PLURALISM AND DETERMINISM*

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Pluralists about material objects believe that distinct material objects can coincide at a time—that they can exactly occupy the same spatial region and be constituted by the same matter at that time.[1] Pluralism is often accepted for reasons of common sense. It seems obvious, for example, that there could be a piece of paper and a paper airplane made from the latter, such that the piece of paper exists before the paper plane is created or exists after the paper plane is destroyed. The artifacts in this scenario would appear to be distinct objects that coincide at various times.[2]

My aim in this paper is to argue that folk-inspired pluralism faces a serious problem concerning determinism. The actual world is deterministic just in case there is only one way in which it can evolve that is compatible with the actual laws of nature. If determinism about the actual world fails, we expect it to fail for reasons of physics. Yet certain of the common-sense cases of distinct, coinciding objects accepted by pluralists seem to show that the actual world is indeterministic on mundane, a priori grounds. It should not be that easy to establish indeterminism.

In section I I shall set the stage for this problem by distinguishing between weak qualitative determinism and strong qualitative determinism, and by arguing that the strong conception is preferable to the weak one. In section II I shall present the problem, which consists in a priori violations of strong qualitative determinism by certain common-sense cases of distinct coincidents. In sections III and IV I shall consider three pluralist replies to the problem, and argue that each of them is implausible. In the context of the final reply I shall connect the indeterminism problem with the familiar grounding problem.

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[1] Some pluralists believe that distinct objects can coincide at all times of their existence, but this stronger view will not play a role here.

[2] Pluralists include Lynne Rudder Baker, "Why Constitution is Not Identity," this JOURNAL, XCIV, 12 (1997): 599-621; and *Persons and Bodies* (Cambridge: Cambridge University Press, 2000); Kit Fine, "The Non-Identity of a Material Thing and its Matter," *Mind*, CXII, 446 (2003): 195-234; and "Coincidence and Form," *Proceedings of the Aristotelian Society*, LXXXII, 1 (2008): 101-118; Mark Johnston, "Constitution is Not Identity," *Mind*, CI, 401 (1992): 89-105; Judith Jarvis Thomson, "The Statue and the Clay," *Noûs*, XXXII, 2 (1998): 149-73; and David Wiggins, "On Being in the the Same Place at the Same Time," *Philosophical Review*, LXXVII (1968): 90-95; and *Sameness and Substance Renewed* (Cambridge: Cambridge University Press, 2001).

I. WEAK AND STRONG QUALITATIVE DETERMINISM

Determinism is a modal notion. It is a feature of a possible world and of the laws of nature governing that world. Intuitively, a world is deterministic if at all times in the world's history there is only one way in which the world can evolve that is compatible with its laws of nature. How should this initial characterization be made precise?

According to David Lewis, determinism is a matter of qualitative differences between worlds. Let a qualitative description of a world be a description of the global pattern of qualitative properties and relations instantiated throughout this world. Such a description says, for example, that there is a green object north of a red object at a certain time. The description, however, does not say which object is the green one and which the red one. That is, the description excludes haecceitistic information about the world. What it takes for a world to be deterministic, according to Lewis, may be stated as the following principle of weak qualitative determinism (which is characterized as weak for reasons to be stated shortly):

> *Weak Qualitative Determinism* (WQD)
> A possible world *w* is deterministic iff for all times *t*, there is no possible world with the same laws of nature as *w*, which matches *w* in its qualitative description up to *t*, but which does not match *w* in its total qualitative description.[3]

On this approach, qualitative differences between worlds are the only differences relevant to questions of determinism. Haecceitistic differences between worlds—differences that concern only which objects have which qualitative properties—are irrelevant. This stance towards haecceitistic properties may be motivated by pointing out that we are interested in determinism in the context of physics, and that haecceitistic properties are not properties described by physical theories. These properties should therefore be left out of the characterization of determinism.[4]

This analysis of determinism works well for many cases. A paradigm failure of determinism is the case of radioactive decay. Up to time *t*, the actual world and some possible world *w* governed by the same laws of nature are qualitative duplicates. At the end of a certain period of time starting at *t*, half of a sample of

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[3] See Lewis, *Papers in Metaphysics and Epistemology* (Cambridge: Cambridge University Press, 1999), pp. 32-33.

