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Confessions of a (Cheap) Sophisticated Substantivalist

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Abstract
I illustrate a challenge to a view that is a response to the Hole Argument. The view, sophisticated substantivalism, has been claimed to be the received view. While sophisticated substantivalism has many defenders, there is a fundamental tension in the view that has not received the attention it deserves. Anyone who defends or endorses sophisticated substantivalism, should acknowledge this challenge, and should either show why it is not serious or explain how to respond to it.

Keywords Hole argument · Substantivalism · Relationalism · Determinism

1 Introduction

The literature on the Hole argument since Earman and Norton's "What price spacetime substantivalism? The hole story" is vast, and I will not do it justice here. Rather, I will highlight a challenge to a view that is a response to the Hole Argument that at various times since the publication of Earman and Norton's paper has been claimed to be the received view. The view, sophisticated substantivalism, has many defenders,[1] but there is a fundamental tension in the view that has not received the attention it deserves. While I present the tension here, with just enough background to highlight its importance, its roots lie in Belot [9]. Those defending or endorsing sophisticated substantivalism need to own up to the tension; whether it rises to the level of a serious objection is an open question.

[1] Those who have defended the view include Butterfield [1], Brighouse [2], Maidens [3], Pooley [4, 5], Bigaj [6], Hoefer and Cartwright [7], and Dasgupta [8].

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2 Substantivalism, Determinism, Shifts and Holes

Substantivalism is simply realism about spacetime points (or regions). Points or regions of spacetime exist, not as logical constructions out of matter, but as entities in their own right. Modern presentations of spacetime theories encourage a realism of this kind: the points of the manifold in the models of modern spacetime theories represent the points of substantivalist spacetime.

The Leibniz shift argument, one of several challenges to substantivalism in the context of Newtonian physics, says consider the actual world, Wa, and consider the possible world, Ws, in which all the material contents of spacetime have been shifted five metres to the east of where it actually is. The substantivalist (purportedly) holds that Wa and Ws are distinct worlds, but these worlds are qualitatively just alike. According to Leibniz, given the principle of identity of indiscernibles (PII) and the principle of sufficient reason (PSR), Ws and Wa are identical, so we should reject substantivalism. These days the argument is not generally seen as compelling, but the claim that the substantivalist denies that Ws and Wa are identical is key to understanding sophisticated substantivalism. It is the natural generalization of this claim in the context of the Hole Argument that is used to generate indeterminism, and the sophisticated substantivalist rejects just this claim.

I take determinism to be a modal notion, and this is the prevailing view in the literature on the Hole argument. Following Earman [10], and Earman and Norton [11], determinism of a world is the primary notion, and determinism of theories is derivative, but nothing of substance below hinges on this relation of priority rather than its converse. Most simply, determinism is the view that there is only one physically possible future compatible with the world's history. Slightly more precisely, and generalized to regions, a world W is deterministic just in case every W' physically possible with respect to W that is physically equivalent with W outside some region R is physically equivalent with W everywhere.

Armed with determinism and the characterization of substantivalism above, the Hole argument purports to show that a substantivalist interpretation of General Relativity (GR) is indeterministic. Two diffeomorphically related models of GR, $<M, g_{ab}>$ and $<M, d \times g_{ab}>$, where $d: M \rightarrow M$ is a diffeomorphism equal to the identity map on some (open) region R of M, distinct from the identity map on M-R, represent distinct possible worlds, W and W'. The worlds are qualitatively just alike, agreeing on the distribution of physical properties across spacetime points everywhere but in region R. Hence the indeterminism, for the worlds are physically equivalent outside R, but not physically equivalent within R.

3 Sophisticated Substantivalism

Sophisticated substantivalism contests the claims that shifted worlds are distinct and that diffeomorphic models represent distinct possible worlds. It encompasses a family of positions united by a commitment to "anti-Haecceitism", which for our purposes

is the denial that there are "distinct possible worlds qualitatively just alike that also differ with respect to how they represent some individual as being in that world" [12]. Thus, armed with anti-Haecceitism the sophisticated substantivalist denies that there are distinct possible worlds corresponding to Leibniz shifts or diffeomorphic models of GR. For the purposes of determinism in the context of the Hole argument two diffeomorphic models do not represent distinct worlds let alone distinct worlds that fail to be physically equivalent on any region.

