finally, no one has yet answered Stan's adequacy challenge for the relationists on Berkeley's behalf.

[8] The inspiration for the label of "vulgar" comes from Berkeley's use of the term to refer to the person of common-sense, as in his famous appellation to "think with the learned, and speak with the vulgar" (*Principles* §51). I do not intend any negative connotations by using the term, nor does Berkeley. Thanks to Lisa Downing for suggesting this label.

[9] Stan (2021, p. 2; cf. 2016b, p. 279). The definitions of each are my own, though based on Stan's work.

[10] In fact, there appears to be only one obvious candidate for a thoroughgoing relativist in the Early Modern period: Christian Huygens (Stan, 2021, p. 3; 2016b, pp. 281–282). Besides Huygens, Stan claims that Leibniz asserted relativism early in his career, but rescinded it in favor of relationism (Stan, 2016b, p. 281). Cf. Rynasiewicz (2000, p. 76).

2. Completism and Berkeley's Concept of Motion

Completism is the view that there is true motion, meaning there is a fact of the matter as to what the velocity of a body is. That there is a fact of the matter allows the completist to distinguish true motions from merely apparent motions. For example, the completist might affirm that the earth truly revolves around the sun, and not *vice versa*; that is, the apparent motion of the sun from our vantage point is just that, merely apparent but not true. Or, if I stand on a boat on a river and another boat passes me, the completist can say that the other boat truly moves while I am truly at rest with respect to the other boat, even if it appears to the passenger on the boat that I move and that their boat is at rest. By denying completism, the relativist cannot say these things. The absolutist appeals to absolute space as the reference frame by which true motions are distinguished from merely apparent ones, but in doing so faces a number of puzzles about absolute space. The relationist attempts to have it both ways. They agree with the absolutist that completism is true, but deny the existence of absolute space, thus avoiding the puzzles associated with it.

In denying absolutism, Berkeley is apparently caught between relationism and relativism. On the one hand, Berkeley makes clear his commitment to some form of completism in both the *Principles* and *De Motu*[11]:

> But though in every motion it be necessary to conceive more bodies than one, yet it may be that one only is moved, namely that on which the force causing the change of distance is impressed, or in other words, that to which the action is applied. For however some may define relative motion, so as to term that body *moved*, which changes its distance from some other body, whether the force or action causing that change were applied to it, or no: yet as relative motion is that which is perceived by sense, and regarded in the ordinary affairs of life, it should seem that every man of common sense knows what it is, as well as the best philosopher: now I ask any one, whether in his sense of motion as he walks along the streets, the stones he passes over may be said to *move,* because they change distance with his feet? To me it seems, that though motion includes a relation of one thing to another, yet it is not necessary that each term of the relation be denominated from it. (*Principles* §113)[12]

> … [T]o determine true motion and true rest, for the removal of ambiguity and for the furtherance of the mechanics of these philosophers who take the wider view of the system of things, it would be enough to bring in, instead of absolute space, relative space as confined to the heavens of the fixed stars, considered as at rest. (*De Motu* §64)[13]

Consider first *Principles* §113, where Berkeley makes two important points. First, Berkeley states that even though motion is a relation between two bodies, only one is properly said to be moved - the one on which the force or action is applied. One body is *truly moving*, while the other is not. Second, Berkeley justifies his endorsement of completism by appealing both to common sense and philosophy. Berkeley explains that in the case of the motion of one's feet along the street, the foot truly moves, and the stones on the street do not, and this is understood by "every man of common sense … as well as the best philosopher."[14] Although Berkeley does not here use the term "true motion,"[15] his explanation of the case clearly implies that we must draw a distinction between apparent and actual motions, and thus is a clear endorsement of completism. This implication is corroborated by *De Motu* §64 where Berkeley uses the term "true motion," claiming that true motion is consistent with the denial of absolute space, and thus affirming a form of relationism. If Berkeley were not a completist in some sense of the term, he could not have said what he says in this passage.

However, Berkeley's other metaphysical commitments appear to imply that completism is false, and that relativism must be true. Consider Berkeley's criticism of Newton's absolutism in *Principles* §112:

> … it doth not appear to me, that there can be any motion other than *relative:* so that to conceive motion, there must be at least conceived two bodies, whereof the distance or position in regard to each other is varied. Hence if there was one only body in being, it could not possibly be moved. This seems evident, in that the idea I have of motion doth necessarily include relation. (*Principles* §112)

Berkeley's argument is familiar in style to many of his other arguments against problematic metaphysical entities. He starts with a concept or idea derived from experience, and argues that such a conception is incompatible with the existence of the problematic metaphysical entity. In this case, Berkeley's concept of motion is found to be incompatible with the existence of absolute motion, because his concept of motion includes relation between two or more bodies. This is made even clearer in *De Motu*:

> … it is clear that we ought not to define the true place of the body as the part of absolute space which the body occupies, and true or absolute motion as the change of true or absolute place; for all place is relative just as all motion is relative … no motion can be understood

[11] A note on my use of passages from *De Motu* in this paper. Given that Berkeley wrote *De Motu* for an essay prize which would have had a Cartesian audience, there is some reason to be cautious in attributing to Berkeley the views he endorses within. My own view (in keeping with Downing 1995b; 2005; Jesseph, 1992, pp. 33–37) is that while Berkeley certainly appears to have suppressed certain elements of his idealism in the work, I see almost no evidence to suggest that the views he advances in *De Motu* are inconsistent with his views in his other major works, including the *Principles* and *Dialogues* (see especially Downing, 2005, pp. 237–238 and p. 259n19, Downing, 1995a, p. 198). Indeed, Berkeley's remarks on space and motion, though more developed than his remarks on the same topic in the *Principles,* often allude to or restate his views from the *Principles* (Jesseph, 1992, p. 34). Berkeley also refers back to the work in the *Correspondence with Samuel Johnson* and *Siris* without caveat, serving as further evidence that he was not dissembling in the work (Jesseph, 1992, pp. 34–35).One final piece of evidence to consider relating specifically to the topic of space and motion is that there would be no reason for Berkeley to dissemble on this topic for a Cartesian audience; indeed Berkeley's views on space and motion expressed outside of *De Motu* actually favor the Cartesians (as relationists) rather than the Newtonians (as absolutists). I thus see no reason not to trust that Berkeley's remarks in *De Motu* reflect his considered opinion about the nature of space and motion, and will cite it as evidence of Berkeley's views on true motion.