[4] See Jeremy Butterfield, "The Hole Truth," *British Journal for the Philosophy of Science*, XL, 1 (1989): 1-28; and Carolyn Brighouse, "Spacetime and Holes," in D. Hull, M. Forbes and R. M. Burian, eds., *PSA 1994* (East Lansing, MI: Philosophy of Science Association, 1994), pp. 117-125; and "Determinism and Modality," *British Journal for the Philosophy of Science*, XLVIII, 4 (1997): 465-81.

some radioactive isotope has decayed in the actual world, whereas three-quarters of the sample remains at the end of that period in *w*. By WQD, the actual world is indeterministic, as expected.

Nevertheless, this conception of determinism is unsatisfactory. There are cases in which WQD does not give the expected classification. These are examples of possible worlds that we intuitively classify as indeterministic but which WQD classifies as deterministic. Suppose with Joseph Melia that there is a world, *w*, with four blue duplicate spheres, including *a*, positioned at the apexes of a perfect tetrahedron.[5] Suppose further that it is a law at this world that, after five seconds have passed, one of the spheres turns pink. In *w*, *a* turns pink after five seconds, while the other spheres stay blue. Intuitively, *w* is an indeterministic world. For the laws of nature fail to determine whether a sphere with a certain (intrinsic and relational) past turns pink. There are spheres in *w* with exactly the same past, such that one turns pink and the others do not. According to WQD, however, *w* is deterministic. All the worlds with the same laws and the same initial conditions in which one of the spheres turns pink have the same total qualitative description; exactly the same qualitative properties and relations are instantiated in the same pattern at these worlds.

For another case, suppose with Gordon Belot and Mark Wilson that there is a world *w* that contains a single symmetrical, homogeneous, cylindrical tower standing on a single homogeneous, perfectly spherical planet with a spherically symmetrical object centrally located on the tower's top.[6] According to the standard treatment of this phenomenon, the tower will collapse by buckling in a particular direction if the object on top exceeds a certain critical weight. In *w*, the tower buckles and the tip of the elbow of collapse comes to rest on a certain segment of the planet. Intuitively, *w* is an indeterministic world. For the laws of nature fail to determine whether a section of the planet with a certain (intrinsic and relational) past gets hit by a tower. There are planet-segments in *w* with exactly the same past, such that one gets hit by a tower and the other does not. According to WQD, however, *w* is deterministic. All the worlds with the same laws and the same initial conditions in which the tower buckles in a certain direction have the same total qualitative description.

We must be careful not to misdescribe these cases. One might say that the world of the spheres is indeterministic, because it is not determined *which* sphere turns pink. In *w*, sphere *a* turns pink and sphere *b* stays blue, whereas in some other world *b* turns pink and *a* stays blue. Similarly, one might say that the world of the tower is indeterministic, because it is not determined *which* segment of the planet gets hit by a tower. In *w*, one segment gets hit, whereas in some other world

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[5] Melia, "Holes, Haecceitism and Two Conceptions of Determinism," *British Journal for the Philosophy of Science*, L, 4 (1999): 639-64, at p. 650.

[6] Gordon Belot, "New Work for Counterpart Theorists: Determinism," *British Journal for the Philosophy of Science*, XLVI, 2 (1995): 185-95, at p. 190; and Mark Wilson, "There's a Hole and a Bucket, Dear Leibniz," *Midwest Studies in Philosophy*, XVIII, 1 (1993): 202-41, at pp. 215-16.

another segment gets hit.[7] I did not say these things. For this haecceitistic understanding of the cases renders them ineffective. As stated above, haecceitistic properties are not properties physics is concerned with, and hence should not be granted the power to violate physical determinism. Determinism is not a matter of which objects instantiate which qualitative properties in which worlds. Thus, if the cases can only be understood as concerning the question which sphere turns pink and the question which part of the planet gets hit by the tower, then they need not worry us. By contrast, I understand the two cases as presenting intuitive violations of determinism that derive purely from qualitative properties and yet slip through the cracks of WQD. It is undetermined whether a sphere of a certain qualitative description turns pink and whether a planet-segment of a certain qualitative description gets hit by a tower, as we can see by inspecting spheres and planet-segments of the given descriptions in the same world—no need to inspect other worlds. The ensuing question is whether determinism could be formulated in a way that registers our intuitive classification of the two cases, as well as being insensitive to haecceitistic differences.

Lewis is right that determinism is only violated by qualitative branching. But there are different types of qualitative branching, namely, *global* and *local*. A qualitative description of a world is a description of the pattern of qualitative properties and relations instantiated throughout this world over time. A qualitative description of an object, of a part of a world, is a description of the qualitative intrinsic and relational properties instantiated by an object over time. Schematically, a qualitative description of an object has the form, 'the x: x is F at t_1, x is G at t_1, x is H at t_2, ...,' where 'F', 'G', 'H' and so on, denote qualitative intrinsic or relational properties. We have *global qualitative branching* when qualitative descriptions of worlds with the same laws of nature that match up to a certain time diverge afterwards. And we have *local qualitative branching* when qualitative descriptions of objects that are parts of worlds with the same laws of nature match up to a certain time but diverge afterwards.

The case of the pink sphere is a case of local qualitative branching without global qualitative branching. World w contains spheres with matching qualitative descriptions up to a certain time but without matching total qualitative descriptions: one sphere with that description turns pink, the others stay blue. So the laws of nature fail to determine what will happen to an object with that past. Similarly for the case of the collapsing tower: there is local without global qualitative branching. World w contains segments of a planet with matching qualitative descriptions up to a certain time but without matching total qualitative descriptions: one segment of the planet with a certain qualitative description up to t gets hit by a buckling tower, whereas another segment with the same description up to t does not get hit by a tower. In both cases, w is indeterministic, not because it is undetermined how w will evolve at a global level, but rather because it is undetermined how w will evolve at a local level. WQD ignores these local failures

[7] Melia describes the cases in this way: "[they are] examples of possible worlds which we intuitively classify as indeterministic yet whose futures differ only over which objects play which role," *op. cit.*, p. 649.

of determinism.[8] In order to capture them, Lewis's conception of determinism must be replaced by a conception honoring local qualitative differences between worlds. Such a conception may be called 'strong qualitative determinism' and stated as follows:

> *Strong Qualitative Determinism* (SQD)
> A possible world *w* is deterministic iff for all times *t*, and for all objects *x* in *w*, there is no object in any possible world with the same laws of nature as *w*, which matches *x* in its qualitative description up to *t*, but which does not match *x* in its total qualitative description.

To emphasize, this is still a qualitative approach to determinism; haecceitistic properties do not play any role. The contrast with WQD is not that differences concerning which objects play which qualitative object-roles in which world are deemed relevant to determinism. The contrast is rather that while WQD recognizes only global qualitative world-roles as relevant for determinism, SQD recognizes local qualitative object-roles as relevant, as well.[9, 10]

Notice, finally, that SQD is independent of how modality *de re* is analyzed. SQD is motivated by the observation that there are different types of qualitative branching, local as well as global, and not by any considerations of modality *de re*. It is worth being clear about this relationship between determinism and modality *de re*, because the formulation of SQD in terms of qualitative descriptions of objects may be misunderstood as presupposing a qualitative analysis of modality *de re*, such as Lewisian counterpart theory. Neither this nor any other analysis of modality *de re* is presupposed. This conception of determinism is neutral on issues of modality *de re*, as a conception of determinism should be.

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[8] Cf. Melia, *op. cit.*, pp. 652-54.

[9] SQD has the further welcome feature of aiding substantivalists about spacetime in avoiding John Earman and John Norton's hole argument; see Earman and Norton, "What Price Spacetime Substantivalism? The Hole Story," *British Journal for the Philosophy of Science*, XXXVIII, 4 (1987): 515-25; and Melia, *op. cit.*, pp. 655-6.

[10] One might worry that SQD is still not sufficient to capture all our intuitions of determinism and indeterminism. Consider a world with three objects, *a*, *b* and *c*. There is, further, an asymmetrical relation R, such that none of these objects bear R to each other until a time *t*. After *t*, it is either the case that *a*R*b*, *b*R*c* and *c*R*a*, or it is the case that *c*R*b*, *b*R*a* and *a*R*c*, but the history of the world until *t* does not determine which complex state of affairs obtains. By SQD, this world is deterministic, but one might insist on intuitive grounds that it is indeterministic. As John Hawthorne points out, this sort of case could be treated by generalizing SQD to ordered *n*-tuples; see Hawthorne, *Metaphysical Essays* (Oxford: Oxford University Press, 2006), p. 243, *n*. 13.

II. PLURALISM AND THE PROBLEM OF CHEAP INDETERMINISM

Strong qualitative determinism, SQD, emerged as a plausible conception. It classifies a wide range of cases in accordance with our intuitions. I want to show now that this conception raises a problem for a certain type of pluralism about material objects. The pluralism that is the target of the following discussion is usually viewed as the standard version. It is folk-inspired, in that the existence of distinct, coinciding objects is motivated by common-sense considerations. Moreover, this pluralism metaphysically analyzes distinct, coinciding objects as three-dimensionalist objects that are intimately related by an asymmetrical dependence relation of constitution.[11] Alternative pluralist accounts, such as standard four-dimensionalism, according to which distinct coincidents are related by sharing temporal parts, will be set aside here.[12] Henceforth, I shall mean the three-dimensionalist, constitutionalist type when I speak of pluralism.

In arguing against pluralism, I shall focus on the following case of distinct coincidents, which is a straightforward instance of the pluralist scheme. Suppose that in the actual world a piece of paper is created in the shape of an airplane—that is, a piece of paper and a coinciding paper plane come into existence simultaneously. At time *t*, the piece of paper is flattened. Since the piece of paper survives the flattening, while the paper airplane does not, they are distinct. Let us assume, moreover, that the piece of paper and the paper plane are qualitative duplicates up to time *t*; they share all their qualitative properties and relations until that time; even the intentional relations in which we stand to them are the same. (This assumption of indiscernibility up to *t* is controversial among pluralists. In section IV it shall be questioned.) In the actual world, then, the piece of paper matches the paper plane in its qualitative description up to *t*, but does not match it in its qualitative description after *t*—the piece of paper exists after *t*, whereas the paper plane does not—and hence does not match it in its total qualitative description. It follows by SQD that the actual world is indeterministic.

The problem with this pluralist case is not the fact that it violates determinism of the actual world. Determinism may, of course, be false. Problematic is rather the way in which it violates determinism. As John Earman and John Norton say,

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[11] Pluralists of this stripe follow the lead of Wiggins, *op. cit.*; see the references in footnote 2.

[12] See Theodore Sider, *Four-Dimensionalism: An Ontology of Persistence and Time* (Oxford: Oxford University Press, 2001), Chapter 5. Prima facie, the problem to be described below arises for four-dimensionalist pluralists as well as for three-dimensionalist ones. It can be argued, however, that four-dimensionalism warrants a different perspective on this problem, perhaps envisaging better prospects of handling the difficulty. For reasons of space, I shall have to leave this more constructive discussion for another occasion and focus on the problem for three-dimensionalist pluralism.

> There are many ways in which determinism can and may in fact fail: space invaders in the Newtonian setting; the non-existence of a Cauchy surface in the general relativistic setting; the existence of irreducibly stochastic elements in the quantum domain, *etc.* [...] Determinism may fail, but if it fails it should fail for a reason of physics.[13]

It is implausible to be able to tell from the armchair and on little reflection that our world is indeterministic. To be sure, determinism should be allowed to fail on a priori grounds. To mention one example, the question whether quantum theory rejects determinism is not settled by the empirical result of any experiment. The situation is rather that some interpretations of the quantum formalism posit deterministic laws, while others posit irreducibly stochastic dynamics.[14] What should not be accepted is the failure of determinism on a priori grounds that are also mundane. That would be cheap indeterminism. And indeterminism should not come for cheap. Determinism should, as Earman puts it, "be given a fighting chance."[15] Yet the case of the piece of paper and the paper plane seems to show the actual world to be indeterministic on obvious, a priori grounds. Supposing that there is a piece of paper, that there is a paper plane made from the latter, and that they are flattened at *t*, the pretheoretical, a priori assumptions that if the paper plane is flattened it goes out of existence, and that if the piece of paper is flattened it continues to exist, are sufficient to establish that there are objects with qualitative descriptions that match before *t* and diverge after *t*, and hence that there is local qualitative branching. This is an objectionably effortless, a priori violation of determinism of the actual world. It should not be that easy. Call this *the problem of cheap indeterminism*.

Cheap violations of determinism involving ordinary objects are numerous. Consider another case. Suppose we arrange a number of bricks in the shape of a house. Then we have a house-shaped aggregate of bricks and we have a house. What happens when a further brick is added at time *t*? The house grows a bit bigger. The aggregate of bricks, however, does not grow at all, for the new brick merely gets attached to it. So there are distinct objects, an aggregate of bricks and a house, whose qualitative descriptions match before *t* but diverge afterwards. The laws of nature thus fail to determine whether an object with a given history will or will not grow in parts. Again, determinism of the actual world seems to fail on mundane, a priori grounds.

This type of failure presupposes the strong version of qualitative determinism, SQD. On the weak version, WQD, the mentioned cases of distinct, indiscernible coincidents do not raise the problem. In the actual world, there is a piece of paper and a paper plane made from the latter. At time *t*, they are flattened. As a result, the piece of paper exists after *t* but the paper plane does not. Any

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[13] Earman and Norton, *op. cit.*, p. 524.

