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HORWICH ON THE LEIBNIZIAN RATIO AGAINST ABSOLUTE SPACE AND MOTION

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ABSTRACT

I will argue that Paul Horwich's classical reconstructions of the Leibnizian arguments against absolute space and absolute motion are flawed. First, I will introduce Newton's conception of space and motion, and Horwich's analysis of the Leibnizian response to Newton's argument. I will then present what, I think, is the correct interpretation of Leibniz's response to Newton. Next, I will explain why Horwich's stance probably follows from his imperfect understanding of Leibniz's notion of force. I will finally present Leibniz's positive argument for a relational conception of space, and maintain that, once again, Horwich is likely mistaken in his analysis of the argument, or rather of what the argument entails.

Keywords: absolute space, absolute motion, general equivalence of hypotheses, force, haecceitism

1. Introduction

The still very much alive debate on the absolute-relational nature of space does not begin, in spite of what several authors tentatively suggest,[1] with the correspondence between G. W. Leibniz and S. Clarke. There are at least two long and rich pre-Modern traditions, one of which extends to Aristotle and the other of which originates probably with the ancient atomists, which also deal with what we call at present *the absolute-relational controversy concerning space.*[2] For Aristotle and his followers, the notion of space is parasitic on the notion of body. The notion of a space independent of a certain arrangement or relation of bodies is incoherent. What is ontologically essential is the notion of body, upon which the notion of space can be construed as an abstraction. For the atomists and their followers, on the other hand, space is real. It is something that has an autonomous existence and that can be thought of as the *container* of bodies. There is nothing incoherent, accordingly, in referring to a space deprived of bodies – that is, a *vacuum*. To put it differently, the idea of space is fully intelligible on its own, independently of the concept of body. For Descartes and the Cartesians, in the

1 *Cf.*, for example, Reichenbach (1958), Nagel (1961).
2 For an outstanding account of its history, see Grant (1981).

seventeenth century, the answer to the question of the nature of space is fundamentally the same as the one provided by Aristotle. Space does not have an independent reality and, accordingly, the existence of a vacuum is prohibited.[3] For other early-Modern philosophers, like Gassendi (who promoted atomism) and Pascal, space has ontological independence and, therefore, the existence of vacuum is permitted.[4]

Notwithstanding this, it is unquestionably in the discussion between Newton and Leibniz, embodied in the Clarke-Leibniz correspondence of 1715–16, where we first find the two sides of this long and frequently ill-defined controversy about the nature of space methodically laid down and argued for.[5] Newton puts forward an absolutist conception of space and motion, where the absoluteness of motion plays an essential role in his defense of absolute space. Leibniz rejects, somewhat obscurely, the absoluteness of motion while offering a positive argument for a relationalist conception of space.

Next I will quickly go through Newton's conception of space and motion, paying special attention to his famous *bucket experiment*, and introduce Horwich's interpretation of Leibniz's response to Newton's argument. In section three, I will present what, I think, is the correct interpretation of Leibniz's response to Newton on the existence of absolute motion, based on Leibniz's own account of the matter. I will then explain, in section four, why Horwich's flawed interpretation probably follows from his imperfect understanding of Leibniz's key notion of *force*. Finally, in section five, I will present Leibniz's positive argument for the relational conception of space and will argue that, once again, Horwich is likely mistaken in his understanding of this argument, or rather in his diagnosis of what the argument entails. I will maintain, in a word, that Leibniz's metaphysical underpinning of the argument –namely, the principle of identity of indiscernibles– does not necessarily bring about the collapse of the most part of modern physics, as Horwich suggests, but merely the abandonment of haecceitism.[6]

2. Absolute space and absolute motion

As noted above, there is a long tradition of thought, beginning with the ancient atomists, according to which the notion of space is independent of the notion of body. The tradition asserts, in other words, that space is ontologically independent from any configuration of bodies that occupy it. Isaac Newton is unquestionably the most distinguished supporter of this view in the seventeenth century, and probably in all history. For Newton, space is an infinite all-pervasive medium made up of qualitatively

3 *Cf.* Garber (1992, 127–36) and (1995, 301). A notable exception to this Aristotelian view among the Cartesians is Cordemoy.