One way to be a sophisticated substantivalist is Shamik Dasgupta's "thin substantivalism" [8]. Couched in the language of "ground", Dasgupta describes the traditional substantivalist as being committed to "thick substantivalism" whereby spatiotemporal properties and relations between objects are grounded in facts about points or regions of spacetime that essentially make reference to individuals. In the context of the manifolds in the models of GTR these "individualist" facts include topological, metric, and mass-energy properties (and relations) of points or regions, and these so-called "thick facts" feature individual points or regions of spacetime essentially. The "thick facts" of the thick substantivalist are one of the main targets of Dasgupta's paper: he argues that they are both redundant and undetectable, and that the substantivalist should reject them in favour of a "thin substantivalism." I won't assess Dasgupta's argument against thick facts. It is the thin substantivalist position that concerns us, and we are interested in whether it represents a good way to be sophisticated.

Thin substantivalism is elegant; the base of grounding facts is comprised of qualitative non-individualistic facts, and these ground all individualist facts. Thus facts like "Spacetime point p has property Q" will be grounded in facts that make no reference to any individual point, rather the corresponding thin grounding facts will include something more like "A spacetime point has property Q", and this would obtain irrespective of which individual point was part of a given "thick fact".[2] Dasgupta's thin substantivalist is no bundle theorist, for, rightly in my view, Dasgupta wants to accommodate symmetric worlds that have parts that are qualitatively indistinguishable from one another. The formal details required to precisely characterize thin facts are complicated, but once the details are complete the position comes with a clear ruling on the shift and Hole arguments. Shifting the material contents across space does not change *any* thin facts, it could (if there were any) change only thick facts, for "a spacetime point has property Q" will be true regardless of whether it is p that has Q or r that has Q; the totality of thin facts in shift scenarios is the same. Thus for the thin substantivalist shifts do not generate distinct situations, since there are no thin facts to ground a difference between the purportedly shifted worlds. Further, any two diffeomorphic models of the Hole argument pick out the same set of thin facts, so indeterminism in the Hole argument does not arise. Anti-Haecceitism is achieved purely as a consequence of "thinness". Elegant (and sophisticated) it is, but the position faces the challenges below.

[2] I am applying Dasgupta's [8] example to points: *This very book is blue* (pointing) verses *A book is blue.* The fact that *a book is blue* "does not contain any reference to any particular book and would obtain even if a different book" (was blue).

4 Shifts, Symmetry Breaking, and the Selcouthe

I am interested in just one tension in the sophisticated substantivalist position, that of symmetry breaking violations of determinism: I will argue that there is, as yet, no well motivated way for the sophisticated substantivalist to accommodate such violations without conceding the indeterminism in the Hole Argument. The relationalist cannot accommodate symmetry breaking violations of determinism either, and so the tension is not telling in the debate between the substantivalist and the relationalist. Still, as I explain below, it would be a count against a position that such violations are ruled out.

The most obvious consequence of sophisticated substantivalism is that Leibniz shifts are not possible. It certainly seems that shifts are possible, that is, that objects could have occupied different points (on the substantivalist ontology) than they do occupy. And despite the long history of the position it's only since the late 1980's that substantivalists have considered denying that Leibniz shifted worlds are distinct.[3] Beyond accommodating intuition and respecting tradition, the hardliner sophisticate (of which Dasgupta's thin substantivalism is one) has no further compulsion to embrace Leibniz shifts, but most sophisticated substantivalists have argued that they can (and should) accommodate Leibniz shifts. I think they should: it *seems* to make sense to say on a substantivalist ontology that objects could have occupied different points, and seems no less sensible to maintain this even if the relative positions of objects remained unchanged. But I do not take the fact that they *seem* possible to be an argument.