[14] For a summary of issues concerning quantum theory and determinism, see Tim Maudlin, "Distilling Metaphysics from Quantum Physics," in M. J. Loux and D. W. Zimmerman, eds., *The Oxford Handbook of Metaphysics* (Oxford: Oxford University Press, 2003), p. 469f.

[15] Earman, *World Enough and Spacetime* (Cambridge, MA: MIT Press, 1989), p. 180.

world with our laws of nature that matches our world in this description up to *t*, also matches it in the description after *t*. Hence, the actual world is deterministic, as desired.

Here is where the earlier discussion of conceptual issues regarding determinism (section I) comes into play. For there are good reasons for adopting the strong version, SQD, which triggers the problem. The weak version fails some of our expectations concerning which worlds should count as deterministic and which as indeterministic. The world of the colored spheres and the world of the collapsing tower, for example, should be classified as indeterministic worlds. SQD achieves this classification, whereas WQD fails to do so. That is why the strong version is preferable.

The antipluralist argument may be summarized as follows: whether there is a violation of determinism of the actual world by local qualitative branching cannot be a matter of common sense; it has to be a matter of physics. If folk-inspired pluralism is correct, however, and if determinism is conceived of along the lines of SQD, then there are pretheoretical, a priori violations of determinism of the actual world. So pluralism is in trouble. Can the problem of cheap indeterminism be avoided?

III. STRENGTHENING AND RESTRICTING DETERMINISM

In this section I will consider two pluralist replies that resort to tweaking SQD, and I will show that both of them are implausible. In the final section I shall consider a reply that accepts SQD but denies that there is local qualitative branching in the cases under consideration. This third response will provide an opportunity to connect the indeterminism problem with the familiar grounding problem, and to place the present considerations in a broader context. All three are replies on behalf of the three-dimensionalist, constitutionalist pluralist, though they will not be assumed to exhaust the logical space of options for the pluralist of this stripe. As regards alternative pluralist ontologies of material objects, I shall set aside the question of the status of determinism in these frameworks, which may well open escape routes not explored here. To emphasize, I shall not attempt to argue that there is no way out of the problem for the pluralist, nor shall I attempt to solve it. My aim is merely to provide reasons for taking the problem seriously, and to invite the pluralists to defend their picture against it.

The first reply is to strengthen SQD. Let us assume that objects that exist at a given time may appear in different possible futures, and consider the following *de re* version of determinism:

> *De Re Determinism* (DRD)
> A possible world *w* is deterministic iff for all times *t*, and for all objects *x* in *w*, there is no possible world *w** with the same laws of nature as *w*, such that *x*'s qualitative description up to *t* in *w** matches *x*'s qualitative description up

to t in w, but x's total qualitative description in w^* does not match x's total qualitative description in w.

On this conception, the world of the colored spheres is correctly classified as indeterministic. Focusing on the sphere that actually turns pink, this very object does not turn pink in another world with the same laws and the same history. Likewise for the tower world. Turning to our cases of coinciding objects, the actual world, which is assumed to contain the paper plane and the coinciding piece of paper, is classified as deterministic, just as we would have expected, on the grounds that the paper plane does not survive the flattening in any world with the actual laws and the same initial conditions, and the piece of paper does survive the flattening in any world with the actual laws and the same initial conditions. The crux of this reply is that according to DRD, local qualitative branching violates determinism only if it happens to one and the same object; and the particular objects involved in our case of distinct coincidents do not have branching futures of the troubling kind. Likewise for the case of the house and the aggregate of bricks: the house must grow and the aggregate cannot grow in the given circumstances.

DRD relies on haecceitistic differences between worlds—differences that concern which objects have which qualitative properties. While according to SQD, local qualitative branching violates determinism independently of which object or objects are involved, DRD recognizes a violation of determinism by local branching only if the branching has a particular object as its locus. This dependence of determinism on haecceitistic information is implausible. As I urged in section I, haecceitistic information about which object plays which role in which world over and above local qualitative information should be irrelevant to physical determinism, because such nonqualitative information is not something physics is concerned with. The strong qualitative conception, SQD, is thus preferable to DRD, and the problem of cheap indeterminism remains.

