

The relativity of motion as a motivation for Leibnizian substantial forms

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Abstract: On several occasions Leibniz refers to the relativity of motion as implying the phenomenality of motion, and appeals to it as a reason for re-introducing substantial forms. This has been widely interpreted to mean that he rejects the reality of motion, and instead reduces it to a result of the coordinated perceptions of substances. I argue here that such an interpretation is at odds with Leibniz's motivation for reintroducing substantial forms in this context, which is to avoid reducing motion to a mere appearance. I support this claim by an examination of his views on the relativity of motion, where true motions are identified in accordance with the most intelligible hypothesis for understanding the phenomena, and the reality of the phenomena of motion derives from their being founded in force.

Introduction

In an unpublished manuscript of the late 1680s, Leibniz wrote

In fact, each substance is a kind of force of acting, i.e. an endeavour to change itself with respect to all the others according to certain laws of its own nature. Whence any substance whatever expresses the whole universe, according to its own point of view. And in the phenomena of motions this fact is especially apparent, for there every single body must be supposed to have a motion in common with any other, as if they were in the same ship, as well as its own motion, reciprocal to its bulk; how this could be so could not be imagined if motions were absolute and each body did not express all others. ("Motion is not Something Absolute"; A VI iv 1638, LoC 333)

There is much to say about this passage, but what is particularly noteworthy for my purposes here is this. One of the signature themes of Leibniz's mature metaphysics, that each substance expresses the universe according to its point of view, is justified by reference to the *motions of bodies*: the phenomena of motions, he argues, are evidence that each body expresses all others. It is implied that the body expresses these relations by its containing a substance with a given point of view; the point of view expresses its spatial relations to all other bodies in the universe from a unique situational perspective; and the substance is conceived as a force or endeavour to change these situational relations of the body to all others as it moves, in accordance with laws internal to it.

According to many contemporary scholars, however, Leibniz's words cannot be interpreted so literally. Substances (monads) do not exist in space, so they cannot be contained in moving bodies. "Point of view", accordingly, cannot be taken as a point in space from which a substance has a perspective on the rest of the universe, and should therefore be regarded as mere metaphor. Actually, there are two objections here, both of them made already by Russell in his (1900). First, points of view cannot be given such a realistic reading because in Leibniz's mature theory monads are not located in points; Leibniz's "point of view" imagery seems to be a holdover from the earlier theory of his youth, where he did conceive substances as contained in points in a real space (Russell 1900, 122-24; Adams 1994, 252). Second, in his mature work Leibniz rejects the reality of space (Russell 1900, 124-26). As Hartz and Cover argue in their well-cited paper, since space is an *ideal entity*, Leibniz would not be entitled to presuppose it in any account of monads and their perceptions, which "are at the ground floor metaphysical level" (1988, 503).

Now, Hartz and Cover argue that the thesis of the ideality of space is a late development in Leibniz's metaphysics, so one might be tempted to argue along those lines that when the above

passage was written Leibniz was still thinking in a more realist vein about the situation of substances. For by the 1680s Leibniz had long ago abandoned his earlier theory that substances are located in points in favour of the claim that a substance has a situation derivatively through its organic body. As we shall see, though, by 1677 Leibniz had already depicted absolute space as a mere “affection of the soul”, and by 1679 the essentials of his mature views on space are in place: space is relational, indeed an order of situations, and these situations are characterized in terms of simultaneous existence or what is “simultaneously perceived”.¹ This therefore seems like more grist for the mill of the idealist interpretation of passages like the one above. Moreover, as Robert Adams observes (1994, 252), by the 1680s Leibniz is clearly characterizing body as a phenomenon. Given the latter fact, Adams argues, body cannot be presupposed in a construction of space from relations among monadic perceptions. He therefore sets about giving a sketch of a view in which the spatial positions of bodies are apparent positions of bodies as phenomena, constructed from the perceptions of the monads: phenomena are contents of the intentional states of monads, interpreted as mind-like entities. On this kind of idealist interpretation Leibniz must be understood as rejecting the reality of motion, reducing it instead to the coordinated perceptions of substances.

But as we shall see, such an interpretation is at odds with the way in which Leibniz argues for the necessity of introducing substantial form (or force) in this context, which is to save the reality of motion and avoid reducing it to a mere appearance. Taken merely geometrically, motion would have no subject; it would consist in a change of external denominations without any corresponding change in internal denominations, and would reduce to mere changes in appearances. The cause of the change in situation would not be assignable, with the consequence that “there would not be any real motion”, as he writes in his *Critical Thoughts on Descartes' Principles*. “Consequently in order for something to be said to move, we shall require not only that it change its situation with respect to the others, but also that the cause of the change, the force or action, be in itself.” (GP iv 396). Taken with respect to cause, moreover, true motions are identified in accordance with the most intelligible hypothesis for understanding the phenomena. So on the one hand, true motions are distinguished from merely apparent ones, and on the other, the reality of the phenomena of motion is founded in force.

¹ See Arthur 2013a for an account of the genesis and development of Leibniz's views on space.