[12] References to Berkeley's works will name the work and section number or page number, where applicable. Quotations from the *Principles of Human Knowledge* are from Berkeley (1949a); quotations from *De Motu* are from Berkeley (1992); quotations from *Three Dialogues* are from Berkeley (1949b); quotations from the *Philosophical Commentaries* are from Berkeley (1989).

[13] The primary evidence for Berkeley's endorsement of true motion and therefore completism comes from these two excerpts and the surrounding passages, particularly *Principles* §113–115 and *De Motu* §64–65, which will be discussed in further detail throughout the paper.Other evidence for Berkeley's endorsement of true motion comes from places where he discusses the motion of the earth or the planets. For example, in *Principles* §58, Berkeley argues that his idealism is consistent with the claim that the earth moves around the sun, implying that he agrees that the earth does in fact move around the sun, and not *vice versa*. See also *Principles* §55, where Berkeley similarly appears to endorse the claim that the earth moves, and the similar discussion of Copernicanism in *Dialogues* p. 238 and *De Motu* §62. Finally, see also *Dialogues* p. 210 for a mention of the motions of the planets.

[14] The fact that Berkeley here refers not just to common sense, but also to "the philosopher" is important for dispelling the worry that Berkeley thinks talk of true motion is merely conventional but not true.

[15] Although Berkeley does not use the term "true motion" in *Principles* §113, he does in §114, and his discussion of motion in §113 is consistent with this concept, hence why I see no reason not to use the term to describe his view in §113.

> without some determination or direction, which in turn cannot be understood unless besides the body in motion our own body also, or some other body, be understood to exist at the same time. For *up, down, left*, and *right* and all places and regions are founded in some relation, and necessarily connote and suppose a body different from the body moved. (*De Motu* §58)

Here again, Berkeley makes clear that his concept of motion is that of the change in position of one body with respect to some other *body*. No other candidate reference frames are allowed, including absolute space. Presumably, this follows from Berkeley's reliance on experience as the principal source of all of our ideas and notions; motion is no exception. Our experience of motion is the perception of change in position of one body with respect to at least one other. Given that we have no other idea of motion besides this, our metaphysics must reflect that.[16] Such a conception of motion clearly rules out the possibility of absolute motion, but it also threatens to rule out the possibility of true motion altogether.

Consider the existence of two bodies *A* and *B* whose position with respect to one another are changing over time. For simplicity, let us assume that either *A* truly moves and *B* is at rest, or *B* truly moves and *A* is at rest. Of *A*, we can ask the question, is it truly moving with respect to *B*, or is it at rest with respect to *B*? To determine which is the case, we would need to select a privileged reference frame anchored to another body *C*, from which the apparent motions of *A* and *B* can be observed. Suppose from *C, A* appears at rest and *B* appears to move. But then the question can be asked, does *C* move with respect to a resting *B,* or *vice versa*? A regress threatens to ensue. The implication is that we could never know whether it is *A* or *B* that is truly in motion, because for any candidate reference frame anchored to *C*, the question can be asked whether *C* is in motion or at rest with respect to *A* and *B*. Given that Berkeley rejects Newton's absolute space on account of its being unknowable (*Principles* §111), he should also reject true motion on account of its being unknowable.

One might attempt to stop the regress by claiming that for some reference frame *C*, when the question is asked, "is it *C* that moves with respect to *A* or *vice versa*?" we can simply appeal again to *C*, thus stopping the regress. However, aside from simply begging the question, this also has the implication that there exists some body *C* that is always at rest. This implication is strange and apparently unacceptable, for it would imply (for Berkeley) that completism is contingent on God choosing to create a body that does not move. Furthermore, there would be no way to know which body does not move, given that all bodies from some reference frame have apparent motion. (Even the "fixed stars", which from our perspective appear not to move relative to one another, still appear to move with respect to us, or other astronomical bodies like the sun, moon, and planets, and comets.)[17] Again, since Berkeley rejects absolute space on account of its unknowability, he must reject this completist account for the same reason. Attempting to stop the regress by positing a fundamental unmoving reference frame thus fails to allow Berkeley to accept completism.

It is worth noting that though the above argument has been cast in the abstract, the predicament described applies in ordinary concrete scenarios as well. Consider a sailor on a ship moving across the sea. The sailor perceives the motion of the water with respect to the boat. Though common sense says the boat moves and the water does not, what reference frame grounds this fact? It cannot be absolute space. For any other candidate reference frame anchored to a body, there will be an apparent motion between either the frame and the water or the frame and the boat. For example, if the earth is used as a reference frame, then from the perspective of the earth, it appears that the water rests and the boat moves. But then the question remains, is the earth moving and the boat at rest, or *vice versa*? To answer this, another reference frame is required, and thus another physical body. The regress ensues. Even though common sense clearly favors saying the boat moves and the water does not, Berkeley's idealist conception of motion appears to rule out such claims. Therefore, there is an apparent tension in Berkeley's views; it appears he cannot both affirm completism and affirm his idealist concept of motion.

3. Metaphysical, Scientific, and Vulgar Completism

Berkeley thus appears to both endorse completism, and to have strong reason to deny completism given his metaphysics. In this section, I will outline a framework for dispelling the apparent tension between Berkeley's endorsement of completism and his relativist conception of motion in which I will distinguish between three types of completism. I will argue that textual evidence supports attributing to Berkeley the denial of metaphysical completism, and the acceptance of both scientific and vulgar versions of completism. Interpreting Berkeley in this way dissolves the apparent tension between his idealist commitments and his affirmations of completism.

