On Where Things Could Be

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Abstract

Some philosophers have replied to Leibniz's "shift" argument against the reality of absolute space by appealing to anti-haecceitist doctrines about possible worlds, influenced especially by David Lewis's counterpart theory. But separated from Lewis's distinctive views about what possible worlds are, it is difficult to understand what those doctrines really amount to, and why they are relevant to the metaphysical issues at hand. In fact, the best way of making sense of the relevant kind of anti-haecceitism is one that really concedes the main point of the Leibnizian argument, pressing us to consider alternative metaphysical accounts of the world's spatio-temporal structure.

1 Shiftiness

Newton famously believed in "absolute space [which] remains homogeneous and immovable" (2004, 64). Leibniz gave a famous argument against Newton's view (2000, Third Letter, 5): If there is absolute space, then all material things could have been in different absolute places, while bearing exactly the same spatial relations to one another. But it would violate the Principle of Sufficient Reason for there to be a different possible world so much like our own. Thus, there is no absolute space.

In more recent decades a certain style of response has gained popularity to the point that it might be considered the "textbook" view.[1] It turns on a doctrine of

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[1] Butterfield 1989; Maidens 1992, 135–6; Brighouse 1994; Hoefer 1996; Pooley 2006, manuscript; Maudlin 2012, 166; Arntzenius 2012, sec. 5.12. (Note that Arntzenius and Maudlin, which I cite as examples of the view's "textbookness", present anti-haecceitism as a standard view, but do not endorse it.) The view of Maudlin (1990) is also in the same family.

modal metaphysics called **anti-haecceitism**. The anti-haecceitist rejects "trans-world identity", and uses this rejection to support the view that there are no possible worlds that differ with respect to how particular things are without also differing qualitatively. So, the reply goes, possible worlds that apparently differ by Leibniz's shift are really the very same world. But it is a bit difficult to understand what this response really amounts to. Some have worried that the anti-haecceitists have just changed the subject, and that these doctrines about possible worlds are irrelevant to the reality of space (Section 2) (Skow 2007; see also Dasgupta 2011, sec. 4). There is a version of anti-haecceitism about space that commits no such mistake—but stating it carefully depends on articulating a distinctive theoretical role for possible worlds to play, one which is importantly different from the familiar role it plays in possible worlds semantics and in most of the metaphysics literature (Section 3). I'll recommend this doctrine as a good candidate for what the anti-haecceitists about space should mean. But it isn't obviously what they *do* mean—for it amounts to conceding much of the Leibniz shift's argument's force, and in particular it requires revisionary metaphysics of space (Section 4). Still, there is no better candidate view in the neighborhood that avoids this consequence (Section 5).

First, though, a bit more detail about the argument. For the sake of fixing ideas I'll focus on simplistic classical physics (though the Leibnizian argument and anti-haecceitist replies apply to more modern theories as well: see Earman and Norton (1987); Earman (1989, ch. 9)). The shift argument I'll discuss targets one particular theory of the nature of the physical world: a Newtonian theory of interacting particles under a central force law in absolute ("full Newtonian" [2]) space and time. Here's an outline of what the theory says.

> There are points of physical space. (When I talk about **absolute positions**, these are what I mean.) These have three-dimensional affine and metric structure.[3]
>
> There are moments of time, which have one-dimensional affine and metric structure.
>
> There are particles. Each particle has a **trajectory**: it has an absolute position in space at each moment in time. Each particle has a **mass**, which is a real number.
>
> There are central forces between particles: for each pair of particles there is a real-valued function that gives the magnitude of the force between them as a function of the distance between them.[4] The **vector**

[2] See Sklar (1977, III.B.1); Friedman (1986, III.1); Earman (1989, sec. 2.5)

[3] This means that for any two points there is a displacement vector which gives the distance and direction from one to the other. Displacement vectors have certain structure of their own, that of a three-dimensional vector space with an inner product. Note I'm talking about a flat space with global vector displacements, not the more general object from differential geometry, a manifold-with-affine-connection.

[4] I'm effectively taking the "force law" to be constitutive of what the force is between two particles, rather than as a nomic constraint on a further thing. But this isn't an important choice point for present purposes.

> **force** of j on i is this magnitude times an acceleration vector pointing from i to j; and the **total force** on i is the vector sum of each of these vector forces.
>
> There is one **law of motion**: the total force on a particle equals its mass times its acceleration. It is physically possible for particles to have certain trajectories if and only if those trajectories collectively obey the law of motion.

Call this theory **Newt**. The conclusion of the shift argument is that Newt does not give the right metaphysical picture of the world. It turns on the fact that uniform translation is a *symmetry* of Newt. What this means is that, however things could be according to Newt, there is another way they could be, just like the first except that all material objects are shifted uniformly in space. Every particle has a different absolute spatial position at each time, but the spatial relations between particles at times are just the same. A bit more carefully: let d be a (non-zero) displacement vector. Then according to Newt, if it's physically possible for each particle i to be at point $x_i t$ at each time t, then it's *also* possible for each particle to be at the point $d + x_i t$ at each time t. This is a consequence of Newt, because if the trajectories x_i obey the law of motion, then so do the displaced trajectories—and according to Newt obeying the law of motion is all physical possibility requires. For short: **shifts are possible**.

(Note when I say "possible" without qualification, I mean *physically* possible—consistent with the laws of physics. I'm not assuming any particular story about what it is to be a law, but I am assuming that laws are something physical theories aim to describe, and can do better or worse at describing.)

But, as Leibniz reasoned, two possible worlds that were shifted like that would be "indiscernible", and so we shouldn't think there are two really different physical situations shifted this way. So Newt distinguishes between physical possibilities with no real physical difference.

Let's say a theory **gets things right** iff it tells the right story about both the physical laws and the world's metaphysical structure. (More on this notion later.) Here's the main argument:

(S) If Newt gets things right, there are distinct shifted worlds.

(D) If Newt gets things right, shifted worlds are empirically equivalent.

(E) There are no distinct empirically equivalent worlds.

(*) So Newt doesn't get things right.

I'll briefly rehearse the motivation for premises (D) and (E). (I'll return to (S) in the next section.) I think the best version is the argument from undetectability, which is developed explicitly by John Roberts (2008) and Shamik Dasgupta (2009, sec. 1.1; 2011, sec. 8). (But note Dasgupta avoids putting things in terms of possible worlds in order to sidestep some of the issues I'm heading into.)

By "empirically equivalent worlds" I mean worlds that agree on everything that can in principle be empirically detected. I take it to be obvious that things' absolute

positions aren't open to direct observation.[5] Even so, it *isn't* obvious that absolute positions are empirically undetectable—this requires argument. Lots of things are empirically detectable without being directly observable. For example, Newton's bucket experiment showed (surprisingly!) that absolute rotation is detectable, at least if Newton's physics is correct (2004, 68ff). We can directly observe the curvature of water's surface, or the tension in a cord, and the laws guarantee that in suitable circumstances these observable matters covary with absolute rotation.

Why aren't there similar experiments we could perform to detect absolute positions, and thus distinguish between shifted worlds? The reason is that if Newt's account of the laws is correct, then shifts (unlike "twists" that change everything's absolute rotation) preserve physical possibility: shifts are a symmetry of Newt's laws. So shifted worlds don't just agree on everything which is directly observable, but also on the causal explanation in terms of the laws for anything that is directly observable. Any device we might build to detect absolute position will work in exactly the same way and give exactly the same observable reading in both of two shifted worlds. So shifted worlds are empirically equivalent. (The undetectability defense of (D) draws together two of the main strands of the shift argument's development: both directly observable structure, as in the *verificationist* strand, and also causal explanatory structure, as in the *determinist* strand.)