The problem with Adams' argument, I contend, is his understanding of what Leibniz means by saying that motion or body is a *phenomenon*, which he interprets in terms of its being reducible to appearances in the perceptions of perceiving substances. Let me begin by discussing this, before moving on to a discussion of the relativity of motion and its implications.²

I. Motion as a phenomenon

In a recent article, Stephen Puryear has argued that in Leibniz's middle period he was a phenomenalist about motion (Puryear 2012, esp. 169-70). Whether "properly speaking" this also makes him an idealist about motion in this period depends on whether he "considered perceiving substances purely immaterial", as Adams supposes. Nevertheless, "If we take idealism about motion to be the view that motion is ultimately reducible to perceiving substances and their modifications, then during his middle years Leibniz was clearly an idealist about motion, since he held that motion is a phenomenon, and phenomena have their being in perceivers." (169)³

This, I believe, is not the right way to understand Leibniz's claim that motion is a phenomenon. Granted, there are occasions—particularly a notorious passage in his correspondence with De Volder in 1704 to which we will return later—where Leibniz seems to say something like this. But I believe that his considered position for almost all the last four decades of his life is analogous to the one I have elsewhere attributed to him about the phenomenality of body. This is that body, as an aggregate of substances, is semi-mental: its *unity* is constituted by its being perceived as one thing.⁴ Its *reality*, on the other hand, is constituted by the constituent substances themselves. So it is a real or well-founded phenomenon, as opposed to an illusory one. If it were just an appearance of unity, it would be a *mere phenomenon*; but the fact that it is an appearance (as one) of the infinity of substances constituting the body, means that it is not illusory, it is the appearance of something there, it is a *real phenomenon*. Analogously, motion too is semi-mental. On the one hand, it is a

² There have been many analyses of Leibniz's depictions of bodies as 'phenomena'. See Hartz 1992 for an analysis of many of the different senses that Leibniz seems to have given this on different occasions, as well as Garber 2009. My own views are closer to those of Rutherford 1990.

³ I am not sure I fully understand Puryear here. He says Leibniz is "clearly an idealist about *motion*", and then seems to retract it on the grounds that it has not yet been decided whether perceiving *substances* are purely immaterial. I will treat him as claiming that motion is phenomenal in the sense of mere appearance, but as not being committed to substance idealism for Leibniz in his middle years.

⁴ See Loftson and Arthur 2006, and Arthur 2011 for a defence. I would add that this interpretation of the unity only as mind-dependent is consistent with Leibniz's philosophy of perception, according to which a perception consists in the representation of an infinity of lesser perceptions as one; here each lesser perception would correspond to the action of a smaller constituent body on the sense organs, and the confused perception to a fusing together or composition of the corresponding endeavours.

change of situation of a body relative to the perceiver; but equally an observer in that body could regard the same motion as a change of situation relative to her. If that were all there were to motion, it would be a *mere phenomenon*, and the reality of motion would consist in the agreement of such mutual perceptions and nothing more. But, Leibniz believes, that is not all there is to motion: what is real in motion is force, and this has a foundation in monadic appetite, that is, in the states of change of the underlying substances from which the moving body is aggregated—such a motion is a real or *well-founded phenomenon*; moreover, as we shall see, true motions can be distinguished from merely apparent ones by the identification of causes.

Before proceeding to my main argument, though, let us consider Puryear's claim in the passage above that simply describing motion as a phenomenon is enough to establish its ideality. That is surely too fast. When Leibniz writes of "the phenomena of motion", for example, he is appealing to a perfectly well established usage extending from ancient times to the present day (witness "Phenomenological Thermodynamics" or "Phenomenological Particle Physics"): a phenomenon in this sense has nothing to do with idealism. The phenomena are things as they appear, they are occurrences which we seek to explain as the results of the actions of various agents; they are not simply images in the minds of perceivers. This is the sense Newton intends, for example, when he talks of inferring the laws of nature from the phenomena.

Now, in astronomy there was an established Platonic tradition that the task of that science is to "save the phenomena": this meant to treat a given mathematical hypothesis as a construction that would correctly predict the apparent positions (i.e. angles) at any time of the heavenly bodies as seen by an observer on Earth. This Platonic injunction could be regarded as neutral or agnostic with respect to the real locations and orbits of bodies; Ptolemy, for example, developed a mathematical theory that saved the phenomena (and was thus a mere instrument for making predictions), but also gave arguments for the correct ordering of planetary orbits, which presupposes that the planets are travelling in roughly circular orbits at various distances from the Earth. Nearer Leibniz's time, though, Osiander, Bellarmine and Baer (Ursus) had insisted that Copernicanism be interpreted as a merely mathematical hypothesis for saving the phenomena, and not as a realistic depiction of orbits. Johannes Kepler vehemently opposed this instrumentalist interpretation, arguing that the Copernican hypothesis is concerned with the real orbits of planets; although various mathematical hypotheses might be devised to fit the phenomena, a true hypothesis (such as the Copernican) must be justified not just by its mathematical fit to those

phenomena, but by the assigning of probable physical causes.⁵ As Nico Bertoloni Meli has lucidly explained (following the lead of Ernst Cassirer), Leibniz appealed to this Keplerian philosophy in opposing Newton's cosmology, which he saw as a mere mathematical hypothesis that failed to provide the cause of gravitational attraction.⁶ As we shall see, as early as 1676 Leibniz ceded that various hypotheses could be devised to save the appearances, but insisted that the Copernican view is established as correctly identifying the Earth's motion as the physical cause of the phenomena, a cause established by reference to various pieces of evidence, such as changes in the apparent diameters of the fixed stars, parallax, the tides, oscillating lamps, and so forth.

From these considerations we may already draw some preliminary conclusions. First, with regard to the physical phenomena of the motions of heavenly bodies, Leibniz took a realist view: they are not simply appearances to an observer, but the effects of physical causes. If motions were simply the coordinated perceptions of perceivers, as on Adams' and Puryear's idealist interpretation, we would expect Leibniz to have adopted an instrumentalist interpretation of Copernicanism.⁷ He did not, and had he done so, this would have completely undermined his criticisms of Newton's gravitational theory for not providing physical causes compatible with mechanism.