One could affirm completism in different domains. Most basically, one could assert that among whatever entities really or fundamentally exist,[18] there is a fact of the matter as to which are truly moving and which only apparently move. Supposing that the earth and the sun really exist, this version of completism could say that as a matter of metaphysical fact, the earth moves around the sun, and the apparent motion of the sun around the earth is merely apparent. However, the ontology of metaphysics can be distinguished from the ontology of science and the ontology of ordinary language, and indeed we can expect these ontologies to differ if one believes that metaphysics, science, and ordinary language have different aims. A familiar example is the scientific instrumentalist, who may have good reason to allow some entities (e.g. forces) into scientific theory while denying their actual existence. This is because the instrumentalist believes that the aim of science is not to accurately describe the real or fundamental nature of things, but rather to provide tools for making predictions about natural phenomena. The case is similar with natural language ontology. Our ordinary thought and talk may not always be directed at the description of reality in a metaphysically precise way. Instead it may be influenced by far more mundane and practical affairs. In this way differences in the aims of these three domains result in differences in the ontologies of these domains. Among these differences may be differences in the way we describe the motions that we attribute to bodies. We can define the three versions of completism arising from these three domains as follows:

[16] This does not strictly follow unless one thinks (as I do) that Berkeley is committed to an intelligibility criterion in metaphysics, according to which entities in ontology must be at a minimum intelligible, or more strongly, conceivable.

[17] Note that Berkeley denies that physical laws of gravitation apply to the stars, given that they appear not to move with respect to one another (*Principles* §106). While it might seem that Berkeley is therefore affirming that the fixed stars do not move *at all*, and therefore are at rest, his remarks in *Principles* §106 do not commit him to this. Winkler (1986) claims that Berkeley's denial of attraction to the fixed stars plays an important role in his theory of true motion, because if the stars were attracted to one another, we would lack a suitable reference frame for determining true motions. While Berkeley will ultimately claim that true motion can be determined by the fixed stars, I do not think this requires that the stars not follow the laws of attraction; for Berkeley only denies that the fixed stars *appear* to be governed by such a law, and that therefore the assumption that they are governed by this law is too hasty.

[18] I have chosen the locution "really or fundamentally" deliberately. The metaphysical domain according to anti-reductionists may be summarized as having to do with what is "real," while the metaphysical domain according to reductionists may be summarized as having to do with what is "fundamental." My account of metaphysical completism is intended to be neutral between these two conceptions.

Metaphysical Completism: For all physical bodies that exist, there is a fact of the matter as to what the velocity of the body is.

Scientific Completism: There is a fact of the matter according to the best scientific theory as to what the velocity of a body is.

Vulgar Completism: There is a fact of the matter about when it is appropriate in ordinary parlance to say which bodies are in motion (and what their respective velocities are) and which bodies are at rest.

Given that Berkeley recognizes a distinction between the metaphysical, scientific, and vulgar domains, we might expect him to take different stances on each of metaphysical, scientific, and vulgar completism. Or so I shall argue.

Consider first metaphysics. For Berkeley, what really or fundamentally exists are ideas. Among our ideas are ideas of motion. Given that ideas of motion are relational, then per the argument given in section two, all ideas of motions must be of merely relative motions, since there is no privileged reference frame which could be used to distinguish true motions from merely apparent ones. If I notice that the sun appears to move with respect to the horizon, metaphysically speaking there is no fact of the matter about whether the sun moves or the horizon moves, for there is no available metaphysically privileged reference frame from which we could determine the true motion. Since among the entities that really or fundamentally exist there is no fact of the matter as to which motions bodies undergo, Berkeley must deny metaphysical completism; i.e., he affirms a metaphysical relativism about motion.[19]

That Berkeley is a metaphysical relativist about motion need not prevent him from affirming completism in the scientific or vulgar domains. Berkeley's completism in the vulgar domain is evident from the *Principles*[20]*:*

> [N]ow I ask any one, whether in his sense of motion as he walks along the streets, the stones he passes over may be said to *move,* because they change distance with his feet? To me it seems, that though motion includes a relation of one thing to another, yet it is not necessary that each term of the relation be denominated from it. (*Principles* §113)

> As the place happens to be variously defined, the motion which is related to it varies. A man in a ship may be said to be quiescent, with relation to the sides of the vessel, and yet move with relation to the land. Or he may move eastward in respect of the one, and westward in respect of the other. In the common affairs of life, men never go beyond the earth to define the place of any body: and what is quiescent in respect of that, is accounted *absolutely* to be so. (*Principles* §114)

> 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. (*Principles* §115)

More will be said about these passages later (particularly, *Principles* §114 and §115), but for now, it is important to note that in each, Berkeley makes an endorsement of completism. A close reading of these passages reveals that in each, Berkeley is careful to endorse only that it is linguistically proper, or in accord with common sense, to ascribe true motions to various bodies. In the first, Berkeley implies that in anyone's "sense of motion," we should say that our feet truly move with respect to the street, and not *vice versa*. In the second, he speaks of "the common affairs of life," claiming that people "account" motion and rest to be true given that the earth is used as the defining reference frame. In the third, he again appeals to the "sense of mankind" and the "propriety of language," giving conditions for when a body can be "said to be" in motion. Berkeley's careful choice of language signals that his intention is not to endorse metaphysical completism, but rather merely to endorse vulgar completism, according to which the true motions of bodies are their motions with respect to the reference frame of the earth.

