Lawful Persistence*

David Builes and Trevor Teitel

Penultimate Draft of Feb 15, 2022

Forthcoming in *Philosophical Perspectives*

Abstract

The central aim of this paper is to use a particular view about how the laws of nature govern the evolution of our universe in order to develop and evaluate the two main competing options in the metaphysics of persistence, namely endurantism and perdurantism. We begin by motivating the view that our laws of nature dictate not only qualitative facts about the future, but also which objects will instantiate which qualitative properties. We then show that both traditional doctrines in the metaphysics of persistence must take on surprising further commitments in order to vindicate our universe being law-governed in this strong sense. For example, we argue that endurantists should adopt a particular version of monism, and that perdurantists should adopt a qualitativist doctrine that dispenses with all individuals at the fundamental level.

1. Introduction

All of our best physical theories, from Newtonian Mechanics to Quantum Field Theory, seem to imply that our world evolves in a regular, law-governed way. Either the future is fully determined by the past, or else the chances of future events are fully determined by the past. However, on closer inspection, it turns out that *none* of our best physical theories, at least on its own, constrains the future in such a strong way. Our physical theories only secure the truth values (or chances) of certain qualitative propositions (those not about any particular objects) concerning the future on the basis of the past. Because the laws of these theories are purely qualitative, for all these physical theories say there might be all sorts of hidden irregularities concerning the evolution of non-qualitative features of the universe. The evolution of the universe might be much more chaotic and irregular than we thought.

* The authors are listed alphabetically: we contributed equally to the paper. For very helpful comments and discussion, we'd like to thank Mark Balaguer, Michael Caie, Ezra Rubenstein, Ted Sider, as well as audiences at MIT and Princeton.

We'll begin by making the distinction between qualitative and non-qualitative regularities more precise. We'll then motivate the view that our universe is law-governed in both of these respects. Our central aim in what follows is to use this strong notion of being law-governed in order to develop and evaluate the two main options in the debate over the metaphysics of persistence, namely endurantism and perdurantism. We'll see that each of these views must take on surprising further commitments in order to vindicate the non-qualitative regularity of the universe. For example, we'll see that arguably perdurantists must also adopt a qualitativist doctrine that eschews individuals at the fundamental level, and that endurantists have reason to adopt a particular version of monism. Our central goal in what follows is to develop and assess the best endurantist and perdurantist packages of views that secure the non-qualitative regularity of the universe. Our hope is that developing and assessing these competing views will serve to advance what currently feels like a dead-locked debate between endurantists and perdurantists.

What are these two positions? Numerous definitions are out there, and the details can get quite delicate. Perdurantists hold that the fundamental individuals are instantaneous temporal stages, each of which exists at only a single time. Facts about how objects persist across time hold in virtue of facts concerning certain sequences of such instantaneous stages.[1] Endurantism, by contrast, countenances fundamental individuals that exist at multiple times, and are wholly present whenever they exist. For our purposes, just these minimal characterizations of the views will suffice. How to state a precise positive vision behind endurantism is hotly contested: some appeal to a primitive notion of exact location, and others cash out the theory by appealing to presentism, among other options.[2] Fortunately, we need

[1] There is a third position in the metaphysics of persistence, sometimes called "exdurantism" or "stage theory," which agrees with perdurantism on these two points. The main disagreement between stage theory and perdurantism concerns whether ordinary English words like 'table' and 'banana' refer to three-dimensional objects or four-dimensional objects. However, their fundamental ontology is the same. Because their fundamental ontology is the same, all of our arguments concerning perdurantism apply equally well to the stage theory.

[2] See Sider (2001) for a canonical definition of the two views. See Merricks (1995) for an alternative, which ties endurantism to presentism. See Magidor (2016) for a critical overview of the traditional arguments in the debate, and an argument that they often fail to distinguish the two views. We take our arguments to avoid this worry.

not take a stand on this issue here: our arguments will not turn on the details of how precisely these two competing views get characterized.

One last preliminary before we get going. Throughout, we'll be restricting our attention to the fundamental facts that are described by our best physical theories (e.g. those about particles, spacetime points, or perhaps the universe as a whole). We won't be considering facts about ordinary macroscopic objects like tables or chairs, whatever these facts turn out to amount to. Given the standard view that non-fundamental facts supervene on fundamental facts, this restriction won't affect any of our arguments. If the laws of physics, together with the past, determine the truth value (or chance) of every fundamental qualitative fact, they will also determine the truth value (or chance) of every non-fundamental qualitative fact. After all, qualitative non-fundamental facts supervene on qualitative fundamental facts. Moreover, if the laws of physics, together with the past, determine the truth value (or chance) of *every* fundamental fact, they will also determine the truth value (or chance) of every non-fundamental fact. Every non-fundamental fact, whether it's qualitative or not, supervenes on the totality of fundamental facts.[3]

2. How Might Laws Govern?

Let us start by defining the various respects in which our universe might be law-governed.[4] Distinguish *qualitative* propositions, which aren't about any particular objects, from all of the rest (which we'll interchangeably call *haecceitistic* or *non-qualitative* propositions). For example, the proposition that someone is standing is qualitative, but the proposition that Larry is standing is haecceitistic. Call a property *F* qualitative just in case the proposition that something has *F* is qualitative; call all other properties non-qualitative or haecceitistic (e.g. the property of *being Alice* is non-qualitative, but the property of *being red* is qualitative).

[3] Hawthorne (2006) argues against full determinism (determinism with respect to both qualitative and non-qualitative facts) by reference to ordinary macroscopic objects. Since we are inclined to accept full determinism for fundamental facts, as well as the claim that non-fundamental facts supervene on fundamental facts, we are inclined to *modus tollens* these arguments, by construing them as arguments against the existence of ordinary macroscopic objects.

[4] The definitions in this section closely mirror and build on those in Teitel (2019).

We will also need the notion of two worlds being *qualitative time-slice duplicates*. For any world w, let a *temporal foliation* of w be a function t_w defined on a subset of $\mathbb{R}$, such that, (i) for every real number r in its domain, $t_w(r)$ is some time-slice of w, (ii) for any real numbers r and r' in t_w's domain, where $r > r'$, $t_w(r)$ is r-r' units of time after $t_w(r')$, and (iii) for every time-slice of w, there exists some r such that $t_w(r)$ is identical to that time-slice. Utilizing this definition, we may say that w and w' are qualitative time-slice duplicates just in case there exist temporal foliations t_w and $t_{w'}$ of w and w' that are defined on the same subset of $\mathbb{R}$, such that for every real number r in the domains of t_w and $t_{w'}$, $t_w(r)$ and $t_{w'}(r')$ have all of the same qualitative intrinsic properties.[5]

With these definitions in hand, we can formulate two notions of determinism:

> **Full Determinism**: For all metaphysical possibilities w and w' where L is true, if there is a time t at both w and w' such that the history of w up to t has the same intrinsic properties as the history of w' up to t, then w and w' agree on the truth value of every proposition.
>
> **Qualitative Determinism**: For all metaphysical possibilities w and w' where L is true, if there is a time t at w and a time t' at w' such that the history of w up to t has the same *qualitative* intrinsic properties as the history of w' up to t', then w and w' are qualitative time-slice duplicates.[6]

---

[5] In this paragraph and in the definitions to follow we are taking for granted that the worlds at issue can be foliated into times. In doing so we are ignoring certain general relativistic worlds that don't admit of anything like a Cauchy surface (the natural analogue of a time in a relativistic setting), as is common in discussions of the hole argument. Relativistic worlds that can be foliated into times of course admit of infinitely many such foliations. The definitions that follow still work as intended at such worlds.

[6] Determinism, in either its full or qualitative guise, is often formulated so as to be time-symmetric rather than future directed (see, for example, Teitel 2019, 353). We formulate determinism in a time-asymmetric way in order to have analogous definitions concerning stochastic laws, which are not time-symmetric. Still, none of our arguments below will crucially turn on this choice-point when defining determinism. For further discussion of distinctions analogous to qualitative vs. full determinism, see Belot (1995), Brighouse (1997), and Melia (1999).

One might be wondering why we didn't end our definition of qualitative determinism by requiring that *w* and *w'* be qualitative duplicates *simpliciter*. We intentionally avoided this stronger formulation because empirical evidence for our best physical theories on its own does not support it. We will discuss this point in detail in section 3.

An analogous distinction can be drawn in the case of stochastic laws. Following Lewis (1980), we will take fundamental chances to be relative to a time. For example, the chance in 2020 that a particular tritium atom will decay by 2030 is some non-trivial value between 0 and 1, but the chance in 2040 that that particular tritium atom decayed by 2030 is either 0 or 1. The *t*-chance of some proposition P is simply the chance at *t* that P is true. We also need some new definitions. Let a *qualitative time-slice profile* be a maximal qualitative intrinsic property that could be instantiated by a time-slice of some world.[7] Now, for any qualitative time-slice profile *P*, time *t*, and real number *r*, let $P_{t,r}$ be the proposition that the time-slice *r* units of time after *t* instantiates *P*.

We can now draw the following distinction:

> **Full Stochasticity**: For all metaphysical possibilities *w* and *w′* where *L* is true, and for all times *t*, if (i) *t* exists at both *w* and *w′* and (ii) the history of *w* up to *t* has the same intrinsic properties as the history of *w′* up to *t*, then *w* and *w′* agree on the *t*-chance of every proposition.
>
> **Qualitative Stochasticity**: For all metaphysical possibilities *w* and *w′* where *L* is true, and for all times *t* and *t′*, if (i) *t* exists at *w* and (ii) *t′* exists at *w′* and (iii) the history of *w* up to *t* has the same *qualitative* intrinsic properties as the history of *w′* up to *t′*, then, for all qualitative time-slice profiles *P*, and all real numbers *r*, the *t*-chance at *w* of $P_{t,r}$ is equal to the *t'*-chance at *w'* of $P_{t',r}$.