And this brings me to a second point: not only was Leibniz a convinced Copernican, he was adamantly committed to *mechanism*. In correspondence with the distinguished medical and legal philosopher Hermann Conring in 1678 he wrote that "*everything in nature happens mechanically*". When Conring scoffed "if you want this to be understood in a Cartesian sense, I for my part do not hesitate to pronounce it a most absurd statement" (Conring to Leibniz, 26th February, 1678; GP i 191), Leibniz responded with one of the most eloquent statements of the mechanist creed ever made:

I recognize nothing in the world but bodies and minds, and nothing in mind but intellect and will, nor anything else in bodies insofar as they are separated from mind but magnitude, figure, situation, and

⁵ See Jardine 1984, for an analysis of the dispute between Ursus and Kepler.

⁶ "Following Cassirer's interpretation, the legitimacy of hypotheses in natural philosophy and mathematics was defended by Leibniz exactly as Kepler had done in astronomy. In their philosophical systems phenomena assume a new dignity and the true hypothesis becomes the instrument for binding them to the laws of knowledge" (Bertoloni Meli 1993, 19).

⁷ Here I agree with Puryear (2012, 147) that Leibniz's commitment to Copernicanism as the most intelligible hypothesis cannot be understood as an instrumentalist position: "the evidence actually weighs rather heavily against such an instrumentalist reading."

changes in these, whether partial or total. Everything else is merely said, not understood. (Leibniz to Conring, 19th March, 1678; GP i 197f.)

Leibniz made this assertion in the same breath as defending himself against Conring's criticism that he would thereby be rejecting substantial forms. On the contrary, he assures Conring, it is the substantial form itself that is the principle that individuates bodies: "Who would deny substantial forms," he writes, "that is, essential differences between bodies?" (Leibniz to Conring, 19th March, 1678; GP i 196). Thus Leibniz does not see substantial forms as undermining mechanism, but as a necessary supplement to it. The key phrase for seeing their compatibility is that there is nothing else in bodies "*insofar as they are separated from mind*". For Leibniz had already for some time considered Mind, or at least a mind-like principle involving memory of its body's past states, to be the key to individuating bodies. And by 1678-9 he had come to consider it to be a kind of form assigned in body that "has some perception and appetite, which are passions and actions of the soul" (A VI iv 1988; LoC 233-35). In fact, forms or entelechies will continue to play this same role of individuating bodies right through the mature Leibnizian corpus. In 1686 Leibniz tells Arnauld that "The soul, however, is nonetheless the form of its body, because it expresses the phenomena of all other bodies according to their relation to its own" (To Arnauld, 14th July 1686, GP ii 58); and in the "Monadology" of 1714 he describes a monad as the entelechy of "the body particularly assigned to it" (*Monadology* §62; GP vi 617). This is in keeping with his understanding of mechanism, since it is only bodies insofar as they are separated from such proto-mental powers as perception and appetite that are reducible to "magnitude, figure, situation, and changes in these"; the substantial forms themselves, on the other hand, although they found the reality of bodies, should play no role in physical explanations.

This endorsement of mechanism was not some passing whim; Leibniz said something similar in his *Hypothesis physica nova* (HPN) of 1671, and the same commitment is not only integral to his criticisms of Newton's theory, as mentioned, but also to his rejection of the vitalism of Stahl in the last years of his life.⁸ According to the Mechanical Philosophy, qualities that had been taken as accidents unproblematically existing in bodies, such as colours and sounds, are instead to be understood as produced in perceivers by the actions of the bodies and intervening medium on our

⁸ In the *Hypothesis physica nova* Leibniz writes "I agree completely with the followers of those excellent gentlemen Descartes and Gassendi, and with whomever else teaches that in the end all variety in bodies must be explained in terms of size, shape and motion" (A VI ii 248). On his espousal of mechanism in his controversy with Stahl, see Justin E. H. Smith 2011, esp. 83-89.

sense organs. Although this was common currency among natural philosophers of his time, Leibniz's most immediate source was Hobbes, who wrote of the colours of objects that our senses make us think that there are such accidents or qualities in the world, but these are only "seemings and apparitions; the things that really *are* in the world without us are the *motions* by which these seemings are caused" (*De homine*, II, §X; Hobbes 1905, 162). Colours and other "secondary qualities", as they came to be called, are therefore semi-mental: the redness of the apple is an appearance in my mind, but insofar as this is not illusory, the phenomenon has a real basis in motions external to the mind, those of the surface of the apple, of the mediating medium or light particles, and of the optic nerve.

In his endorsement of mechanism, Leibniz is committed to all this. But, crucially, he goes one step further, and claims that a similar analysis should apply also to the qualities that mechanists take as primary: extension, shape and motion. In a typical passage scribbled on the back of a bill in 1683, he wrote:

And just as colour and sound are phenomena, rather than true attributes of things that contain a certain absolute nature without respect to us, so too are extension and motion. For it cannot really be said just which subject the motion is in. Consequently nothing in motion is real besides the force and power things are endowed with, that is to say, beyond their having such a constitution that from it there follows a change of phenomena constrained by certain rules. (*Wonders concerning the nature of corporeal substance*; A VI iv 1465; LoC 263)

Thus, as Puryear correctly observes, "Like phenomena in general, motion [for Leibniz] continues to be a perception-dependent feature of the world even when it has a foundation in something that exists independent of perception (i.e. force)." (Puryear 2012, 169) When Leibniz says that bodies and motions are phenomena like colour and sound, he is assimilating them to the mechanists' account of secondary qualities: extension and motion are not, despite what the mechanists hold, primary qualities. Like sound and colour, they are appearances of something external to the perceiver. In the case of bodies, what is external to the perceiver is an (infinite) aggregate of substances. In the case of motion, he claims here, it is "the force and power things are endowed with". But now we need to examine why Leibniz believes that this follows. Why, on a purely mechanistic view, can we not say which subject the motion is in? And how does this show the insufficiency of the mechanical philosophy to give a complete account of physical reality?