Berkeley's affirmation of vulgar completism gives him the resources to avoid the consistency problem, insofar is it gives him a principled reason for both rejecting true motion at the metaphysical level while accepting it at the vulgar level. Even if it is not true metaphysically speaking that bodies have a true motion, nevertheless it is true according to our common thought/practice that bodies have a true motion, and this difference is accounted for by the different aims of metaphysics and common thought/practice.[21] However, this distinction can only take Berkeley so far, since Berkeley wishes not only to agree with the vulgar about true motion, but also with the physicist. In particular, Berkeley wishes to agree with the various claims about the true motions of the planets and the sun made in

[19] By denying true motion from Berkeley's metaphysics, we are not denying that motions are real, but only that real motions have a single determinate velocity with respect to absolute space or a privileged reference frame. For Berkeley, the motions I perceive are real; however, my perception of the motion is a perception of relative motion (cf. *Principles* §112), i.e., the perception of the changing distance relation between two bodies. This changing distance relation is real, but that does not mean that the motion is a true motion, i.e., that the velocities of the bodies as viewed from my frame of reference are the "true velocities." For example, when I see the sun moving with respect to the horizon, from *my reference frame* it appears that the sun's motion is true. However, for Berkeley there is no metaphysical reason to privilege my reference frame over any other possible reference frame, as argued above. So while the motion I perceive is real (insofar as I correctly perceive that the sun and horizon move with respect to one another), it is not true (insofar as there is no reference frame to ground a distinction between true and merely apparent motion).

[20] There is little to indicate an endorsement of vulgar completism in *De Motu*, rather only an endorsement of scientific completism. Perhaps this is because Berkeley's object in *De Motu* is dynamics, and thus there is no reason to spell out the case for vulgar completism as in the *Principles*.

[21] Bordner (2011) argues that Berkeley's defense of common sense is a defense "insofar as he defends that most basic belief of the Vulgar: that the world perceived immediately is the real world" (Bordner, 2011, p. 328). However, this does not mean that Berkeley thinks all beliefs of the vulgar are correct, nor that we must always side with the vulgar when their beliefs conflict with metaphysics. On my view, even though the vulgar speak in a way that appears to conflict with Berkeley's considered opinion about the metaphysics of true motion, their speaking this way does not threaten the belief that the real world is immediately perceived. There is thus no conflict between Berkeley's distinction between metaphysics and common sense in this domain, and with Berkeley's defense of common sense.Another of Berkeley's claims about common sense, that we ought to "think with the learned but speak with the vulgar" comes from a passage where Berkeley is discussing true motion according to the Copernican system: "[We] ought to *think with the learned, and speak with the vulgar*. They who to demonstration are convinced of the truth of the Copernican system, do nevertheless say the sun rises, the sun sets, or comes to the meridian: and if they affected a contrary style in common talk, it would without doubt appear very ridiculous. A little reflection on what is here said will make it manifest, that the common use of language would receive no manner of alteration or disturbance from the admission of our tenets." Although the conflict here is between common sense ways of talking and *science* rather than *metaphysics*, it is clear that Berkeley thinks the common sense ways of talking are completely appropriate, and that this does not undermine the truth of some other system which strictly speaking conflicts with it. Similarly, I suggest that Berkeley believes we can think relativism with the learned, while speaking completism with the vulgar. Thanks to Patrick Connolly for inviting me to reflect more on the relationship between Berkeley's defense of common sense and his views on true motion.

Newton's *Principia* (while, of course, denying that absolute space grounds these true motions).[22] However, the true motions of the planets as given by Newton cannot be founded upon the reference frame provided by vulgar completism: the earth. Berkeley requires another domain, and a different reference frame, to account for the natural philosophers' claims about true motions.

In both the *Principles* and *De Motu*, Berkeley provides an account of how natural philosophers ground the true motions of bodies by providing an alternative reference frame that goes far beyond the reference frame of the earth:

> But philosophers[23] who have a greater extent of thought, and juster notions of the system of things, discover even the earth it self to be moved. In order therefore to fix their notions, they seem to conceive the corporeal world as finite, and the utmost unmoved walls or shell thereof to be the place, whereby they estimate true motions. (*Principles* §114)

> [F]or determining true motion and true rest, by means of which ambiguity is eliminated and the mechanics of those [natural] philosophers who contemplate a wider system of things is furthered, it would suffice to take the relative space enclosed by the fixed stars, regarded as at rest, instead of absolute space. (*De Motu* §64)

Berkeley's claim is that when a scientist considers motions on a grander scale than terrestrial phenomena, they make use of a more suitable reference frame for the determination of true motion: an imaginary shell of the universe, fixed by the fixed stars.[24] Using this as a reference frame, scientists can determine the true motions of bodies, which is useful for understanding the "wider system of things," rather than the practical affairs of life. While we shall evaluate the adequacy of the provided reference frame later, for now it is enough to see that Berkeley endorses completism not just in the vulgar domain, but also in the scientific domain, and provides a separate reference frame for each.

Berkeley's expressed attitude towards scientific completism is decidedly instrumentalist, and is of the same variety as his widely acknowledged instrumentalism about dynamics. Given that the aim of science is only to predict and explain the phenomena,[25] interpreters claim that although in metaphysics Berkeley denies the existence of physical forces, in science the usefulness of the concept of force for prediction and explanation justifies its use. The above passages indicate a similar treatment of true motion. Berkeley describes the practice of finding a reference frame for true motion as a practice of engaging in fiction, performed for some other purpose than the accurate description of metaphysical reality. In both cases, Berkeley describes the reference frame not as a real, resting body, but as a mere "conception" (*Principles* §114) which is "regarded as at rest" (*De Motu* §64). The fictive reference frame is chosen for the sake of "[fixing] their notions" (*Principles* §114) and so that "ambiguity is eliminated and [mechanics] … is furthered" (*De Motu* §64). In this Berkeley is acknowledging a distinction between the aims of science and the aims of metaphysics, and expressly allowing the use of a fiction for the sake of furthering the aims of science.[26]

In every one of the explicit endorsements of completism mentioned above, Berkeley includes caveats which commit him to only vulgar and scientific completism. The best explanation for this, along with the fact that other tenets of Berkeley's philosophy commit him to metaphysical relativism, is that Berkeley recognized the relativistic implications of his metaphysics and therefore was careful to endorse true motion only in the vulgar and scientific domains. We therefore have strong evidence for believing that Berkeley is a vulgar and scientific completist, and thus for holding that Berkeley endorses a form of instrumentalism about true motion that is similar in nature to his dynamical instrumentalism. In what follows, I will argue that this interpretation of Berkeley helps us solve two additional problems for Berkeley: first, whether he can consistently adopt the force criterion while rejecting the existence of forces, and second, whether he can provide an adequate criterion for true motion.