[7] P is a maximal qualitative intrinsic property of x if and only if P is a qualitative intrinsic property of x, and, for every qualitative intrinsic property Q, that x is P metaphysically necessitates that x is Q, or that x is P metaphysically necessitates that it's not the case that x is Q.

For convenience, we will say that a world is *fully lawful* iff its laws satisfy either full determinism or full stochasticity, and we will say that a world is *qualitatively lawful* iff its laws satisfy either qualitative determinism or qualitative stochasticity. As alluded to above, we have strong empirical reasons for believing that our world is qualitatively lawful. However, there is reason to think that it might not be fully lawful, because all candidate laws of nature are qualitative propositions. This possibility has been extensively discussed in the literature on the hole argument, which purports to show that General Relativity (GR) fails to be fully deterministic, because GR's laws fail to fix haecceitistic propositions about which particular spacetime points have which field values. Responses to the argument generally seek a doctrine in the metaphysics of spacetime or modality that restores GR's full determinism (see Norton 2019 for an overview). Yet this all raises the question: why care about full determinism in the first place (see Teitel, 2019, 356-57)? Why not simply call the argument sound and move on? Indeed, some (e.g. Brighouse 1997) claim that any reasons to expect our physical theories to be deterministic support only qualitative determinism. Given that the vast literature on the hole argument is premised on there being reason to rescue GR's full determinism, the absence of a compelling argument in support of our laws obeying this strong sense of determinism is a striking omission.[8] Fortunately, we think that this omission can be remedied.

One way to motivate the thought that our world is fully lawful is by pointing out that, if the laws are silent on future non-qualitative facts, then the evolution of the universe might be much more irregular, complicated, and chaotic than we thought. For example, consider a classical Newtonian theory of N particles evolving through spacetime. Suppose the laws of physics constrain only the qualitative facts that will obtain at future times. Moreover, for now suppose that the laws of nature are neutral between competing theories of persistence (we will consider the option of dropping this assumption later on). Then the following scenario is nomically possible:

[8] The closest one finds to an argument is Earman and Norton's oft-quoted claim that "a metaphysics which automatically decides in favour of indeterminism is [...] unacceptable. Determinism may fail, but if it fails it should fail for a reason of physics" (1987, 524), where both uses of 'determinism' here refer to full determinism. We don't find this claim compelling, for the reasons given in Teitel (2019, 356).

> **Future Tuesday Reset**: Up until now, there have always been the same *N* particles, which have been enduring through time as they evolve by Newton's laws. However, next Tuesday, at exactly midnight, each of these particles will spontaneously pop out of existence and be replaced by numerically distinct particles, in such a way that preserves the (qualitative) truth of Newton's laws at all times. The new *N* particles continue to endure forever.

Analogous haecceitistically different nomic possibilities can also easily be generated on a perdurantist view. For example, consider any perdurantist world that obeys Newton's laws, which consists of *N* particle trajectories through space-time, each of which is composed of infinitely many numerically distinct particle time-slices. For any such possibility, one can consider a distinct nomic possibility that arbitrarily interchanges two particle-time slices, while keeping the qualitative history of the universe unchanged. In general, if the world is merely qualitatively lawful, and the laws do not explicitly take a stand on the metaphysics of persistence, then the world leaves open all sorts of complex non-qualitative nomic contingencies. To the extent that we don't think our world is subject to such irregular evolution, we should regard our world as fully lawful.

The second, and in our mind most important, motivation stems from the metaphysics of laws. We think that the best explanation for why our world is qualitatively lawful also supports the claim that our world is fully lawful. This explanation takes qualitative laws to be evidence for some non-Humean conception of laws. When we look at the guiding slogans behind the non-Humean conception of laws, they support the view that our world is fully lawful rather than merely qualitatively lawful. One of us (Teitel (2019, 356-357)) has pressed this point before, arguing that proponents of non-Humean views "should be reluctant to concede that our laws of nature are simply silent on a huge range of non-qualitative facts" (356), as they must be if our world is merely qualitatively lawful. The idea here is that if our world fails to be fully lawful then future states are massively underdetermined by past states and the laws, because the laws don't fix which objects follow which. Intuitively, the laws of physics are supposed to make the world evolve in the way that it does, but the world wouldn't "know" how to evolve if it didn't know which future objects to generate. The non-Humean view seeks to explain the future in terms of the past and the laws of nature. This explanatory ambition is a failure if

non-qualitative features of the future are entirely brute and inexplicable. This kind of non-Humean conception of laws is controversial. Still, those convinced that the qualitative regularity of our universe supports such a conception also thereby have reason to regard our world as fully lawful.[9]

A final motivation for thinking that our world is fully lawful stems from certain views in the metaphysics of time, namely presentism and the growing block theory.[10] According to presentism, only present things exist, and according to the growing block theory, only past and present things exist. Because both of these views deny the existence of future objects, they face the challenge of accounting for non-trivial truths about the future. It certainly seems that there are *some* non-trivial truths about the future, such as the claim that a particular banana will not be ripe in one week, or the claim that our laws of physics will still hold true tomorrow. However, given the view that truth depends on being, these non-trivial truths about the future must somehow be made true by the present (and/or the past). A natural way to account for these truths is by appealing to the laws of physics. In the case of presentism, Markosian (2013) has defended the view that all propositions about the future (or the past) are true if and only if (and because) they are nomically necessary given the present time.[11] In the case of the growing block view, Briggs and Forbes (2012) have defended the related view that all propositions about the future are true if and only if (and because) they are nomically necessary given the past and present. However, if our world is merely qualitatively lawful, there is a danger that this kind of strategy won't be able to secure any non-trivial *haecceitistic* claims about

[9] See Bhogal (2020b), Builes (2021b), and Segal (forthcoming) for reasons to think that Humeanism leads to inductive skepticism. There's an important question of *which* non-Humean views are rendered more likely by regularities like qualitative determinism. We won't take a stand on this issue here, but for discussion see Hildebrand (2013, 2014, 2018), Tugby (2017), and Hildebrand and Metcalf (forthcoming).

[10] For defenses of Presentism, see Markosian (2004) and Zimmerman (2011). For defenses of the growing block view, see Tooley (1997) and Forbes (2016).

[11] Similar proposals (at least for future truths) have been defended by Peirce (1934), Lukasiewicz (1967), and Thomason (1970). As Sider (2001: 39) points out, because the presentist can only appeal to the laws and a single instant of time, they need to believe that certain physical quantities concerning rates of change (such as velocity or momentum) are intrinsic to a time in order for a corresponding time-slice version of full determinism to have a chance of being true. For more on the question of whether rates of change are intrinsic, see Lange (2005), Easwaran (2014), Builes (2020), and Builes and Teitel (2020).

the future, such as the claim that a particular particle, or a particular person like you or I, will continue to exist in one second. This is perhaps particularly pressing for the presentist who wishes to account for past truths in a similar way. There are all sorts of non-qualitative truths about the past, such as the fact that Aristotle was a philosopher. In order for this kind of strategy to be a fully general strategy regarding past and future truths, our world must be fully rather than merely qualitatively lawful.

3. Two Radical Options: Qualitativism and Monism

We've argued that a wide range of different metaphysical commitments should incline one to regard our world as fully lawful. As mentioned at the outset, our plan is to use this constraint to develop the best versions of the two main competing views in the metaphysics of persistence, endurantism and perdurantism. We now turn to this task.

There are two radical ways that endurantists or perdurantists might try to secure a fully lawful world: either by rejecting fundamental non-qualitative facts altogether or by rendering them trivial.

The first option involves a commitment to *Qualitativism*, according to which necessarily there are no fundamental non-qualitative facts. Many different versions of qualitativism have been developed, however it is fair to say that they all remain controversial.[12] Still, qualitativism seems to provide one promising way to bridge the gap from qualitative laws to full laws. At least at first glance, it seems that the entire distinction between qualitative laws and full laws is collapsed given qualitativism.

However, this tempting thought is too quick. By itself, qualitativism does not automatically bridge the gap from qualitative laws to full laws. Consider the case of Future Tuesday Reset and a corresponding world, call it No Reset, that is a qualitative time-slice duplicate of Future Tuesday Reset, except that no reset ever occurs. On the assumption that the laws of nature

[12] For a sampling of Qualitativist views, see Van Cleve (1985), Hawthorne and Cortens (1995), Dasgupta (2009, 2017), Builes (2021a), and Turner (2011, forthcoming). For a sampling of arguments against qualitativism, see Kment (2012), Cowling (2017), and Turner (2017).

only constrain the qualitative facts that obtain at particular times (an assumption that we will revisit later on), Newton's Laws do not distinguish these two worlds, because they are qualitative time-slice duplicates. However, while these two worlds are qualitative *time-slice* duplicates, they are not qualitative duplicates *simpliciter*. In one of the worlds, there are *2N* particles throughout the history of the universe, and in the other there are only *N* particles throughout the history of the universe. This is a purely qualitative difference between these two worlds. This kind of case serves as a counterexample to the claim that qualitativism on its own entails that if our world is qualitatively lawful then our world is fully lawful. Even under qualitativism, the laws of nature may still be silent on *qualitative cross-time identity facts*, such as the cross-time identity facts that differ between Future Tuesday Reset and No Reset.

In order to secure full lawfulness given qualitative lawfulness, qualitativists must supplement their view with some principle that fixes the qualitative cross-time identity facts across all nomic possibilities. It's easy to see how this might work for perdurantists: simply supplement qualitativism with the claim that it's impossible for fundamental physical objects wholly located at one time to be numerically identical to fundamental physical objects wholly located at another time. The laws of nature can be used to determine the (chances of) qualitative time-slice propositions at future times, and the additional qualitative cross-time identity facts can be determined by the thesis that any two things wholly located at distinct times must also be distinct. In other words, qualitativists can bridge the gap between qualitative laws and full laws by endorsing the following thesis:

> **Strong Perdurantism**: Necessarily, for all *x* and *y*, if *x* is wholly located at time *t* and *y* is wholly located at time *t'*, where *t* and *t'* are distinct, then *x* and *y* are distinct.[13]

How might the story go for qualitativists who also endorse endurantism? There are several options here. For example, at all worlds where the laws imply that particle number is conserved, the endurantist might propose that particles endure throughout all of time, thereby

[13] The technical notion "wholly located" (and related notions like "exact location") has been defined by different philosophers in different ways, but none of our arguments will turn on the details of the definition. For an influential way of understanding the term, see Sider (2001).

precluding any enduring objects from popping into or out of existence. However, there remains the further issue of stating precisely *how* particles endure through time, in order to rule out strange possibilities where (for example) particles discontinuously "swap places" with one another. We will discuss principles in this spirit in detail below, under the heading of 'Ontological Inertia'. We shall see that the principle is easy to formulate in a monistic setting, where there is only one fundamental object at any time, but trickier to write down in an orthodox pluralist setting.

The second way in which one might try to collapse the distinction between qualitative laws and full laws is by endorsing a version of monism, which might seem to trivialize the further constraint stemming from non-qualitative regularities. According to monism, the universe as a whole is a fundamental individual, and there are no fundamental parts of this universal whole. If the only fundamental individual is the entire universe, then there doesn't seem to be any room for non-qualitative irregularities of the kind present in Future Tuesday Reset. Such irregularities require that there be more than one fundamental individual, which we can then change across nomic possibilities. Yet this is precisely what monism denies, and so it seems like the doctrine entails that our world is fully lawful if it's qualitatively lawful.

Again, however, this tempting thought goes by too quick. One can distinguish two versions of monism. On a three-dimensional version of monism, the entire universe *at a time* corresponds to a fundamental individual, and on a four-dimensional version of monism, the entire "block universe" corresponds to a single fundamental individual.

At least in principle, a three-dimensional version of monism is *consistent* with the claim that there is only ever one fundamental individual. For example, on an endurantist version of three-dimensional monism, one might hold that there is a single fundamental three-dimensional object that eternally endures through time.[14] Still, three-dimensional versions of monism, even

[14] It is worth noting that some of the standard arguments for Monism are more naturally construed as arguments for a three-dimensional version of monism. For example, Schaffer's (2013) argument that the cosmos is fundamental because it is the one and only thing that evolves by the fundamental laws is primarily carried out in a three-dimensional, endurantist setting. Moreover, the kind of holism implied by quantum entanglement (e.g. see Ismael and Schaffer 2020), at least in a non-relativistic setting, supports only a three-dimensional version of

espoused as necessary truths, do not on their own bridge the gap between qualitative laws and full laws, since they are vulnerable to the same problems as non-monistic theories. For example, in an endurantist setting, one could consider the monistic analog of Future Tuesday Reset, where the world endures through time until next Tuesday, and then instantly gets replaced by a numerically distinct enduring universal object. In a perdurantist setting, where there are infinitely many fundamental individuals that correspond to different time-slices of the universe, one can generate distinct nomic possibilities simply by permuting any two individuals at different times without making any qualitative changes to the universe.

By contrast, four-dimensional versions of monism, if regarded as at least nomically necessary, do successfully bridge the gap between qualitative laws and full laws, provided these theses are formulated using notions that are acceptable to the four-dimensional monist.[15] Since it is nomically necessary that there is only ever one object, there cannot be any non-qualitative irregularities as the world 'evolves' in time. For the four-dimensional monist, the evolution of the world merely corresponds to qualitative variation within the single world-object. Still, we want to stress that four-dimensional monism falls outside of the standard dichotomy between endurantist and perdurantist theories of persistence. No fundamental objects are wholly present at different times, so the view does not vindicate endurantism. Yet neither does the fundamental ontology consist of instantaneous temporal stages, so the view also doesn't vindicate perdurantism. For this reason, we doubt that those invested in the traditional debate will see four-dimensional monism as an attractive supplement to their position; rather, the position seems to embody a revision of the very notion of persistence through time that sparks the traditional debate.

Monism, since quantum entanglement relations do not relate things across time. Of course, there are independent relativistic reasons for why one might favor a four-dimensional ontology rather than a three-dimensional ontology, and there is an ongoing debate about how endurantists (as well as A-theorists of time) should respond to this challenge from relativity. For a sampling of different responses, see Gibson and Pooley (2006), Gilmore (2008), Balashov (2010), and Zimmerman (2011).

[15] As currently formulated, both full determinism and full stochasiticty appeal to things that the four-dimensional monist would reject (e.g. the existence of distinct times and appeals to "the history of w up to t"). The four-dimensional monist must paraphrase full determinism and full stochasiticty using their own preferred ideology. See Cornell (2016) and Sider (2008) for how the monist might try to do this.

In sum, there are certain versions of qualitativism, and perhaps monism, that ensure that our world is fully lawful, given that it is qualitatively lawful. In particular, qualitativist views that endorse some modal principle akin to Strong Perdurantism, and four-dimensional versions of monism both bridge the gap to full lawfulness.

In the rest of the paper, we'll examine whether more standard endurantist and perdurantist views can bridge the gap between qualitative laws and full laws. We'll start by dropping qualitativism and considering these views in the simplest possible setting, where there is only ever a single fundamental individual at any given time (corresponding to a three-dimensional version of monism). Doing so simplifies the exposition, allowing us to outline our central claims without introducing other complications. We'll then consider various more popular pluralist ontologies, according to which multiple individuals like particles, or spacetime points, or both, are fundamental.

4. Endurantism and Full Lawfulness

Suppose it's nomically necessary that, for any time t, there is a single fundamental individual ψ_t (the 'world-at-a-time'), and that the world is qualitatively lawful. In an endurantist setting, the primary obstacle to the world being fully lawful comes by way of the kind of counterexample present in Future Tuesday Reset. What if the world has always endured through time until now, but then is suddenly replaced by a numerically distinct enduring world-individual next Tuesday?

We think there are two natural strategies for the endurantist to pursue. First, the endurantist might embrace some principle about how things endure that holds with metaphysical necessity; in particular:

> **Ontological Inertia$_{\text{Monism}}$**: Necessarily, if three-dimensional Monism is true, then, for all times t and t', $\psi_t = \psi_{t'}$

Ontological Inertia$_{\text{Monism}}$ rules out any case analogous to Future Tuesday Reset where the universe simply pops out of existence, and it also bridges the gap between qualitative

lawfulness and full lawfulness. By Ontological Inertia$_{\text{Monism}}$, any initial segment of a nomically possible world will involve only a single enduring object. So, for any two worlds *w* and *w'*, if they agree on all of their intrinsic properties up to a time, they must include the same enduring object up to that time. The qualitative laws together with Ontological Inertia$_{\text{Monism}}$ will then secure the same truth values (or chances) for all future propositions in *w* and *w'*, since the only haecceitistic propositions in *w* and *w'* must concern the same enduring object that existed in the past.

A second strategy that the endurantist might pursue is to claim that some feature of our laws of nature ensures that the world eternally endures through time, in effect transforming a principle like Ontological Inertia$_{\text{Monism}}$ into a distinctively *nomic* necessity rather than a metaphysical necessity.

We will begin by discussing the prospects of the first strategy. The main problem for this strategy is to independently motivate the truth of Ontological Inertia$_{\text{Monism}}$. Why can't the world simply pop out of existence and be replaced by an enduring duplicate? This rhetorical question can be supplemented with a conceivability argument. It seems perfectly conceivable for there to be a world that violates Ontological Inertia$_{\text{Monism}}$. On the assumption that conceivability is at least a prima facie guide to possibility, we have a prima facie counterexample to Ontological Inertia$_{\text{Monism}}$. We see three ways in which the endurantist might defend Ontological Inertia$_{\text{Monism}}$. We'll consider each in turn. We'll then turn to the prospects of the alternative, distinctively nomic, strategy.

4.1. Attempt 1: Essences

Some philosophers appeal to essences to block conceivability arguments.[16] For example, it might be conceivable that water is XYZ, but it is still impossible that water is XYZ because it is essential to water that it is H_2O, and hence necessarily water is H_2O.[17] In the case we are

[16] See Goff (2019) for a recent example.

[17] Here we're assuming that if some proposition is essential to some object, then that proposition is necessary. One way to secure this implication is by reducing necessity to essence, following Fine (1994). However, we take the instances of the implication we'll rely on in the main text to be plausible irrespective of whether the general Finean reduction itself succeeds.

considering, the endurantist could say that, for any time t, it is essential to ψ_t that, for any time t' after t, $\psi_t = \psi_{t'}$. In other words, the endurantist could say that it is an essential property of the world that it continues to exist so long as time continues to exist.[18]

Notice that it is not enough for the endurantist to say that this essential property holds for *actual* ψ_t's. Ontological Inertia$_{\text{Monism}}$ is a modal claim that would be false so long as it's even possible for there to be a world that lacks these essential properties. The essentialist must therefore endorse the following claim:

> **Essential Ontological Inertia$_{\text{Monism}}$**: Necessarily, if three-dimensional Monism is true, then, for all times t, it is essential to ψ_t that, for all times t' after t, $\psi_t = \psi_{t'}$

Although Essential Ontological Inertia$_{\text{Monism}}$ does imply Ontological Inertia$_{\text{Monism}}$, we don't think it's a very attractive strategy for the endurantist to pursue. Our main worry is that positing these sorts of metaphysically necessary essential properties simply doesn't get us very far in independently motivating Ontological Inertia$_{\text{Monism}}$. Insofar as we find ourselves puzzled about why Ontological Inertia$_{\text{Monism}}$ should be true, we also find ourselves puzzled as to why Essential Ontological Inertia$_{\text{Monism}}$ should be true. One could always come up with some hypothesis about the essences of things in order to reach one's desired modal conclusions, but we don't find this kind of procedure very illuminating.[19]

Our second worry is that this kind of strategy is entirely disanalogous to the standard essentialist replies to conceivability arguments. In the case of water, when we conceive of a world where water is XYZ, our conceiving does correspond to a possible world that could have turned out to be the actual world. It is just that, given that water is actually H_2O, the world we are conceiving of is misdescribed. While we do successfully conceive of a possible world where the watery-stuff around us is XYZ, the corresponding substance doesn't get to

[18] This essential property need not conflict with cosmological models where the universe comes to an end in a "big crunch," provided that there is no time "after" the big crunch.

[19] For discussion and defense of the worry about essentialist theses in this paragraph, see Teitel (2019, 383-386), who argues for it as concerns attempts to explain modal principles about spacetime in terms of essentialist theses.

count as water.[20] In the case of Essential Ontological Inertia$_{\text{Monism}}$, when we are conceiving of a three-dimensional monistic world where the universe endures for some time but then gets instantly replaced by a numerically distinct enduring object, there is no possible world that corresponds to our conceiving. Although it seems perfectly conceivable for there to be a three-dimensional monistic world that simply *lacks* the essential properties described in Essential Ontological Inertia$_{\text{Monism}}$, anyone who endorses this kind of essentialist strategy must think that this conceiving doesn't correspond to any metaphysical possibility.

4.2. Attempt 2: Temporal Rationalism

Another attempt to independently motivate Ontological Inertia$_{\text{Monism}}$ begins with the observation that Future Tuesday Reset involves an entirely brute and inexplicable change in reality. Why did the world endure until next Tuesday instead of next Wednesday? And why did the world get replaced by $\psi_{\text{next Tuesday}}$ rather than some other possible world-individual? There don't seem to be any good answers to these questions. It therefore seems that any world that violates Ontological Inertia$_{\text{Monism}}$ would involve completely brute and inexplicable changes in reality.

In recent times, some philosophers have ventured to revive the *Principle of Sufficient Reason* (PSR), according to which no fact can be brute and inexplicable in this way.[21] If the endurantist endorses the PSR, then they could motivate Ontological Inertia$_{\text{Monism}}$ on the grounds that any violation of Ontological Inertia$_{\text{Monism}}$ would violate the PSR. In fact, the endurantist need not endorse the PSR in full generality to derive Ontological Inertia$_{\text{Monism}}$. They only need to endorse the following:

> **Temporal Rationalism**: Necessarily, if the world changes from one state to another, there is an explanation of why the world changed in that way.[22]

[20] This analysis of the H_2O-water case can be made more precise using the tools of two-dimensional semantics (e.g. see Chalmers 2008).

[21] For defenses of different versions of the PSR, see Pruss (2006), Della Rocca (2010), Dasgupta (2016a), and Pruss and Koons (2021).

[22] Note that Temporal Rationalism need not imply determinism, since one could explain why the world changed in the way it did by appealing to objective chances (see Pruss 2006: ch. 8).

Temporal Rationalism is a weakening of the PSR that allows for certain aspects of the world to be brute, such as the initial conditions of the universe, the laws of nature, or the conjunction of all contingent truths. Because of this, Temporal Rationalism avoids perhaps the biggest objection to the PSR, namely that the PSR implies that every truth is a necessary truth.[23] Moreover, there are also independent motivations for Temporal Rationalism. For example, Tugby (2017) has formulated a principle analogous to Temporal Rationalism, which he calls the "Principle of Change," which has the advantage of resolving an important objection to dispositional essentialist views regarding fundamental physical properties.

Ultimately, whether one accepts Temporal Rationalism as an adequate motivation for Ontological Inertia$_{\text{Monism}}$ will depend on one's prior metaphysical commitments. On the one hand, one might be attracted to a certain kind of link between conceivability and possibility, which seems to tell against Temporal Rationalism. After all, it seems conceivable for a world to change in inexplicable ways. Somewhat ironically, perhaps the best motivation for endorsing a link between conceivability and possibility is due to a thesis which Chalmers (2002) calls *Modal Rationalism*. Chalmers (1996: 136-38) motivates Modal Rationalism on the grounds that violations of a suitably idealized connection between conceivability and possibility would involve brute and inexplicable restrictions on the space of possible worlds. On the other hand, the best motivation for Temporal Rationalism also involves a rationalist rejection of the possibility of brute and inexplicable changes in the universe. We won't take a stand between these two rationalist principles here, but we do think that Temporal Rationalism at least provides a better way forward for the endurantist than Essential Ontological Inertia$_{\text{Monism}}$ in their task of motivating Ontological Inertia$_{\text{Monism}}$. That being said, we suspect that most endurantists would be loath to embrace a strong rationalist principle like Temporal Rationalism.

4.3. Attempt 3: Hume's Dictum for Non-Humeans

In our view, a more promising way forward for the endurantist involves endorsing a certain sort of non-Humean view that recognizes necessary connections in nature; in particular, that

[23] See Bennett (1984) and Van Inwagen (2015) for defenses of this argument.

the present state of the world necessitates future states in accordance with the laws of nature.[24] On the sort of views we have in mind, if the laws dictate that state A evolves into state B then the fact that A evolves into B will turn out to be *metaphysically* (rather than merely nomically) necessary. For example, any "Aristotelian" view of natural necessity---according to which fundamental physical properties have intrinsic causal powers or dispositions to behave in certain ways---will be an instance of such a view (see footnote 32 below for some proponents). However, proponents of other metaphysical accounts of laws of nature have also argued that the laws of nature describe metaphysically necessary truths (for example, Wilson (2013)).

A common objection to such views is that they seem to violate *Hume's Dictum*:

> **Hume's Dictum**: Necessarily, there are no necessary connections between wholly distinct entities.[25]

Two entities are wholly distinct just in case they do not mereologically or spatiotemporally overlap. The caveat of being "wholly distinct" is important because even defenders of Hume's Dictum will acknowledge that there can be necessary connections between an entity and itself, an entity and its parts, and so on. For example, the fact that x is 2 kg might necessitate that x is not 4 kg, the fact that x has a color might necessitate that x has a shape, the fact that x is 2kg and mereologically complex might necessitate that all of x's proper parts have a mass of at most 2kg, and so on. However, necessary connections between wholly distinct entities have seemed much more problematic. How could one entity being a certain way make it impossible for another wholly distinct entity to be some other way? Again, one could motivate Hume's Dictum by means of a conceivability argument. No matter what way some entity is, it seems

[24] Even if the laws of nature are chancy, the present state of the world still necessitates *some* facts about the future. So long as there are some non-trivial features of the future that get assigned a maximal chance of 1 (e.g. black holes not spontaneously forming in the absence of matter), then there will be necessary connections between the present state of the universe and future states of the universe.

[25] See Wilson (2010) for a critical assessment of the different kinds of motivations that have been offered for Hume's Dictum, and various nuances in formulating the principle. See Segal (2014) for a recent defense of the principle.

conceivable for a second wholly distinct entity to have any collection of compossible intrinsic properties.

Our suggestion is that the non-Humean endurantist can use Hume's Dictum to their advantage. In particular, they can use Hume's Dictum to motivate the following thesis:

> **Non-Humean Ontological Inertia$_{\text{Monism}}$**: Necessarily, if three-dimensional Monism is true, then if non-Humeanism is true, then for all times t and t', $\psi_t = \psi_{t'}$

Note that for the non-Humean, Non-Humean Ontological Inertia$_{\text{Monism}}$ is sufficient to bridge the gap between qualitative laws and full laws, because the non-Humean will think that the only nomically possible worlds are ones where the present state of the world necessitates future states in accordance with the laws of nature.

The crucial point is that the monist non-Humean endurantist is able to satisfy Hume's Dictum if and only if they endorse Non-Humean Ontological Inertia$_{\text{Monism}}$. To argue for this claim, consider again the case of Future Tuesday Reset, where the world is replaced by a distinct world-individual next Tuesday. If this is to be a nomically possible world for the non-Humean, it must be that the world before next Tuesday bears a necessary connection (in accordance with the laws of nature) to the world after next Tuesday. Since the world before next Tuesday is wholly distinct from the world after next Tuesday, this is an explicit violation of Hume's Dictum. More generally, if there are any two times t and t' such that ψ_t is wholly distinct from $\psi_{t'}$, then if the laws of nature generate necessary connections these would be connections between wholly distinct entities, violating Hume's Dictum. However, if for any two times t and t', $\psi_t = \psi_{t'}$, then there would be no violations of Hume's Dictum. The world would never bear any necessary connections to anything besides itself.[26]

[26] Two qualifications about the biconditional in this paragraph. First, to fully argue for the left-to-right direction, we'd need to argue against some more exotic views, according to which ψ_t is distinct yet mereologically coincident with $\psi_{t'}$, rendering them not wholly distinct, and hence blocking the relevant violation of Hume's Dictum. However, we don't think there's much to recommend this option, and so we ignore it in the main text. For a sympathetic exploration of something in the vicinity of this option, see Segal (2014). Second, to fully argue for the right-to-left direction, we must set aside views according to which the laws themselves count as an entity that

The intuitive idea behind this appeal to Hume's Dictum is that the causal connection between the present and the future would be broken if the world simply popped out of existence and was replaced by an entirely new and wholly distinct world that popped into existence. How could the new world possibly "know" about what went on with some wholly distinct entity in the past? How could the present world manage to make necessary demands on some future time in which it doesn't even exist?

Although she does not appeal to Hume's Dictum, Haslanger (1989) defends a similar conclusion. She summarizes her discussion as follows:

> [T]he past can be causally efficacious in the present only through things presently existing. Therefore, if nothing from the past [endures] to the present, the past can set no constraints on the present; the "causal message" cannot be communicated across the gap [...] From this we can see that [endurantism] does provide us intelligibility in explanations of change. Natural explanations work by showing the systematic causal interconnections between things. Without [endurance], the causal story becomes unconnected; neither the past nor the future can get a hold on the present in a way that is causally efficacious. (21)

A similar point can be read into Thomson's (1983) famous complaint about perdurantism:

> I said this seems to me a crazy metaphysic. It seems to me that its full craziness only comes out when we take the spatial analogy seriously. The metaphysic yields that if I have had exactly one bit of chalk in my hand for the last hour, then there is something

might witness a violation of Hume's Dictum. However, just about every candidate view in the metaphysics of laws doesn't construe laws as an entity, and hence would vindicate our reasoning. The only exception here would be a version of primitivism about laws, according to which laws are sui generis entities (suggested by some remarks in Maudlin (2007)). However, more orthodox understandings of primitivism take some nomic *ideology* as fundamental, such as a primitive 'it's a law that' operator (analogously to how modalists view *metaphysical* necessity). These more orthodox versions of primitivism don't construe laws as entities of some kind, and so pose no threat to our reasoning in this paragraph.

> in my hand which is white, roughly cylindrical in shape, and dusty, something which also has a weight, something which is chalk, which was not in my hand three minutes ago, and indeed, such that no part of it was in my hand three minutes ago. As I hold the bit of chalk in my hand, new stuff, new chalk keeps constantly coming into existence *ex nihilo*. That strikes me as obviously false. (211)

One way to account for the remark that new chalk keeps constantly coming into existence "*ex nihilo*" is by reference to a background intuition that there can't be intelligible causal connections between the past pieces of chalk and the wholly distinct future pieces of chalk. The natural way to avoid the absurdity of new chalk continually popping in and out of existence is instead to countenance a single piece of chalk that endures across time.

We see, then, that endurantists sympathetic to non-Humean necessary connections in nature might have entirely independent reasons to endorse Non-Humean Ontological Inertia$_{\text{Monism}}$: by doing so, they can satisfy Hume's Dictum, which many take to be independently plausible. It just also turns out that by endorsing Non-Humean Ontological Inertia$_{\text{Monism}}$, the non-Humean endurantist also thereby bridges the gap between qualitative lawfulness and full lawfulness. Both of us take there to be strong independent arguments for non-Humeanism, and are sympathetic to Hume's Dictum, and hence regard this route as the most promising one for endurantists to pursue in their task of motivating Ontological Inertia$_{\text{Monism}}$.

4.4. Attempt 4: Distinctively Nomic Ontological Inertia

So far we have been pursuing the strategy of supplementing the laws of nature with a principle that holds with metaphysical necessity, along the lines of Ontological Inertia$_{\text{Monism}}$, in order to rule out cases like Future Tuesday Reset. However, full lawfulness can also be secured by a weaker view which renders cases like Future Tuesday Reset metaphysically possible yet *nomically* impossible. On this view, some feature of our laws of nature ensures that the world always endures through time.

Notice that this strategy need not require abandoning the common view that laws of nature are qualitative. So far we have been working with the assumption that the laws of nature take the following qualitative form: if the fundamental things are qualitatively so-and-so at some

time, then there are fundamental things that are qualitatively so-and-so at such-and-such other times. These laws simply take no stand on whether the fundamental objects at one time continue to exist at other times, thereby leaving them vulnerable to threats to full lawfulness like Future Tuesday Reset. Yet there are other forms for qualitative laws to take that aren't neutral on cross-time identity facts; we'll call any such laws *strong laws*. For example, these laws might state that if some particle is qualitatively so-and-so at some time, then *that very particle* is qualitatively so-and-so at such-and-such other times. Or a monistic analogue: if the three-dimensional world-object is qualitatively so-and-so at some time, then *that very world-object* is qualitatively so-and-so at such-and-such other times. Notice that laws of this form are still qualitative, yet they build in endurance, thereby ruling out cases like Future Tuesday Reset above: if objects pop out of existence then laws of this form are simply false.

Even though strong laws can be qualitative, we want to flag that they would still be unfamiliar in various respects. For example, such laws would no longer be neutral on the metaphysics of persistence: if it were built into the laws of nature that any fundamental objects there are at a time endure for the rest of time, then the truth of endurantism (and the falsity of perdurantism) would be an immediate consequence of the laws of nature themselves. In addition, strong laws would be unlike ordinary scientific laws in that they govern features of the physical world that are in principle empirically undetectable. For example, no scientific experiment could possibly detect the difference between worlds like Future Tuesday Reset and No Reset. Nevertheless, we don't find these unfamiliar features of strong laws to be at all worrying: in our view, it is unsurprising that different metaphysical views about persistence across time might lead to different formulations of the laws of nature, which dictate how the universe evolves as time goes on. We leave it to those who find these unfamiliar features problematic to make good on this worry. If they are right then that would only further support our pessimistic evaluation of the strong laws strategy.

In our view, the reasons to be skeptical of strong laws emerge by examining different views about the metaphysics of laws of nature. Let us consider the main theories of laws in turn.

To start, consider the Dretske-Tooley-Armstrong (DTA) theory, according to which laws describe a second-order "necessitation" relation between properties.[27] Crucially, the necessitation relation here is meant to hold between sparse universals or fundamental properties, such as mass or charge. A familiar complaint about this theory is that it limits the form that laws of nature can take.[28] As concerns the present strong laws strategy, let us grant that the theory can deliver laws to the effect that if some fundamental property is instantiated at a time then some other fundamental property is instantiated at such-and-such other times, even though there's room here for debate.[29] The trouble is that the strong law strategy also requires laws to pin down which particular things have the fundamental properties at the other times, via cross-time identity facts. And we don't see a plausible means of including these additional facts within the strictures of the DTA theory. Doing so seems to require recognizing infinitely many non-qualitative haecceitistic properties as sparse universals (e.g. *being* ψ_t), which can then themselves stand in the second-order necessitation relation. However, such a view not only requires a very implausible account of sparse universals, but it also requires countenancing infinitely many non-qualitative laws of nature. We doubt anyone would want to embrace the resulting DTA-friendly vision.

Let us now turn to Humean theories of lawhood, in particular the popular Ramsey-Lewis "best systems analysis" (BSA), according to which laws are just certain especially simple and informative summaries of the ways things are across all of space and time.[30] Here there's no obstacle to the endurantist's strong laws being candidate laws, for the BSA imposes no in-principle constraints on what form laws of nature can take. Our central worry is that, given this metaphysic of lawhood, the strong law strategy doesn't in fact independently motivate the nomic analogue of Ontological Inertia$_{\text{Monism}}$. And our reasons for thinking this are just the familiar complaints about the explanatory circularity of Humean theories.[31] Once

[27] See Dretske (1977), Tooley (1977), and Armstrong (1983) for classic developments of this view.

[28] See, for example, Wilson (1987) and Maudlin (2007).

[29] The issue turns on whether the DTA theorist can accommodate temporal-derivatives.

[30] For an introductory survey of Humeanism about laws of nature, together with how the view might respond to various objections, see Bhogal (2020a).

[31] For versions of this worry see Lange (2013, 2018), Shumener (2019), and Emery (forthcoming). For Humean responses to this worry, see Dorst (2019), Bhogal (2020c), and Hicks (2021).

counterexamples like Future Tuesday Reset drive home that nothing in endurantism itself secures full lawfulness, if in fact things never pop out of existence we'd like some independent motivation for this additional feature of our world. Why is it that things never pop out of existence? This independent motivation is what the strong laws strategy is meant to provide. Yet given the Humean theory, its being a law of nature that, say, things never pop out of existence, just consists in things in fact never popping out of existence, and moreover this claim being very simple and informative. In this way, given the Humean theory, the strong law strategy merely *presupposes* that things don't pop out of existence, rather than providing any independent motivation for this claim.

What about the broad family of views that explain lawhood in terms of the intrinsic causal powers of fundamental properties? The general view here is that something having certain fundamental properties might necessitate certain dynamical effects, simply in virtue of the thing having the fundamental property. Laws of nature are then the necessary truths stating that everything that has the fundamental property has such-and-such dynamical behaviour.[32] As a toy example, it might be that necessarily anything with mass thereby attracts other objects with mass, simply in virtue of what it is to have mass. We think that such views hold some promise of securing endurantist strong laws, but they still face significant challenges.

A first worry is that prominent versions of this view, often called 'dispositional essentialism', would need to appeal to the essences of fundamental properties in order to secure a distinctively nomically necessary version of Ontological Inertia$_{\text{Monism}}$, and this appeal to essences raises some of the same concerns as our first attempt of explaining Ontological Inertia$_{\text{Monism}}$ by appeal to essences.[33] Moreover, alternative ways of developing the view that do not employ the notion of essence arguably nevertheless also fall prey to one of the worries we raised for the essentialist strategy, stemming from lack of informativeness. For instance, suppose that instead of employing the notion of essence, the view stated that *what it is to be* a

[32] For some views in the relevant family, see Shoemaker (1980, 1998), Bird (2007), Jacobs (2011), Demarest (2017), Tugby (2021), Builes (2021b), and Kimpton-Nye (2021).

[33] As mentioned above, views in the family at issue often explicitly aim to vindicate the result that the laws of nature turn out metaphysically rather than merely nomically necessary. On such versions, we could speak of Ontological Inertia$_{\text{Monism}}$ itself, rather than its distinctively nomic analogue.

certain fundamental property (say being a material object) necessitates that anything that instantiates it never pops out of existence. Yet this would still not get us very far in independently motivating why necessarily nothing pops out of existence. Insofar as we were unsure about this latter claim, we will be just as unsure about this claim detailing what it is to be a certain fundamental property (or analogous claims about what certain causal powers necessitate, and so on).

A second worry has to do with the kinds of dispositions or causal powers that are needed to secure endurantist strong laws. One natural way to think of dispositions is that they necessitate that an object will behave in certain ways in certain conditions *if* that object continues to exist. For example, perhaps the property *being negatively charged* necessitates that (say) an electron will take a certain trajectory in the presence of certain electromagnetic fields *if* the electron continues to exist. Alternatively, perhaps the property *being negatively charged* necessitates the unconditional claim that an electron will take a certain trajectory in the presence of certain electromagnetic fields (and hence that an electron will continue to exist in the presence of certain electromagnetic fields). Let us say that a *weak disposition* of an object is a disposition whose manifestation conditions are always conditional on the future existence of that object, and let us say that a *strong disposition* of an object is a disposition whose manifestation conditions are not conditional on the future existence of that object.

In order to secure endurantist strong laws, the causal powers theorist must hold that the causal powers of fundamental properties involve strong dispositions. This claim merits further discussion than we can give it here. But let us register a couple of difficult questions proponents of the claim must answer. Is it metaphysically necessary that fundamental causal powers involve strong dispositions? If it is, then why are weak dispositions impossible? If it isn't, then presumably there are possible casual powers, which we can label mass*, charge*, spin*, etc., that are just like the fundamental causal powers in the actual world except that they involve only weak dispositions. Why is it that our world has the properties of mass, charge, and spin, rather than the properties of mass*, charge*, and spin*? Furthermore, on the assumption that fundamental dispositions must have a categorical basis, what is the difference between the categorical bases of (say) mass, charge, and spin, and the categorical bases of

mass*, charge*, and spin*?[34] These are some of the questions that this strategy would have to answer in order to give a compelling account of endurantist strong laws. We don't want to claim that principled answers to these questions cannot be found, but the proponent of the present strategy has their work cut out for them.

The final main theory of lawhood is primitivism, according to which the notion of lawhood is fundamental.[35] Like Humeanism, primitivism imposes no in-principle constraints on the form of the laws, so there's no barrier to the endurantist's strong laws counting as primitive laws of nature. Does countenancing the nomic analogue of Ontological Inertia$_{\text{Monism}}$ as a primitive law of nature independently motivate the principle? The answer will depend on one's background views regarding the viability of primitive laws. Some have worried that primitive laws do no better than Humean laws at accounting for natural regularities (e.g. see Hildebrand 2013), and many have worried that it is unclear how primitive laws are supposed to "govern" the evolution of the universe.[36] However, insofar as one is willing to appeal to primitive laws to account for other qualitative natural regularities, it seems that one should be equally willing to appeal to primitive laws to account for the distinctively nomic analogue of Ontological Inertia$_{\text{Monism}}$. That being said, primitivism about laws of nature is a controversial theory, and one that we suspect many endurantists won't want to endorse.

To sum up, we think that the strong laws strategy faces different objections depending on one's background metaphysics of laws. On some views, appealing to strong laws is perhaps more successful than attempts 1 and 2 above, in terms of essence or Temporal Rationalism. Nevertheless, we still maintain that the most promising and illuminating strategy for endurantists to pursue goes via attempt 3 above, which appeals to Hume's Dictum.

---

[34] Alternatively, a defender of endurantist strong laws can say that the kinds of physical properties investigated by physics (e.g. mass, charge, and spin) only involve weak dispositions, but every physical object in the universe possesses an additional "metaphysical" strong disposition to keep on existing. Many of the same questions would arise on this proposal. Is it metaphysically necessary that everything possesses the strong disposition to keep on existing? If not, why do things in the actual world possess that disposition? Lastly, what is the categorical basis of this strong disposition?

[35] For proponents, see Carroll (1994, 2018), Maudlin (2007), and Kment (2014).

[36] See Emery (forthcoming) for some different accounts of the notion of governance.

5. Perdurantism and Full Lawfulness

This time, suppose again for illustration that it is nomically necessary that, for any time t, there is a single fundamental individual ψ_t (we'll turn to more orthodox pluralist views in the next section). Further, suppose that Strong Perdurantism is true. As a result, for any distinct times t and t', $\psi_t \neq \psi_{t'}$. Given these assumptions, how might one bridge the gap between qualitative laws and full laws?

The trouble for such a view comes via examples we've already seen, of mere haecceitistic differences between nomic possibilities. For example, given any four-dimensional nomic possibility w, we can simply generate new nomic possibilities as follows: pick two times t and t' and swap the individuals ψ_t and $\psi_{t'}$ without changing any qualitative facts about w. Alternatively, consider some nomic possibility w containing some individual ψ_t, and consider the nomic possibility w^*, that's qualitatively identical to w, except it contains some new individual ψ^*_t, that doesn't exist at w, in place of ψ_t.

Like the case of endurantism, the perdurantist might pursue two different strategies. First, they may supplement the laws of nature with a principle that holds with metaphysical necessity, which renders impossible the problematic putative possibilities. Second, they may try to modify the laws of nature so that the problematic possibilities are rendered *nomically* impossible, albeit still metaphysically possible.

We think that this second strategy is untenable for the perdurantist. It is an important feature of endurantist strong laws that they can pin down which fundamental objects exist at future times in a purely qualitative manner: future fundamental objects are just whatever objects have already existed in the past. This is the crucial feature that allowed these qualitative laws to avoid threats to full lawfulness like Future Tuesday Reset. However, for perdurantists fundamental objects wholly located at one time never exist at any other times. So their strong laws must instead be non-qualitative, stating precisely *which* distinct things exist at future times. Otherwise, the laws will be vulnerable to haecceitistic threats to full lawfulness. There would presumably then need to be infinitely many such strong perdurantist non-qualitative laws, stating which particular things there will be for any way things could be non-qualitatively at any time at any nomic possibility. We don't see how such laws could be stated in anything

approaching a non-arbitrary fashion, not to mention their infinite complexity. Indeed, none of the central positions in the metaphysics of laws would render an infinite list of non-qualitative propositions plausible candidates to be laws of nature.

Consequently, we think that the perdurantist must maintain that the problematic putative possibilities are in fact metaphysically impossible. In particular, to block the relevant counterexamples, perdurantists should appeal to the modal doctrine of anti-haecceitism:[37]

> **Anti-Haecceitism**: No metaphysical possibilities differ without differing qualitatively.

Anti-haecceitism precludes mere haecceitistic differences between metaphysical possibilities, and clearly bridges the gap between qualitative and full lawfulness.

The challenge for perdurantists is to independently motivate the modal doctrine of anti-haecceitism: why is modal space restricted in this manner? After all, anti-haecceitism implies that every qualitative structure can be realized in only one possible way by any individuals. What explains this strong restriction on modal space? Indeed, it seems perfectly conceivable for a qualitative structure to be filled in by different individuals.[38]

It seems to us that the only way to adequately motivate anti-haecceitism is to endorse a qualitativist view, which recall says that necessarily there are no fundamental non-qualitative facts. Recall also from the outset that we're taking for granted that every non-fundamental fact supervenes on some fundamental facts. As a result, qualitativism renders anti-haecceitism unmysterious: if necessarily all fundamental facts are qualitative, then no metaphysical possibilities differ only over non-qualitative facts, otherwise we'd have a case where the non-

[37] Some more exotic weaker modal doctrines would also do the job here (e.g. those that allow for mere haecceitistic differences, provided some such difference must occur at all times or none, thereby preserving full lawfulness). However, we doubt anyone tempted by some such modal doctrine would settle for anything weaker than the principled stopping point of anti-haecceitism itself.

[38] For further discussion and development of this worry for anti-haecceitism, see section 4 of Teitel (2021).

fundamental fails to supervene on the fundamental.[39] We don't think there could be a satisfying explanation of anti-haecceitism that doesn't go via such a qualitativist doctrine.[40]

The alternative would be to reject the demand to independently motivate anti-haecceitism, and instead to adopt it as a brute constraint on the space of metaphysical possibilities. We want to just make a comparative response to such a view: notice how sharply it contrasts with the sorts of proposals that we considered in the previous section on behalf of endurantists. For example, the endurantist proposal of appealing to Temporal Rationalism, or appealing to Hume's Dictum while also espousing non-Humean necessary connections in nature, each offer some independent motivation for full lawfulness given endurantism. The present proposal to accept anti-haecceitism as a brute modal constraint fails to offer any similar insight. We therefore conclude that those who reject qualitativism should take endurantism to have a distinctive advantage over perdurantism.

6. Full Lawfulness and Pluralistic Ontologies

We have so far been discussing how the constraint of full lawfulness promises to transform the traditional debate between endurantists and perdurantists given the assumption of three-dimensional monism as a simplifying expository device. Does the dialectical situation change dramatically under more orthodox pluralistic conceptions of what fundamental individuals there are? We'll see in this section that many, but not all, of the conclusions we reached in the sanitized monistic setting carry forward unchanged.

There are three standard pluralistic ontologies. The first is a relationist ontology with only material objects like particles. The second is a "supersubstantivalist" vision that eschews material objects and countenances only spacetime, often motivated by contemporary field

[39] On an eliminativist version of qualitativism, which says that necessarily there are no non-qualitative facts full-stop (whether fundamental or non-fundamental), we can simplify the reasoning in this paragraph (in particular, we'd no longer need the supervenience claim).

[40] Those who reject qualitativism might try to explain anti-haecceitism by appealing to certain kinds of very strong qualitative and non-qualitative essential properties, of the sort investigated by Teitel (2019). But as discussed earlier in the main text, we agree with his claim there that such essentialist approaches are not actually explanatory.

theories combined with the doctrine that fields (including matter fields) are just properties and relations distributed over spacetime. The third is the standard "dualist" picture which countenances spacetime as well as some material objects, such as particles, located in spacetime. We'll consider each of these visions in what follows, starting with perdurantism, then turning to endurantism, and then finally discussing a common "mixed" option according to which matter endures but spacetime perdures.

Starting with perdurantism, here the dialectic rehearsed in section 5 is unchanged on any of the standard pluralistic ontologies. Given a perdurantist relationism, for example, we can generate threats to full lawfulness by considering nomic possibilities that permute particular temporal stages of whatever material objects there are, or by replacing some such stage with some new instantaneous stage, leaving everything qualitatively unchanged. Supersubstantivalism, as standardly understood, is a perdurantist view where the only objects are spacetime points and regions (which perdure), with various fields distributed over spacetime. Threats to full lawfulness in this setting are just those extensively discussed in the literature on the hole argument (recall section 2). The new nomic possibilities at issue agree on all qualitative propositions, but differ over which particular spacetime points have which field values within some subregion of spacetime. Finally, a pure perdurantist version of the dualist view would countenance perduring material objects located in a perduring spacetime. And here we are saddled with both the threats to full lawfulness faced by the perdurantist relationist as well as those faced by the perdurantist supersubstantivalist.

The way forward for perdurantists who countenance any of the standard pluralistic ontologies is just the one we outlined in section 5. We think blocking the threats to full lawfulness requires adopting the modal doctrine of anti-haecceitism. Yet this modal doctrine demands some independent motivation. And the best means of doing so goes via the qualitativist doctrine that necessarily there are no fundamental non-qualitative facts. We don't take appealing to essentialist facts to offer a promising alternative. Indeed, the only alternative option for perdurantists would seem to be to embrace anti-haecceitism as a brute modal principle.

Let's turn now to how the three pluralistic ontologies look under endurantism. Here the dialectic is more complex. Let's start with an endurantist version of a relationist view, and for

simplicity let's assume that the relevant fundamental material objects are just particles. Notice that Future Tuesday Reset poses a counterexample to full lawfulness for endurantists in a pluralist setting: just imagine whatever enduring particles there are popping out of existence and being replaced by distinct enduring particles, all the while preserving all qualitative facts. So it seems that pluralist endurantists must embrace some analogue of Ontological Inertia$_{\text{Monism}}$ to rule out such possibilities. In the monist setting, just requiring that the one thing there is continues to endure forever was sufficient to pin down all future non-qualitative facts given some initial state and qualitative lawfulness. However, there are two new worries that arise in a pluralist relationist setting.

First, there is a worry that particle number might not be conserved through time. For example, consider an example of radioactive decay where a neutron (made up of one up quark and two down quarks) transforms into a proton (made up of two up quarks and one down quark), an electron, and an electron antineutrino.[41] In this example no pluralist principle akin to Ontological Inertia$_{\text{Monism}}$ can fix the identity of the post-decay particles since there are strictly more particles after the radioactive decay than before the radioactive decay. This shows that any endurantist particle-based ontology has a hope of securing full determinism via a principle of ontological inertia only if particle number is conserved.[42]

Second, even if we restrict ourselves to a particle-based ontology where particle number is conserved, we need a principle that not only rules out enduring objects popping out of existence, but also dictates *how* they endure across time. It's easy to see how the story might go at specific possibilities. For instance, at all relationist worlds where enduring objects never overlap, perhaps we can uniquely pin down the future non-qualitative facts given qualitative lawfulness by requiring that enduring objects never pop out of existence and also never move discontinuously. However, we don't think a single principle can do the requisite work in full generality; rather, worlds with different laws will call for different principles. To see this, consider worlds where enduring objects always move on continuous trajectories but can

[41] This is an example of "β^-" decay, as discussed in Basdevant et al. (2005).

[42] If particle number is not conserved, then we don't see any other strategy for the endurantist particle-based relationist to secure full lawfulness other than to accept anti-haecceitism, just like the perdurantist.

overlap. Nothing in this description tells us whether two enduring objects that briefly overlap on some occasion subsequently "passed through" each other or "bounced off" of each other. Yet the sought after principle dictating how objects endure across time must take a stand on this question. Notice, though, that both scenarios are perfectly conceivable: which occurred at some world will depend on the laws of nature of that world. The lesson here is that endurantist pluralists cannot aim to formulate a direct analogue of Ontological Inertia$_{\text{Monism}}$ that works in full generality, but should instead seek a more circumscribed principle that rescues full lawfulness on a case-by-case basis, in a manner that takes into account the details of the laws of nature at issue.

Irrespective of how the relevant principle ultimately gets formulated given our laws or any others, the challenge facing pluralist endurantists will be the same as the one we discussed in section 4: independently motivate the truth of the pluralist version of ontological inertia, rather than simply stipulate it. The analogue of attempt 1, in terms of essential properties, we take to be unsuccessful for the reasons we've seen above. Attempt 2, by contrast, carries over unchanged: appealing to the weakened PSR in the form of Temporal Rationalism would also motivate the pluralist version of ontological inertia. Yet the problem of motivating even this weakened version of the PSR remains as glaring as it was before. Crucially, attempt 3 is a non-starter in this pluralist setting. Yes, endurantism would enable non-Humeans to avoid violations of Hume's Dictum concerning a single particle across time (because the particle at one time is not wholly distinct from the particle at some other time). However, most laws will also impose constraints relating wholly distinct particles. For example, Newton's law of gravity in this non-Humean setting would describe a necessary connection between any particle there is and every other particle, and endurantism simply does nothing to address these other violations of Hume's Dictum. Thus we see that attempt 3 to motivate ontological inertia---via preserving Hume's Dictum for those who countenance necessary connections in accordance with the laws of nature---is applicable only in the monist setting we adopted in section 4. In a non-Humean pluralist setting, Hume's Dictum is a non-starter from the get-go. What about attempt 4, in terms of strong laws of nature? This view gains plausibility in this pluralist setting, given that, as we just saw, the pluralist's analogue of Ontological Inertia$_{\text{Monism}}$ at a possibility must be sensitive to that possibility's laws. Nevertheless, all of our worries about developing strong laws, for each alternative conception of the metaphysics of laws, carry forward to the

pluralist setting unchanged. We see, then, that for endurantist pluralist relationists the only ways forward are attempts 2 or 4 (namely, appeal to Temporal Rationalism or strong laws of nature).

Let us turn now from the relationist ontology to the two others, which countenance either only spacetime, or spacetime in addition to material objects. Both ontologies face the same problem given endurantism: commitment to enduring spatial points (irrespective of whether one countenances material objects as well) is widely held to be problematic because it seems to lead to physically redundant structure. The problem is that enduring spatial points immediately generate a standard of absolute rest: namely, being located at numerically one and the same region of space across time. As is familiar, such ideology of absolute rest seems to play no explanatory role in our best physical theories, and many for that reason will be reluctant to endorse enduring spatial points.[43]

Perhaps some endurantists will be content to just embrace this extra spatiotemporal structure, as independently motivated by their metaphysical theory despite playing no role in our best physics. To such endurantists we then pose the same dialectic as before. Avoiding counterexamples to full lawfulness akin to Future Tuesday Reset requires adopting a pluralistic analogue of Ontological Inertia$_{\text{Monism}}$. The resulting principle will be more local, depending on the details of the laws of nature of whatever worlds are at issue. For example, because standard spacetime theories contain inertial structure, one such principle could require that necessarily all spatial points endure along inertial trajectories. In fact, the proponent of enduring spatial points could instead *define* inertial structure by reference to the structure of enduring spatial points: for example, a particle can be said to be on an inertial trajectory iff it is moving at a constant velocity with respect to enduring space itself. This reveals that it is far from clear whether the posit of enduring space is in fact physically redundant: those who do not countenance enduring space must regard any inertial structure in spacetime as fundamental, while those who do countenance enduring space can reduce inertial structure to facts about enduring spatial points and the spatial distances between such points.[44] In any case, the key

[43] For discussion of how exactly the inference here might proceed, see Dasgupta (2016b).

[44] For a related point about the advantages of Newtonian spacetime, see Sider (2020: 108-109).

issue of motivating a pluralist principle of ontological inertia for spatial points will remain: in a pluralist setting the only means of independently motivating such a principle must stem from attempts 2 or 4 above, via Temporal Rationalism or strong laws of nature. As we have seen, attempt 1 via essential properties is problematic, and attempt 3 via preserving Hume's Dictum for non-Humeans requires monism.

Let us now turn, finally, to the "mixed" version of the second pluralistic ontology, which countenances both material objects and spacetime, and maintains that matter endures yet spacetime perdures. The issues raised by this view mirror some of the issues we've already seen in this section. We can generate threats to full lawfulness by considering permutations or replacements of particular spacetime points. We can also generate such threats by considering nomic possibilities where the enduring material objects are permuted or replaced by new enduring objects. Addressing the former perdurantist threats is arguably best done by adopting qualitativism. And in the present pluralist setting the latter endurantist threats call for Temporal Rationalism or strong laws of nature (which are the only means of independently motivating the pluralist's analogue of Ontological Inertia$_{\text{Monism}}$). And the challenges we have already seen for these strategies remain as glaring as ever.

7. Upshots

We have covered a lot of ground, and the dialectical situation is somewhat messy. Let's summarize the central conclusions we've reached.

First, perdurantists should arguably also embrace qualitativism. Perdurantists had to embrace anti-haecceitism in order to vindicate full lawfulness, and qualitativism was the most promising means of independently motivating this modal principle. Of course they could embrace this principle as a brute modal constraint. But ideally they'd embrace a metaphysic that implies the principle if there is one to be found. We take the contrapositive here to be especially striking. If, like most philosophers, you embrace some individuals at the fundamental level, and hence reject qualitativism, then you should also embrace endurantism. In this way, our discussion offers a powerful argument for endurantism stemming from the constraint of full lawfulness.

If you're an endurantist you have a few paths forward. If you embrace monism, you can attempt to independently motivate Ontological Inertia$_{\text{Monism}}$ via attempt 2 in terms of Temporal Rationalism or attempt 4 in terms of strong laws of nature. Nonetheless, we argued that the most promising strategy for monists goes via attempt 3, in terms of vindicating Hume's Dictum given the presence of necessary connections in accordance with the laws of nature. If you embrace pluralism, on the other hand, your only options for independently motivating the pluralist's analogue of Ontological Inertia$_{\text{Monism}}$ must go via attempts 2 or 4. Furthermore, endurantist pluralists faced some additional obstacles that endurantist monists did not (for instance, they seemed to require that particle number be conserved). We think this overall dialectical situation gives endurantists reason to embrace monism. Most notably, attempt 3 in terms of vindicating Hume's Dictum fared significantly better than the rest as a means of motivating ontological inertia. Yet we also saw that this Hume's Dictum motivation is available only in a monistic setting. So we see that full lawfulness also enables one to construct an argument for monism, stemming from endurantism and Hume's Dictum.

Lastly, we also take our previous discussion to have an important moral for the metaphysics of time, which we have so far not addressed. The moral concerns the A-theory of time, according to which the present is in some sense metaphysically privileged. Arguably the most serious challenge to the A-theory stems from relativistic physics: the A-theory requires there to be a privileged notion of simultaneity in order for there to be a privileged notion of the present, but relativistic spacetimes seem to lack a privileged notion of simultaneity. The standard A-theoretic response to this objection is to supplement orthodox relativistic spacetime with a privileged standard of simultaneity.[45] However, many reject this extra posit on the grounds that it has no independent motivation. We believe our discussion provides the sought after independent motivation for a privileged notion of simultaneity, even setting aside the A-theory. Recall that we have argued that those who embrace the orthodoxy of non-qualitativism have reason to favor endurantism over perdurantism. Yet, crucially, any endurantist who embraces substantivalism is thereby committed to absolute simultaneity. As we saw in section 6, the endurantist substantivalist who embraces pluralism must countenance enduring spatial points. These points generate a standard of absolute rest, and in the context

[45] See, for example, Markosian (2004) and Zimmerman (2011).

of Special Relativity, a standard of absolute rest also generates a standard of absolute simultaneity (being simultaneous with respect to the privileged inertial rest frame).[46] On the other hand, if the endurantist substantivalist embraces monism---believing that the only fundamental individual is a three-dimensional space that endures though time---then this space itself serves as the privileged standard of simultaneity. So either way endurantist substantivalists are committed to a privileged notion of simultaneity. Moreover, substantivalism is widely taken to be more plausible than relationism in light of contemporary physical theories.[47] Putting these points together, all who embrace the orthodoxy of non-qualitativism should arguably embrace a privileged notion of simultaneity, for reasons entirely independent of the A-theory of time.

Let us, finally, reiterate the central general moral that we started with: the constraint of full lawfulness matters to debates about the metaphysics of persistence. We have seen that the constraint has independent motivation, and reveals some quite surprising commitments of the two central positions. There remains work to be done comparing and evaluating the resulting packages of views. Still, now we have before us the more fleshed out metaphysical visions of the world that we should arguably be adjudicating between. Whichever way the balance of considerations ultimately points, we're confident that considerations of how best to preserve full lawfulness promise to breathe some new life into traditional debates concerning how things persist through time.

---

[46] While an objective standard of absolute rest clearly generates an objective standard of simultaneity in Special Relativity, things are more complex in General Relativity. However, a similar result still holds. In particular, specifying an objective class of "absolute rest" worldlines throughout the spacetime manifold (corresponding to a congruence of time-like geodesics) allows one to specify a unique foliation of spacetime into orthogonal hypersurfaces (generating an objective standard of simultaneity), so long as that family of worldlines has a vanishing "rotation tensor". For more on this result, see Poisson (2004: 36-40).

[47] As Earman summarizes, "The absolutist can point to three reasons for accepting a substratum of space-time points: the need to support the structures that define absolute motion, the need to support fields, and the need to ground the right/left distinction when parity conservation fails" (1989, 173). See Pooley (2013) for a recent overview of the debate between substantivalism and relationism.

References

Armstrong, David. 1983. *What is a Law of Nature?* Cambridge: Cambridge University Press.

Balashov, Yuri. 2010. *Persistence and Spacetime*. Oxford University Press.

Basdevant, Jean-Louis, Michel Spiro, and James Rich. 2005. *Fundamental in Nuclear Physics*. New York: Springer.

Belot, Gordon. 1995. New work for counterpart theorists: Determinism. *The British Journal for the Philosophy of Science* 46, no. 2: 185-195.

Bennett, Jonathan 1984. *A Study of Spinoza's Ethics*. Indianapolis: Hackett.

Bhogal, Harjit. 2020a. Humeanism about laws of nature. *Philosophy Compass* 15, no. 8: 1-10.

Bhogal. Harjit. 2020b. Induction and the Glue of the World. *Australasian Journal of Philosophy*. doi: 10.1080/00048402.2020.1793788

Bhogal, Harjit. 2020c. Nomothetic Explanation and Humeanism about Laws of Nature. In *Oxford Studies in Metaphysics Volume 12*, edited by Karen Bennett and Dean Zimmerman, p. 164-202. Oxford: Oxford University Press.

Bird, Alexander. 2007. *Nature's Metaphysics: Laws and Properties*. Oxford University Press

Briggs, Rachael and Graeme Forbes. 2012. The Real Truth About the Unreal Future. In *Oxford Studies in Metaphysics Volume 7*, edited by Karen Bennett and Dean Zimmerman, 257-304. Oxford: Oxford University Press.

Brighouse, Carolyn. 1997. Determinism and Modality. *The British Journal for the Philosophy of Science* 48, no. 4: 465-481.

Builes, David. 2020. Derivatives and Consciousness. *Journal of Consciousness Studies* 27, no. 9-10: 87-103.

Builes, David. 2021a. The World Just Is The Way It Is. *The Monist* 104, no. 1: 1-27.

Builes, David. 2021b. The Ineffability of Induction. *Philosophy and Phenomenological Research*. https://doi.org/10.1111/phpr.12753

Builes, David and Trevor Teitel. 2020. A puzzle about rates of change. *Philosophical Studies* 177, no. 10: 3155-3169.

Carroll, John. 1994. *Laws of Nature*. Cambridge: Cambridge University Press.

Carroll, John. 2018. Becoming Humean. In *Laws of Nature*, edited by Walter Ott and Lydia Patton, 122-138. Oxford: Oxford University Press.

Chalmers, David. 1996. *The Conscious Mind: In Search of a Fundamental Theory*. Oxford:

Oxford University Press.

Chalmers, David. 2002. Does Conceivability Entail Possibility? In *Conceivability and Possibility*, edited by Tamar Szabo Gendler and John Hawthorne, 145-200. Oxford University Press.

Chalmers, David. 2008. Two-dimensional semantics. In *The Oxford Handbook to the Philosophy of Language*, edited by Ernest Lepore and Barry Smith. Oxford University Press.

Cowling, Sam. 2017. Conceivability Arguments for Haecceitism. *Synthese* 194, no. 10: 4171-4190.

Dasgupta, Shamik. 2009. Individuals: An Essay in Revisionary Metaphysics. *Philosophical Studies* 145, no. 1: 35–67.

Dasgupta, Shamik. 2016a. