



Incongruous Counterparts, Intrinsic Features and the Substantivality of Space

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INTERPRETATIONS OF "WHY DO MIRRORS REVERSE RIGHT/LEFT BUT NOT UP/DOWN?" DISCUSSED IN THIS PAPER

(R) Reading Interpretation

Why is it that while both the placard and its mirror image read up to down, the placard reads left to right while the mirror image of the placard reads right to left?

(G) Getting-into-the-portrait Interpretation

Why is it that when I get into my portrait it fits vis-à-vis top/bottom but fails to fit vis-à-vis right/left?

(D) Direction Interpretation

Why is it that when I face my image in a mirror the direction that is up (headward) for my image is the same direction as up (headward) for me, while the direction that is right for my image is the direction that is left for me?

(W) Wiggling Interpretation

Why is it that when I wiggle my right arm my mirror wiggles his left arm even though when I wiggle my head my image wiggles his head too?

CORRESPONDING SENSES OF 'REVERSE'

The mirror reverses_r the object x/y = The object reads y to x while the mirror image of the object reads x to y .

The mirror reverses_s me x/y = When I get into my portrait it fails to fit vis-à-vis x/y .

The mirror reverses_a x/y = The direction that is x for my image is the direction that is y for me and vice versa.

The mirror reverses_w me x/y = When I wiggle my x part my image wiggles his y part and vice versa.

For purposes of intelligibility, these interpretations and corresponding senses of 'reverse' have been simplified; in no case is question X really equivalent to "Why do mirrors reverse_x right/left but not up/down?"

INCONGRUOUS COUNTERPARTS, INTRINSIC FEATURES
AND THE SUBSTANTIVIALITY OF SPACE

KANT argued, as part of his argument that space is an a priori intuition, from the existence of incongruous counterparts (such as right- and left-handed gloves otherwise alike) to the existence of space as an entity over and above the material objects in it and their spatial relations to one another. Peter Remnant and John Earman have argued that Kant's argument is incoherent.¹

¹ Remnant, "Incongruent Counterparts and Absolute Space," *Mind*, n.s., LXXII, 287 (July 1973): 393-399. Earman, "Kant, Incongruous Counterparts, and the Nature of Space and Space-Time," *Ratio*, XIII, 1 (June 1971): 1-18; parenthetical page references to Earman are to this paper.

Graham Nerlich has recently invoked the dependence of facts about handedness on global features of space to attempt to revindicate Kant's argument.² I will argue here that, even taking account of the dependence of facts about handedness on global features of space, noticed by Earman and utilized by Nerlich, there is no good argument against relationism founded on facts about handedness. Or, more precisely, there is no good argument against relationism based on handedness which goes beyond the best standard arguments against relationism which invoke no facts about handedness at all.

I

Remnant and Earman believe Kant's argument incoherent for the following reason: Kant says that, since the internal relations of parts of left- and right-handed objects are the same, nothing about the structure of these objects could differentiate them. Therefore, what makes them different must be a difference in the relationship they bear to space itself. But if we invoke "space itself," the only account we could plausibly offer to explain the difference in handedness of the objects would be their differential congruity with parts of space itself. But a right- and a left-handed glove would each coincide with some "piece" of space itself; so what makes one left- and the other right-handed? The only answer could be the handedness of the piece of space with which they coincide. But if there is a feature of a piece of space, its handedness, which determines whether an object coincident with that piece of space is right- or left-handed, then why can't the same feature hold of the objects themselves and serve to differentiate them? And if there is no such "internal" feature of the objects, then how does the invocation of space itself help us?