The second reply is to restrict SQD. The aim is to argue that local qualitative branching involving distinct, coinciding objects does not violate determinism, because it belongs to a kind of branching to which SQD is not sensitive. Call local qualitative branching with determinism-violating powers *genuine* branching. When is branching genuine? A rough idea might be that branching is genuine when it is fundamental branching or is grounded in fundamental branching. Local qualitative branching concerns qualitative properties of material objects. Fundamental local qualitative branching concerns fundamental, or underived, qualitative properties of material objects. Let us assume a distinction between structured material objects, including artifacts and organisms, whose parts are held together by some "principle of unity", and unstructured material objects, including simple particles and masses of matter—the latter being mereologically unchangeable, arbitrary fusions of particles. Let us assume that structured objects are constituted by various unstructured objects at various times. We shall also assume that unstructured objects have many properties fundamentally, such as the properties of having a given mass at a time and of having a given material object as a part at a time, and that structured objects have many properties that they derive from

fundamental properties of unstructured objects that constitute them; the former inherit these properties from the latter. Perhaps a structured object has a given mass at a time and a given part at a time only in virtue of being at that time constituted by an aggregate that has that mass and that part nonderivatively at that time.

Now recall the following alleged violation of determinism. Suppose we arrange an aggregate of particles in the shape of a house. Then we have the aggregate and we have a house. When a further aggregate of particles, say in the shape of a brick, is added at time *t*, the house acquires new parts, whereas the original aggregate of particles does not, since the new particles merely get attached to it. So there are distinct objects, an aggregate of particles and a house, whose qualitative descriptions match before *t* but diverge afterwards. The pluralist could block this violation of determinism by arguing that the present case does not involve genuine branching. The house is a structured object that has its mereological properties only derivately. It is derivatively composed of certain particles at a time in virtue of being constituted by an aggregate that is nonderivatively composed of these particles at that time. What underlies the house's change in parts over time is thus a succession of nonidentical, mereologically rigid aggregates of particles: there is an aggregate of particles, *a*, and a slightly larger, nonidentical aggregate, *b*, such that *a* constitutes the house before *t* and *b* constitutes the house after *t*. When described at the level of nonderivative mereological properties of aggregates, it is not the case anymore that there are objects whose qualitative profiles match before *t* but diverge mereologically afterwards. Since no change in parts occurs at that level, the mereological branching is not fundamental, and hence not genuine with respect to the demands of determinism. In other words, the house's mereological change is metaphysically shallow, and so is the mereological divergence between the house and the aggregate of particles. The divergence disappears at the level of nonderivative mereological properties, and therefore lacks the power of violating determinism. While not all pluralists will buy into this view about mereological profiles of structured objects, I think that this is their best shot at downgrading the local qualitative branching in the mereological case.[16]

Unfortunately, this response does not work for the case of the piece of paper and the paper plane. Here the qualitative divergence concerns persistence. While the piece of paper matches the paper plane in its qualitative description up to *t*, the piece of paper exists after *t*, whereas the paper plane does not. Pluralists could avail themselves of the view that a structured object has various properties at a time only in virtue of being at that time constituted by an aggregate that has those properties nonderivatively at that time. Existence at a time, however, is certainly not one of those properties. A structured object does not derivatively exist at a time in virtue of being at that time constituted by an unstructured object that nonderivatively exists at that time. If unstructured material objects persist

[16] This response is similar to Hawthorne's (*op. cit.*, pp. 125-6) "inheritance-answer" to the different problem of restricting the dynamical laws of our best physics, in order to avoid an apparent clash between these laws and the behavior of certain ordinary objects.

through time nonderivatively, then so do structured ones. Moreover, it makes no difference if existence at a time is grounded in spatiotemporal occupation.[17] For it is equally implausible to hold that a structured object derivatively occupies a spacetime region in virtue of being constituted by an unstructured object that nonderivatively occupies that region. (Three-dimensionalist pluralists might spell out the details of spatiotemporal occupation in different ways.) The familiar pluralist's structured objects are not abstract "constructions" from unstructured aggregates, who are spatiotemporal only in a derivative sense. Rather, structured objects are spatiotemporal in the same robust sense in which unstructured objects are. So the case at hand resists the proposed deflationary treatment. The paper plane vanishes into thin air at *t*, whereas the piece of paper stays. The plane's disappearance, however, is not a metaphysical superficiality. It is just as fundamental as the coincident piece of paper's continued persistence. This instance of local qualitative branching is genuine, giving rise to an unwanted violation of determinism. The pluralist needs to look for another way out.