A less obvious, and more serious, consequence of the position is that symmetry-breaking violations of determinism are not possible. The canonical example is in Wilson [14]: imagine a spherically symmetric tower with a spherically symmetric weight on top that will collapse by buckling. Imagine further that while the angle and time of the collapse is determined the direction of collapse is not determined. The buckle of the tower could have been located at different points of spacetime, even if the tower is situated in a perfectly spherically symmetric world. Are violations of indeterminism of this kind impossible? Many want to stop short of saying that, but to allow for them requires some modification of the sophisticated substantivalist position given anti-Haecceitism.

While intuition and respect for tradition provide reasons to maintain the possibility of symmetry breaking violations of determinism, just as they provide reasons to maintain the possibility of shifts, there is something closer to an argument to the effect that anyone who thinks that symmetric worlds of the kind ripe for symmetry breaking should make the conceptual space for symmetry breaking violations of determinism for such worlds. All but the most extreme empiricists countenance the possibility of worlds that exhibit symmetries such that one part of a world is qualitatively indistinguishable from another part of that world. The best-known example within metaphysics is Max Black's [15], a world that contains two qualitatively indistinguishable globes and nothing else, but there are solutions to Einstein's Equation that exhibit high degrees of symmetry also; certainly worlds with a high degree of symmetry are no anathema to the physicist. Black's globes, and the qualitatively indiscernible parts in worlds that exhibit such a high degree of symmetry are weakly discernible [8]. But once we grant

[3] It is first suggested in [13].

such worlds we can offer a simple counting argument for maintaining the conceptual space for symmetry breaking violations of determinism. We have (at least) two distinct (albeit qualitatively indistinguishable) parts to a world, parts that by assumption share all their intrinsic qualitative physical properties.[4] It is logically possible that those parts evolve in different ways and at some point cease to share all their intrinsic qualitative physical properties.[5] But since there are (at least) two such parts, there are (at least) two different ways this could happen depending on which of the parts evolves in which way: for example, knowing that exactly one of the Max Black globes will change colour in one second leaves open which of the two globes changes colour, if there is nothing determining which one changes colour (again, as much a logical possibility when the globes are only weakly discernible as when they are not qualitatively indistinguishable), then there is more than one physically possible future compatible with the world's history depending on which of the two globes changes colour.

These kinds of examples have motivated sophisticated substantivalists to find a way to accommodate the possibility of shifts and symmetry breaking violations of determinism. Dasgupta's thin substantivalism cannot, without modification, accommodate symmetry breaking violations of determinism. The thin facts across these purportedly different possibilities are the same. And, given the arguments just rehearsed, I take this to be a significant count against the view. The standard approach of sophisticated substantivalists to make room for symmetry breaking violations of determinism or Leibniz shifts is to claim that while there are no two distinct possible worlds qualitatively just alike that also differ with respect to how they represent some individual as being in that world (that is, to insist on their anti-Haecceitism), nevertheless there is some way to cash out the claim that shifts are possible or that the tower could have collapsed in a different direction, and that this does not require the existence of distinct qualitatively indistinguishable possible worlds. This option is available to the thin substantivalist, but, as we'll see, this option brings with it further challenges.

One way to do this borrows Cheap Haecceitism from David Lewis. Lewis, when dealing with *de re* modality, explains his view that no two worlds differ in what they represent *de re* regarding any individual, but that possibilities are not always possible worlds. Rather, to maintain the truth of claims like "I might have been one of a pair of identical twins. I might have been the first-born, or the second born" that is, claims that "involve no qualitative difference in the way the world is" [16] we use other

[4] I won't defend an account of what makes a property a "physical" property here, but the argument does not depend on what the details of such an account would be. By intrinsic I mean non-relational. This argument does hinge on there being intrinsic qualitative physical properties, but amongst those working on the Hole Argument this is not an area that has been the focus contention.