4. Completism and Berkeley's Concept of Force

Recall that as described in the introduction, the *consistency problem* is really two problems, the first of which we have now dispatched. There still lingers an additional worry, generated by the tension between Berkeley's claim that true motions are those which are caused by a force and his anti-realism about forces. Throughout *De Motu* and other writings, Berkeley endorses dynamic anti-realism, *i.e.* the claim that physical forces do not exist. Berkeley instead adopts an instrumentalist attitude towards physical forces, claiming that attraction, action/reaction, and force as they appear in the *Principia* are to be treated as "mathematical hypotheses" rather than as describing the true nature of things.[27] However, as seen above, Berkeley adopts what we may call the "force criterion" for true motion:

True Motion: A body *A* is truly in motion only if:

(1) *A*'s position changes with respect to some other body *B*, and

[22] This is particularly evident in *Principles* §110: "The best key for … natural science, will be easily acknowledged to be a certain celebrated treatise of *mechanics* …" which he then goes on to identify as Newton's *Principia*.

[23] In this and other cited passages, when Berkely refers to "philosophers" he is referring to "natural philosophers," or what we would now call "scientists." The distinction tracks Newton's own in the *Principia* between ordinary affairs and "philosophy." Newton uses "philosophy" to refer to his system of rational mechanics as opposed to "practical mechanics."

[24] I am certainly not the first to recognize that Berkeley attempts to use the fixed stars as an important part of his account of true motion. Brook (1973, pp. 140–145) argues that Berkeley's attempt to ground true motion with the reference frame of the fixed stars does not work, because he gives no reason for why the fixed stars should be privileged. On my view, Berkeley's choice of the fixed stars is justified not because the fixed stars are in any sense *metaphysically privileged*, but rather because the fixed stars are *convenient* for fixing our notions in natural philosophy, as Berkeley claims in *Principles* §114. Winkler (1986) considers the many roles that the fixed stars play in Berkeley's theory of force and motion, as well as the argument against the bucket experiment. Although I agree with much of Winkler's analysis, there are certain important differences between our views - see fn. 33 and 40 for more details.

[25] For Berkeley, scientific explanation is nomological; it involves showing "the conformity any particular phenomenon hath to the general laws of nature" (*Principles* §62). There is thus no requirement that the entities be real or that the scientist appeal to causation in order to give explanations of natural phenomena. For the importance of prediction in science, see *Principles* §59.

[26] While most (Peterschmitt, 2008 is one exception) now accept that Berkeley is an instrumentalist about dynamics specifically, it is *not* widely agreed that Berkeley is an instrumentalist about all scientific domains or even all parts of physics. Downing (1995b) has convincingly argued that Berkeley's instrumentalism does not extend to corpuscles or atoms. Further, Ott (2019) has argued that Berkeley's theory of laws is also not instrumentalist. See also Hight (2010) for a helpful summary of the varieties of instrumentalism attributed to Berkeley. Given that we are still coming to understand in which domains Berkeley is an instrumentalist, it is thus a significant result of my paper to show that Berkeley is in fact an instrumentalist concerning true motion, since it adds to our growing understanding of those domains to which Berkeley's instrumentalism extends.

[27] Cf. *De Motu* §17, §28, §66–67. For an analyis of Berkeley's instrumentalism and antirealism about force, see Downing (2005, pp. 238–253) and Downing (1995b).

(2) *A*'s change in position is a result of an applied force. (*Principles* §115)[28]

It would seem that the denial of the existence of physical forces and the acceptance of the force criterion are in tension, because the force criterion seems to imply that forces exist.[29]

Here again, the threefold distinction between metaphysical, scientific, and vulgar completism comes to the rescue. If Berkeley thought that true motions reflected deep metaphysical facts about the nature of bodies and their movements, then it would be quite odd for him to claim that forces, which do not exist, are the criterion for something that does exist, that is, true motion. But given that Berkeley claims that true motion is only necessary for the purpose of fixing notions and eliminating ambiguity in physics, the problem dissolves. There is no tension between claiming that an entity (force) does not exist but is useful for making accurate predictions in physics, and claiming that this very entity can be used to distinguish true motions from merely apparent ones, for the sake of fixing notions and eliminating ambiguity in physics. The tension only arises if one uses the fiction as a criterion for something that actually exists, and this Berkeley does not do.

It is worth emphasizing a way my solution differs from candidates alluded to in the literature. Some have claimed that Berkeley's endorsement of the force criterion in *Principles* §113–115 does not commit Berkeley to the existence of forces as they are understood in mechanics. According to Lisa Downing, Berkeley intends only our "everyday concept of force or action (rather than the dynamicists' unintelligible notion)."[30] This helps dispel the tension between the force criterion and Berkeley's dynamic antirealism because Berkeley's force criterion refers to our ordinary concept of force, rather than the scientific one he attacks in his case against dynamic realism. However, I think it is unlikely that in endorsing the force criterion, Berkeley intends only the everyday concept of force, for two reasons. The first is that Berkeley also appears to endorse the force criterion in *De Motu* §64, in which work he only discusses the scientific concept of force rather than the everyday concept. If his *De Motu* endorsement were intended for only the everyday concept of force, Berkeley would have signaled this. Absent any caveat, it is clear his referent there is the scientific concept discussed throughout. Second, Berkeley's force criterion is a straightforward paraphrase of the same criterion which Newton states in the *Principia*:

> The causes which distinguish true motions from relative motions are the forces impressed upon bodies to generate motion. True motion is neither generated nor changed except by forces impressed upon the moving body itself, but relative motion can be generated and changed without the impression of forces upon this body … Again, true motion is always changed by forces impressed upon a moving body, but relative motion is not necessarily changed by such forces." (*Principia* p. 415).[31]

In the *Principia,* it is abundantly clear that Newton's force criterion refers to the scientific concept of force deployed throughout. Given that Berkeley straightforwardly adopts the criterion, we should expect that the concept of force he intends is scientific rather than everyday.[32]