4 Garber (1992, 136–43) and (1995, 301–2).

5 It must be acknowledged, however, that even the correspondence between Leibniz and Clarke is plagued with mutual distrust and a surprising lack of understanding. Grant, in connection with the correspondence, affirms (1981, 250): "It was less a genuine dialogue than two monologues in tandem where, by some strange coincidence or prearranged harmony, the letters of each correspondent contain identically numbered paragraphs that frequently treat the same theme".

6 One might wonder here why Paul Horwich's views on this matter deserve a separate discussion, more so if deemed mistaken. Why is his 30-year-old reconstruction of, as well as his reaction to, Leibniz's relationist conception of space still relevant to us? My answer to this question, which is admittedly somewhat idiosyncratic, is that Horwich's views are still taught in many classrooms, and his 1978 paper is still often presented as a faithful approach to Leibniz's relationism. I want to thank one of the referees for putting this question to me.

indistinguishable points. Each such point continues to exist throughout time. All material objects occupy at a given time a definite set of space-points. And for an object to be in motion is for it to occupy distinct sets of space-points at different times.[7] It seems clear that Newton's absolutist conception of space does not rely on, or derive from, the notion of body. Although our measurements invariably refer to relative spaces – that is, the relative positions of material bodies, there always exists this underlying absolute space in which the notions of absolute position and absolute motion make sense. Newton says:

> Absolute space, in its own nature, without relation to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces, which our senses determine by its position to bodies … Place is a part of space which a body takes up, and is according to the space, either absolute or relative … Absolute motion is the translation of a body from one absolute place into another; and relative motion, the translation from one relative place into another … But because the parts of [absolute] space cannot be seen, or distinguished from one another by our senses, therefore in their stead we use sensible measures of them … And so, instead of absolute places and motions, we use relative ones, and that without any inconvenience in common affairs. But in philosophical disquisitions, we ought to abstract from our senses, and consider things themselves, distinct from what are only sensible measures of them. (Newton 1687, Book I, Scholium to definition VIII)

It is beyond doubt, then, that in Newtonian mechanics absolute space is *real* –as opposed to (say) a useful mathematical device which allows us to distinguish between inertial and non-inertial systems, independently of the presence of material bodies and their metrical and topological configuration. It is beyond doubt, moreover, that absolute space would be just as real even if the world happened to be, counterfactually, a perfect vacuum.[8]

But Newton goes beyond the mere postulation of an absolute space that cannot be, allegedly, empirically pinned down to offer a positive argument from which its existence can be conclusively inferred. The argument is based on his famous *bucket experiment*. In Newtonian mechanics all coordinate systems moving rectilinearly and uniformly – that is, all inertial coordinate systems – are identical as far as the laws of motion are concerned.[9] It is not possible to perform any mechanical experiment

7 *Cf.* Horwich (1978, 398).

8 It is not beyond doubt, however, what absolute space *is* for Newton. According to Garber (1995, 302), in the second edition of 1713 of the *Principia* Newton identifies absolute space with God himself. However, in his correspondence with Leibniz, Clarke, championing the Newtonian view, claims that absolute space is just a property or quality of God. But Earman (1989, 112) affirms that Clarke's opinion on this matter differs from Newton's. He points out, based on Newton's *De Gravitatione*, that Newtonian absolute space "has its own manner of existence which fits neither substances nor accidents" (Hall and Hall 1962, 132). Still, Earman thinks that Newton's *overall* doctrine can be viewed as a firm defense of space conceived as a substance (1989, 113), and he cites Newton again from *De Gravitatione*, who claims that the manner in which absolute space exists, which fits neither substances nor accidents, "approaches more nearly to the nature of substance" (Hall and Hall 1962, 132). Grant (1981, 254), however, agrees with Garber that Newtonian absolute space, despite all ambiguities, can be positively identified with a three-dimensional, infinitely extended God.