Leibniz defended (E) (or something similar) by appeal to the Principle of Sufficient Reason (PSR): "that nothing happens without a reason why it should be so rather than otherwise" (2000, Second Letter, ¶1). God would have had no grounds for a rational choice between creating either of two shifted worlds—so God could not have created either of them. But the theological premise is not especially convincing.[6]

I take the best defense of (E) to be an appeal to Occam's Razor. If possible worlds agree with respect to everything empirically detectable, then any distinction our theory makes between them is empirically idle. So it is better to do without the distinction. Of course, this kind of principle is defeasible. As Tim Maudlin puts it,

> Man is not the measure of all things, and there is no reason to believe that all real properties must fall within the power of human observation. Still, one should be made at least uncomfortable by the postulation of empirically inaccessible physical facts. Ceteris paribus, one would prefer a theory without them (1993, 192).

[5] Maudlin challenges this (1993, 190–1), but while the challenge shows *something*, I don't think it succeeds in showing that absolute positions are observable in the way that counts. See Dasgupta's reply (2009, sec. 1.4).

[6] "[E]liminating God from this scenario leaves no problem at all; since no such choice was ever made, there need never have been rational grounds to make it" (Maudlin 1993, 191). Leaving God in the scenario, it still isn't clear that there couldn't be arbitrariness in God's choice to create, as Clarke maintains. ("But this sufficient reason is often times no other than the mere will of God", 2000, Second Reply, ¶1). For a version I like better, see van Inwagen (1995). A good God might make "disjunctive decrees", willing general features but not every detail of what creation is like. Then some facts would have no deeper explanation than that the world had to be *some* way or other in order to fit God's general purposes.

So really we should hedge the premise (E) and the conclusion of the argument:

(E*) A theory that implies there are distinct empirically equivalent worlds is a bit embarrassing.

(**) So Newt is a bit embarrassing.

(But I won't generally pronounce the hedge.) This means the argument only has any real bite if Newt has some rival *without* commitments to absolute positions, which is otherwise about as good.[7] Still, the embarrassment of empirically superfluous physical structure is at least reason to look for such an alternative theory.

A theory with absolute position facts is less parsimonious than a similar theory without them would be. But while we want simpler theories, we don't want them *too* simple. After all, a theory without absolute *rotation* facts would also be more parsimonious, but Newton's bucket showed us that these *do* play an essential empirical role in Newtonian physics. What shifts show is that absolute positions are "unbucketable": if Newt gets the laws right, then absolute positions are empirically idle, fair game for elimination.

2 Cheapskates

Newt is committed to the physical possibility of shifts: its laws do not rule them out. But maybe the move is too quick from this *possibility* to the premise

(S) If Newt gets things right, there are distinct shifted worlds.

Some hold that there is a gap between *possibility* and *possible worlds*, so that (S) does not follow from the possibility of shifts.

David Lewis is the chief defender of this sort of gap (1986, sec. 4.4). The key to his defense is a rejection of *trans-world identity* in favor of *counterparts*. According to Lewis, for a particular thing to be possibly F is for it to have a counterpart which is F in some world. The crucial way in which counterparthood differs from identity is that a single thing can have more than one counterpart in any particular world. Thus a single world w can provide multiple ways a thing x could have been, one for each of x's counterparts in w. (And in particular, an object can have a distinct counterpart in its *own* world.)

Lewis's counterpart theory allows him to hold two doctrines that may at first seem incompatible. Lewis is an *anti-haecceitist* in that he holds that there are no possible

[7] Or as Frank Arntzenius puts it:

> I should slightly qualify my claim that the Leibniz shift argument is no good whatsoever. I do not deny that it can be good to have a theory which has fewer "symmetries"—where by "symmetry" I mean a transformation which leaves the dynamics and the phenomena invariant. Getting rid of apparent redundancies in one's formalism is indeed, other things being equal, a good thing, for it reduces one'e commitments—*but only if it leads to a simpler (empirically adequate) theory* (2012, 178, original emphasis).

worlds that differ with respect to how particular things are, without also differing *qualitatively*. But he also accepts certain haecceitistic possibilities: for example, you might have lived in the first of two duplicate epochs of history, or you might have lived in the second epoch. There is no qualitative difference between these two ways things might have been. Lewis accepts that both are possible, but holds that they do not correspond to different worlds. There is just one world that underlies both possibilities, and you have two different counterparts in that world. This combination of anti-haecceitism about what *worlds* there are, with haecceitism about what *might have been*, Lewis gives the label **cheap haecceitism**.

These Lewisian doctrines look like they might present an escape route from the shift argument. Following Lewis, the "cheap haecceitist" about absolute space says that shifts are possible, but there are no possible worlds that differ merely by a shift.[8] The possibility of particles being uniformly displaced from where they actually are does not correspond to a distinct possible world. Instead, it corresponds to the *actual* world, with shifted points considered as counterparts: each displaced point $d + x$ is a counterpart of the point x. The shift does not give us a different world—just our own world reconsidered. So we can accept the possibility of shifts without accepting (S).

Brad Skow objects to this reply: if worlds come apart from what is *possible*, then worlds are beside the point. All the shift argument really relies on (he claims) is *contingency* in where things are.

> Leibniz argued that if space exists, then it is possible for each thing to be located one foot to the left of where it actually is, at each time. Leibniz also claimed that this is not in fact possible, and concluded that space does not exist.
>
> … There is a distinct, but similar, argument against substantivalism: if space exists, then there is a possible world according to which each thing is located one foot to the left; but there is no such possible world; so space does not exist.
>
> … The first argument both makes better sense of things Leibniz says than the second one does and is more interesting in its own right (2007, 106–7).

Skow's claim is that if possibility and possible worlds come apart, possible worlds are irrelevant to the reality of space. The Leibnizian argument can be restated without mention of possible worlds:

(1) If Newt gets things right, shifts are possible.

(2) But shifts aren't possible.

(3) So Newt doesn't get things right.

[8] I should note that not all of those I cited in footnote 1 are cheap haecceitists: some of them deny even the *possibility* of shifts—and others seem to sometimes affirm the possibility and sometimes reject it. I'll address some alternative views like this in Section 5. Pooley is the most explicit defender of cheap haecceitism about space.

The cheapskate's anti-haecceitism does nothing to diminish the force of the restated argument.

On behalf of the cheapskates, Oliver Pooley resists Skow's charge.

> But this is baffling. Leibniz's PSR decrees that God must have acted for a reason when creating the actual world. Surely it is the possible worlds argument that is most relevant to this scenario. It is only if there are two distinct yet indiscernible worlds that God is forced to make an arbitrary choice in actualising one but not the other. On the other hand, if we suppose … that there is just a single possible world corresponding to each way things might be qualitatively, there is no dilemma (manuscript, 102).

He might offer the same speech about the detection version of the argument: it is different *worlds* that really raise the problem of empirically idle structure, not mere contingency.

