



Leibniz and the Plurality of Space-Time Frameworks

I. The Question of Distinct Frameworks

Leibniz advocated a theory of space (and time) as “relative”—that is, as relative to the physical things ordinarily said to be located *within* space (and time). He opposed the doctrine of Newton’s *Principia* which cast space and time in the role of empty containers existing on their own and having a makeup that is indifferent to the things emplaced in them. For Leibniz, space and time are simply relational orders of being. Owing to the general tenor of his theory, Leibniz is sometimes seen as a precursor of Einstein and modern relativity theory. But this view is mistaken or, at any rate, misleading. Leibniz—unlike Einstein and modern relativists—is not thinking of the relativity of dynamical principles to the choice of a coordinate system *within* nature, so that we are involved in a situation of comparison from the perspective of various world-included frameworks. Rather, Leibniz’s thesis that “space is relative to the things in it” has regard to the perspective of various alternative possible worlds taken as a whole. The mutual attunement of whatever is included in a common world is the foundation for space and time, which have no existence apart from the concordance of the mutual “perceptions” of substances (in Leibniz’s sense of this term). “[T]here is no spatial or absolute nearness or distance between monads. And to say that they are compressed into a single point positioned in space is to use of certain fictions of our mind when we seek to visualize imaginatively that which only be understood.”¹

As Leibniz saw it, the Newtonian theory of “absolute” space envisages

this space as an entity in its own right, a content-indifferent container that would be filled up with different substantial content in the case of different possible worlds. His own view of space and time as something content relative implies—by way of contrast—that every possible world must have its own characteristic spatial (and temporal) structure. The issue comes down to a *metaphysical*—rather than *physical*—bone of contention. For in physics we study *this* world alone, whereas the point at issue is that of the world-transcending question, Do *different* “possible worlds” have their own characteristic spatial structure or should they be conceptualized as so many different ways of filling up one single common content-indifferent space-time container?

2. Spatiality: The Conception of Space as Everywhere the Same

To begin with, we have to recognize the *idea or conception* of space must (for Leibniz) be uniformly one and the same with respect to all possible worlds. What space is, is one (conceptually uniform) thing; what is space is another (potentially world-variable) one. This is true for space as it is for any and every *concept*. A possible world may or may not contain *men*, and its intelligent creatures may be very different from ours, but it cannot alter what *humanity* is. (The concept of humanity may not find *application* in some other possible world, but it cannot undergo *alteration* there.) The *concept* of spatiality is world-uniform because it is world-indifferent. In every world-setting space answers to the same conception: it is “the order of *coexistence*”—and time “the order of *succession*.” For Leibniz, every concept is what it is with respect to any and every possible world—the concepts of space and time included.

Let us, however, look at the matter from another point of view. The ancient atomists had an interesting theory of possibility. Confronted with a question like, “Why do horses not have horns, as cows do?” they responded, “The hornlessness of a horse is just a local idiosyncrasy of *our* world—our own environing particular neighborhood in the universe. Somewhere else in the infinite vastness of space, there is another world, otherwise just like ours, in which horses *do* have horns.” The atomists thus envisaged space as one vast all-encompassing framework in which all possibilities are concurrently encompassed.

Did Leibniz hold a view of this nature? Was space for him one, all-encompassing matrix that embraced the actual and possible alike—a *superspace* embracing all possible worlds along with our own, *actual* world?

Surely not. A space for Leibniz is the order of coexistence (*ordo coexistentiae*), and distinct substances in distinct worlds do not coexist with one another. (*Coexisting* substances are a fortiori *compossible*.) And there are as many such spatial orders as there are families of *compossibilia*. The limits of a space are coordinate with the realm of the substances comprising its correlative world. For Leibniz, every world has its own space that has no room left over for any further, world-external contents. There is no superspace in which distinct possible worlds are colocated with one another. Leibniz, as we may say, was a “one-world, one space” theorist.

If Leibniz had defined space as the order of possible existents at large—rather than as the order of possible coexistents—then, to be sure, there would only be one single, all-comprehending space. For it is clear that different substances in different possible worlds do bear various relations to one another—the relation of *difference* for one thing, but also *similarity* (in various regards) and so on. But while there are cross-world *relations* among possible substances, there are not—and indeed cannot be—any cross-world *spatial relations*. Space is the order of coexistence, and spatial relations are confined to coexistents. Distinct worlds are spatially disjoint—or better (since disjointness is itself a spatial term) they are spatially *unrelated*—somewhat like the dream worlds of different people (which is Leibniz’s own illustration, as we shall shortly see). There is no way of getting from one to the other by any mode of transit, real or imaginary.