9 This is, of course, the old Galilean principle of relativity. The relativistic principle of relativity, unlike the Galilean

within one of these systems so as to determine whether it is moving or resting relative to absolute space. One can arbitrarily predicate *any* velocity of inertial systems, as long as the *relative* velocities are preserved. It is clear, then, that the existence of absolute space does not follow from, and seems even undermined by, Newtonian kinematics. Newton, however, observes that the existence of absolute space can indeed be inferred from dynamical considerations, more particularly, from the behavior of rotating bodies. And this is precisely what the bucket experiment is intended to show.

We start with a bucket of water suspended by a twisted rope. The rope is left free to unwind. The bucket begins to rotate. After a few moments, the motion of the bucket is transferred to the water. The bucket and the water are now rotating freely. But the bucket is suddenly stopped –before the rope begins to wind again. And the water keeps rotating.

We can divide this process into four successive stages:

(a) Bucket and water at rest: flat water	(b) Bucket rotates, water at rest: flat water
(c) Bucket and water rotating (at rest relative to each other): concave water	(d) Bucket at rest, water rotates: concave water

According to Newton, all four stages of this experiment can only be fully accounted for if we assume the existence of absolute space. The relative motion of bucket and water fails to account for the concavity of water in (c) and (d), since such relative rotation is neither necessary – stage (c) – nor sufficient – stage (b) – condition for concavity. And so, Newton concludes, the water's concavity must be a consequence of its absolute rotation relative to absolute space.

The argument can be reconstructed as follows:[10]

> (1) To explain the concavity of water one must find some circumstance which is present during (c) and (d) and absent during (a) and (b).
> (2) The relative rotation of bucket and water does not satisfy (1).
> (3) The only plausible alternative is, then, the absolute rotation of water.
> (4) Absolute rotation is the change of absolute spatial location with respect to time.
> ∴ (5) The water's absolute spatial location changes from (a)–(b) to (c)–(d).

The immediate lesson that follows from (5) is, of course, that absolute space exists. Now, this argument can be famously objected to in various ways depending on which particular premise is targeted. The most celebrated objection is due to Ernst Mach, who challenges the acceptability of (3). Mach (1883) notes that the water's rotation relative to the distant "fixed" stars could also explain its concavity, for this circumstance

principle, encompasses as well the laws of electromagnetism developed by J. C. Maxwell in the nineteenth century.

10 Newton's argument, as stated in the *Principia*, involves only three steps. Moreover, it has been argued –*cf.* Rynasiewicz (1995) – that the argument does not involve *explanation* at all. I want to thank one of the referees for stressing these points.

is present only during (c) and (d).[11] There is another famous approach, however, which targets the acceptability of (4). According to this approach, Newton's idea that absolute motion is to be identified with a change in absolute spatial location is unjustified. The most influential proponent of such approach is Sklar (1974). Sklar maintains that absolute motion is not to be identified with motion relative to an absolute frame of reference. He claims, moreover, that absolute motion is not to be viewed as a *kind* of motion – i.e. change with respect to something external – at all, but rather as a *monadic* property of things, which at times belongs to objects. For Sklar, therefore, absolute motion is just an intrinsic property of bodies, such as mass, charge, spin, and so forth. And its empirical detection, in spite of Newton's argument, does not amount to evidence for the existence of absolute space.

According to Horwich's classical and influential analysis (1978), Sklar's strategy against Newton's argument is precisely the strategy that Leibniz puts forward in response to Newton. Horwich claims, oddly enough, that Leibniz's answer to Newton's argument is that the water in (c) and (d), receding from the axis of motion, does indeed experience absolute motion, due to the fact that its rotation is the *cause* of the relative motion of the water with respect to the bucket. He says:

> … Leibniz adopted just this position in response to Newton's argument. He maintained that certain objects in motion relative to others were the *cause* of that relative motion; and these could be said to be in absolute motion. Such objects are said to be in absolute motion, not in virtue of any variation in their absolute position, but merely because they are responsible for the changes in their position relative to other objects. (Horwich 1978, 402)

According to Horwich's interpretation of Leibniz, then, the water in (c) and (d) is indeed in absolute motion, but this is so not in virtue of any variation in its absolute position – its position relative to absolute space, but merely because it is *responsible* for the changes in its position relative to other bodies. And so this purportedly allows Leibniz to circumvent Newton's result in terms of the existence of absolute space.