Earman goes on (7) to maintain that there is such an internal feature of objects, the orientation of their parts. Right- and left-handed objects differ in their internal structure in that their parts have a different orientation with respect to each other. A failure on Kant's part to realize that orientation of parts is just as much an "intrinsic" feature of the objects as, say, size of parts and magnitude of angles between them is the fundamental mistake which led him into thinking that any argument from handedness to belief in space

² "Hands, Knees, and Absolute Space," this JOURNAL, LXX, 12 (June 21, 1973): 337-351; parenthetical page references to Nerlich are to this paper. A similar claim that the dependence of orientation properties on global features of space provides a refutation of relationism, is made, without argument, in Ted B. Humphrey, "The Historical and Conceptual Relations between Kant's Metaphysics of Space and Philosophy of Geometry," *Journal of the History of Philosophy*, xi, 4 (October 1973): 483-512, p. 488, n. 11.

itself as an entity over and above the things in it was either needed or plausible. There is no more puzzle about handedness than there is about any other internal feature of objects which differentiates them. And if there is such a puzzle the invocation of space as an autonomous entity in no way resolves it.

But Earman retrenches a bit (8/9). Suppose our space is globally nonorientable. Then there will be a continuous rigid motion (crm) that brings a handed object into congruence with its incongruous counterpart, even though the two objects cannot be brought into congruence by any local crm.³ But how could even a global crm change an intrinsic internal feature of an object? So the “intrinsicness” of handedness seems questionable.

It is just this theme that Nerlich takes up in his attempt to argue from facts about handedness to the substantiviality of space. At least I take it that Nerlich is arguing for substantivalism. He calls his opponent a “relativist,” but never makes it fully clear what constitutes a relativist. His actual claims are:

Which of these . . . determinate characters [being enantiomorphic, i.e., a member of a possible pair of incongruous counterparts or, instead, homomorphic, i.e., being bringable into congruence with any object of the same size and with the same magnitude of angles between parts] the hand bears depends, still, on the nature of the space it inhabits, not on other objects. The nature of this space, whether it is orientable, how many dimensions it has, is absolute and primitive (345).

. . . space [is] a definite topological entity [and] can only be a primitive absolute entity; . . . *its* nature bestows a character of homomorphism, leftness or whatever it might be, on suitable objects. My conviction of the profundity of Kant's argument rests on my being quite unable to see what the relativist can urge against this, except further relativist dogma (350).

. . . what differentiates a thing which is an enantiomorph from one of its incongruous counterparts is a matter of how it is *entered into the space*. . . .

The idea of entry is only a metaphor, clearly. . . . It is not easy to find a way of speaking about this which is not metaphorical. But a very penetrating but not so painfully explicit way of putting the matter is Kant's own, though I believe it still to be a metaphor. The difference between right and left lies in different actions of the creative cause (351).

³ Throughout this article I assume, without loss of philosophical generality, that the space is one of constant curvature.

I am not sure just what it means to say that space is "absolute and primitive." I believe that the notion of handedness being the result of a "creative cause" is irrelevant to the debate between substantialists and relationists. I take it that a relativist is one who espouses a relationist theory of space. I think that Nerlich may be right in saying that handedness is a matter of how an object is "entered into space," but I believe that the existence or nature of handed objects is irrelevant to deciding between a relationist and a substantialist theory of space.

II

Consider two objects. Are they incongruous counterparts, or can they be made congruent by a *crm*? One might think that there was some "intrinsic feature" of the objects that decided this question. In one sense this turns out to be true, but we must proceed with some caution.

Suppose that the objects are two-dimensional and are both on the same plane. It may be possible to bring them into congruence by a *crm* that takes at least one of them out of the plane, but not possible by any *crm* that keeps both confined to the plane. Similarly for objects in our apparently three-dimensional space. If our space really is three-dimensional and if it is orientable, then the objects may be such that no *crm* can bring them into congruence. Yet *had*, contrary to fact, space been four-dimensional, or if it *had*, contrary to fact, been nonorientable, then a *crm would* have existed which *would* have made them congruent, if the objects are typical "incongruous counterparts."

So, bringability into congruence or its impossibility depends not only upon "the structure of the objects themselves," but upon the structure of space "as a whole," its dimensionality and its global orientability.