But why would this be? The traditional role for possible worlds to play, both in the possible worlds semantics and in most applications to metaphysics, is as ways things might have been. Worlds are supposed to obey the "Leibniz biconditionals":

(P) p is possible iff p is true at some possible world

(N) p is necessary iff p is true at every possible world

But the cheapskate's "worlds" don't do this. Say q is some complete qualitative description of a Newt-world, and p is some absolute position claim consistent with it. The cheapskate says that q-and-p and q-and-not-p are both possible. The first possibility would imply by (P) that p is true at some q-world. The second possibility implies by uncontroversial modal principles that if-q-then-p is not necessary, which would imply by (N) that p is not true at every q-world. So there would have to be at least two q-worlds—one where p is true and one where p is not true—which conflicts with anti-haecceitism.[9]

If the cheapskate's worlds aren't doing the traditional job outlined by (P) and (N), then it isn't clear what job they *are* doing. So it isn't clear what distinctness of shifted worlds *adds* beyond contingency of absolute position. To satisfactorily answer Skow's objection, the cheap haecceitist needs to meet two challenges. First: to articulate a role for possible worlds to play which goes beyond the traditional role of tracking what could have been the case. The cheapskate needs to say what distinctive work a "world" does that something that obeyed (P) and (N) wouldn't be fit to do. The second challenge is to explain why the shift argument's premise (E) only plausibly applies to the things that play this distinctive world-role. Whatever the cheap haecceitist says is

[9] This argument implicitly relies on two premises which I also take to be part of the standard possible-world-role. First: if $q \wedge p$ is true at w then p and q are each true at w. Second: if q is not true at w or p is true at w, then $q \supset p$ is true at w. These in turn follow from the principle that truth-at-a-world is closed under (single-premise) logical consequence, and the principle that one of q or $\neg q$ is true at w, at least in the case where q is a qualitative proposition. (Some counterpart theorists might reject this for non-qualitative propositions.) A comment from Cian Dorr helped me see this way of pressing the point.

special about worlds as opposed to mere ways things could have been, it must make it plausible that there is something distinctively bad about being committed to distinct empirically equivalent *worlds*, without putting the same constraint on our commitments just to what is possible.

Lewis has a clear answer to the first challenge. According to Lewis, possible worlds are maximal spatio-temporally connected parts of reality—genuine concrete universes like our own. Lewis thinks these things do not exactly correspond to all the different ways things could have been because things of that sort couldn't have the patterns of overlap required for genuine trans-world identity (1986, sec. 4.2). But *this* way of meeting the first challenge is of little help. First, because not many of those who are attracted to anti-haecceitism about space will accept Lewis's peculiar doctrine about what worlds are. And second, because this view of what worlds are provides no obvious way to meet the *second* challenge. Why would Occam's Razor tell us to dispense with empirically idle differences between distinct spatiotemporally connected regions of concrete reality, as opposed to distinct ways things could have been? (Well, maybe the Razor cuts out *all* those Lewis-worlds—but why just the empirically equivalent ones in particular?)

The Lewisian reply is no help. So the cheapskate needs some other way of answering these two challenges. This is what I'll now provide.

3 Facts and worlds

Here is my proposed answer to the first challenge.[10]

Some ways we represent the world *correspond to reality*, and others don't, though they may still succeed at some other job—they may be useful placeholders in our reasoning, or signal conventions, or do something else. It isn't generally obvious at the outset which representations have which status. Distinguishing them is a project of metaphysics.

It would be nice to say more precisely what the difference between "metaphysically first-rate" and "second-rate" representations consists in, but this is not easy (cf. Field 1994; Fine 2001; Dreier 2004; Sider 2012, ch. 11). Consider an example. According to the Minkowski interpretation of special relativity, claims about absolute simultaneity are "meaningless"—not in the sense that they are unintelligible gibberish, but in the sense that they don't correspond to any genuine, determinate, objective way for the world to be. The (nowadays out of favor) Lorentz interpretation holds the opposite, that absolute simultaneity is objectively meaningful. Suppose the Lorentzian says:

(4) A and B are simultaneous

(He might add: and I *don't* just mean simultaneous-in-my-frame.) What should Minnie the Minkowskian say about (4) ? The claim is *intelligible*, and Minnie may even want

[10] See also (Russell, forthcoming).

to use similar claims herself in suitably hygienic contexts.[11] But in that case some of the things that might at first seem tempting to say about (4) will be difficult to sustain. Minnie shouldn't just say

(5) A and B are not simultaneous

This would be taking sides on a question which she thinks has no objective answer. She might want to say (4) isn't *true*. But "true" has a "thin" deflationary use, on which it is axiomatic that

(6) (4) is true iff A and B are simultaneous

(7) (5) is true iff A and B are not simultaneous

Minnie can't say that neither (4) nor (5) is true, consistently with (6) and (7) (unless she gives up classical logic) (see Williamson 1996, 187ff; Field 2003). (She might go on to distinguish "disquotational truth" from "correspondence truth", like McGee and McLaughlin (2000)—but this relabels the difficult distinction rather than explaining it.) Minnie might want to say that (4) doesn't express a *proposition*. But as with truth, we have a "thin" conception of propositions as mere "shadows of sentences", according to which it is clear that (4) expresses the proposition that A and B are simultaneous.

Rather than search further for some account of what Minnie should say (4)'s "factual defectiveness" consists in, I'll just assume that we can make sense of the distinction somehow or other, and put a label on it. Using "proposition" in an inclusive, lightweight sense, we can say that some propositions are **factual**.[12] It is hard to see how we could get by without some distinction of this sort—since debates with the same general structure as the one between the Lorentzian and Minkowskian are everywhere in philosophy of physics. I'll mention just a few of the many examples. Theories of space-time structure are distinguished by whether they are committed to objective facts about which events at happen at the same location, or about how fast things move, or about which things accelerate—and so the question of what kind of structure space-time has is partly a question of which of these are genuinely factual matters (e.g Earman 1989, 30ff). A related debate is about whether there is any objective difference between a universe like ours and its time-reversal (e.g. Maudlin 2002). Another is about whether there are objective facts about the values of quantities that vary under gauge symmetries (e.g. Healey 2001). Yet another is about whether quantum mechanics teaches us that there is really no objective fact about whether Schrödinger's cat lives or dies (as opposed to merely living-at-a-branch-of-the-wave-function) (e.g. Saunders 1995). These debates are difficult to understand without some notion like factuality.

[11] For example, it is common practice to define "meaningful" notions like the space-time interval in terms of "meaningless" notions of spatial and temporal distance. This practice seems to rely on the intelligibility of the latter.

[12] Roughly following Fine. Only roughly, because Fine's primitive is a sentence operator ("It is factual that …") rather than a predicate of propositions. This is because Fine wants to remain officially neutral on the metaphysics of propositions. I'm helping myself to lots of intensional objects, so it would be pointless for me to be so cagey.

If we accept a distinction between two sorts of propositions, factual and non-factual, then we can also make sense of a parallel distinction between two sorts of *world*. There is a "thin" conception of possible worlds as mere ways things could have been—possible specifications of all ordinary "thin" propositions—and then there is a "thick" conception of possible worlds as ways the *real world* could have been—possible specifications of the *factual* propositions.