I will present next Leibniz's principle of the "general equivalence of hypotheses" – general relativity of motion – and discuss his somewhat obscure argument, based on this principle and his theory of rigid motion, against Newton's bucket experiment. It will then become clear, I believe, that notwithstanding all its obscurity and alleged inconsistencies, Leibniz's argument cannot be what Horwich takes it to be.

3. The general equivalence of hypotheses

The Galilean principle of relativity states that any coordinate system moving rectilinearly and uniformly behaves identically as far as the laws of motion are concerned. This means that, as a matter of physical law, it is not possible to perform any mechanical

11 It is worth noting that, notwithstanding Hans Reichenbach and Ernest Nagel's famous accounts, Newton himself considered the possibility of explaining the water's inertial effects in terms of its motion relative to external bodies. But he dismissed this possibility, together with Leibniz and Huygens, because he judged it implausible. *Cf.* Earman (1989, 65) and Huggett (1999, 20).

experiment within these systems which determines whether they are in absolute motion or at absolute rest. Following this principle, then, one is entitled to assert that any hypothesis describing the state of motion of any set of inertial systems is equivalent to any other hypothesis, as long as the relative motions of these systems are preserved.

We observed in the previous section that Newton's bucket experiment is intended to demonstrate that this equivalence of hypotheses is not a general feature of the science of mechanics, since there exist circumstances, where dynamical considerations come into play, in which, for Newton, it is possible to establish which bodies are absolutely moving and which bodies are not. Thus, the water receding from the axis of motion in (c) and (d) is, for Newton, absolutely rotating, while the flat water in (a) and (b) is not. It is incorrect, as a result, to contend that all hypotheses describing the state of motion of this system are equivalent, as long as the relative motions are preserved. There is a privileged coordinate system, the one that Newton associates with absolute space (the one in which the stars are fixed), in which the water can be truthfully described as being in absolute motion.

And it is exactly at this point, of course, where the main conflict between Newton and Leibniz concerning the relativity of motion arises. Leibniz refuses to accept that there exists any privileged coordinate system. He rejects, in other words, the idea that there is a way in which absolute motion can be, even in principle, detected – which could in turn be transformed, as Newton does above, into an argument for the existence of absolute space. Leibniz maintains, on the contrary, that the equivalence of hypotheses is not restricted to kinematics, but is rather a general principle of mechanics. In one of his letters to Huygens (1694), he writes:

> Newton recognized the equivalence of hypotheses in the case of rectilinear motions; but he believes, with respect to circular motions, that the effort circulating bodies exert to move away from the center or from the axis of circulation allows us to recognize their absolute motion. But I have reasons that lead me to believe that there are no exceptions to the general law of equivalence. (Ariew and Garber 1989, 308)

And in *A Specimen of Dynamics* (1695), he says:

> … The entire nature of motion is relative, so that from the phenomena one cannot determine with mathematical rigor what is at rest, or the amount of motion with which some body is moved. This holds even for circular motion, though it appeared otherwise to Isaac Newton … He thought that, with the help of circular motion, he could discern which subject contains motion from centrifugal force, something with which I could not agree. (Ariew and Garber 1989, 125)

It seems clear then that Leibniz's response to Newton cannot be what Horwich takes it to be. But why is it that Leibniz clashes with Newton on the absoluteness of circular motion based on its inertial effects? What are the *reasons* that drive Leibniz "to believe that there are no exceptions to the general law of equivalence". If we now confidently establish that Leibniz's response to Newton, notwithstanding Horwich's account, does not amount to a recognition of absolute motions and the contention that absolute motions are not, against Newton, the harbinger for absolute space – which amounts to a rejection of step (4) above, then we must find an alternative *ratio* which moves Leibniz to reject Newton's argument. We must find, that is, some argument which forces Leibniz to rebuff Newton's notion of absolute motion and absolute space and uphold the general equivalence of hypotheses.[12]