On my interpretation, it is not a problem that Berkeley's force criterion refers to the scientific concept of force, because the force criterion is not being used to find *metaphysically* true motions, but rather only *scientifically* true motions. Given an instrumentalist analysis of both the concept of true motion and the concept of force, we see that Berkeley can consistently accept the force criterion as well as dynamic antirealism. As such, Berkeleys affirmation of completism appears to be consistent with his other metaphysical views.[33]

[28] It is of no help to attempt to claim that Berkeley abandons the force criterion in *De Motu* as Asher (1987) argues. There are two reasons. First, the force criterion appears in *De Motu* §64: "For however forces may be impressed, whatever *conatus* there may be, we admit that motion is to be distinguished by actions exerted on bodies." Though subtle, this is evidence that Berkeley still accepted the force criterion in *De Motu.* Second, although Berkeley did make changes to *Principles* §113 and §115 from the first to the second and third editions, he nevertheless maintains a version of the force criterion throughout (the changes are relatively insignificant for our purposes, and mostly have to do with Berkeley abandoning the term "impressed force" in favor of the more general "applied force" (see Downing, 2005, pp. 235–237 for analysis). Given that the second and third edition of the *Principles* were published after *De Motu*, we can infer that Berkeley continuously affirmed the force criterion throughout his mature career (at least until 1734).

[29] The problem of Berkeley's assertion of the force criterion was raised at least as early as Silver (1973, p. 606), who claims Berkeley's assertion is explained by either "confusion or careless prose," and that it indicates a "covert inconsistency between his philosophy and inertial dynamics[.]" Mirarchi (1977) responds to Silver by distinguishing between different concepts of force in Berkeley's philosophy, arguing that Berkeley is consistent so long as we interpret him as using the term force in a certain non-referential or quasi-referential way. Mirarchi's response is perhaps most similar to my account, insofar as he appears to be appealing to a sort of instrumentalism about force to resolve the apparent tension between Berkeley's endorsement of the force criterion and his dynamical antirealism. Mirarchi does not, however, consider the importance of the force criterion for Berkeley's theory of true motion, nor how instrumentalism about true motion specifically is required for fully dispelling the tension, as I argue.

[30] Downing (2005, p. 237).

[31] References to Newton's *Principia* are from Newton (1999).

[32] While my solution works well for Berkeley's remarks in *De Motu* and in later editions of the *Principles*, it faces a challenge in accounting for Berkeley's remarks in the first edition of the *Principles* (which he struck from later editions), where he claims that a lone body in existence could have a force applied to it, even absent any resulting motion of the body: "when one only body … is imagin'd to exist; some there are who think that it can be moved all manner of ways, who' without any change of distance or situation to any other bodies; which we shou'd not dey, 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" (*Principles* §115, 1710 ed.). Berkeley's example here is meant to show that change in position with respect to another body is necessary for true motion; i.e., conditions (1) and (2) of **True Motion** are both necessary. However, as Downing (2005, p. 236) notes, Berkeley's example of a lone body with an impressed force seems to imply that Berkeley grants the real existence of forces (distinct from the motions they cause) with real causal power into the natural world.Downing argues that Berkeley struck this passage from later editions because he recognized these problematic implications, having considered more carefully the status of forces in the natural world. However, according to Downing, Berkeley kept the endorsement of the force criterion as stated before this passage because he recognized that it could be interpreted as an "everyday concept of force or action (rather than the dynamicists' unintelligible notion)" (Downing, 2005, p. 237). Though I have argued that Berkeley's intended concept of force in these passages is scientific, rather than merely ordinary, I otherwise agree with Downing's strategy. Berkeley likely struck the passage in later editions after more carefully considering the concept of force, and realizing the problematic implications of the passage. Further evidence that Berkeley had not carefully thought through a concept of force appears in his notebooks: "I differ from Newton in that I think the *recession ab axe motus* is not the effect or index or measure of motion, but of the *vis impressa*. it sheweth not w^{t} is truly move but w^{t} has the force impress'd on it. or rather that wch hath an impressed force" (*Philosophical Commentaries* §456).

[33] Note that my approach also avoids the need to attribute a strong form of reductionism to Berkeley, as Winkler (1986, p. 31) does in his consideration of the force criterion: "we should [not] dispense altogether with the notion of force in our account of true motion. The proper response is to reinterpret that account in a way that accords with the reduction of corporeal force to motion." Winkler acknowledges that Berkeley does not indicate how such a reduction would work, and that we must supplement Berkeley's remarks with an account of our own. See also fn. 40.

5. The Adequacy Problem

Having addressed the consistency problem, we now move to the adequacy problem. If Berkeley is indeed a scientific completist, we then face the question of whether or not he can provide an adequate criterion for true motion. The importance of this question has been made salient in a recent article by Marius Stan, who argues that in the early modern period, only the absolutists were capable of providing an adequate criterion for true motion. An adequate criterion was necessary, Stan argues, because the doctrine of true motion was necessary for rational mechanics. In other words, the scientific discoveries of Newton's *Principia*, along with a host of other discoveries based on Newton's laws of motion, stand and fall with a theory of true motion, which in turn requires the specification of an adequate criterion.[34]

According to Stan, a theory of true motion was necessary not just for grounding scientific descriptions of celestial phenomena (like the orbit of the earth around the sun). It was also necessary for grounding the widely accepted law of inertia, which itself served as a foundational law in rational mechanics. The law of inertia states that in the absence of external applied forces, bodies persevere in their states of rest or uniform motion. The state of rest or uniform motion described here can not be merely apparent motion. For if it were, then the law of inertia would be false (or at least, to make it true would require positing numerous bizarre forces, resulting in a highly complicated and counterintuitive theory). The law of inertia must therefore describe the *true* states of motion and rest in bodies. Therefore, providing an adequate criterion for the true motion of bodies was necessary for grounding one of the fundamental laws of rational mechanics, and thus mechanics as a whole.