IV. MODAL DIFFERENCES, DETERMINISM, AND THE GROUNDING PROBLEM

As a third reply, the pluralist might try to avoid coincidence-based indeterminism by denying that the two coinciding objects match qualitatively before *t*—that is, by denying that the troubling cases involve local qualitative branching. What differentiates the paper plane and the piece of paper? It is common and natural to answer that the paper plane cannot survive flattening, whereas the piece of paper can—in short, that the paper plane is not flattenable, whereas the piece of paper is. This is a difference in the *modal* properties of the two coinciding objects.[18] The pluralist might hold that modal potentialities, such as being flattenable, are properties that an object has *at a time*, and that the application of these properties to an object at a time does not depend on facts about the object at other times—that these modal properties are intrinsic to a time.[19] The construal of modal potentialities as temporally intrinsic allows the pluralist to invoke them in

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[17] For spatiotemporal accounts of persistence, see Yuri Balashov, *Persistence and Spacetime* (Oxford: Oxford University Press, 2010); and Thomas Sattig, *The Language and Reality of Time* (Oxford: Oxford University Press, 2006).

[18] Distinct coincidents might also differ in a variety of nonmodal ways at the same time. For example, a paper plane might be defective at a time, while the piece of paper coinciding with it at that time is not. They might also differ in aesthetic respects or concerning which intentional relations we bear to them (See Fine, "The Non-Identity of a Material Thing and its Matter," *op. cit.*). They might differ in these ways, but they need not. Those variations among coincidents are not compulsory, and therefore cannot be relied upon by the pluralist in her treatment of the present problem. Modal differences, on the other hand, are likely to be found in all ordinary cases of distinct coincidents. Differences in essential properties will be addressed briefly in footnote 24 below.

[19] Cf. Hawthorne, *op. cit.*, p. 101f.

specifying the qualitative history of an object up to a certain time, independently of what happens to the object later on. This puts the pluralist in a position to deny that the piece of paper and the paper plane are qualitatively indiscernible up to *t*, on the grounds that the former is flattenable at *t*, whereas the latter is not. As there is no qualitative match between the two objects before *t*, there is no local qualitative branching and no violation of determinism. This is a picture that promises the pluralist a way out of the problem of cheap indeterminism.

However, the picture fails to meet a plausible explanatory requirement. The modal difference between the piece of paper and the paper plane—namely, that one is flattenable while the other is not—stands in need of explanation. Simply accepting the difference as a brute fact is out of the question. (Some pluralists will be content with brute potentialities. I am here addressing the more ambitious type.) There can be no modal difference without an underlying nonmodal, categorical difference. What could this underlying difference be? This issue is widely known as the *grounding problem*.[20] Here I am not interested primarily in the question whether constitutionalist pluralists can solve this problem. (Let me just state that I take the prospects to be good—as evidenced in particular by Kit Fine's work on the issue.[21]) What I am rather getting at is that on any promising way of explaining the *de re* modal differences between the piece of paper and the paper plane, these differences may not be appealed to in solving the problem of cheap indeterminism. In short, the pluralist cannot solve both problems together. Let me explain.

In response to the grounding problem, it is quite natural to point to sortal differences, or kind differences, between the distinct coincidents. The idea is to construe sortal differences between coinciding objects as nonmodal differences, and to let such differences explain a wide variety of modal differences between the objects. Thus, the nonmodal explanation of why the piece of paper is flattenable and the paper plane is not, is that they belong to different kinds. This explanation is plausible. (It is certainly far more natural than the view that kind-membership is explained by having a certain modal profile.) But the explanation is incomplete as an answer to the grounding problem, because sortal differences between distinct coincidents are themselves in need of explanation. While it should be acknowledged that there may well be fundamental facts of kind-membership concerning, for example, kinds of fundamental particles, it would be implausible to view facts concerning membership of the macroscopic kinds *piece of paper* and *paper plane* as fundamental. Surely, something's belonging to these kinds is explicable in other terms.

Now, whatever the grounds of kind-membership are, kind-membership is not fixed by an object's qualitative profile *at a time*—kind-membership is not

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[20] For detailed statements of the problem, see Karen Bennett, "Spatio-Temporal Coincidence and the Grounding Problem," *Philosophical Studies*, CXVIII, 3 (2004): 339-71; and Louis deRosset, "What is the Grounding Problem?" *Philosophical Studies*, CLVI, 2 (2011): 173-97.