3. Distinct Worlds Must Have Distinct Spaces

For Leibniz, substances are located in different spaces *because* they contradict one another: The world in which people otherwise like my parents had a daughter instead of a son for their only child has to be a different world from this one thanks to compatibility considerations, and has to have its own distinctive spatiotemporal structure on the basis of these differences. It takes different worlds, and thus different space orders, to accommodate incompatible arrangements for substances.

In the Paris period, Leibniz enunciated a position that—as I interpret him—he continued to hold throughout his life:

[T]here could exist an infinity of other spaces and worlds entirely different [from ours]. They would have no distance from us [nor other special relations to us] if the minds inhabiting them had sensations not related to ours. Exactly as the world and the space of dreams differ from our waking world, there could even be in such a world quite different laws of motion.²

Leibniz thus holds that every possible world has its own space as it has its own laws. There are many spaces, even as there are many law manifolds. To say this does not countervail against the undoubted fact that what a *space* is like what a *law* is, is something that is uniform throughout all possible worlds. The concept for (or genus) is uniform even though its exemplifications (or instances) are distinct.

If one confronts the thesis that, for Leibniz, “Space is one and the same everywhere, for all possible worlds,” one must accordingly recognize that this is so in one sense but not so in another. It is true if we take in view the *concept* of space, but false if we take in the *item* to which this concept applies. For while space is—everywhere—the “order of coexistence,” it turns out that what this order is, is necessarily different in different worlds, since different worlds contain different and incompatible substances and these substances *internalize* such differences. (A difference in substances entails a difference in their relations, which entails a difference in ordering relations.)

The space of the physical world, so Leibniz writes to Samuel Clarke, is not separable from its matter.³ But space—spatiality as an order of coexistence—pertains not only to the actual world, but to every possible one. The substances and their inherent interrelationships simply *constitute* their world. Thus in no possible worlds can space be separated from the substances that “fill” it. Space—to reemphasize—is nowise a content-neutral container.

For Leibnizian possible worlds, then, a difference in *things* brings a difference in *spaces* in its wake, even as it carries with it a difference of laws. There is, in fact, a deep analogy between Leibniz’s treatment of the law system and that of the space system of possible worlds. And the following passage regarding laws (from a letter to Arnauld) is one that Leibniz would certainly apply to space as well:

Just as there is an infinity of possible worlds, so also is there an infinity of laws, paired one for one, and every possible individual of every world includes in its notion the laws of its world.⁴

4. How Are Distinct Spaces Distinct?

It is worthwhile to pose abstractly the general (Leibniz-transcending) issue: Just exactly what is the cash-value difference between speaking of a plurality of *distinct* spaces as opposed to speaking of a *single* all-comprehending superspace with many distinct sectors of subspaces? And just as one is inclined to say that the reality of real physical objects resides in their locatability is one common and unified *actual* space,⁵ why could one not say that the possibility of the possible lies in its locatability in one vast and all-inclusive common and unified superspace?

The answer here turns on two (interrelated) issues: Is the so-called superspace such that

(1) The various sectors themselves bear such fundamentally *spatial* relations to one another as (for example) relative proximity and distance?

(2) The various sectors are so *interconnected* with one another that one can envisage some sort (however unorthodox) of “transport” along an itinerary leading from each to the others?

Clearly, if the answer to both of these questions is *no*—if the so-called “subspaces” are disconnected from and spatially unrelated to one another—then there is no warrant for speaking of all-embracing “superspace” at all.

The point is simply this—that space is individuated as a single space through the mutual relatedness and connectedness of its parts, and where these elements of mutual relation and interconnection are absent, the warrant for speaking of a single space is lacking.

Now when these general considerations are brought to bear on the Leibnizian situation, it is clear that the spaces of distinct possible worlds are—or can be—so unrelated and disconnected as to remove all warrant for speaking of a single uniting space. The “Wonderland” of Lewis Carroll’s Alice, the “Land of Oz” of L. Frank Baum’s stories, and the “Planet Zeta” world of the Dr. Who adventures (taken as rough indications of Leibnizian worlds) are sufficiently devoid of spatial connections and relations with one

another that there is no warrant for taking them as distinct sectors of a single spatial matrix. (Actually, this claim about these fictions involves an overstatement, since in each instance it was possible by some process—however mysterious—to transpose someone thence from *our* world.)