Now if space is such that the objects are incongruous counterparts, then we can talk about some "intrinsic feature" of them, that is, some feature of them preserved under all *crm*'s of them, which differentiates them—their handedness. But we must realize that (1) the very existence of such a feature depends upon the overall structure of the space, and that (2) which object has which "handedness" depends upon "how it is situated" in space as a whole.

I think this is true, as far as it goes; but the consequences of this truth must be examined with caution. Notice first that a similar argument can be constructed about a feature of an object that has nothing to do with its handedness.



Consider the objects in diagram (a). Is there a motion that transforms them into the objects in diagram (b) which (1) is continuous and which (2) never brings a bar into coincidence with the circle? Well, that depends. What is the space like in which the objects are situated? If it is two-dimensional, the answer to our question is "No." If it is three-dimensional, the answer is "Yes."

Call the arrangement in (a) "opposite-sided." Call that of (b) "same-sided." Is there an "intrinsic feature" of the object arrangements which is opposite- (same-) sidedness, that is, a feature of the arrangement preserved under all continuous transformations that never bring a bar into coincidence with the circle? That depends upon the space in which the objects are placed. If there is such a feature, what determines which object arrangement has it? The answer is: "How the objects are placed in the space." Perhaps there is some crucial disanalogy here with the left-right case, but I fail to see it. There is nothing mysterious about incongruous counterparts. Many features of a given set of objects, with a specified set of internal relations of its parts to one another, depend both for their existence, and, if they exist, for their nature, on the nature of the space in which they exist and on how the parts of the object are situated in the space.

If that is what Nerlich (and Kant?) mean, then they are right. But Nerlich (and Kant) also think that such facts refute the relationist theory of space. They do no such thing.

What is the relationist view of space? It is, at least in the version familiar from Leibniz to Reichenbach, that space is nothing but the collection of actual and possible spatial relations among actual and possible material objects. There are, or may be, some material objects. And there are, or may be, some spatial relations among them. And, spatially speaking, that is all there is. There is no such thing as "space itself considered as an entity" which "exists over and above" the material objects and their spatial relations.

The invocation of *possible* objects and *possible* spatial relations among them is crucial here, just as "permanent possibilities of sensation" are crucial for the phenomenalist. If we wish to be phenomenologists and yet talk about unobserved material objects,

then we must, if we are to translate all material-object talk into sense-datum talk without loss of content, tolerate subjunctive as well as indicative sense-datum assertions. Just so, if we wish to talk about places in the world at which no material objects exist, and even more if we wish to be able to talk about spaces totally devoid of contained matter, then, if we are going to translate all talk about "space itself" into talk about the spatial relations among material things, we had better allow talk about possible objects and their possible spatial relations as well as talk about actual objects and their actual spatial relations.

Now the reader might not like the invocation of possibilities, their possible relations to one another, subjunctive or counterfactual assertions, etc. If he finds these totally abhorrent, then he will probably reject the relationist theory of space. Since versions of relationism that eschew such notions are pretty implausible, he may opt for substantivalism immediately.

Alternatively, he may argue like this: Talk about the possible relations among possible material objects is all right, so long as one understands that it is "grounded" in belief in the *actual* nature of *actually* existing substantival space. Just so, we can understand the language of "possible sense-data of possible observers in possible perceptual situations" only because of our belief in actual material objects.

Each of these positions rests on a deep philosophical objection to relationism. The arguments may even constitute devastating objections to the relationist account. All that I wish to claim here is that the following assertions are correct:

(a) Given the full relationist resources, including possible objects and possible spatial relations among them, we can account for all the interesting features of left and right, etc.

(b) Or, more correctly, we can account for these features just as well on the relationist account as we could on any substantivalist account. If there are any "mysteries" about left and right unsolvable on the relationist account, the invocation of space as a substantival entity will be of no use in solving these puzzles.