For Newton and the absolutists, the solution to the adequate criterion problem is simple: absolute space provides the reference frame for true motion, which therefore makes the law of inertia (and the rational mechanics for which it provides a foundation) true. Though the absolutists faced epistemological worries about how true motions could be known given the inaccessibility of absolute space to the senses, they did possess an answer to the metaphysical question regarding the ground of true motion and thus rational mechanics. According to Stan, the relationists missed the import of this point, and thus misdirected their criticism of Newton:

> … we can see that most of Newton's opponents simply missed the point. Namely, it is beside the point to object to Absolute Space by gesturing at stories of how we might acquire the representation of space; or how the common allegedly use space talk (as Leibniz and Berkeley notoriously did to counter Newton). Even if true, their crude stories above remained beside the point, because the real task was to ground the inertial kinematic structure of the new science, not to dabble in armchair semantics. In regard to that ask, however, Newton's opponents achieved far less than he did, philosophically. (Stan, 2021, p. 4)

Stan goes on to argue that relationism failed to provide a proper grounding for rational mechanics, because relationists could not specify a reference frame that could ground the law of inertia. This is because a relationist, without absolute space, appears to have no other candidate reference frame than *other physical bodies*. According to Stan, the question of what physical body can serve as a reference frame for inertial motion "is as hard as it is simple, and no one then answered it" (Stan, 2021, pp. 4–5).

The problem Stan poses for the relationist must be distinguished from another related one. Stan's concern is not that *in practice*, relationists are incapable of finding inertial reference frames and using them to make determinations about forces and motions. For the absolutists admitted that in practice, our only way of perceiving and gaining knowledge of motion is through sensible measures of the "properties, causes, and effects" of the motions.[35] Newton summarizes the method thus:

> It is certainly very difficult to find out the true motions of individual bodies and actually to differentiate them from apparent motions, because the parts of that immovable space in which the bodies truly move make no impression on the senses. Nevertheless, the case is not utterly hopeless. For it is possible to draw evidence partly from apparent motions, which are the differences between the true motions, and partly from the forces that are the causes and effects of the true motions. (*Principia* p. 414)

The method for determining true motions depends in part on observed apparent motions, and in part on the causes and effects of these motions. These causes are forces, and their effects include not only the motions of bodies, but other observable physical changes of bodies (e.g. the tension in a cord, the deformation of a non-rigid body, or the shape of a fluid, like water in a bucket). Thus while Newton thinks absolute space is necessary for grounding our concept of true motion, in practice true motions are found by sensible measures which are taken as evidence for motion in absolute space. All of these are sensible measures of true motion available to the relationist. Stan's criticism of the relationists is not that they could not make use of these sensible measures of true motion, but rather that they had no grounds to hold that the motions discovered by such sensible measures are indeed *true*. In other words, Stan's worry is not about the practice of mechanics, but rather about whether the results of such practice can really be said to reveal the true metaphysical nature of the motions of bodies. Without absolute space, Stan claims the relationist has no frame of reference to ground the distinction between true motion and merely apparent motion. Therefore inertial mechanics cannot inform us of true motions.

Given that Stan's worry for relationism is metaphysical, we can see that it would only apply to the metaphysical completist, and not the scientific completist. The concern is *not* that without absolute space, the inertial mechanics of the *Principia* would fail to deliver general laws useful for the accurate prediction of the phenomena. Rather the concern is that without absolute space, the inertial mechanics of the *Principia* would fail to deliver descriptions of the actual motions of bodies considered metaphysically. Berkeley only claims that our concept of true motion functions to "fix our notions" and eliminate ambiguity. Given that Berkeley does not think that inertial mechanics delivers an accurate description of the actual motions of bodies considered metaphysically (because his idealism entails there is no metaphysical fact of the matter), he does not owe an answer to the question posed by Stan. In other words, given that Berkeley only affirms scientific and vulgar completism, he does not need a *metaphysically* adequate criterion for true motion.

One might still wonder whether Berkeley provides a *scientifically* adequate criterion for true motion. I will not argue here that he does, but will instead only argue that Berkeley is on no worse footing than Newton. This is because Berkeley basically adopts Newtonian scientific practice while rejecting their metaphysical interpretation of its results. There are two components to Berkeley's answer, since Newton employs at times two different scientific criteria for true motion: the force criterion, and the fixed stars criterion. We have already discussed the force criterion, which Berkeley explicitly adopts along with the whole of Newtonian mechanics under an instrumentalist gloss. With regard to the determination of true motions by the forces which cause them, Berkeley

[34] Newton himself recognized the need for a theory of true motion for his rational mechanics. At the end of the scholium to the definitions, after introducing and defending absolutism, Newton sets up the rest of the *Principia* by claiming that "in what follows, a fuller explanation will be given of how to determine true motions from their causes, effects, and apparent differences, and, conversely, of how to determine from motions, whether true or apparent, their causes and effects. For this was the purpose for which I composed the following treatise" (*Principia* p. 415).

[35] *Principia* p. 411.

can be on no worse footing than Newton, since he adopts the same practice as Newton.

It is slightly less clear what role the second criterion is meant to play in Newton's theory of true motion. For in the scholium to the definitions, Newton constructs a thought experiment intended to show that the fixed stars can not on their own provide an adequate criterion for the determination of true motion, because it could not be known whether the bodies in question or the fixed stars are moving based on the facts of the case.[36] Newton then shows that other facts about the case (namely, the tension in a cord which is an effect of a force) could determine which bodies are truly in motion. The case appears to establish the primacy of the force criterion for the determination of true motion. Nevertheless, in particular with respect to celestial mechanics, Newton does make use of the fixed stars for the observation of the motions of bodies. Consider, for instance, Newton's report of Kepler's third law of planetary motion in Phenomenon 4:

> The periodic times of the five primary planets and of either the sun about the earth or the earth about the sun—the fixed stars being at rest—are as the 1.5 powers of their mean distances from the sun. (*Principia* p. 800)[37]

Newton makes use of the fixed stars as a reference frame for the determinations of planetary motions which he then uses to demonstrate that the motions of the planets are a result of the force of gravity. It is clear then that the fixed stars criterion also plays an important role in Newton's account of true motion.[38]