Different Leibnizian world spaces cannot form parts of a unifying superspace because they must be fundamentally *disjoint*—not only in a *physical* but even in an *intellectual* sense. In the extremely interesting opuscle on space “On Existence, Dreams, and Space,” Leibniz writes:

[S]pace is that which makes that many perceptions cohere with each other at the same time . . . The idea of space is, therefore, that through which, as is recognized, we separate clearly the place, and even the world, of dreams, from ours . . . From this it follows furthermore that there can be infinitely many spaces and, hence, worlds, such that between them and ours there is to be no distance . . . Plainly as the world and space of dreams differ from ours, so too can they have other laws of motion . . . When we awake from dreams we come upon more congruences that govern bodies, but not that govern minds . . . Whoever asks whether another world, or another space, can exist is asking to this extent whether there are minds that communicate nothing to us.⁶

With Leibniz, moreover, there is a special reason why there can be no such thing as a many-world embracing superspace. We know that, for Leibniz, a substance internalizes its relations to others within the property system that constitutes its complete individual concept. Insofar as they go beyond this property internalization, all relations are only “things of the mind,” mere *entia rationis* whose “being” is virtual and imaginary, devoid of any real existence in its own right. And this is true, in particular, of spatial relations.⁷ The spatial relations among substances of the same possible world—like all other relations among them—thus have at least a derivative, supervenient reality, namely, that which arises through the prospect of their being realized along with their terms. But a “relationship” among the incompatible substances of different possible worlds—since they relate *impossible* terms—can never have both feet together on the *terra infirma* of at least possible corealization. It is, for Leibniz, already stretching matters to speak of spatial relations among compossibilities; to contemplate spatial relations among *impossibles* would stretch the concept of special relatedness beyond

its working limits. (As we have seen, space is “the order of *coexistence*,” and impossibles are such that—by their very nature—they cannot possibly coexist.)

5. Why Distinct Spaces?

It is clear *why* Leibniz wanted to insist on the irreconcilable distinctness of the different spaces of different possible worlds. For if those worlds could be colocated within one superspace, then it would be feasible to realize *all* possibilities by the old atomists’ device of shelving each world in its appropriate spot in the all-inclusive matrix. Any prospect for an ethics of creation choice would now be removed, and we would return to the omninecessitarianism of Spinoza.

Leibniz develops this line of thought in an interesting essay of 1679:

But I was pulled back from this precipice by considering those possible things which neither are nor will be nor have been. For if certain possible things never exist, existing things cannot always be necessary; otherwise it would be impossible for other things to exist in their place, and whatever never exists would therefore be impossible. For it cannot be denied that many stories, especially those we call novels, may be regarded as possible, even if they do not actually take place in this particular sequence of the universe which God has chosen—unless someone imagines that there are certain poetic regions in the infinite extent of space and time where we might see wandering over the earth King Arthur of Great Britain, Amadis of Gaul, and the fabulous Dietrich von Bern invented by the Germans. A famous philosopher of our century does not seem to have been far from such an opinion, for he expressly affirms somewhere that matter successively receives all the forms of which it is capable (Descartes, *Principles of Philosophy*, pt. 3, art. 47). This opinion cannot be defended, for it would obliterate all the beauty of the universe and all choice.⁸

What, however, of the ontological status of other spaces? They do have reality of some sort—for they “really” are the coexistence-order relations of the manifolds of possibility that they relate. But this reality is not, of course, one of actual existence. What is at issue is, at best, the purely mental exis-

tence of possibilities as subjects of thought in the mind of God (*sub ratione possibilitatis*). “And so the reality of bodies, of space, of motion, and of time,” so Leibniz writes to des Bosses in 1712, “consists in their being phenomena for God (*phaenomena Dei*) of objects of the vision of His knowledge.”⁹ The reality of such phenomena is merely mental—though we ought, no doubt, to hesitate just a bit in using “mere” where it is God’s mind that is at issue.