2. Motion considered geometrically

Leibniz has three discernible lines of argument premised on the relativity of motion, as to why the principles of the mechanical philosophy are insufficient, and need supplementing:

1. If motion be taken *entirely* geometrically, then one is not entitled to assume any forces in it, not even passive forces such as the greater resistance to being put in motion of a more massive body assumed by the Cartesians. Attempts such as his own earlier one to derive such inertia assuming only extension and endeavour violate the relativity of motion. But the relativity of motion is a necessary consequence of motion as understood geometrically. Therefore in order to account for the correct laws of collision (specifically, what we now call the law of conservation of linear momentum), a passive force of inertia must be assumed that is not reducible to purely mechanical principles.
2. If motion is understood as mere change of situation, then it is entirely relative, and the subject of motion cannot be identified. But then the assigning of causes of motion becomes arbitrary. Therefore there must be more to motion than mere change of situation, or things will not be capable of action and passion.
3. Situation, and change of situation, are extrinsic denominations. But there are no purely extrinsic denominations; so the foundation of situation, and of change of situation, must be in the modifications of substances. Change of situation, Leibniz will argue, must be grounded in a primitive active force whose modifications will be the derivative forces that constitute what is real in motion at any instant.

The first thing we need to understand, then, is why Leibniz regarded the relativity of motion as intrinsic to motion considered geometrically, i.e. as mere change of situation. He gives a typical statement of this claim in the *Discourse on Metaphysics* of 1686:

For motion, if one considers only what it precisely and formally comprises, that is to say, change of place, is not an entirely real thing, and when several bodies change situation among themselves, it is not possible to determine, solely by a consideration of these changes, to which among them the motion should be attributed—as I could show geometrically if I wanted to stop to do so. (*Discourse on Metaphysics*, GP iv 444)

Actually, the latter statement is not an idle boast. Leibniz had provided precisely such a demonstration in a manuscript probably written during his last summer in Paris, or very soon

thereafter, “Mechanical Principles” (A VI iii 101-111).⁹ First he takes two bodies in mutual relative motion, and considers four cases. He shows that the same appearances will follow if B is at rest and A moves towards it with a uniform velocity v , if A is at rest and B moves towards it with a uniform velocity $-v$, if A and B are moving along a line towards one another with velocities $\frac{1}{2}v$ and $-\frac{1}{2}v$, and if A and B are moving uniformly in the same direction with a difference in velocities of v . He then considers (case 5) whether it will make any difference if they are regarded from an eye in a third body C (at rest with respect to B) observing the motions of A and B, and shows that the phenomena—all the mutual changes of situation at each instant—will appear the same, even when C is instead allowed to move along in the same direction as B but with half its velocity, as (case 6). Therefore, Leibniz, concludes, not even an omniscient being will be able to determine which body is in absolute motion: “whatever speed or direction we attribute by assuming an absolute motion for one of the bodies, we will always find that anyone must then understand motion in the others in such a way that everything will appear as before” (109).

But how, one might ask, does that make merely geometric motion “not entirely real”? The idea is that things would *appear* exactly the same whichever of several bodies is considered to be at rest provided all their relative motions are the same. Leibniz expresses this by saying that (if motion is conceived geometrically) it makes no difference to the phenomena which body is taken to be really at rest. As he writes in the unpublished second part of the *Specimen dynamicum* of 1695,

Now, it must be admitted that it is impossible for pure [*nuda*] extension, involving only geometric notions, to be capable of action and passion. ... From this it follows that ... motion considered apart from force—that is, insofar as only the geometric notions of size, shape and their variation are considered in it—is really nothing other than change of situation. Therefore *motion, as far as the phenomena are concerned, consists in a mere relation [respectu]* ... It must therefore be maintained that, if several bodies are in motion, it cannot be inferred from the phenomena which of them is in absolute, determinate motion or at rest; rather, rest can be attributed to any of them you choose and the same phenomena will still be produced. (*Specimen dynamicum II*, GM vi 246-47)

⁹ The title *Principia Mechanica* is supplied by the Akademie editors, who date it very tentatively as 1673-76 (?). As Dan Garber observes (2009, 108), there are many themes that resonate with ideas first articulated in the Spring-Summer of 1676, including the claim that “the full cause must produce a unique effect” and that shape is an incomplete concept. For a translation of this piece and commentary, see Arthur 2013b.

Now let us turn to the first of the three objections listed above. Leibniz's starting point in the Mechanical Philosophy was his encounter with the Laws of Collision that Wallis, Wren, Mariotte and Huygens had established in 1669. Correcting Descartes' impact laws, they had reached the correct conclusion that it is the quantity of motion in a given direction that is conserved in collisions. For this quantity, mass times speed in a given direction (i.e. vector velocity), Leibniz would later coin the term "quantity of progress", the quantity which we, after Newton, call (linear) momentum. If a smaller body collides with one with a larger mass it will be able to impart proportionately less of its speed to it, which is why Leibniz sometimes refers to this as the "law of compensation". But taking mass as a primitive is not strictly in accord with the mechanist program, since it is not derivable from extension and motion. Accordingly, in his *Theoria motus abstracti* and *Hypothesis physica nova* of 1671 Leibniz offered a theory of collisions based solely on endeavour and eschewing the concept of bulk or mass altogether. "The outcomes of all collisions would be determined by a simple composition of endeavours" (A II iii-VE 7877), with endeavours conceived as instantaneous velocities; a body, of itself, could offer no resistance to motion. I will not go into the details of this theory here, which have been well described elsewhere (see Garber 1995, 273-77). Suffice to say that the theory fails: Leibniz cannot get it to reproduce the phenomena.