(c) If there are uneliminable difficulties with the relationist account of space, they have nothing to do with features of the left-right distinction, the enantiomorph-homomorph distinction, dimensionality, or orientability.

(d) The notion of the "creative cause" of the spatial features of objects is of no relevance to the dispute between the relationist and the substantivalist accounts of space.

The notion of space as "absolute" is ambiguous, but, I will argue, notions of orientation are irrelevant to "absoluteness" in any of its senses. It is not clear what sense is to be given to the notion of space as "primitive." Whatever sense we can give to it is such that there seems to be no good argument from the facts about oriented objects to space being primitive in any way that would disturb a relationist.

(a) Suppose that there is a three-dimensional hand. What, from the point of view of the relationist, makes it an enantiomorph, or, alternatively, a homomorph? If it is an enantiomorph, what makes it a left hand or a right hand? Is leftness (rightness) an intrinsic feature of the hand in this case? Suppose that the hand is not an enantiomorph, but is, instead, a homomorph. How can this be the case? If it is the case, is there still some sense in which the hand is still left (or right)? And does leftness (rightness) in this sense now constitute an intrinsic feature of the hand?

According to the relationist, the hand is an enantiomorph if and only if there is a *possible* incongruous counterpart for it. That is, if and only if there is a possible object such that (1) its parts have the same lengths as the parts of the original hand and the same absolute values of the magnitudes of the angles between them, but (2) there is no crm that will bring the hands into congruence. All this is perfectly acceptable relationist talk. No reference is made to "the entity, space, itself," but only to possible objects and possible spatial relations among them.

Now if the hand is an enantiomorph it will be either right- or left-handed. That is, in a world in which there are enantiomorphs the members of a pair of incongruous counterparts are possessed of an intrinsic feature, that is, a feature preserved under all crm's, which is their handedness.

Now Nerlich claims that the handedness of an object is dependent upon "the way it is entered into the space." Is this correct? That depends upon what you mean. If this means that the handedness of an object is dependent upon the spatial relation of its parts to one another, then the claim is certainly true. But then, the triangularity of a triangle depends upon the spatial interrelation of its parts, and so triangularity would also depend upon "how the object is entered into the space."

Is there any interesting way in which handedness differs from triangularity? Well, yes. Handedness, in the full sense, exists only if there is an orientation property of the object which is preserved

under all crm's. That is what we mean by the object's handedness in the full sense. But, as we know, the existence of such a feature depends upon topological features of the space as a whole—its dimensionality and its orientability. This is not surprising, for the dimensionality of the space and its orientability determine the class of all crm's and, hence, what is preserved under them. There is no analogous dependence of the very existence of triangularity on the over-all topology of the space, and in this sense handedness differs from triangularity. If that is what it means for the handedness of an object to depend "on the way the object is entered into the space," then handedness is so dependent. But that does not mean that handedness is not an intrinsic property of the object in a space in which handedness exists, and there is no good argument against relationism in these interesting topological facts.

But is handedness *really* an intrinsic feature of the object? If you mean by 'intrinsic' a feature of the object which is preserved by all transformations of a specified kind, then handedness may well be an intrinsic feature of an object. For example, if space is an orientable three-space and the object a three-dimensional hand, then if by 'intrinsic' you mean "preserved under all continuous rigid motions," then handedness will be an intrinsic feature of the hand.

If by 'intrinsic' you mean, however, that the feature is one that any object similar in construction specifiable in only local terms (lengths of parts, magnitudes of angles between parts and what we will soon call 'local handedness', for example) will have, irrespective of the nature of the space in which the object is embedded, then handedness is not intrinsic. For an object of a given construction so specified may not even be "handed" in the full sense at all—if it is in a nonorientable space, for example; whereas another possible object, describable in the same terms in the local way, but now taken as embedded in an orientable space, will indeed have full handedness. If 'intrinsic' means "independent of the topology of the space as a whole," then handedness is not intrinsic.