6. A Superspace After All?

But is there not, after all, a somewhat different basis for holding Leibniz committed to a superspace theory? For spaces—all spaces—are *entia rationis* (since there is no such *substance* as a space). And if (as Leibniz indeed sees it) the entire manifold alternative possible worlds exists *in concept* in the mind of God *sub ratione possibilitatis*, then do these spaces not after all exist in one overarching framework? Does not *God* relate the different spaces of the different possible worlds—coordinating them within one all-embracing superspace? Is not God’s conception of a plurality of world spaces tantamount to a conception of a single vast spatial matrix that embraces a plurality of parts?

Surely not. The fact that the mind of God conceives the various possible space orders no more means that they are comprehended within one superspace than does the fact that he conceives infinitely many laws means that they are all comprehended within one superlaw or the fact that he conceives infinitely many men means that these are all parts of one superman.

A plurality of distinctly conceived spaces is something very different from the conception of a single space with a plurality of sectors. To be sure, if, for Leibniz, space were (*contra factum*) the order of what can possibly *exist*, rather than which can possibly *coexist*, then we would be led to a single plurality-involving superspace. But in this event the very conception of space would have to play a role in Leibniz’s system very different from its actual one.

For Leibniz, the concept of a space arises from the relations among possible coexistents, and these will inevitably be embraced *within* a common world. Spatial relations do not—and cannot—relate different possible worlds to one another spatially. Thus, for a good reason different Leibnizian worlds

do not bear spatial relations to one another—for good reason. Their “co-existence” in the mind of God is not the *sort* of coexistence that can give rise to a “space.” As Leibniz explicitly says in the Jagodinsky passage quoted above, spaces arise out of relationships of “distance,” which (with Leibniz), in turn, root in the perceptions of substances, and *there are no cross-world perceptions*. The substance of distinct worlds do not have any distance from one another—not that their distance is 0, the whole concept just does not apply.

7. Cross-World Spatial Comparisons

The contention that different possible worlds have their own spaces does, however, encounter one theoretical difficulty whose bearing is general and goes outside a specifically Leibnizian context. For can we not, in fact, actually make cross-world spatial comparisons? Suppose M. Eiffel had made his tower a centimeter shorter. Clearly, this diminished tower cannot be accommodated within *this* world of ours along with the actual tower. The world it inhabits is clearly *another* possible world. But surely it would still maintain various spatial relations to the thing of this world: it would still be in Paris—it would be closer to Rome than to Toronto, would it not?

In the Leibniz setting, the answer here is not straightforward—it is yes *and* no.

Think back to Leibniz’s treatment of comparable contrafactual hypotheses, the hypothesis, say, that Julius Caesar had been born normally, without requiring his mother to undergo a “caesarian” section. We know how Leibniz treats this. He insists that this variant Caesar is *not* identical with ours. The Principle of the Identity of Indiscernibles precludes strict identification. Only because of a general *resemblance* can we speak—loosely and inaccurately (popularly and without metaphysical strictness)—of this variant individual as a “Julius Caesar” (i.e., as somehow a surrogate that can be “identified” with the Julius Caesar of our world).

The situation with respect to space must be viewed in a strictly analogous light. If the Eiffel Tower were a centimeter shorter, it would *not* really be in Paris any longer—not, that is to say, in *our* actual Paris. The “Paris” in which it is located—and the “Rome” and “Toronto” to which it has spatial relations are not those of our world, but would be very different cities located in quite

another world. Thus it does not, in fact, have any spatial relations to the things of our actual world. It is, unquestionably, authentic Leibnizian doctrine that spatial relationships can obtain only *within* and not *across* possible worlds.

This point is reinforced when we recall the full scope and variety of Leibnizian possibilities. There are, to be sure, those possible substances that arise from hypotheses that modify *actualia*—the Adam who does not sin, the Judas who does not betray, the Caesar who does not cross the Rubicon. But not all possible substances need be variant (but nonidentical!) versions of actual substances. We need not be in a position to associate a possible substance with any actual individual—not every hypothetical world is a roman à clef reworking of the actual one. Leibnizian possible worlds will, in general, differ very drastically from ours in their makeup—so drastically as to remove any basis for spatially relating their constituents and those of our world.

8. Must the Spatial Structure of Other Worlds Be Like That of Ours?

But even if distinct Leibnizian possible worlds have distinct spaces, will it not, nevertheless, be the case that the spatial *structure* of other worlds will be the same—or at any rate similar—to the spatial structure of ours? Will they not have the same *geometry* at any rate?