His argument, which is almost unanimously deemed obscure and unsatisfactory,[13] goes, in a nutshell, as follows. First, Leibniz puts forward a theory of motion in which the cohesion of rigid bodies in motion is not due to any true firmness or rigidity in them, but rather a corollary of their concurrent motion, of a kind of internal coordinated movement. Second, Leibniz notes that all motion is in straight lines or compounded of straight lines: "All motion is rectilinear or composed of rectilinear motions" (Ariew and Garber 1989, 135). Third, Leibniz formulates the principle of the equivalence of hypotheses for uniform and rectilinear motion – i.e. the Galilean principle of relativity, according to which any inertial coordinate system is as good as any other. Finally, in *A Specimen of Dynamics* (1695), he puts all these pieces together and writes:

> I cannot agree with certain philosophical opinions of certain important mathematicians, who … take motion to be an absolute thing, and strive to prove this from rotation and the centrifugal force that arises from it. But since rotation also arises only from a combination of rectilinear motions, it follows that if the equivalence of hypotheses is preserved in rectilinear motions, however they might be placed in things, then it will also be preserved in curvilinear motions. (Ariew and Garber 1989, 136–7)

Thus, the idea seems to be that all curvilinear motion is ultimately made up of very short segments of uniform and rectilinear motion, the direction of which is constantly changed, though preserving an internal coordinated movement, by collision with other bodies. And then, since the equivalence of hypotheses is valid in every case of uniform and rectilinear motion, it must also be valid in all cases of curvilinear motion. In a piece written in 1689, Leibniz emphatically establishes this conclusion, asserting that the general equivalence of hypotheses precludes all possible observers from detecting absolute motions, even when such curvilinear motions are present:

> Since we have already proved through geometrical demonstrations the equivalence of all hypotheses with respect to the motions of any bodies whatsoever, however numerous, moved only by collision with other bodies, it follows that not even an angel could determine with mathematical rigor which of the many bodies of that sort is at rest, and which is the center of

12 Along similar lines, Garber (1995, 306) concludes that "… Leibniz knew of Newton's claim, and just as he rejected absolute space, he rejected Newton's absolute motion".

13 *Cf.* Garber (1995, 306), Earman (1989, 71–3), Stein (1977, 3–6). It is quite likely Leibniz himself was not completely satisfied with his relational treatment of rotation, which is suggested by the fact that he never published his response to Newton.

motion for the others. And whether the bodies are moving freely or colliding with one another, it is a wondrous law of nature that no eye, wherever in matter it might be placed, has a sure criterion for telling from the phenomena where there is motion, how much motion there is, and of what sort it is, or even whether God moves everything around it, or whether he moves that very eye itself. (Ariew and Garber 1989, 91)

As suggested above, a majority of scholars agree that at least two problems compromise Leibniz's argument. Since such problems do not concern the main thread of this study, I will just mention them here. First, leaving aside whether the argument is consistent with Leibniz's rejection of atomism in the first place, there is no explication in the theory as to the mechanism by which the motion of rigid bodies, especially of rotating bodies, can be accounted for in terms of some rectilinear coordinated motions. How can such motions be coordinated precisely in order to produce rotations? Second, the argument is based on the assumption that there is an absolute and independent notion of rectilinear motion. But this assumption, to be consistent with Leibniz's relationalism, is unwarranted.[14]

Now, Horwich's assertion that, for Leibniz, certain objects "… could be said to be in absolute motion" has been, I think, well discredited. No motion can disrupt the general equivalence of hypotheses. But Horwich's rationale behind this claim is that some objects in motion are the *cause* of relative motions. And, in my opinion, he mistakenly claims of these objects in motion to be, for Leibniz, identifiable as being in absolute motion. I will maintain in what follows that Horwich's mistake arises, quite likely, from his somewhat imperfect understanding of Leibniz's notion of *force*.

4. Force, mechanistic philosophy, and Aristotelian metaphysics

Horwich notes that certain objects in motion relative to others can be viewed as the *cause* of that relative motion, which is consistent with Leibniz's view that, given a set of bodies in relative motion, there is always a *force* applied to some of them that causes the relative motion. However, Horwich believes that, for Leibniz, this claim is equivalent to the claim that those bodies upon which the force is applied can be positively identified as being the recipient of such force – exactly like we can positively identify objects as being the bearer of *intrinsic* properties such as mass, charge, spin, etc. – which singles them out as being in absolute motion. And this, as discussed above, is likely wrong. For Leibniz, no force can disrupt the general equivalence of hypotheses. Even though we know that there are forces acting on some of the objects in relative motion, there is nothing to be done which could determine which objects are indeed the *cause* of the relative motion. As Garber voices the point:

… But, Leibniz argues, underlying motion there must be force, the cause of motion, something that goes beyond the mechanist's world of extension and its modes, something that really pertains to one body rather than another. There is, in this sense, a correct frame for determining motion, the frame in

14 *Cf.* Earman (1989, 72–3).

> which the motions observed are the effects of real underlying forces which are their causes. But such a frame could never be identified. (Garber 1995, 308)

It seems clear that the presence of forces acting upon objects does not disrupt the general equivalence of hypotheses.[15] For Leibniz, there is no inconsistency in claiming both that motion actually belongs to certain bodies, those bodies upon which the forces are applied, and that we are incapable, as a matter of principle, of determining which bodies are these.

But now a subsequent problem arises. We know, on the one hand, that Leibniz (as Newton, Descartes, and many others) sees the world through the eyes of the seventeenth century mechanistic philosophy, according to which, roughly speaking, everything in the world is matter and motion. And, on the other hand, we have just learned that forces, for Leibniz, are beyond the realm of matter and motion – that is, beyond the realm of material bodies and their relative motion. Why does he bring up forces then? Why does he turn to forces when dealing with matter and motion? A plausible explanation is, as Garber points out, that Leibniz's conception of force performs the primordial task of fitting the physical world of matter and motion into the Aristotelian metaphysical scenario in which Leibniz places the mechanical world. Garber says:

> In this way Leibniz can say … that everything in the world happens mechanically, but that the world of the mechanical philosophers is grounded in something quite different than extended matter and motion, an Aristotelian metaphysics of substantial form and primary matter; it is the dynamics, the science of force that links the underlying Aristotelian metaphysics with the physics of the mechanists. (Garber 1995, 293)

But this is just half the response. Why does Leibniz, opposing Newton, think it necessary to attach non-mechanical forces to the mechanical phenomenon of motion? Why does he specifically resort to forces as such critical metaphysical anchoring? The answer, I think, is that Leibniz, if we accept his commitment to the Aristotelian metaphysical background, needs a subject for motion. For Leibniz, a mere relative motion would lack a determinate subject, being then impossible for it to be a real constituent of the world. Leibniz finds it completely unintelligible that there could be a property that is not really a property of an individual, a property that is irreducibly relational. Hence, if motion is to be real, Leibniz believes that it must be grounded in something that is not a mere relation, something that is a real property of things. And this is precisely the role that, from this perspective, non-mechanical Leibnizian forces play. As Garber puts it:

> For Leibniz, all real properties of things in the world ultimately reside in genuine individuals. If that is the case, it is evident why mere motion, the mere change of place, just won't do; for it to be intelligible that there is

15 Leibniz acknowledges, however, that there might be an exception to this rule, whenever human beings are the seat of the force. In such cases, we might be able to determine which bodies are the *cause* of motion through the effort felt.

> motion at all, there must be something nonrelativistic, something that is an absolute and nonarbitrary property of some individual thing, that is the cause and ground of motion. This is where force comes in. The present state of the world must have a ground in reality, in some configuration of forces; something must be there, though Leibniz cannot say what specifically. (Garber 1995, 309)

But this is clearly not the kind of force that Horwich has in mind when he maintains that forces, which *cause* relative motions, let us pinpoint which objects are in absolute motion and which objects are not. He seems to uphold, on the contrary, the classical-mechanical Newtonian notion of force. And thus his assertion, which I have been disputing here, that Leibniz's response to Newton's bucket experiment simply amounts to an indication, with Sklar, that step (4) in the Newtonian argument is unjustified – that is, that absolute motion is not necessarily motion relative to absolute space. For Leibniz, once again, nothing can disrupt "the general equivalence of hypotheses". Not even forces. Leibniz's conception of force, despite Horwich's account, does not appear to bring about our physical recognition of absolute motion, but rather the metaphysical grounding of relative motion in reality.

5. Absolute space, haecceitism, and the identity of indiscernibles

In the third letter to Clarke (1716), Leibniz writes:

> I have many demonstrations to confute the fancy of those who take space to be a substance, or, at least, an absolute being. But I shall only use, at present, one demonstration … I say, then, that if space were an absolute being, something would happen for which it would be impossible that there should be a sufficient reason – which is against my axiom. And I can prove it thus. Space is something absolutely uniform, and without the things placed in it, one point of space absolutely does not differ in anything from another point of space. Now, from hence it follows (supposing space to be something in itself, besides the order of bodies among themselves) that is impossible there should be a reason why God, preserving the same situation of bodies among themselves, should have placed them in space after one certain particular manner and not otherwise – why everything was not placed the quite contrary way, for instance, by changing east into west. But if space is nothing else but this order or relation, and is nothing at all without bodies but the possibility of placing them, then those two states, the one such as it is now, the other supposed to be the quite contrary way, would not at all differ from one another. Their difference therefore is only to be found in our chimerical supposition of the reality of space in itself. But in truth, the one would exactly be the same thing as the other, they being absolutely indiscernible, and consequently there is no room to inquire after a reason for the preference of the one to the other. (Ariew and Garber 1989, 325)

This is Leibniz's famous argument for a relational conception of space.[16] Unlike the prior argument presented above to counter Newton's argument, this offers a *positive* rationale for upholding the relationalist conception of space. The structure of this argument can be reconstructed thus:

(1) Let us assume space is an absolute being.
(2) Space, without bodies placed in it, is uniform (homogeneous and isotropic): one point does not differ from any other point.
(3) For everything there is, there is a sufficient reason (*ratio*).
(4) But there is no sufficient reason why God should have placed the world, preserving its internal relative structure, in a particular orientation or specific region of absolute space.
(5) Statements (3) and (4) contradict each other.
∴ (6) Space is not an absolute being.

Leibniz quickly points out that his relationalist conception of space does not give rise to a similar problem, for if space is nothing but a set of relations among material bodies, then any purportedly *different* arrangement of them in terms of their spatial orientation or their location in space would "collapse", given Leibniz's principle of identity of indiscernibles, into one and the same arrangement.

Many responses have been famously put forward over the centuries to counter this argument. We could naturally avoid its conclusion by rejecting either premises (2) or (3). We could entertain, for example, that it follows from the general theory of relativity that space is not uniform – although, in favor of the Leibnizian view, the structure of space is indeed correlated with the distribution of matter. Or we could simply maintain that (3) is untenable, for several interpretations of quantum mechanics suggest a moderate principle of indeterminacy or acausality in the physical world. I will bring the present discussion to a close, however, by examining Horwich's own response to the argument, which, I think, is based on an extremely feeble attack on Leibniz's principle of identity of indiscernibles (PII).

As just noted, Leibniz believes that PII makes his relationalist conception of space immune to any threat of inconsistency between the principle of sufficient reason and the conjectured existence of multiple but indiscernible worlds. All such indiscernible worlds would *collapse* into one and the same world. But Horwich accuses PII of being untenable because, he claims, PII has devastating consequences for modern physics. He declares:

> Such Leibnizian arguments are by no means conclusive. Not only have we presented no justification for the particular Principle of the Identity of Indiscernibles upon which they rely, but, when applied in other areas, the Principle quickly leads to unacceptable results. Thus Leibniz refutes atomic theory, arguing that if particles A and B were qualitatively identical, there

16 Next, Leibniz shows in the same way that time is just "the successive order of things" (Ariew and Garber 1989, 325).

> would not be a distinct possible world, indiscernible from our own, in which their positions are interchanged. This sort of reasoning would leave us an intolerably impoverished ontology, annihilating most of what physics tells us to believe in. (Horwich 1978, 409)

Horwich is then arguing that: (i) there is no obvious justification for PII; (ii) PII has awful consequences for modern physics, and must then be rejected. Concerning (i), it is not true that Leibniz presents us with PII without any justification – *cf.*, for instance, *Discourse on Metaphysics*, section 9 (Ariew and Garber 1989, 41–2). But even if we put aside Leibnizian metaphysics and consider PII in a broader context, there are many reasons of empiricist-verificationist nature – *cf.*, for example, Reichenbach (1958, 210) – that could certainly be brought to its defense. The point I would like to address at this juncture, nevertheless, is (ii).

Horwich claims that PII is unacceptable because its application to modern physics yields an intolerably poor ontology. Let us study his case in more detail.[17] Imagine two particles of the same kind – say, two electrons – A and B in world w_1. The set of properties of A and B is respectively P_A and P_B. These sets are coextensive, except for their position vectors (x_A, y_A, z_A) and (x_B, y_B, z_B), which are different. Consider now world w_2 in which everything else is like in w_1 but P_A and P_B have been interchanged – that is, A and B have swapped locations. According to PII, w_1 and w_2 are identical, since a world in which A is defined by P_A and B is defined by P_B is indiscernible from a world in which A is defined by P_B and B is defined by P_A. And this result is what Horwich finds intolerable. He states that this conclusion carries the seeds of an almost complete destruction of contemporary physics, the annihilation of "… most of what physics tells us to believe in".

I believe, as suggested above, that there exists a serious *non sequitur* in Horwich's reasoning. The application of PII to physics would just rule out, as the previous example clearly reveals, the viability of physical haecceitism.[18] PII just precludes, in other words, the possibility of attaching any indexical mark or "this-ness" to particles A and B, for the attachment of such marks would necessarily entail that w_1 and w_2 are different, although indiscernible, worlds. But there is nothing in PII which compromises the alleged richness and multiplicity of modern physics' ontology beyond the abandonment of haecceitism, or which refutes atomic theory. It can be easily proved, in contrast, that the abandonment of haecceitism based on PII does not amount to any substantial weakening of the otherwise generous ontology of modern physics – abandoning haecceitism, by itself, does not entail in any way the *collapse* of complex structures into

17 What follows does not constitute in any way an exhaustive discussion of PII and haecceitism. I personally agree with the view – *cf.*, for instance, Earman (1989) – that haecceitism should not be lightly abandoned for very general and somewhat elusive reasons, but rather, if at all, for specific reasons on a piecemeal basis. I have discussed this matter elsewhere in connection with quantum mechanics. In the present paper, the question of haecceitism is only tangentially addressed, to the extent that it compromises Horwich's reconstruction of Leibniz's position.

18 The term *haecceitas* was originally coined by Duns Scotus, to refer to the individual essence or "this-ness" of things. The term is here employed in the following sense – *cf.* Albert (2000, 45): Haecceitism"…is the doctrine that two worlds which differ from each other by means of nothing over and above a simple permutation of the positions of otherwise identical material particles are (nonetheless) different".

simpler ones.[19] Horwich, nonetheless, states that PII "… quickly leads to unacceptable results", but he fails to demonstrate how, in his view, such disastrous consequences would certainly be the case.

The only sense in which, in my view, Horwich's point would be of real concern is the following. PII would indeed be a major threat to the ontology of physics if we lived in a highly symmetrical universe. As Black's classical paper (1952) notes, the ontology of a highly symmetrical world subjected to PII would "collapse", due to the indiscernibility of its symmetrical parts, to a minimally symmetrical ontology. Differently put, in any world subjected to PII, a high level of symmetry is inconsistent with a high level of ontological complexity. And this conclusion is certainly disturbing.[20] But Horwich, in any case, does not appear to be considering this possibility. He seems to believe, on the contrary, that PII constitutes a decisive blow to the ontology of physics regardless of whether our world is highly symmetrical or not.

It is my belief, in sum, that Horwich's contention that PII is intolerable because it rules out most of modern physics is false. PII just excludes the possibility of haecceitism in physics – which is not, in any obvious way, unacceptable. However, PII would indeed be a serious threat to the ontology of modern physics if we lived in a highly symmetrical world. But such diagnosis is hardly new but rather a classical and well-known result. And Horwich, in any case, does not appear to be thinking about this possibility.

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19 For an argument against the alleged negative consequences that abandoning haecceitism has for modern physics, see Albert (2000, 45–8).

20 *Cf.*, however, Hacking (1975).

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