Berkeley recognized that Newton and his fellow astronomers made use of the fixed stars (considered as at rest) in determinations of the motions of bodies, and by this reference frame Berkeley suggests all the true motions of the scientist may be referred:

> In order therefore to fix their [the natural philosophers'] notions, they seem to conceive the corporeal world as finite , and the utmost unmoved walls or shell thereof to be the place, whereby they estimate true motions. If we sound our own conceptions, I believe we may find all the absolute motion we can frame an idea of, to be at bottom no other than relative motion thus defined. For as hath already observed, absolute motion exclusive of all external relation is incomprehensible: and to this kind of relative motion, all the above-mentioned *properties, causes, and effects* ascribed to absolute motion, will, if I mistake not, be found to agree. (*Principles* §114, emphasis mine[39])

Berkeley claims that in place of absolute motion, scientists in practice use a special kind of relative motion, namely, motion relative to the fictional shell of the universe (or what Berkeley in *De Motu* calls "the relative space enclosed by the fixed stars" [*De Motu* §64]). True motion conceived as relative to this fictional shell can still be distinguished from other sorts of (merely apparent) relative motions by the very same properties, causes, and effects that Newton gives for true motion. Berkeley even explicitly singles out the laws of motion (which of course includes the law of inertia) as a law that is made true by this conception of true motion:

> The laws of motions and effects, and the theorems containing the calculations of the same for different figures of the paths, as well for accelerations and diverse directions, and for more or less resistant media, all these hold without the calculation of absolute motion. (*De Motu* §65).

Berkeley thus basically accepts the whole of Newton's scientific practice regarding the discovery of true motions, but rejects Newton's interpretation of the metaphysical implications of this. His scientific criterion for Newton's inertial mechanics is thus the same as Newton's criterion, and therefore Berkeley is on no worse footing with respect to the scientific criterion than Newton.[40]

If my interpretation of Berkeley is correct, then I have shown that Berkeley requires no metaphysical criterion for true motion, and that his scientific criterion fares as well as that of Newton and the absolutists. Thus on my interpretation, Berkeley's relationism avoids the criticism offered by Stan, where he claims that early modern relationists missed the point by failing to recognize the importance of the question of what grounds inertial mechanics. Rather than recognize the importance of such a question, Berkeley diffused it by holding that the only ground required for inertial mechanics was scientific completism rather than metaphysical completism.

6. Conclusion

Scientific instrumentalism faces many challenges, and the instrumentalism about true motion I attribute to Berkeley here is no exception. I am not here defending Berkeley's version of instrumentalism, and I am not claiming that Berkeley's instrumentalist account of true motion is on the whole better than the one offered by early modern absolutists. My aim is much more circumspect. I hope to have shown that Berkeley's views are at least immune to criticism along the lines of the consistency problem and the adequacy problem. On my interpretation, Berkeley's views on true motion are consistent with his other metaphysical views, and are at least as scientifically adequate as Newton's. Because of his instrumentalism about true motion, he does not face the challenges of metaphysical adequacy leveraged by Stan. Berkeley's theory of true motion is therefore apparently a stronger contender than it initially appears. The plausibility of Berkeley's views on true motion I take to be an interesting topic for future research, and it stands and falls with the strength of his arguments for instrumentalism, which I have not here reviewed. What I have shown is that if Berkeley is granted an instrumentalism about true motion, then his views are both consistent with his other metaphysical commitments, and capable of providing an adequate foundation for Newton's mechanics.

[36] Newton's reason is similar to the reason I give above in section II.

[37] See also the first two phenomena (*Principia* pp. 797–799).

[38] Just how important a role is up for debate. Newton indeed later claims to demonstrate that the fixed stars are at rest with respect to the center of the universe, on the "hypothesis" that "The center of the system of the world is at rest," and that there is no observable parallax from the rotation of the earth (*Principia* p. 816, p. 819). Much depends on the status of the crucial hypothesis that the center of the system of the world (which turns out to be the center of gravity of the solar system) is at rest. See Rynasiewicz (2011, §6.2).

[39] Berkeley's word choice here intentionally reflects Newton's in the scholium to the definitions (*Principia* p. 411).

[40] On my interpretation, Berkeley endorses the force criterion and the fixed stars criterion because he observes Newton deploying both within the *Principia*. Berkeley leaves the exact relationship between these two criteria undefined, as does Newton. In this I disagree with Asher and Winkler, who claim that Berkeley had more or less dispensed with the force criterion by the time he wrote *De Motu* (1721) and republished the *Principles* (1734). While Asher does not consider the problem of Berkeley maintaining the force criterion in the 1734 edition, Winkler does, and claims that Berkeley maintained it only because Berkeley is a reductionist, and therefore talk about forces will be isomorphic with talk about motions. As such, the forces attributed to bodies will be reducible to the motions observed with respect to the fixed stars, and thus talk of one will be equivalent to talk of another. I hesitate to attribute this strong form of reductionism to Berkeley, primarily because Berkeley himself does not provide any indication of how a reduction of force to motion would proceed, and attempted accounts to supply one are too complicated to reasonably attribute to Berkeley without at least some textual indication he thinks of reduction this way. Furthermore, given that Berkeley borrows the force criterion from Newton, and we should certainly hesitate to attribute a strong reductionism to Newton, I think it is unlikely that Berkeley intends for the forces used in the force criterion to be reducible to motions.

CRediT authorship contribution statement

Scott Harkema: Writing – review & editing, Writing – original draft.

Declaration of competing interest

None

Acknowledgments

Thanks to Lisa Downing, Chris Pincock, Lisa Shabel, Todd DeRose, William Marsolek, and especially Patrick Connolly for helpful feedback on earlier drafts. Thanks also to audiences at the 2021 NYC workshop in Early Modern Philosophy (Technion) and the 2022 APA Pacific. Special thanks are also due to two anonymous reviewers for very helpful and constructive feedback on an earlier draft.

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