There is nothing whatever in Leibniz's philosophy that constrains him to answer this question affirmatively. Consider again the possible world whose Eiffel Tower was built a bit shorter (say because the iron founders who made the girders worked a trifle less exactly). Its spatial structure would be virtually identical with that of ours. But this is a very specialized circumstance, one that will certainly not be realized in general. No doubt some alternative possible worlds will have the same generic *structure* as ours, but there is nothing to suggest that they must all do so.

These considerations point to an interesting question. If space were a content-indifferent container, if alternative possibilities were simply a matter of shifting things around in one selfsame space, then clearly the truths about this space would hold in every possible world. And so geometric truths—truths about the structure of space—would be necessary. But if space is something world-relative, if different worlds would have different space orderings, then the truths of geometry will be contingent. Just how does

Leibniz view this issue of the status of geometry as necessary or contingent?

To the best of my knowledge, he does not ever address this question directly. Nonetheless, it is pretty clear what he would say if he did so. For in thinking of the manifold of Leibnizian possible worlds, we must avoid any inclination to keep our imagination under too tight a rein. Possible worlds can differ from ours very drastically indeed. (Some, after all, might contain only a finite number of monads.) And worlds whose substance are radically different and behave in line with radically different laws of nature, might well have a spatial structure quite different from ours. For Leibniz, the truths of geometry—unlike those of arithmetic—almost certainly belong to the contingent sphere.

It seems plausible to suppose that Leibniz's own project of analysis situs ("topology" as we nowadays call it) actually represents an attempt to devise a theory of spatial relationships that does not involve the whole range of specific commitments of a full-blown Euclidean geometry. Leibniz would surely have been neither surprised nor dismayed at the discovery of non-Euclidean geometries, and he would have had no difficulty in assimilating such a diversity of spatial structures to his own theory of space.

9. The Important Fact That, for Leibniz, Time Is Coordinate with Space

Let us now turn to time. Here we can be brief. Time, for Leibniz, is conceptually coordinate with space: one could not have space in an atemporal context, nor conversely. For space is the order of *coexistence*—that is, the order among the mutually contemporaneous states of things; while time is the order of *succession*, that is, the order among the various different mutually coexisting states of things which, qua mutually coexisting, must of course have some sort of spatial structure.

It is helpful to explain what is going on here by a cinematographic analogy. To be sure, Leibniz himself did not think of the matter in this naive pictorial way. But he thought of it in roughly equivalent terms—namely, in terms of mathematical analogues in the theory of real-variable functions. However (Plato notwithstanding), not all philosophers are mathematicians, and a pictorial approach may help to get the point across more effectively.

Take a motion picture film: the film reels, say, for *Gone with the Wind*.

And let us suppose that an immense jigsaw puzzle is created by the cutting up of this film—first into individual frames and then even more finely. The Leibnizian ordering problem is now a twofold one, first to assemble all of the individual frames—the contemporaneity (or coexistence) slices that define its spatial order; and secondly the ordering of these contemporaneity slices into the proper sequence that defines a temporal order. For Leibniz, space and time thus stand in an inseparable coordination with one another in the overall ordering process that begins from that starting point of the particular states of individual substances and arrives at an all-comprehending spatio-temporal order. This coordinated symbiosis of space and time is an important aspect of Leibniz’s metaphysics. With him—unlike Kant—space and time are mutually coordinate in such a way that neither is more fundamental than the other.

For present purposes, the important consideration is that the factor of world-to-world variation thus comes in once again—but now with respect to time itself. For the temporal order need by no means be that of the present “Newtonian” world in which time (presumably) flows in the equable manner of a continuous parameter changing uniformly. A *discrete* time consisting of discrete discontinuous jumps, for example, is in principle perfectly conceivable on Leibnizian principles—not, to be sure, as a condition holding in this best of possible worlds, but for one of its possible albeit suboptimal alternatives. In general then, time, like space, need not be structurally uniform across possible worlds.

10. Can a Possible World Lack Spatiotemporal Structure?

We come finally to a rather delicate Leibnizian issue. Could a possible world lack having a spatiotemporal structure altogether? Could the states of its substances be in such a whirl of “blooming, buzzing confusion” that a space-time order is simply lacking?