Thus the first consequence that Leibniz draws from the failure of his early theory (and some later attempts in 1676) is this: from body as pure extension and forces reduced to endeavours, one cannot account for the inertial mass assumed in the law of conservation of the conservation of the (vector) quantity of motion. So without some supplementary account of the passive force of resisting changes of motion, the foundations of mechanism as understood by his contemporaries are inadequate to explain one of the bedrock successes of mechanism, the laws of bodily collisions. Prior to his official introduction of substantial forms, this constituted an open problem for Leibniz, since it was not clear to him how a body (even one equipped with a mind) would contain in itself the information needed for it to rebound in accordance with "the law of compensation". In the spring of 1676 he was working with a kind of occasionalist philosophy which appealed to God as the "universal mind" to "assist" bodies so that they collided in such a way as to conserve the quantity of motion:

When two bodies collide, it is clear that it is not the mind of each one that makes it follow the law of compensation, but rather the universal mind assisting both, or rather all, equally. On the other hand, it is not necessary for the same quantity of motion always to be conserved in the world, since

if one body is carried by another in a certain direction, but is moving of its own accord equally in the contrary direction, it will certainly come to rest, i.e. it will not leave its place. From this it follows that the conservation of the quantity of motion must be asserted of the action, i.e. relative motion, by which one body is related to another or acts on another. (“On Motion and Matter”, A VI iii 493).

Here we see a clear recognition that the quantity of motion that is conserved in collisions is the product of relative velocity and the body’s magnitude, not motion regarded as an absolute quantity. That is, according to the laws of collision established by Huygens et al., the conservation of quantity of motion applies to relative motion.

This leads Leibniz to draw a second consequence from the failure of his earlier theory. For, like Descartes’ own rules of collision given in the Third Law of his *Principles*, his are in violation of the relativity of motion—as Huygens himself might perhaps have pointed out to Leibniz when they were together in Paris. Like Descartes, Leibniz had tacitly assumed a background space, a kind of general extension of the plenum within which the bodies were moving. Now, if one is able to assume such a space as a really existing container, then real motion would be a change of location in this absolute space, as Leibniz explains in an unpublished manuscript from early 1677:

If *space* is a certain thing supposed in pure extension, whilst the nature of *matter* is to fill space, and *motion* is change of space, then motion will be something absolute; and so when two bodies are approaching one another, it will be possible to tell which of them is in motion and which at rest; or, if both are moving, with what speed they are moving. And from this will follow those conclusions which I once showed in the *Theory of motion abstractly considered*. But in reality space is not such a thing, and motion is not something absolute, but consists in relation. (“Space and motion are really relations”, A VI iv 1968; LoC 225)

Thus if a privileged space is identifiable as that presupposed by the rules of collision, as in Leibniz’s theory in the HPN, then the equivalence of hypotheses (as to which body is to be taken as at rest) cannot hold. By contraposition, therefore, if one accepts the relativity of (even only inertial) motions, one cannot identify any such space as absolute space.¹⁰

¹⁰ This undermines Puryear’s claim that in Leibniz’s considered view, “Motion, like force, is absolute in the sense that it is not relative to a frame of reference” (2012, 167). He rightly points out that using the term “frame of reference” is anachronistic, and that Leibniz has in mind a space relative to a body or system of bodies (rather than that together with a system of three space and one time coordinates); but the point stands that Leibniz took the equivalence of hypotheses to rule out absolute motions as motions relative to an absolute space in the Newtonian sense.

3. Substantial forms reinstated

How, then, does one identify the subject of motion? If no body can be said to “have” the motion rather than any other (since any of them may equally be regarded as at rest, so long as the relative motions are all preserved) then it appears that the system of relative motions is more nearly a property of the world as a whole, as Leibniz reasons in February 1677:

A remarkable fact: motion is something relative, and one cannot distinguish exactly which of the bodies is moving. Thus if motion is an affection, its subject will not be any one individual body, but the whole world. Hence all its effects must also necessarily be relative. The absolute motion we imagine to ourselves, however, is nothing but an affection of our soul while we consider ourselves or other things as immobile, since we are able to understand everything more easily when these things are considered as immobile. (“Motion is something relative” [Febr. 1677], A VI iv 1970; LoC 229)

The wording of this passage is quite revealing about how the relativity of motion factors into Leibniz’s motivations for substantial forms. He has argued that insofar as motion is understood geometrically—that is, as mere change of situation—individual subjects of motion cannot be distinguished, and motion has to be regarded as an affection of the whole world. Now he argues that since there is no absolute space within which individual subjects could be distinguished, the appearance of absolute motion is an effect of the fact that we see things from our own point of view, regarding ourselves as immobile.

But suppose God now creates the world in such a way that motions as they appear to each individual in the world from his or her own point of view are all completely compatible with one another. Here we need to interpret “point of view” literally, so as to include the situation of each individual’s body in relation to all the others it co-exists with, yielding representations that will change as the body moves. Each such representation could be regarded as a perception, provided the individual is equipped with organs of sense in which these representations are presented with varying degrees of clarity and confusedness. Supposing the individuals are also equipped with appetites that take them through the changes of representation in an autonomous fashion, according to some internal law, then one has all the ingredients of Leibniz’s substantial forms. He argues just this in a piece written in about 1681:

Insofar as God relates the universe to some particular body, and regards the whole of it as if from this body, or what is the same thing, thinks of all the appearances or relations of things to this body

considered as immobile, there results from this the substantial form or soul of this body, which is completed by a certain sensation and appetite. (*The Origin of Souls and Minds*; A VI iv 1460; LoC 261)

Similarly, five years later he argues in the *Discourse* that God produces substances as results of considering the world from all its infinite points of view:

For God ... considers all the faces of the world (*toutes les faces du monde*) in all possible ways, since there is no aspect that escapes his omniscience. The result of each view of the universe, as seen from a certain place, is a substance which expresses the universe conformably to that view, if God should see fit to actualize his thought and produce that substance. (*Discourse on Metaphysics* §14; GP iv 439)

Now such passages might be taken to confirm the picture that Adams has proposed. If ultimately all that exist are these perceiving forms, and God creates in each one a representation of the whole rest of the universe from its point of view, then all that exist are these appearances or relations of other things to it, in such a way that the systems of relations of all such substantial forms harmoniously cohere. There would be no real bodies, just their appearances; likewise, there would be no real motions, just changes of appearances and of relations of bodies with one another in one coherent whole.