I should spell this idea out a bit more. (Further details are included in an appendix.) For any particular kind of proposition—or **subject matter**—there are various specific ways for things to be with respect to propositions of that kind. Take the matter of *what color snow is*: the propositions that snow is white, that snow is blue, that snow is light blue, and so on. A way for this matter to be ascribes some specific color to snow. If w is a way for a certain matter P to be, then we say that a P-proposition p is **true at** w if (intuitively speaking) w is one of the specific ways for p to be true. Two P-ways **agree on** a matter Q iff each Q-proposition is true at both ways or neither. (You can, if you like, identify P-ways with certain sets of propositions—its maximal logically consistent subsets. But the important thing about them is just the theoretical role they play.)

A subject matter is a way of dividing up logical space—a way of making a certain kind of distinction between alternative scenarios, and ignoring other kinds. There are two important divisions for our purposes. First: we want to rule out physically impossible scenarios. Let's call the kind of proposition that only distinguishes between *possible* scenarios **purely possible**: a purely possible proposition is one that logically implies each physical necessity.[13] Each way for the purely possible propositions to be is a way that things *could* be. This is the thin sort of possible world, which I'll call a **possibility**. Possibilities obey the "Leibniz biconditionals" (P) and (N).

Second: for some purposes we don't want to distinguish between alternative possibilities with no genuine difference in the reality they represent. The propositions which make no invidious discriminations of this sort are the *factual* propositions. The ways for the purely possible, factual propositions to be are the thick sort of possible world—ways "the world in itself" might have been—which generally I'll call just call **possible worlds**. (I'm following Lewis's usage in keeping "possibilities", rather than "possible worlds", hooked up to (P) and (N). But this terminological choice is a bit arbitrary.)

Possibilities are more specific than possible worlds. A world settles every factual question, but mere possibilities can be even more specific than that: they can make merely "conventional" distinctions as well. Two thin possibilities may be merely "verbally different", alternative ways of representing the exact same objective reality.

We say a possibility u **represents** the (unique) possible world that says the same thing as u about each factual proposition. So this is the characteristic principle for

[13] So inconsistent propositions count as purely possible. This is a bit terminologically awkward, but technically it is really what we want, because as I discuss in the appendix, a subject matter is a Boolean algebra of propositions, and as such it should include its "bottom" element. This doesn't mean there are any "impossible possibilities".

individuating worlds:

(F) If two possibilities represent the same world then they agree on every factual proposition.

In this account, possibilities and possible worlds are devices for thinking about two different questions. We tell some story (about absolute positions, or which events are simultaneous, or which duplicate epoch you live in, or whatever). The first question is: could things have been the way the story says? If so, we have a possibility, and if two alternative stories are each possible, we have two distinct "thin" possibilities. The second question is: if things were the way one story says, would the world be *genuinely different* from the way the other story says, as opposed to merely a different way of representing what is really the same situation? In this case, we don't just have distinct possibilities, but distinct *worlds*.

(I'm not committed to anything about what internal structure worlds and possibilities might have, if any—the important thing is just their different roles. But one might take the view that the things that play the possibility-role are mathematical structures—the *models* of a physical theory. At any rate it is a common view that, like these possibilities, models stand in a many-one representation relation to physically possible worlds.[14] But the question of how best to interpret models is marginal to the issues at hand.)

Let's suppose we accept this distinction between metaphysically "thin" and "thick" propositions, and thus between metaphysically "thin" possibilities and "thick" possible worlds. This meets the first challenge, to sketch a role for possible worlds to play that makes sense of how they come apart from what is possible. With this understanding of the role of worlds, we can now meet the second challenge as well, to defend the cheapskate against Skow: it is really *distinct worlds* that matter for the shift argument, rather than mere contingency.

Skow's unworldly version of the shift argument relies on the premise (2) that shifts are not possible. How might this be defended? First there is Leibniz's own defense. Skow writes:

> Leibniz offers the principle of sufficient reason as his reason for accepting [(2)]. The principle says that all contingent facts have explanations—"nothing happens without a reason why it should be so rather than otherwise". Substantivalists who are Lewisian anti-haecceitists still accept unexplained contingencies—they still admit that it is possible for each thing to be located one foot to the left of where it actually is, at each time—no matter what they say about possible worlds. This would not have satisfied Leibniz (2007, 107).

But even those who are convinced of Leibniz's PSR shouldn't be convinced by this, if they recognise contingency in the *non-factual*. Non-factual matters shouldn't be

[14] For example, Earman speaks of models as "different modes of presentation of the same state of affairs" (See 1989, sec. 8.7, sec. 9.6).

thought of as part of the world that God creates. If there is no genuine difference between a p-world and a not-p-world, then there is no arbitrariness in God's creation—even if neither p nor not-p is necessarily true. (This might have been the thought motivating Pooley's reply to Skow.)

What about the Occamist defense? There is a good reason to reject distinctions between empirically equivalent *worlds*. The reason comes from principle (F): distinct worlds disagree on some fact. Empirically equivalent worlds agree on every empirically detectable fact, so if they are distinct, then they disagree on some *undetectable* fact. Thus a proliferation of distinct empirically equivalent *worlds*, of the sort that obey (F), means a proliferation of empirically undetectable *physical facts*. And this is the sort (or anyway, one sort) of proliferation of metaphysical commitments that Occam's Razor cuts down. On the other hand, mere contingency of *non-factual* matters—proliferation of alternative metaphysically equivalent representations that are consistent with the laws—doesn't raise any such problem. Saying "there is no fact of the matter" is a way of rejecting metaphysical commitments, not taking them on. Occam's Razor doesn't cut the non-factual, so there is no empiricist objection to mere contingency of this sort.

4 Sophisticated substantivalism?

This way of understanding cheap haecceitism about absolute position meets both challenges, and escapes Skow's objection. It says that shifts are possible, but shifted possibilities don't represent genuinely different ways for the world to be. I also think the world-role I have sketched is a pretty good candidate for what the cheapskate might be implicitly relying on in order to make sense of the difference between worlds and possibilities.[15]

But even though this kind of cheap haecceitism avoids the inference from "shifts are possible" to "there are distinct shifted worlds", it does not escape altogether. For it does *not* amount to a way of rejecting the original premise (S), that *if Newt gets things right*, there are distinct shifted worlds. The reason is that the particular theory Newt is not only committed to the possibility of shifts, but also to there really being a genuine *difference* between shifted possibilities.

I'll spell out the argument for this carefully. Recall that for a theory to get things right is for it to tell the right story both about what is physically possible and also about what the world is ultimately like: both to get the laws right and to get the facts right. I noted in Section 1 that Newt's law of motion is compatible with shifts, and thus if Newt gets the laws right then shifts are physically possible. Applying principle (P), then,

(8) If Newt gets the laws right, there are shifted physical possibilities.

[15] There are some hints at this reading, but I can't find anything very explicit. Pooley characterises the haecceitism he rejects as saying that permuting individuals produces "pairs of genuinely distinct possible worlds" (Pooley 2006, 15). Brighouse: "shifted worlds are just different ways of talking about the same world" (1994, 124).

That's the first step.

To get the *facts* right, a theory needs to describe the world in factual terms. Newt describes the world in terms of the absolute positions that particles have at particular moments. If Newt gets the facts right, then these claims should correspond to reality: they should be factual. Consider the propositions: i is at x at t (for each particle i and position x and time t). Call this matter **where things are**.[16] In short, then:

(9) If Newt gets the facts right, where things are is a factual matter.