Leibniz would surely argue that this cannot be—that a world cannot lack a space-time order altogether. After all, even a chaotic arrangement is some sort of ordering—even a random ordering is an ordering (and a very characteristic sort of ordering at that). In the *Discourse on Metaphysics*, Leibniz formulates the issue in the following terms:

That God does nothing which is unordered, and that it is not even possible to assume events which are not according to rule. The volitions or actions of God are commonly classified into ordinary and extraordinary acts. But it is well to understand that God does nothing without order. So whatever passes for extraordinary is so only in relation to some particular order established among creatures. For as concerns universal order, everything is in conformity with it. So true is this that not only does nothing happen in the world which is absolutely irregular but one cannot even imagine such an event. For let us assume that someone puts down a number of points on paper entirely at random, as do those who practice the ludicrous art of geomancy; I maintain that it is possible to find a geometric line whose law is constant and uniform and follows a certain rule which will pass through all these points and in the same order in which they were drawn. And if someone draws an uninterrupted curve which is now straight, now circular, and now of some other nature, it is possible to find a concept, a rule, or an equation common to all the points of the line, in accordance with which these very changes must take place. There is no face, for example, whose contour does not form part of a geometric curve and cannot be drawn in one stroke by a certain regular movement. But when the rule for this movement is very complex, the line which conforms to it passes for irregular. Thus we may say that no matter how God might have created the world, it would always have been regular and in a certain general order.¹⁰

To be sure, there are possible worlds so chaotic in their makeup that it would be inappropriate to think of the relationships among the state of its substances as generating a “spatiotemporal order” *as we know it*, judging in terms of the continuities and regularities of our world. But to say this is to say little more than that the world with which we are familiar—the world we ourselves inhabit—is a very special one in the Leibnizian framework. It is, after all, the best possible world in a manner that puts prime emphasis on lawfulness and rational order—and thus on the geometric elegance of space and time.

In sum, then, Leibniz holds that every possible world has a spatiotemporal structure of some sort—one that is as attuned to and characteristic of it as the substances that constitute it and the laws which govern them.¹¹

Notes

1. C. I. Gerhardt, ed., *Die philosophische Schriften von G. W. Leibniz*, vol. 2 (Berlin: Weidmann, 1879), pp. 450–51 (hereafter cited as *Phil.*); L. E. Loemker, ed., *Leibniz: Philosophical Papers and Letters* (Amsterdam: D. Reidel, 1970), p. 604 (hereafter cited as Loemker).
2. Jagodinsky, p. 114. (Cf. note 6 below for details of this reference.)
3. Fifth letter to Clarke, §29 and 62.
4. *Phil.*, vol. 2, p. 40.
5. See Anthony Quinton, “Spaces and Times,” *Philosophy* 37 (1962): 130–47. Cf. also Norman Swarts, “Spatial Worlds and Temporal Worlds: Could There Be More Than One of Each?” *Ratio* 17 (1975): 217–28. This discussion moots the prospect of several distinct space-time frameworks for the real. These discussions are, however, different from our present inquiry that in effect asks whether the space-time framework of frameworks for *realia* do or do not coincide with those for *possibilia*.
6. Jagodinsky, p. 113. This opusculum was written during Leibniz’s Parisian visit in 1676. It was published (with Russian translation) in I. Jagodinsky, ed., *Leibnitia elementa philosophiae arcanae de summa rerum* (Kazan, 1913). My access to this text is through the translation and commentary prepared by H. N. Castaneda for his interesting essay “Leibniz’s Meditation on April 15, 1676 about Existence, Dreams, and Space,” in A. Heinekamp et al., eds., *Leibniz à Paris*, vol. 1 (Wiesbaden: Franz Steiner Verlag, 1978), pp. 91–130.
7. Cf. the passage of note 1 above.
8. From the essay “On Freedom,” in Loemker, p. 263.
9. *Phil.*, vol. 2, p. 438.
10. *Discourse on Metaphysics*, §6; Loemker, p. 306.
11. This essay is a somewhat revised version of a paper of the same title that appeared originally in *Rice University Studies* 63 (1977): 97–106. The paper was part of an ongoing dialogue with Prof. Yvon Belaval. See his “Note sur la pluralité des espaces possibles d’après la philosophie de Leibniz,” in R. Berlinger et al., eds., *Perspektiven der Philosophie*, vol. 4 (Amsterdam, 1979), pp. 9–19.