[5] I take this to be true, but I confess to be able to offer little in the way of argument for it. Suppose we grant that there are intrinsic qualitative physical properties (an assumption I am making) then to claim that it is logically possible that qualitatively indistinguishable parts evolve in different ways is an extraordinarily weak assumption, for logical possibility is the cheapest kind of possibility there is. I take the burden of proof to be on someone who would deny this claim. In the Max Black example, assuming, for the sake of the example, that colour is an intrinsic qualitative physical property, it amounts to the view that it is possible for just one of the globes to change colour. Another example might be more compelling. Imagine a world empty but for two atoms of a particular radioactive isotope with a half-life, say, of 138 days, and let's say one atom decays after 138 days and the other doesn't, and continue the analogous reasoning. Logical possibility is all I need, for I am arguing here that someone who endorses highly symmetric worlds needs to make the conceptual space for symmetry breaking violations of determinism.

individuals in the actual world as our "this-worldly" counterparts. This gives us a way to countenance the possibility of Leibniz shifts, for while the anti-Haecceitist says there are no possible worlds differing only on where in space the material contents are located, nevertheless, in one Newtonian world there are multiple possibilities, one in particular is that in which any given point has the properties of its "this worldly" counterpart that lies five metres to the west; shifts are possibilities (they are just not represented by different possible worlds). And it gives us a way to countenance the different possibilities for the buckle of the tower in Wilson's example: The buckle was located at point p, but could have been located at q in virtue of q being p's this-worldly counterpart.

A recent approach that attempts something similar is Tomas Bigaj's "Serious Essentialism" [6]. Bigaj is not concerned with defending the possibility of Leibniz shifts (neither motivated by respecting tradition here nor intuition) but does want to be able to countenance symmetry breaking violations of determinism, while avoiding the indeterminism of the Hole argument. He endorses anti-Haecceitism, but defends a particular brand of essentialism whereby all fundamental objects have qualitative essences, and fundamental objects of the same kind have the same essence. He endorses counterpart theory constrained by essentialism: the only counterpart of a given object in the actual world is itself (thus he is not a Cheap Haecceitist), and counterparts of any object, x, must share x's essential properties.

For Bigaj, since Leibniz shifts simply redistribute matter across space in such a way that both preserves the essential properties of points of space, and produce a universe that is qualitatively indistinguishable from the non-shifted situation, his anti-Haecceitism ensures that shifted worlds are not distinct possible worlds. On his view Hole argument diffeomorphic models do not violate determinism, for it "is clear that for every point p in model (M, Oi) its image-point d(p) in (M, d $\times$ Oi) will possess the exact same metric properties, and hence will be its counterpart. And because d* drags not only metric properties but all geometric objects Oi from p to d(p), the resulting structure is isomorphic with the original one, and therefore qualitatively indiscernible from it. Hence models (M, Oi) and (M, d $\times$ Oi) must refer to one and the same possible world." [6]

But for symmetry breaking violations of determinism he employs his own brand of cheap *de re* representation through qualitative essences and, like the Cheap Haecceitist, provides us with possibilities that are not possible worlds. According to Bigaj, while no object has a world mate counterpart other than itself, distinct world mates with the same essences can provide truth conditions for the counterfactuals needed when a symmetry breaking violation of indeterminism appears to be afoot. Upon discussing an example in which one of the globes in the Black world changes colour the required counterfactual "Things could be such that the world would have the exact same history, and yet an object qualitatively identical to this sphere up to moment t would not turn pink after t" is, according to Bigaj, "made true by the existence of the second sphere which in fact didn't turn pink. That way the serious essentialist can agree that the symmetric scenarios indeed violate some form of determinism" [6].

Distinguishing possibilities from possible worlds is all well and good, but, as Skow [17] has pointed out, embracing a distinction between possibilities and possible worlds, and granting that possible worlds do not exhaust possibilities, allows a re-casting of

the Leibniz shift and Hole arguments using possibilities instead of possible worlds. Shifts are distinct possibilities (but not distinct possible worlds) in virtue of the existence of "this worldly counterparts" or "world mates with the same essences" of the relevant points of space. Tower Collapses that buckle at different places are likewise distinct possibilities (but not distinct possible worlds) in virtue of those points that are world mates of the right cheap flavour (either that of the Cheap Haeccietist or Serious essentialist). And in the Hole argument there are world mates of points in the region on which the diffeomorphism is not the identity that are equally ready to step into play just these roles. If these are all distinct possibilities, we are owed an account of why these possibilities amount to nothing in discussions about determinism, for without such an account any claim that we have a substantivalist position that allows us to avoid the indeterminism in the Hole argument is hollow. Certainly, determinism is typically characterized using possible worlds, but while they are the standard device for capturing the spirit of determinism, once we grant that there are possibilities that are not possible worlds recasting determinism using them is not so hard to do: A world W is deterministic just in case given the physical state of the world on some region there is just one possibility for the physical state of the world everywhere. And now the Cheap Haecceitist and serious essentialist have to deal with the indeterminism in Hole argument all over again, for diffeomorphic rearrangements of properties across spacetime points are distinct possibilities (but not distinct possible worlds).