Now consider two shifted possibilities. These tell different stories about where things are: they give different answers to every question about the absolute position of a particular particle at a particular time. If one of them says that i is at x at t, the other says i is instead at $d + x$ at t. If these propositions are *factual*, then the possibilities disagree on a factual matter. This implies, by (F), that they represent distinct possible worlds. That's the second step.

Summing up:

(8) If Newt gets the laws right, there are shifted possibilities.

(9) If Newt gets the facts right, where things are is a factual matter.

(10) Shifted possibilities disagree on where things are.

(F) If possibilities disagree on a factual matter, they represent distinct worlds.

(S) So if Newt gets the laws right and Newt gets the facts right, there are distinct shifted worlds.

The **Newtonian substantivalist** says there are absolute position facts: *where things are is a factual matter*. But this implies that a difference in where things are is a genuine metaphysical difference, and thus a genuine difference between worlds, in the sense that sets them apart from mere possibilities.

Cheap haecceitism, spelled out the way I have suggested, says that shifts are possible, but they don't represent genuinely different ways for the world to be. This amounts to *metaphysical* anti-haecceitism about space:[17] it implies that there are no genuine facts about where particular things are at particular times. And so it implies that Newt really doesn't get the facts right, because Newtonian substantivalism is wrong. This looks like an unwanted conclusion: after all, the cheapskates are called "sophisticated substantivalists", and have seen their anti-haecceitism as a way of *avoiding* the shift argument, not conceding its conclusion.[18]

Despite this appearance, some "sophisticated substantivalists" may really be happy to accept metaphysical anti-haecceitism, and thus reject Newtonian substantivalism

[16] More precisely, the subject matter is the smallest Boolean algebra of propositions that includes these propositions.

[17] In essentially the sense of (Fine 2005). Compare Dasgupta's "generalism" (2009).

[18] A complication I am ignoring is that for other reasons—the so-called "kinematic shift"—even in the context of Newtonian physics most sophisticates don't accept the absolute enduring locations of Newt, but rather absolute *space-time* locations. (And in other contexts, the facts in question would not concern the absolute positions of particles but rather field values at particular positions.) But parallel considerations apply.

as I have framed it. This fits with some of their writings—Pooley is the most explicit: "Facts about the world are exhausted by purely general facts. The way the world is, fundamentally speaking, is purely qualitative" (manuscript, sec. 3.3.3). The absolute position facts I have been discussing—*i* is at *x* at *t*—are *singular* facts about the positions of particular things at particular times, so evidently Pooley rejects them. These facts are central to Newt's characterisation of the physical world. So evidently Pooley rejects the metaphysical adequacy of Newt, as well.

I tend to think of metaphysical views that reject commitments to absolute spatial positions of particular things as kinds of relationism, broadly speaking, rather than substantivalism.[19] But the label is not worth arguing over. (Dasgupta finesses the issue by distinguishing "thick" and "thin" substantivalism.) Whatever label we give them, the rejecters face the same challenge as relationists: to find some alternative empirically adequate theory of space without those commitments. Neither Newt nor anything like it avoids them. And Dasgupta persuasively makes the case that nothing the sophisticates have said amounts to a serious alternative theory (2011, sec. 5). He also offers some promising gestures in the direction of an account of space-time that dispenses with particular absolute positions, but so far (as he acknowledges) nothing that amounts to a worked-out theory (sec. 10–11).

The puzzling thing is, if the sophisticates are really in this camp, why they haven't seemed to appreciate the challenge to produce an alternative theory. Indeed, rather than taking up the relationist's burden, the sophisticates seem to reaffirm what looks like exactly the sort of commitment that gets Newt into trouble ("a commitment to the real existence of space and its parts … as concrete, *basic* entities in the world" (Pooley, manuscript, sec. 3.3.1, original emphasis)). So I'm not sure what they have in mind. I have offered a view that makes sense of many of the things sophisticates want to say about shifts and possible worlds. But this view does not escape the shift argument's conclusion, and sustaining the view requires revisionary metaphysics that does without facts about where things are.

Perhaps the sophisticates simply haven't appreciated the consequences of their view. But another option is that they don't understand worlds in the way I have suggested—as tracking differences in genuine facts. Of course, if they are cheapskates, then they also can't think of worlds as mere *possibilities*, the things that obey (P) and (N). On that conception, it is incoherent to say that things could have been shifted, but there aren't shifted possibilities. So, unless they are to fall to Skow's objection,

[19] For what it's worth, Earman does too—the cheapskate as I understand her says the same thing as Earman's relationist in this passage, with possibilities standing in for "pictures":

> If it works, Leibniz's argument shows that the substantivalist provides a phony picture of physical reality, but the phoniness is not that of a doctored photograph that shows the cat on the mat when it is really on the sofa. Rather, the substantivalist picture provides an accurate rendering or representation of reality, but the representation relation is one-many, with many (indeed, uncountably many) substantivalist pictures corresponding to the same relationist reality. Mistakenly thinking that the correspondence between his picture and reality is one-to-one rather than many-one leads the substantivalist into problems …(1989, 120; see also 170–173).

they must be relying on some other conception of the role of worlds, as distinct from mere possibilities. The last thing I'll do is briefly examine a few other candidate views, and argue that they don't meet the sophisticates' needs.

5 Other anti-haecceitisms

Perhaps the sophisticates' "possible worlds" involve a distinction not between two kinds of proposition, but rather between two kinds of *possibility*. The idea is that while shifts are possible in some "thin" way, even so they fall short of being possible in the full-fledged "thick" way.[20]

The thought would have to be that the kind of possibility that shifts enjoy is different from the kind which is used in motivating premise (D), that shifted worlds are empirically equivalent. Recall that it was crucial to (D) that shifts are symmetries of the laws: they preserve physical possibility and thus don't interfere with physical explanations of the phenomena. So the kind of possibility which is relevant to (D) is the kind that our physical theories aim to describe by stating laws.

This means that if shifts aren't really possible in this way, then Newt does not succeed at describing what is genuinely physically possible: Newt does not get the laws right. So it looks to me like this too amounts to accepting the conclusion of the shift argument—but in an importantly different way from either the relationist or the metaphysical anti-haecceitist. This view doesn't require revision of Newt's metaphysical account of spatial structure. Instead it requires some alternative account of what is physically possible, in the "thick" sense involved in physical laws and explanations. I'll consider three ways this alternative account might go.

One thought is that physical laws ought to be purely general, rather than involving singular necessities. Newt's law of motion is *de re*. The theory begins with an ontological preamble—there are positions, times, and particles, with certain structure—and then it goes on to the law of motion: necessarily, those things satisfy a certain dynamical condition, $F = ma$. In this account the ontology takes wide scope over the laws. But one might think this is the wrong way around: maybe the laws should take wide scope over the ontology instead. A revised system would say: necessarily, there are positions, times, and particles, which have certain structure and satisfy the dynamical condition. This version makes no requirement that it is the *same* positions, times, and particles in each situation.

[20] This would make sense of the way that some sophisticates seem to waver between different modal doctrines. For instance, Carl Hoefer writes: "Contingency [does not guarantee] that we need accept a genuine possibility distinct from the initial situation" (Hoefer 1996, 18). But also: "It is true that Clarke conceded to Leibniz that the world could have been created just as it is, but moved over three feet in space … My claim is that Clarke should not have conceded this" (19–20). Similarly Maudlin (not a true cheapskate, but his view belongs in the same family) writes: "The substantivalist would evidently deny that, strictly speaking, this very space-time could have had different spatio-temporal properties". But he goes on: "It is quite open to the substantivalist to be a counterpart theorist about the counterfactual locutions that physicists are wont to use," so there is some sense in which he admits the possibilities after all (Maudlin 1990, 550).

But if this is all the laws say, then they are extremely liberal about singular possibilities. It is consistent with a law of this form for any object to have any possible qualitative profile whatsoever. This is not anti-haecceitism, but **extreme haecceitism**.[21] In particular: this view still says that shifts are physically possible—and in fact, so are arbitrary geometric jumbles of points, or for positions to swap roles with particles. We might still say we conventionally *ignore* some of these possibilities in most circumstances.[22] But this view is not a way of escaping the shift argument. Purely general laws put even weaker constraints on absolute positions than Newt's, so they make it even harder to see how things' absolute positions could be detectable in principle. In the extreme haecceitist revision, absolute positions dangle even looser than in Newt.

A second way to revise Newt is in the opposite direction: not by stripping down its *de re* commitments, but by strengthening them. One way of doing this is to say that spatial positions have their occupation properties essentially: for each i and x and t, either it is necessary that i is at x at t, or it is necessary that i is *not* at x at t.[23] This will have to be combined with the view that it is contingent *which* absolute positions there are (as in the extreme haecceitist version), or else this theory would rule out all physical contingency whatsoever. This theory rules out the physical possibility of shifts: it says that if a particle i is at x, then it *couldn't* have been at the position $d + x$—though it *could* have had a position which isn't spatially related to x at all. Insofar as we want to say that, in some sense, i *could* have been displaced from where it is, we'll have to gloss this in terms of counterparts.

I have no knock-down argument against the essentialist revision, but there are a few reasons it doesn't seem very attractive.

Shifts show us that there is a mismatch between Newt's account of the laws and its account of the facts—its facts outrun its laws, in that some of its facts vary under empirical symmetries. This mismatch offends against parsimony. Eliminating these facts would restore balance and remove the offense. But it only adds to the offense to instead tack on new laws that don't have shifts as symmetries. To be sure, this would also restore a kind of balance, ensuring that the facts in question don't vary under symmetries of the laws—but only by matching the excessive complexity of the facts with further complexity in the laws (that is, in the physical necessities). I have no objection to essentialist principles as such, but in this case they don't seem well-

[21] In the sense of (Lewis 1986, 239). (Except it is a doctrine about what is possible, while Lewis's version is framed as a doctrine about possible worlds—particularly worlds of Lewis's idiosyncratic kind.)

[22] Compare Lewis:

> Both [my theory and extreme haecceitism] begin by acknowledging quite a wide range of possibilities, and afterward cut down the range by accessibility restrictions. Thus I don't deny that poached eggs are genuine possibilities—it's just that they're inaccessible for the likes of us, in other words they're not among our counterparts (243).

[23] This version is anti-haecceitist about what is physically possible: that is, it says that it is impossible for things to be qualitatively the same but individualistically different. This is, for instance, Skow's (2007, 100) preferred sense of "anti-haecceitism". (Except he is talking about metaphysical possibility.) This view about space is basically the classical analogue of Maudlin's essentialist response to the "hole" argument in the general relativistic context (1990).

motivated. Unlike the law of motion, these extra necessary principles don't play any natural role in physical explanations. Thus they don't make it plausible that absolute positions really are detectable in principle.

At a more abstract level, shifts show us that Newt has an equivalence class of possibilities where just one possibility would empirically suffice. The essentialist fix is to pick a single member to do duty for the whole equivalence class. But this just feels arbitrary. It seems more natural to say that there is no genuine distinction being made among the equivalent alternatives, rather than to admit the distinction and privilege one of the possibilities.[24]

One final version is worth considering. Rather than saying the laws are more permissive than Newt about singular possibility, or that they are more demanding, one might want to say that there are just *no facts* about singular physical possibility. According to this view, the laws are purely general in that physical possibility and impossibility are only really "meaningful" for general propositions, in the first instance.

This way of understanding the sophisticates is strongly suggested by their common rejection of *trans-world identity*. What does this rejection amount to? One could understand it as simply denying that any individual exists at more than one possibility. But it is natural to follow David Kaplan when he observes, "that view is properly reserved for the Haecceitist who holds to an unusually rigid brand of metaphysical determinism" (1975, 723)—like the essentialist we just considered. A different way of taking it, the view Kaplan originally called "anti-Haecceitisim", denies that trans-world identity even makes sense: "there is no notion of trans-world being" (723). In Kaplan's terms, the view is that the overlap between the domains of individuals at different possibilities is "an artifact of the model" we use to represent what is possible rather than "a feature of the metaphysical reality being modeled", that is, what is genuinely possible (722). Or as Kit Fine puts it, "anti-Haecceitism … states that the identity or non-identity of individuals in distinct possible worlds is a matter of convention" (1978, 125; see also 2005). If possible worlds correspond to what is possible in the traditional way, then Fine's technical results show that the thought that trans-world identity isn't meaningful lines up with the thought that *de re possibility* isn't meaningful. The things you might say that turn on which trans-world identities hold are the very same things that turn on what is possible for particular individuals (at least in the language of first-order quantified modal logic).

So perhaps it is best to understand the cheapskates as advocating *this* kind of anti-haecceitism: conventionalism about *de re* modality. Now, when applied to physical possibility, I don't see the appeal of the view. Physics teaches us about the nature of physical things. Some philosophers understand physical possibility as fundamentally resting on objects' "essences" or "powers", where these are thought of as something

[24]The essentialist fix is analogous to gauge-fixing. Take the simple case of the potential field in classical electro-magnetism. This varies under a gauge symmetry: different physically possible potentials are empirically equivalent. One way to compensate for this would be to posit an extra physical necessity (for instance, that the potential essentially has a certain divergence). But while gauge-fixing is helpful for calculations, as metaphysics it seems obviously worse than the standard response, which is to say that the genuine facts are *gauge-invariant* facts about the electro-magnetic field, rather than the potential.

that cuts finer than just how they must or can be. Anyone who accepts that sort of view should accept the basic point that *de re* physical necessity is part of the realm of scientific inquiry. I don't accept that sort of view—I am thinking mainly of the *laws* as our primary tool of physical explanation rather than either of these alternatives. But even so, I do think the laws give us insight into the nature or essence or powers of the physical world and its parts at least in the coarse-grained sense of what is physically possible for them. Certainly (if we take physical possibility seriously at all) laws at least constrain the possible distribution of masses and distances and that sort of thing. But if physics gives us this kind of insight into the natures of physical properties and relations, what is so special about physical *individuals*, that the laws must be silent about them? One possible answer is that there aren't any facts about such things for the laws to govern. But if we have ruled that answer out, I don't see why we should think singular physical possibility makes any less sense than qualitative possibility.

Still, regardless of its other merits, it's hard to see how conventionalism about singular physical possibility helps as a reply to the shift argument. It's true that if there are no objective facts about singular possibility, then we can't straightforwardly say that shifts are a symmetry of the laws—that they take physical possibilities to physical possibilities. But while this escapes the letter of the undetectability argument for (D), it doesn't escape the spirit. The reason we can't say shifts are a symmetry of the laws is not because there is some causal-explanatory *difference* between shifted worlds—the sort of difference that might make it possible in principle to detect where things are in absolute space. On the contrary, since the laws are silent about the positions of particular things, these positions don't figure into straightforward physical explanations at all. *De re* conventionalism makes it no easier for absolute positions to have a role in explaining the phenomena: nomic *silence* about where things are is just as unhelpful as nomic contingency. So according to this view, absolute positions remain empirically idle superfluous structure—and it is still better to eliminate them, if we can.

None of these three ways of modally revising Newt seems to help. The shiftiness of where things are doesn't call for a different account of physical modality, but rather a better metaphysical account of spatial structure.

A Ways for matters to be

Here I'll explicate some structural features of my account of possibilities and possible worlds: the logical structure of subject matters, the existence and uniqueness of ways for them to be, and the way in which the relation between possibilities and possible worlds arises from from logical features of factuality and possibility. In particular this provides some context and formal justification for the principles (P) and (N) for possibilities and (F) for worlds (in Section 2 and Section 3). Underlying this apparatus is an important mathematical pattern of correspondences called Stone duality. The traditional theory of possible worlds rests on one part of this duality: if propositions form a Boolean algebra, they can be represented as sets of worlds. But the pattern is more general, and has wider applications (see Koppelberg 1989, secs. 2 and 7).

A **subject matter** is a **Boolean algebra of propositions**: a set of propositions closed under operations of conjunction and negation, where these obey certain identities given by classical propositional logic.[25] (For instance, the double-negation of a proposition is the very same proposition. If you think of propositions as finer-grained than this, you can take me to be discussing equivalence classes of the finer-grained propositions up to Boolean equivalence.) In general when I use logical words like "consistent" I mean them in the narrow sense of Boolean logic.

Let P be a subject matter. **Ways for P to be** are a set W with a **truth** relation between P and W with the following properties:

(11) $\neg p$ is true at w iff p is not true at w

(12) $p \wedge q$ is true at w iff p and q are both true at w

(13) $v = w$ iff v and w agree on P

The last condition is an individuation principle: for v and w to be the *same* way for P to be is for the very same P-propositions to be true at v as at w. Stone's theorem tells us that for each subject matter P there is a set of ways for P to be, and it is "unique up to unique isomorphism": if W and W' are both sets of ways for P to be, then there is a unique bijection $f : W \to W'$ such that p is true at w iff p is true at $f(w)$. (The usual way to construct these "ways" is as ultrafilters: maximal logically consistent subsets of P.) Let $W(P)$ be the set of ways for P to be.

Relations between subject matters correspond to "dual" relations between the ways for them to be. Suppose P and Q are subject matters, and $f : P \to Q$ is a **homomorphism**—a function that respects their logical structure, in that it takes negations to negations and conjunctions to conjunctions. Then Stone duality also tells us that there is a unique function $f^* : W(Q) \to W(P)$, the **dual** of f, such that for $p \in P$ and $w \in W(Q)$,

(14) $f(p)$ is true at w iff p is true at $f^*(w)$

In the context of a correspondence like this, it makes sense to count p as true at $w \in W(Q)$ iff $f(p)$ is true at w, or equivalently, p is true at $f^*(w)$. Then these three principles fall out of (11), (12), and (13):

(P*) For $p \in P$, p is true at some $w \in W(Q)$ iff $f(p)$ is consistent

(N*) For $p \in P$, p is true at every $w \in W(Q)$ iff $f(\neg p)$ is inconsistent

(F*) For $v, w \in W(Q)$, $f^*(v) = f^*(w)$ iff v and w agree on P

The structure of possibilities and worlds both come from this duality, in two different ways.

Let's first consider where possibilities come from. The *possible* propositions are not a subject matter in my sense. (They are not closed under negation or conjunction.)

[25] Similar results also apply under weaker conditions, in particular for lattices without classical negation. This may be important if non-factual propositions violate the law of excluded middle, as Field (2003) argues. But I won't pursue it.

But there is a natural way of using possibility to come up with a subject matter. If Prop is the algebra of all propositions, and n is the logically strongest necessary proposition (the conjunction of all of the laws), then let Prop/n be the set of conjunctions $p \wedge n$ for $p \in$ Prop—what in Section 3 I called the *purely possible* propositions. These form a Boolean algebra, using the "inner negation" that takes $p \wedge n$ to $\neg p \wedge n$. The function that takes p to $p \wedge n$ is a homomorphism from Prop to Prop/n.

This is an example of a general kind of relation between subject matters: a **quotient map** from Prop to Prop/n. Looking at the original space of propositions, we ignore certain distinctions: all the propositions which are inconsistent with n are wiped out, and so propositions that only differ in ways that are physically impossible—propositions which are necessarily equivalent—are blurred together. In general we can produce a quotient algebra using any **congruence** relation—an equivalence relation of propositions such that the Boolean operations take equivalents to equivalents, like the relation of necessary equivalence. It is natural to think of quotients as *conditional* subject matters: Prop/n is how things are conditional on the physical laws.

Here is another fact of Stone duality: *quotients are dual to embeddings*. That is, if $f : P \to Q$ is a quotient map, then $f^* : W(Q) \to W(P)$ is one-to-one. Effectively, we can identify ways for Q to be with some subset of the ways for P to be. In the case at hand, the ways for the purely possible propositions to be—the *possibilities*—naturally correspond one-to-one with a subset of the ways for *all* propositions to be—namely, those at which n is true. Furthermore, we can see that the principles (P) and (N) for possibilities are the special cases for this quotient map of (P*) and (N*) (since p is possible iff $p \wedge n$ is consistent, and p is necessary iff $\neg p \wedge n$ is inconsistent).

Next let's consider the *factual* propositions. Unlike the possible propositions, it is natural to suppose that these are closed under Boolean connectives: if it is a matter of genuine fact whether p, and whether q, then the same goes for $\neg p$ and $p \wedge q$. So the set of factual propositions Fact is a subject matter which is a *subalgebra* of Prop. To put it a bit more generally, there is a one-to-one homomorphism—an **embedding**—from the factual propositions into Prop. (In this case it is the identity function.) Intuitively, if P is embedded in Q, this means that P is a coarser-grained, less specific matter than Q; P is *settled* by Q.

A final fact of Stone duality is that *embeddings are dual to quotients*. That is, if $f : P \to Q$ is an embedding, then $f^* : W(Q) \to W(P)$ is a quotient map, in the sense that each $w \in W(P)$ corresponds to an equivalence class of ways for Q to be—those which agree on P.[26] Intuitively, since Q is more specific than P, each way for Q to be simply adds some extra detail to some particular way for P to be. The P-ways result from blurring away this extra detail from the more specific Q-ways. In the case at hand, since Fact is embedded in Prop, the ways for the factual propositions to be—the *worlds*—are a quotient of the ways for Prop to be. Each way for Prop to be represents some world, and the principle (F*) says that two Prop-ways represent the

[26] This links my discussion of subject matters as algebras with a version that is more prevalent in the literature, as equivalence relations (or partitions) on the set of possible worlds (Hamblin 1958; Lewis 1998).

same world iff they agree on every factual proposition.

So far we have considered separately what is possible and what is factual, and the corresponding notions of a *possibility* and of a *world*. *Possible worlds* arise from taking both of these together. The *possible facts* conditionalize the factual propositions on the laws: this is the subject matter Fact/n of factual propositions up to necessary equivalence. The ways for Fact/n to be are the *possible worlds*. The possible facts are a quotient of the factual propositions, so the possible worlds can be identified with a subset of the mere worlds—those which are possible. The possible facts can also be embedded as a subalgebra of the purely possible propositions—those purely possible propositions which are factual. (I am assuming that n is itself factual.) So the possible worlds can also be identified with equivalence classes of the mere possibilities. (These two ways of thinking about them are isomorphic.) Note finally that the principle (F) is a special case of (F*) (where f is the embedding of Fact/n into Prop/n).

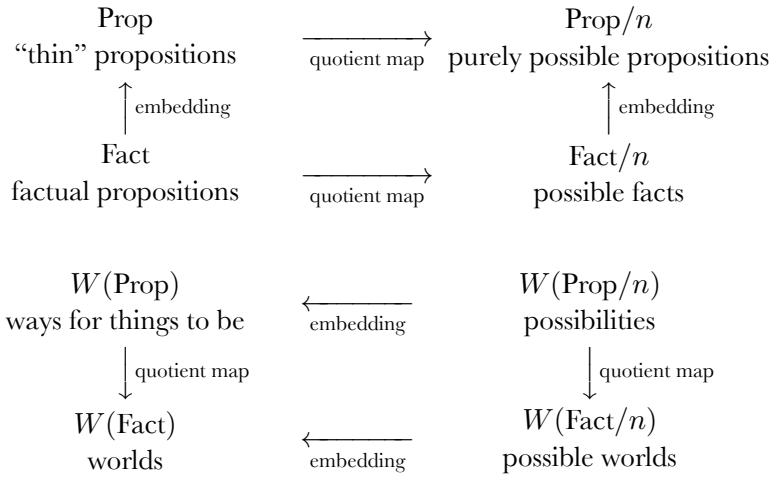

Figure 1: Relationships between different kinds of propositions and the ways for them to be.

References

Arntzenius, Frank. 2012. *Space, Time, and Stuff.* Oxford University Press.

Brighouse, Carolyn. 1994. Spacetime and holes. *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association* (Jan.): 117–125. doi:10.2307/193017.

Butterfield, Jeremy. 1989. The Hole Truth. *British Journal for the Philosophy of Science* 40 (1): 1–28.

Dasgupta, Shamik. 2009. Individuals: An Essay in Revisionary Metaphysics. *Philosophical Studies* 145 (1): 35–67.

Dasgupta, Shamik. 2011. The Bare Necessities. *Philosophical Perspectives* 25, no. 1 (Dec.): 115–160. doi:10.1111/j.1520-8583.2011.00210.x.

Dreier, James. 2004. Meta-Ethics and The Problem of Creeping Minimalism. *Philosophical Perspectives* 18, no. 1 (Nov.): 23–44.

Earman, John. 1989. *World Enough and Space-Time: Absolute versus Relational Theories of Space and Time*. Cambridge: MIT Press.

Earman, John, and John Norton. 1987. What Price Spacetime Substantivalism? The Hole Story. *The British Journal for the Philosophy of Science* 38 (4): 515–525.

Field, Hartry. 1994. Disquotational Truth and Factually Defective Discourse. *The Philosophical Review* 103 (3): 405–452.

———. 2003. No Fact of the Matter. *Australasian Journal of Philosophy* 81, no. 4 (Dec.): 457–480. doi:10.1080/713659756.

Fine, Kit. 1978. Model Theory for Modal Logic Part I—The De Re/De Dicto Distinction. *Journal of Philosophical Logic* 7, no. 1 (Jan.): 125–156.

———. 2001. The Question of Realism. *Philosophers' Imprint* 1 (1).

———. 2005. Reference, Essence, and Identity. Chap. 1 in *Modality and tense: philosophical papers*, 19–40. Oxford: Clarendon Press.

Friedman, Michael. 1986. *Foundations of Space-Time Theories: Relativistic Physics and Philosophy of Science*. Princeton University Press.

Hamblin, C. L. 1958. Questions. *Australasian Journal of Philosophy* 36, no. 3 (Dec.): 159–168.

Healey, Richard. 2001. On the reality of gauge potentials. *Philosophy of Science* 68 (4): 432–455.

Hoefer, Carl. 1996. The Metaphysics of Space-Time Substantivalism. *Journal of Philosophy* 93 (1): 5–27.

van Inwagen, Peter. 1995. The Place of Chance in a World Sustained by God. In *God, Knowledge, and Mystery: Essays in Philosophical Theology*, 104–123. Ithaca: Cornell University Press.

Kaplan, David. 1975. How to Russell a Frege-church. *Journal of Philosophy* 72 (19): 716–729.

Koppelberg, Sabine. 1989. *Handbook of Boolean Algebras*. Ed. J. Donald Monk and Robert Bonnet. Amsterdam: North Holland.

Leibniz, G. W., and Samuel Clarke. 2000. *Correspondence*. Ed. Roger Ariew. Indianapolis: Hackett Publishing Company.

Lewis, David K. 1986. *On the Plurality of Worlds*. Oxford: Blackwell.

Lewis, David K. 1998. Relevant Implication. *Theoria* 54, no. 3 (Dec.): 161–174.

Maidens, Anna. 1992. Review. *British Journal for the Philosophy of Science* 43 (1).

Maudlin, Tim. 1990. Substances and Space-Time: What Aristotle Would Have Said to Einstein. *Studies in History and Philosophy of Science* 21, no. 4 (Dec.): 531–561.

———. 1993. Buckets of Water and Waves of Space: Why Spacetime Is Probably a Substance. *Philosophy of Science* 60, no. 2 (June): 183–203.

———. 2002. Remarks on the passing of time [in English]. *Proceedings of the Aristotelian Society* 102:pp. 259–274. http://www.jstor.org/stable/4545373.

———. 2012. *Philosophy of physics: space and time* [in English]. Princeton: Princeton University Press. ISBN: 0691143099 9780691143095.

McGee, Vann, and Brian McLaughlin. 2000. The Lessons of the Many. *Philosophical Topics* 28 (1): 129–151.

Newton, Isaac. 2004. Principia. In *Philosophical writings,* ed. Andrew Janiak, 40–93. Cambridge University Press.

Pooley, Oliver. 2006. Points, Particles, and Structural Realism. In *Structural foundations of quantum gravity,* ed. Dean Rickles, Steven French, and Juha Saatsi, 83–120. Oxford University Press.

———. manuscript. The reality of spacetime.

Roberts, J. T. 2008. A Puzzle About Laws, Symmetries, and Measurable Quantities. *British Journal for the Philosophy of Science* 59 (2): 143–168.

Russell, Jeffrey Sanford. forthcoming. Possible worlds and the objective world. *Philosophy and Phenomenological Research.*

Saunders, Simon. 1995. Time, quantum mechanics, and decoherence [in English]. *Synthese* 102 (2): 235–266. ISSN: 0039-7857, doi:10.1007/BF01089802, http://dx.doi.org/10.1007/BF01089802.

Sider, Theodore. 2012. *Writing the Book of the World.* Oxford University Press.

Sklar, Lawrence. 1977. *Space, Time, and Spacetime.* 1st paperb. Berkeley: University of California.

Skow, Bradford. 2007. Haecceitism, Anti-Haecceitism and Possible Worlds. *The Philosophical Quarterly* 58 (230): 98–107.

Williamson, Timothy. 1996. *Vagueness.* New York: Routledge.