[21] See, *inter alia*, Fine, "Coincidence and Form," *op. cit.* See also deRosset, *op. cit.*, which contains an overview of recent approaches.

temporally intrinsic. The piece of paper and the paper plane belong to different kinds and yet share a categorical, nonsortal qualitative profile at various times.[22] Kind-membership is rather fixed by properties that an object has *simpliciter*, or absolutely. Ordinary kinds are invariant, characterizing an object *sub specie aeternitatis*.[23] For this reason, the pluralist is not allowed to appeal to invariant kinds and their grounds as a way of preventing local qualitative branching. Let us make explicit a constraint concerning which properties may be appealed to, which has been presupposed all along. Determinism concerns the qualitative evolution of objects over time; it is a matter of whether the laws of nature and the qualitative history of an object up to a time determine the object's qualitative profile after that time. To specify the qualitative history of an object up to time *t* is to specify the qualitative properties and relations that the object has at any time of its existence until *t*, and to leave out any properties and relations it has after *t*. Determinism is thus not sensitive to properties that characterize an object absolutely, or *sub specie aeternitatis*, for these properties are not suited to specify temporally intrinsic qualitative profiles, partial histories, of objects. This is why the pluralist is not allowed to appeal to invariant kinds (and their grounds) as a way of preventing local qualitative branching. Invariant kinds are unsuited for the purpose of specifying the partial history of an object. They do not belong to the category of temporally intrinsic qualitative properties to which determinism is sensitive.[24]

Summing up, the objection to the solution of the problem of cheap indeterminism in terms of modal differences between coincidents is the following. It seems that the only hope the constitutionalist pluralist has of grounding modal differences between coinciding objects is to do so in terms of temporally unrelativized, absolute properties of objects that ground sortal differences between the objects as well as modal ones. (Note again that I think that this can be done.) Absolute differences between the piece of paper and the paper plane, however, are not differences to which determinism is sensitive. As a result, the pluralist faces a

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[22] The way I understand the notion, coinciding objects can be categorically indiscernible even if one has certain properties derivatively, such as its mass, that the other has nonderivatively. On derivative properties, see the discussion in section II above.

[23] I am here abstracting from how exactly invariant kinds, or substance sorts, are grounded. The kind *piece of paper* may well be more fundamental than the kind *paper plane*, and hence the explanations of kind-membership may differ significantly between the two cases. Nevertheless, both kinds are grounded in absolute properties of objects. This is the only aspect of relevance for the present argument.

[24] I have been discussing the strategy of avoiding coincidence-based local qualitative branching by appeal to differences in modal potentialities of the coinciding objects. One also hears pluralists distinguish the coincidents in terms of their essential properties. In our main case, one object is essentially paper-plane-shaped while the other is not. As essentiality is standardly understood, something has a property essentially just in case it has the property at all times and in all worlds at which it exists. Essential properties thus understood are clearly not temporally intrinsic, and therefore cannot be invoked in specifying partial histories of objects, as determinism demands. In the interest of length, I shall refrain from discussing nonmodally understood essential properties. Suffice it to say that they would not seem to be temporally intrinsic, either.

dilemma: solve the grounding problem by appeal to absolute properties of objects and leave the problem of cheap indeterminism wide open; or solve the problem of cheap indeterminism by appeal to temporally intrinsic modal differences and leave the grounding problem in the dark. The pluralist cannot have it both ways.[25]

Let me conclude. The problem of cheap indeterminism marks a tension between strong qualitative determinism, SQD, and certain cases of local qualitative branching involving distinct, coinciding ordinary objects: if SQD and the cases are accepted, then the actual world is indeterministic on mundane, a priori grounds. My discussion of various replies shows that it is difficult to find a cure that isn't worse than the disease. I conclude that pluralists should take this problem seriously.

[25] One might have other complaints about grounding modal differences of coincidents in temporally extrinsic differences. After all, this strategy allows no causal explanation of why the paper plane vanishes at *t* and the piece of paper stays, in terms of facts intrinsic to *t*. Whatever could motivate the demand for such an explanation, it is not a demand I support here. (Pluralists and nonpluralists typically take the explanation of modal differences—that is, the grounding problem, as understood here—far more seriously than the causal explanation of temporal differences. See Fine, "Coincidence and Form," *op. cit.,* pp. 104-5, and Hawthorne, *op. cit.,* pp. 102-3, for liberal views on the temporal issue.) My complaint is a different one. If temporally intrinsic causal explanation fails and gives rise to local qualitative branching, it had better fail for a reason of physics (see section II). Mundane violations of determinism are out of the question.