There is another kind of example of purported indeterminism in the literature that requires the attention of a sophisticated substantivalist. How one believes it ought to be handled will influence how the substantivalist navigates the examples above, but it has not been discussed extensively outside of Brighouse [18, 19], Belot [9], and Melia [20]. It reveals a further wrinkle in the challenge for the sophisticated substantivalist position. This kind of example purports to be a symmetry *preserving* violation of determinism. Some of these examples are strange to the point of being selcouthe[6]: Belot [9] suggests that we imagine a world, Continuum, in which a single A particle exists in full Newtonian spacetime. After 13 years A decays into continuum many B particles forming a spherical shell around the place of decay. Each B particle moves at the same rate along its radius. Focus on two of the B particles, B1 and B2. B1 could have had B2's trajectory and vice versa, but nothing in the history would determine which B particle plays which role. Here again there appears to be more than one possibility, and for the Cheap Haecceitist or serious essentialist in the selcouthe case we have world mates ready step into play just the right roles again. Selcouthe alternatives are distinct possibilities (but not distinct possible worlds) in virtue of q (B1's location at t) being a world mate with the same essential properties as p (B2's location at t), and as distinct possibilities they are potential determinism violators.

We are now ready to fully state the challenge for the sophisticated substantivalist position. In fact for anyone attracted to substantivalism who wants to avoid the indeterminism in the Hole argument it is a challenge worth thinking carefully about. How can a substantivalist, in a well motivated, defensible way, accommodate symmetry breaking violations of determinism, deny that the Hole argument presents examples of purported indeterminism, and deny that selcouthe symmetry preserving examples

[6] https://quod.lib.umich.edu/cgi/m/mec/med-idx?type=id&id=MED39264.

are cases of indeterminism? The challenge faces the Cheap Haecceitist, the serious essentialist, and the thin substantivalist. It's a challenge that has been largely ignored in the literature on the Hole argument, even among those who consider sophisticated substantivalism the received view. But anyone who defends or endorses sophisticated substantivalism, or defends or endorses an approach to the hole argument whereby determinism is not violated by hole diffeomorphs, should acknowledge this challenge, and should either show why it is not serious or explain how to respond to it.

5 Solution Via Determinism

One attempt to meet the challenge is to endorse a definition of determinism that simply rules the cases accordingly. Both Belot [9] and Melia [20] offer a definition of determinism that succeeds in this regard. While Melia offers two different conceptions of determinism, I will focus here on just the one shared by Melia and Belot, for the concerns I have apply equally to both. The conception of determinism is characterized in terms of possible worlds, and the trick is to be able to capture when parts of a world that have been qualitatively indistinguishable cease to be qualitatively indistinguishable even when this makes no qualitative difference to the worlds as a whole, but to *only* capture those situations, and not the alleged symmetry preserving violations of determinism where parts of the world remain qualitatively indistinguishable. When we have models of a space–time theory that describe qualitatively indistinguishable initial segments of worlds, that is models that have initial segments that are related under a "qualitative isomorphism", we can do this by requiring that there be a global qualitative isomorphism between the models that *extends* the initial one. The formal definition that Belot and Melia present uses the Lewis's language of duplicates: two things are duplicates if they share all of the same natural qualitative properties and relations. More formally, according to Belot and Melia, a world W is deterministic if, whenever W' is physically possible with respect to W, and t, t', and f from W_t to W'_t, are such that f is a duplication,[7] there is some duplication g from W to W' whose restriction to W_t is f. The definition does the trick. It rules Belot's selcouthe example as deterministic, for every duplication of the initial segment of the worlds with A particles will be extendable to a global duplication of the world, since B1 and B2 share all their qualitative properties. It rules the hole argument models as deterministic, since there is no object as described by the two models outside of the hole region R that exists in the hole region R and has different qualitative properties as described by the two models, or bears different qualitative relations to other objects in the hole region R: any non-global qualitative isomorphism is extendible to a global qualitative isomorphism between the two models.