One could make several objections to this interpretation. Leibniz does not appear to be arguing here that there are no real bodies or motions; in fact, the argument seems to be premised on the reality of bodies and their motions, and God arranging everything so that there is a perfect harmony between the appearances produced within the substantial form of each substance and the physical phenomena occurring outside it. On the face of it, the reduction of bodies to appearances is not compatible with Leibniz's own way of presenting his philosophy as a hypothesis of a pre-established harmony between two realms, that in which "body expresses the whole universe through the interconnection of all matter in the plenum", and that in which "the soul also represents the entire universe by representing the body which belongs to it in a particular way" (*Monadology* §62; GP vi 617). But I will not pursue such objections here. The inadequacy of this picture can be demonstrated by staying within the topic of relativity of motion.

For the above picture is insufficient to solve the problem of the subject of motion. On the phenomenalist picture, bodies would still not be beings capable of action and passion. A

comparison with Spinoza seems particularly apt here, especially given Leibniz's later criticisms of Spinoza for reducing the world to phenomena. Spinozan individuals express from their own vantage point all their relations to other individuals. As modes of extension, they are bodies in efficient causal relations with all other bodies. But they are not substances, and their actions consist solely in these causal relations, of which sentient individuals can be aware to a greater or lesser degree. Now Leibniz followed Spinoza in attributing action to that individual in which the cause is expressed more clearly. But given the relativity of motion, this is problematic. A subject in a stagecoach, for instance, regarding herself as immobile, could change situation with respect to a group of pedestrians on the street. Meanwhile, the pedestrians, regarding themselves as immobile, would see the passenger moving with respect to them, and given the mutuality of change of situation, both passenger and pedestrians would describe the appearances truly, neither would be more correct than the other. God could create the universe so that all the relations of one subject to the others are as it appears from that point of view. But then motion would be a mere phenomenon of God as the only substance, since bodies are completely ephemeral and transitory.¹¹ There would be no more reason for saying that I threw a ball than for saying that all the other bodies in the universe conspired to make it appear that way, although the ball remained entirely stationary. So no individual could be held responsible for his own actions.

Whether such a relativity of the subject of action would have been acceptable to Spinoza, it clearly would not have been to Leibniz. He could not accept that individual human subjects were mere modes, nor that they were not responsible for their own actions. As we know, Leibniz developed a metaphysics in which substances are beings capable of action, and their actions are attributable to them individually, not in relation to other existents. This involves their containing within them the reason for their own actions, reasons bound up with the notion of *appetition*. In a word, what is lacking in the phenomenalist picture is a proper recognition of the significance of the dynamism at the heart of Leibniz's metaphysics. The entelechies presumed in bodies not only give a foundation for the reality of these bodies and their motions—something I will come back to in a moment—but also for a theory of action that makes the substances the true authors of their own actions, and not just actors relative to other actors. In every interaction, therefore, there had to be

¹¹ Leibniz says that if Spinoza were right that there is only one substance, "then everything except God would be transitory, and would sink into mere accidents and modifications, since there would not be in things the basis of substances, which consists in the existence of monads." (Letter to Bourguet, December 1714; GP iii 575).

a way of distinguishing which were the true motions, and which were only apparent motions caused by the motions of other bodies relative to them. And the true motions had to involve the identification of causes. As we shall see now, Leibniz was alive to this.

4. Motion with respect to cause

So far I have restricted the discussion to what Leibniz says about motion insofar as it is conceived geometrically, in terms of relations of situations. But in all the passages I have quoted from this occurs as the first item in a contrast between *motion conceived merely geometrically* and *motion with respect to cause*. Motion cannot be attributed to a subject if one is considering it only as change of situation; but it can be attributed to a subject if one knows something about the causes involved. As he writes in the “Mechanical Principles” of 1676, “No one doubts that the coach moves over the ground rather than the ground under the coach” (A VI iii 104-05). In this vein, the passage I quoted above from “Motion is something relative” of February 1677 continues:

It should be noted, however, that when we consider motion not formally as it is in itself, but with respect to cause, it can be attributed to the body of that thing by whose contact change is brought about. (“Motion is something relative”, A VI iv 1970; LoC 229)

This echoes Leibniz’s account in the “Mechanical Principles”, where he writes:

From these things it is clear that in the case of two bodies, motion should be attributed to that one which contains the cause of their mutual situation having changed, because we have seen it receive a blow, or because it is dislocated and deformed, or shows signs of having received some other blows and of having had a change wrought in it as a result of this. (“Mechanical Principles”, A VI iii 104-05)

In this same essay Leibniz applies similar considerations to the Copernican controversy, arguing that the hypothesis of the annual motion of the Earth—that is, that it “changes its situation to the fixed stars”—“would certainly be sufficiently corroborated” by such phenomena as changes in the apparent diameter of the fixed stars and parallax. Likewise its diurnal motion would be established by the fact that “hanging lamps constantly vibrate from East to West, or that waves impinge only on eastern and western shores” (A VI iii 105-06). One might have thought that Leibniz should deny the truth of the Copernican hypothesis. But his distinction between “motion as it is in itself” and “motion with respect to cause” allows him to identify, in a given scenario, which motions are merely apparent. The coach is moving and the ground is still, because we know the horses are

pulling the coach. Of course, the ground itself could be moving, but that is not relevant to explaining which of the two relative motions is true and which apparent. Likewise, with respect to the fixed stars—that is, taking them to be at rest—it is clear that the simplest hypothesis to explain the phenomena (and to distinguish true from apparent motions) is that according to which the Sun is taken to be at rest and the Earth in motion, both around its own axis and around the Sun.