What does it mean, according to the relationist, for the hand to be a homomorph? Only that, given any possible counterpart to the hand, that is to say any possible object whose parts have the same lengths and the same magnitude of angles between them, then there is a possible crm that brings them into congruence.

Suppose that there are no enantiomorphs. In what sense can the hand still be said to be left-handed or right-handed? Well, suppose, there is a possible crm that takes the hand into its counterpart

because, although the hand is in an oriented three-space, the three-space is embedded in a four-space. Note that all this talk about "being in an oriented three-space" and "there being an embedding four-space" is all perfectly intelligible from a relationist standpoint. The assertions are, of course, explicated in terms of possible spatial relations among possible objects, and the lawlike features of the collection of such relations.

Now although any two three-dimensional hands which are counterparts and which are in the three-space will be bringable into congruence by a crm that takes at least one of the hands out of the three-space into other parts of the embedding four-space, it will still be the case that there are pairs of possible incongruous counterpart hands in the three-space, in the sense that (1) the members of the pair are counterparts, and (2) no crm that keeps both hands in the three-sub-space will bring the hands into congruence.

In this case, one of the hands will be "left in the three-space" and the other "right in the three-space." And each of the hands will be characterized by an "intrinsic feature": "being three-left" or "being three-right." The feature is intrinsic in the sense that an object that has it continues to have it no matter how many crm's it undergoes, *so long as the motions keep it confined to its original three-space*. What we see here is an illustration of the following general truth: What we mean by an intrinsic feature of an object is relative to some particular kind of transformation of the object we have in mind. A feature may be intrinsic relative to transformations of one kind, but not so relative to transformations of a different kind. There is nothing special about handedness here. For, as we saw, a structure can be intrinsically same-sided relative to one transformation (keeping the bars in the diagram in the plane) yet neither intrinsically same-sided nor intrinsically opposite-sided relative to some other transformation (allowing motions of the bars through all of three-space). That is just what we mean by 'intrinsic'.

Suppose that the hand is a homomorph despite the fact that it is in a three-space not contained in any embedding four-space. Once again, this statement is perfectly intelligible from a relationist point of view. Why is the hand a homomorph despite the absence of an embedding four-space? Perhaps because the three-space is globally nonorientable. Then all hands can be brought into congruence with their counterparts by global crm's; although there will still be possible pairs of hands such that (1) they are counterparts and (2) no *local* crm can bring them into congruence.

Suppose this is so. The hand is now obviously neither a left hand nor a right hand in the full sense. Kant thought this absurd, but Nerlich reasonably asserts that this just shows that Kant never considered the real possibility of higher-dimensional spaces or non-orientable spaces being the case. It is clear that our hand is now not "three-left" or "three-right" either. Is there any intrinsic feature of the hands which distinguishes the members of a locally incongruent pair of counterparts even though they are bringable into congruence by a global crm?

By this time the answer should be evident. In such a non-globally-orientable three-space each hand is still either *locally-left* or *locally-right*. Of course there is no sense in asking whether a hand locally-left at point p is locally-left or locally-right when moved to point q . On the other hand, if p, q and the path taken by the object between them are all contained in a region of the space over which the local orientations can be extended in a globally consistent way, then *partial global extensions of the purely local notion are possible*.⁴ Nor, of course, will it generally be true that an object locally-left at p at one time, then continuously rigidly moved about in the space and then returned to p will still be locally-left at p upon its return to the point of origin of its travels. This is just what it means to say that the space is globally nonorientable.

Notice also the following: Suppose we have a three-dimensional hand. Consider its "local-three-handedness." This will be an intrinsic property of the hand in the sense that it will be invariant under any local crm's that keep the hand confined to the original three-space in which it was located.