The trick works. But while the trick works, and according to Melia "there is no reason the substantivalist cannot accept this definition", the question remains what reasons there are to accept it. One argument is that it rules according to intuition (or perhaps according to what we would like to say): we have an intuition that the tower

[7] Those properties Lewis dubs "natural" are those that "carve nature at the joints", formally he is happy to take these as primitives of his theory.

collapse set up is indeterministic, but we don't have a strong intuition (or we don't want to say) that the A particle decay selcouthe world or the hole argument models violate determinism, and the definition rules cases accordingly. While this can be part of the argument to accept the definition, it cannot be the whole story. The Cheap Haecceitist and the serious essentialist have granted that there are possibilities that outrun qualitatively indistinguishable possible worlds, and we have distinct possibilities that differ simply in virtue of which objects are playing which roles. Symmetry breaking possibilities are only some of the distinct possibilities that differ in these ways. Where is the argument that it is only those different possibilities that are coupled with a symmetry break that matter for the question of determinism? We need such an argument to provide reasons to endorse the definition; the argument ought not simply be that it gets us the outcomes that we may desire. If a world, W, is deterministic just in case there is just one possibility for the physical state of the world everywhere given the physical state of the world on some region, and we allow that possibilities may differ just in virtue of which objects play which roles, then how are we to explain why only the symmetry breaking possibilities that differ in this way are the ones relevant for determinism?

6 Points, Particles, Properties, and Possibilities

I will end with an illustration of how fleshing out the ontological commitments of the substantivalist can have some striking consequences regarding de re possibilities, and can thereby influence whether one would count various examples as ripe for indeterminism. What follows is absolutely not exhaustive of the options, nor is any substantivalist position below one that I am defending here, but the examples illustrate first, that how one might be thinking of substantival ontology will influence one's intuitions about the examples above, second, that if the way one is thinking about substantival ontology is not clear and unambiguous, one's intuitions about the examples will not be clear and unambiguous, and third, that a foray into ontology is one potential way to help us meet the challenge outlined above.

There is something very suggestive about the general approach of Dasgupta, for his "thin substantivalism" provides a clear example of how one's ontology constrains what is possible. Anti-Haecceitism for the substantivalist falls out of thin substantivalism. The view provides an explanation of *why* shifts are not distinct, for thin facts could not ground a distinction between shifted worlds. The problem with the position, as I see it, is that it cuts down the possibilities too drastically for the substantivalist's purposes by not allowing the multiple ways that symmetry breaking can happen (and this should at least be logically possible on the substantivalist view). But the view serves well to highlight the point that choices of ontology constrain what is possible and what is not.

The substantivalist believes that spacetime points exist, not as logical constructions out of matter, but in their own right. Given this commitment there are two natural ontological pictures for the substantivalist: A two-category ontology, where in addition to points of spacetime there are particles/objects, or a one-category ontology in which there are points, and properties of points, but no objects in addition. The way substantivalism is characterised in the literature of the Hole and shift arguments does

not distinguish these two different ways of thinking of the substantivalist's ontology, but modern presentations of spacetime theories, at least when characterised by philosophers, naturally lend themselves to the one-category view. For Earman, the manifold substantivalist takes the manifold M of the models as the "basic object of predication" (Earman p. 126). And Norton describes substantivalism as "The notion that the manifold represents an independently existing thing is quite natural in the realist view of physical theories. In that view one tries to construe physical theories literally… The literal reading is that this manifold is an independently existing structure that bears properties" [21].[8] The two-category ontology has room for thinking of some geometric object fields as a distribution of properties over points of spacetime as well an ontology of objects or particles located at points, but since this complicates things in ways that will be clear from just looking at the one and two category "pure" options, I leave it out of the discussion here. Granting that possibilities can be distinct despite being qualitatively indistinguishable, the range of distinct such possibilities can be quite different depending on whether one is a one-category or two-category substantivalist.