This distinction between “motion formally as it is in itself” and “motion with respect to cause” is a traditional distinction, and can be found even in thinkers such as Swineshead and Heytesbury of 14th century Oxford. It certainly figured prominently in reactions to Galileo’s account of motion by Fabry, Mersenne and their contemporaries in the 17th century. In Leibniz’s case, once he has articulated it in 1676 in connection with the simplest hypothesis for explaining the phenomena, it remains a staple of his philosophy. He will later slightly refine the wording, using “most intelligible” in preference to “simplest”, and arguing that the hypothesis that correctly distinguishes the true from the apparent motions should be taken as itself true, but otherwise it is the same position that he defends in the *Dynamica* begun around 1689:

Universally, when motion occurs, we find nothing in bodies by which it could be determined except change of situation, which always consists in relation (*in respectu*). Thus motion by its nature is respective. But this is to understand these things in mathematical rigour. Meanwhile, we attribute motion to bodies according to those hypotheses by which they are most aptly explained, and the truth of the hypothesis is nothing other than its aptness. (*Dynamica*, Prop. 19, GM vi 507-08)

That is, we can say that a body is truly in motion (with respect to cause) when we have identified the most intelligible hypothesis that accounts for the production of the relative motions. This account tallies with Leibniz’s mature philosophy of cause, as can be seen by comparing it with the following remarks in a piece—incomplete, but probably intended for publication—roughly contemporary with (and consistent with) the *Discourse on Metaphysics*:

And that thing from whose state a reason for the changes is most readily provided is adjudged to be the cause. Thus if one person supposes that a solid moving in a fluid stirs up various waves, another can understand the same things to occur if, with the solid at rest in the middle of the fluid, one supposes certain equivalent motions of the fluid <in various waves>; indeed, the same phenomena can be explained in infinitely many ways. And granted that motion is really a relative thing, nonetheless that hypothesis which attributes motion to the solid, and from this deduces the waves in the liquid, is infinitely simpler than the others, and for this reason the solid is adjudged to

be the cause of the motion. Causes are not derived from a real influence, but from the providing of a reason. (*Specimen inventorum*, A VI iv 1620, LoC 311; my emphasis)

Of course, between 1676 and 1686 a profound change has occurred in Leibniz's natural philosophy, the introduction of force and the discovery of its correct measure in 1678. It is not an accident that he should have discovered the correct measure through a consideration of causes, namely, through his principle that "the full cause must be contained in the entire effect". Leibniz first articulates this Full Cause Principle in the summer of 1676: "Any full effect, if the opportunity presents itself, can perfectly reproduce its cause, that is, it has forces enough to bring itself back into the same state it was in previously, or into an equivalent state" (Hess 1978, 204). This did not immediately yield the correct measure; that arrived only after a sustained effort at the beginning of 1678. But the breakthrough depended on the idea that physical force is the capacity to act, to do work. Using the Full Cause Principle, Leibniz was able to show that this remains in a body whether it is expressed in motion (living force) or not (dead force): a body that has been raised through a given height against gravity has the same capacity to do work as it does when it has acquired motion falling through that height. In an elastic collision each body has its living force (mv^2) converted into elastic force (with the capacity to do the same work), and then back again into an equivalent living force ($m(-v)^2$) as it rebounds. Thus, provided their relative speed is the same, "the action or impact of bodies on each other will be the same": "if the appearances of the phenomena in question are the same, then, whatever may turn out to be the true hypothesis, that is, whichever bodies might in the end turn out to be truly in motion or at rest, the outcome in terms of the phenomena ... which result will be the same" (*Specimen dynamicum II*, GM vi 248). So in an isolated body or system of bodies, the same total force remains, whatever hypothesis is made about which bodies are at rest. Force is therefore what is absolute in motion, unlike the Cartesian quantity of motion, whose absoluteness is contrary to the relativity of motion and would require an absolute space. Thus although motion consists "only in relation (*respectu*)," "and there is no way of determining precisely how much absolute motion should be assigned to each subject," still "motive force, i.e. the power of acting, is something real, and can be discerned in bodies." (A VI iv 1622-23; LoC 315).

Forces in this sense, however, the forces that are determined as the causes of bodies acting and being acted upon by one another, are derivative forces. And derivative forces, according to Leibniz, are instantaneous modifications of something permanent. But all material things are

constantly changing. So if what is real in motion is derivative active force (whether living or dead), it must be a modification of something that is not extension and its modifications, namely *form*. This argument is buttressed by the further consideration about extrinsic denominations. For substances are situated through their bodies: they are where they physically act, so to speak. Now, situation, and change of situation too, are *extrinsic denominations*. But according to Leibniz, there can be “no purely extrinsic denominations”, and therefore no change in an extrinsic denomination without a corresponding change in some intrinsic modification of the individual substance. He identifies the relevant modification for situation as involving “a degree of expressing a remote thing in the thing itself, either of affecting it or receiving an affection from it. So, in fact, situation really involves a degree of expressions” in the substance (“On the Principle of Indiscernibles”, C 8-10). Similarly, change of situation must have a substantial basis. Leibniz identifies this as the primitive active force or appetite that takes each substance from one state to those following.

Returning now to the objections mentioned in the introduction about the reality of space, we see that Leibniz maintains a much more nuanced position than has been supposed. Bodies have relations of situation to other simultaneously existing bodies, and these are mutual; so, likewise, are the changes of situation of bodies. But all these relations are instantaneous: there is no one enduring space in which bodies are situated, on account of the relativity of motion. But with respect to cause, we can identify the most intelligible hypothesis, yielding the true versus the merely apparent motions among some set of phenomena. This will serve to give us an absolute space, not as an enduring entity, but as a convenient fiction based on the hypothesis that certain bodies are immobile. (This is a fiction because there is nothing with respect to which they can be absolutely immobile.) In the fragment quoted at the beginning of this paper, Leibniz writes:

Absolute space is no more a thing than time is, even though it is pleasing to the imagination; indeed it can be demonstrated that such entities are not things, but merely relations of the mind trying to refer everything to intelligible hypotheses—that is, to uniform motions and immobile places—and to values deduced on this basis. (“Motion is not Something Absolute”; A VI iv 1638, LoC 333)

Moreover, the fact that bodies do not actually exchange any impetus, Leibniz thinks, reflects the fact that causes are not derived from a real influence. Therefore, rather than have the universal mind “assist” bodies in having them behave according to the law of compensation, as he had suggested in 1676, God must have given them the means to have successive representations that properly reflect the motions occurring in their collisions with other bodies. Above all, this must

consist in a force of acting. But it must also consist in a passive force that is the ground for their representation of their reaction to other bodies. Without this, Leibniz argues, there is no way that they could contain within themselves the means to resist the forces experienced in their collisions with other bodies. There would be no ground for what he called “the law of compensation” or for the conservation of living force except in a divine mandate imposed from above. Thus, he argues in the passage with which we began, each body must contain within it both the representation of its spatial relations to other bodies and the means to change its representations in accordance with their respective masses and speeds, and this is found in its substance or force:

In fact, each substance is a kind of force of acting, i.e. an endeavour to change itself with respect to all the others according to certain laws of its own nature. Whence any substance whatever expresses the whole universe, according to its own point of view. And in the phenomena of motions this fact is especially apparent, for there every single body must be supposed to have a motion in common with any other, as if they were in the same ship, as well as its own motion, reciprocal to its bulk; how this could be so could not be imagined if motions were absolute and each body did not express all others. (“Motion is not Something Absolute” [c. 1686-9]; A VI iv 1638, LoC 333-35)

4. Conclusion

I have not tried here to give a full treatment of Leibniz’s views on the relativity of motion, nor is it part of my brief to defend his position from all criticism. What I have tried to do is to show how the relativity of motion, considered geometrically, functioned as one of his motivations for rehabilitating substantial forms; and that when this is taken seriously, a different picture emerges from the idealistic position about motion usually attributed to him.

In closing, let me address one of the passages most often cited both as supporting an idealistic interpretation of Leibniz’s position on matter and motion, as well as perhaps indicating where he finally moves over to a frankly idealistic position. It occurs near the end of a long and exhaustive reply (30th June, 1704) to De Volder’s criticisms of his views expressed earlier in their correspondence:

Indeed, considering the matter carefully, it should be said that there is nothing in things except simple substances, and in them, perception and appetite. Moreover, matter and motion are not so much substances or things as the phenomena of perceivers, the reality of which is located in the harmony of perceivers with themselves (at different times) and with other perceivers. (LDV 307; GP ii 268)

This wording seems in keeping with what Puryear wrote about motion being “ultimately reducible to perceiving substances and their modifications” and phenomena “having their being in perceivers”, which he took to be tantamount to a commitment to idealism. But if what Leibniz meant by this was that he had now abandoned his former position respecting the reality of motion, which required not only that a body “change its situation with respect to the others, but also that the cause of the change, the force or action, be in itself” (GP iv 396), we would certainly have expected him to say more. What we find on inspecting the rest of the letter, though, is a summary of the position he had been urging throughout the correspondence: Body and motion are not simply extension and change of situation, which are mere mathematical abstractions. Extension is an abstraction from the extended, whereas a really extended body presupposes “a nature that is supposed to be diffused, repeated and continued”, a nature “which constitutes physical body”, consisting in “the principle of acting and being acted upon”, i.e. active and passive force (LDV 305; GP ii 269). Force, on the other hand, “is that which is momentary in action, but with a relation to the following state” (307; 270). Force, that is, is really in the things that are acting and are extended. If there were no such “internal force or foundation of actions ... there would be no natural principle of change at all, and so no natural change would occur” (309; 271).

Earlier in the letter Leibniz writes that “extended mass is nothing but a phenomenon founded in things, like the rainbow or perihelion” (303; 268); what he means by this, I contend, is not that bodies are mere appearances, but appearances to us of those natures which constitute bodies as extended. It is those natures, the forces in bodies, that constitute them as real phenomena. Bodies are “real things”, he writes in the same letter, whose “parts are not indefinite, but are actually assigned in a certain way, in accordance with the divisions and subdivisions that nature actually institutes by different motions”. This, of course, requires that the motions effecting the subdivisions also be real. But these are mutable and transitory, like the derivative forces, and therefore must be modifications or limitations of something permanent, namely a primitive active force in bodies.

All of this, I submit, indicates that Leibniz intends that the phenomena of bodies and motions are real, that they contain substances or forces in the robust sense that a thing must be where it acts, and that these substances or forces are the foundations of the phenomena, and are what constitute them as real. Body in reality is just an aggregation of unities, of the derivative passive forces whose diffusion constitutes its extension, and its appearance as extended, homogeneous and one, is dependent on our perceiving it as such; whereas the motion of a body is an appearance

resulting from its change of situation relative to an observer, a motion which could be made to disappear by changing the observer's frame of reference; nevertheless, its reality consists in the force it is endowed with, an internal principle of change in the body whose phenomenal measure at any instant is invariant. Although the appearances of these phenomena depend on our perception, their reality does not. As Leibniz responded to Locke's observation that to creatures with much finer senses than ours, "the yellow colour of gold would then disappear, and instead of it we should see an admirable texture of parts": "[Agreed;] but the colour yellow is a reality, all the same, like the rainbow." (NE 219)

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