Even if that three-dimensional space is embedded in a four-dimensional superspace and even if the three-space is globally nonorientable, the local-three-handedness of the object is still well defined. It is, in fact, independent of the embedding of the three-space in any higher-dimensional space and independent of the global connectivity and orientability of the three-space. So in this sense of 'intrinsic',

⁴ In more detail the situation is like this: Even if a space is globally nonorientable there may be subregions of it such that we can divide all the counterpart objects in the region into two classes of opposite handedness. An object of given handedness in the region cannot be brought into congruence with its counterpart of opposite handedness in the region by any crm that keeps the object in the region. If this is so we can talk about "handedness with respect to the region." Of course in a nonorientable space the following situation can arise: (a) there is a region, A , such that there are pairs of objects in the region which are counterparts and such that no crm of the objects confined to A can bring them into congruence; (b) there is another region, B , partially overlapping A , which is, like A , regionally orientable; but, (c) the region that is the union of A and B is such that any two counterparts in the united region can be brought into congruence by a crm in the united region.

which connotes independence from questions of embedding of a space in higher-dimensional spaces and of global orientability of a space, local-three-handedness is a truly intrinsic feature of an object. I think that it is this fact that makes us want to say that a hand in our world is either left-handed or right-handed irrespective of the existence of any four-dimensional embedding space unknown to us or of the fact that the three-space of our world might, in fact, be globally nonorientable. The kind of handedness we normally have in mind is local-three-handedness, and this is independent of these possibilities about our physical space.

More fully and correctly: (1) we have very good reason to believe that there are locally-three-handed objects, since there clearly exist possible counterparts incongruous under any local crm that keeps them confined to three-dimensional space; (2) we have very good reason to believe that this local-three-handedness can be extended to a regional-three-handedness over the presently observable spatial universe, since the three-space we are presently aware of seems quite globally orientable; (3) in so far as we have good reason to believe that our three-space is not embedded in a four-space, we have good reason to believe that there are regionally-handed objects; and (4) in so far as we have good reason to believe that our three-space is a globally orientable three-space, we have good reason to believe that there are handed objects in the world, *simpliciter*.

So all the crucial notions: being an enantiomorph, being a homomorph, having a specified number of dimensions, being orientable or nonorientable, being left and right—in the full, local, or “subspace” senses, are all completely intelligible from a relationist point of view.

(b) If someone objects to any of the notions I have invoked above, or, rather, to the particular definitions of particular geometric spaces or objects—such as enantiomorphism, local-handedness, etc.—let him ask himself whether postulating space as a substantial entity is going to leave him any better off.

If he wants to talk about the dimensionality of his “space” or its orientability, he will need just the same characterizations for this entity that we needed for our lawlike-governed collection of possible relations among possible material objects. Treating space as an object, rather than as a collection of possible relations among possible material objects, solves none of the difficulties in defining the various geometric notions necessary to characterize the “structure of space.”

And if he objects to my postulation of relativized intrinsic features of objects, like enantiomorphism, local-enantiomorphism, or enantiomorphism-in-a-subspace, he should consider this: The only good that the postulation of substantival space is going to do for him in defining the relevant notions of the features of objects is that he will be able to predicate these features of the "space" in which an object is contained instead of predicating them of the object itself. He can then "explain" the nature of the object as being its relation to its containing space.

But this explanation seems no explanation at all, and the relationist objection is familiar. If all these features are well definable of the containing spaces of possible objects, why not just predicate them of the objects themselves and be done with it? The relationist argument, as always, consists partly in the claim that postulating substantival space provides no explanations and no understanding over and above postulating possible objects and their possible spatial relations. Worse yet, such postulation confuses the issue by making it look as though there were additional features of the world (for example, locations in substantival space) which really don't exist at all.

Notice that substantivalism is equally useless in answering such traditional positivist questions as: "How do we know which objects are left and which are right?" and "Mustn't there be some independent feature lawlike-connected with handedness in order for it to make sense to say that an object is left- or right-handed?" For if there are any real puzzles here, and I think that there are not but only confusions and pseudo-problems, then these real puzzles are just as much puzzles about handed pieces of space as they are about handed objects in space.