A two-category substantivalist is a realist about both points and particles. Let's suppose this realism does not suggest that points and particles be treated any differently in modal contexts.[9] Suppose objects/particles are only ever located at points (or regions), and points (or regions) are only ever occupied by objects/particles. Suppose further that each category is such that we can fix/stipulate which X in a possibility is the same as the actual X independently of X's qualitative properties, and each category is such that we can fix/stipulate which X is the same as the actual X independently of X's location or occupant. Add to this a Skyrms inspired principle of recombination whereby to get our possibilities "We rearrange some or all of our relationships between some or all of the objects" [24], and now imagine Newtonian absolute space empty but for two qualitatively indistinguishable particles A and B. Given that points p and q are occupied there are two distinct possibilities on this two-category view, one in which A is at p and B is at q, and one in which A is at q and B is at p. This kind of ontological picture licences the possibilities required for shifts, tower collapse indeterminism, Hole argument indeterminism and selcouthe indeterminism.[10] It is something like this naive picture that I believe motivates the traditional substantivalist views about these examples, and it would explain some commonly held intuitions in these cases.

On the one-category view we can distinguish possibilities that are qualitatively indistinguishable, but how this plays out will depend on one's view of the nature of properties, and will often be different than the two-category view. I will run through

[8] Super-substantivalism, discussed by Friedman [22] and Sklar [23], is a one-category ontology, but it's not a position discussed in the literature on the hole argument.

[9] I take the most compelling argument to be a realist about any kind of entity to come from what our best physical theories commit us to. My interest in realism about points of space or spacetime is motivated by just this kind of principle. But this reason does not, by itself, provide reason to treat any such entities differently in modal contexts.

[10] It does not, of course, suggest that we care about all these apparent violations of determinism equally.

the examples taking properties to be universals.[11] Adopt Armstrong's account of properties as universals that "carve nature at the joints", that are concrete, that are multiply located, and are "wholly located" at each place they are instantiated [25]. Agree that we can, again, stipulate which point in a possibility is the same point as the actual point independently of the point's qualitative properties (and adopt the same Skyrms style principle of recombination). Then some qualitatively indistinguishable distinctions between possibilities that can be made on the two-category view cannot be made on the one-category view. Imagine, again, Newtonian absolute space empty but for two qualitatively indistinguishable delta functions (let's call them A and B, though this talk pushes one to the extreme of awkwardness), one (say A) with a peak at p and the other (B) with a peak at q. Here there cannot be two distinct possibilities. Possibilities will be distinct from each other provided the properties of at least one given point p in a possibility, P, get shifted to a point q that does not have same property as p in P. But when we are redistributing properties on points in such a way that every point gets the same property instantiated at it after the redistribution we don't get distinct situations, for universals are multiply located and wholly located at each place they are instantiated, and the recombination does not changes any of these instantiation facts. On this view shifts almost always generate new possibilities,[12] but if the shift results in every point having the same property it had before the shift, as it will in infinite spatial recurrence worlds, then the shift does not generate a new possibility. Tower collapse worlds are distinct possibilities, differing in just which point instantiates the property corresponding to the buckle of the tower. But interestingly there are no selcouthe symmetry preserving distinct possibilities. Playing out the symmetry preserving selcouthe examples of Belot with on the one-category view (where properties are either Armstrong universals or classes of actual objects) will not allow symmetry preserving potential violations of determinism. What about the Hole argument? Here, sadly (at least for those of us keen on being sophisticated substantivalists), we still have distinct possibilities on the one-category view *unless* the Hole diffeomorphism maps every point to a point with the same properties.