(c) What is the *real* substantivalist objection to relationism? The best philosophical argument I know is the claim either that (i) it makes no sense at all to talk about possible objects and possible spatial relations, but only about actual objects and their actual relations, and on this ground spatial talk is not wholly translatable into relationist talk without loss of content, or (ii) that talk about possibilities makes sense only because of the underlying assumption of some actual substantival entity and its actual features, and in the case in question this can only be substantival space and its actual geometrical structure.

Now there are deep philosophical issues here. But one thing is clear, and that is the fundamental irrelevance of particular

facts about enantiomorphism, homomorphism, or handedness. For if the relationist must invoke possibilia in order to explicate these notions, he must invoke them to explicate far more basic spatial concepts—for example, there being an empty spatial location in the actual world or there being a possible world of totally empty space. It was to account for these notions relationally that the idea of possible objects and their possible spatial relations was originally invoked. If the substantialist wants to refute relationism on these grounds, he need not go to such *recherché* lengths as the invocation of questions about orientation and orientability. His quarrel with the relationist lies on much broader issues.

The only other arguments that I know for substantialism which have any persuasiveness are those from particular aspects of physics, say from the “absoluteness” of absolute acceleration in Newtonian mechanics, special relativity and, perhaps, general relativity as well. It is these arguments which, I take it, Earman finds persuasive. I am not sure that they are at all convincing, but in any case they hardly rest upon the possibility or nature of enantiomorphic, homomorphic, or handed objects.⁵

(d) Is handedness the result of a creative cause? Perhaps so. For there is neither more nor less reason to believe that the handedness of an object is the result of some causal factors than there is to believe any feature of the object to be the result of causes. But features of an object which consist in the relation of its parts to one another, or of the actual and possible relations of the object to other actual and possible objects, can surely be the result of causes. So even if handedness is “the result of the action of a creative cause,” this in no way indicates anything inadequate whatever in the relationist account of what handedness *is*.

Is space “absolute?” Well, if that means “Is space a substance?,” we have already seen the irrelevance of the consideration of notions of orientation to that issue. If it means “Do absolute motions in Newton’s sense exist?,” then surely nothing could be more irrelevant than the existence or nature of enantiomorphic objects.

Is space “primitive?” If that means that the existence of space temporally precedes there being objects in it, then all arguments

⁵ For a detailed discussion of the philosophical debate between the substantialist and the relationist, and of the relevance or irrelevance of the results of physics to the philosophical debate, see my *Space, Time, and Spacetime*, chap. III, “Absolute Motion and Substantial Spacetime,” University of California Press, forthcoming.

from orientation are irrelevant. If it means that we can imagine space without material objects, but no spatial objects without space, then this is conceded by the relationist. There can be a collection of possible relations among possible objects without there being any objects or any actual relations among them; but there can't be an actual object with actual spatial features unless there are some possible objects with possible spatial features. Once again, questions of orientation are completely irrelevant.

If "Space is primitive" means "The relationist claim that all spatial talk can be translated into talk about the spatial relations among material objects is wrong," then, as we have seen, the allegation of primitiveness is just the allegation of the substantialist about the incorrectness of the relationist account, and, as we have seen, the existence or the nature of features of orientation are completely irrelevant to the issue.

Is the relationist or the substantialist account of space (or space-time) correct? I don't know. What is clear, however, is that the existence and nature of incongruous counterparts are irrelevant to the issue.

If Kant and Nerlich are claiming that questions of orientation can be understood fully in the context of an understanding of the topology of space as a whole, then they are right. This is an important topological fact, and Kant may, indeed, have been anticipating this in his discussion of the handedness of objects. But if they are claiming that any facts about the existence or nature of orientation features add any weight to the other well-known arguments of the substantialist against relationism, then they are plainly in error.

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