Where does this leave us? My own view, for the reasons outlined above, is that we don't yet have a satisfactory sophisticated substantivalist position that avoids the indeterminism in the Hole argument, allows for symmetry breaking violations of determinism, and yet avoids the selcouthe examples of Belot. We do have a definition of determinism, Melia's and Belot's, that can allow us to make these judgments, but that definition is silent on why it is that among the distinct possibilities that differ in which objects play which roles, only the symmetry breaking possibilities are relevant to the question of determinism. To adequately defend sophisticated substantivalism there is still some hard philosophical work to be done.

[11] The story is effectively the same when taking properties to be classes of actual objects. There are other accounts of properties, for example, tropes, and the story will likely be different depending on the particular view of tropes one might entertain.

[12] Where we understand shifts on the one-category view as a redistribution of properties to points where points of space acquire the properties of those points some distance away from them.

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References

1. Butterfield, J.: The hole truth. The British Journal for Philosophy of Science **40**(1), 1–28 (1989)
2. Brighouse, C.: Spacetime and holes. In: PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association (Vol. 1, pp. 117–125). Philosophy of Science Association (1994)
3. Maidens, A.: World enough and space–time: absolute versus relational theories of space and time (1992)
4. Pooley, O.: Points, particles and structural realism. In: Rickles, D., French, S., Saatsi, J. (eds.) The Structural Foundations of Quantum Gravity, pp. 83–120. Oxford University Press, New York (2006)
5. Pooley, O.: Relationist and substantivalist approaches to spacetime. In: Batterman, R. (ed.) The Oxford Handbook of Philosophy of Physics, pp. 522–586. Oxford University Press, New York (2013)
6. Bigaj, T.: Essentialism and modern physics. Metaphysics in Contemporary Physics **104**, 145–178 (2015)
7. Hoefer, C., Cartright, N.: Substantivalism and the hole argument. In: Earman, J., Janis, A., Massey, G.J., Resche, N. (eds.) Philosophical Problems of the Internal and External Worlds, pp. 23–43. University of Pittsburgh Press, Pittsburgh (1994)
8. Dasgupta, S.: The bare necessities. Philosophical Perspectives **25**(1), 115–160 (2011)
9. Belot, G.: New work for counterpart theorists. British Journal for Philosophy of Science **46**(2), 185–195 (1995)
10. Earman, J.: A primer on determinism, vol. 37. Springer Science & Business Media, Berlin (1986)
11. Earman, J., Norton, J.: What price spacetime substantivalism? The hole story. British Journal for the Philosophy of Science **38**(4), 515–525 (1987)
12. Fara, D.G.: Dear haecceitism. Erkenntnis **70**(3), 285–297 (2009)
13. Field, H.: Realism, mathematics & modality. Oxford University Press, New York (1989)
14. Wilson, M.: There's a hole and a bucket, dear leibniz. Midwest Studies in Philosophy **XVIII**, 202–240 (1993)
15. Black, M.: The identity of indiscernibles. Mind **61**, 153–164 (1952)
16. Lewis, D.: On the plurality of worlds. London **5**, 221–236 (1986)
17. Skow, B.: Haecceitism, anti-haecceitism and possible worlds. The Philosophical Quarterly **58**(230), 98–107 (2008)
18. Brighouse, C.: Determinism and modality. The British Journal for the Philosophy of Science **48**(4), 465–481 (1997)
19. Brighouse, C.: Understanding Indeterminism. Philosophy and Foundations of Physics **4**, 153–173 (2008)
20. Melia, J.: Holes, haecceitism and two conceptions of determinism. The British Journal for the Philosophy of Science **50**(4), 639–664 (1999)
21. Norton, J. D: The hole argument. In: Zalta, E. N. (Ed.) The Stanford Encyclopedia of Philosophy, Fall 2011 Edition. http://plato.stanford.edu/archives/fall2011/entries/spacetime-holearg/
22. Friedman, M.: Foundations of Space–Time theories: Relativistic Physics and Philosophy of Science. Princeton University Press, Princeton (1983)
23. Sklar, L.: Space, Time, and Spacetime, vol. 164. University of California Press, California (1977)
24. Skyrms, B.: Tractarian nominalism. Philosophical Studies **40**(2), 199–206 (1981)
25. Armstrong, D.M.: Universals. An Opinionated Introduction. West-view, London, Boulder (Colorado) (1989)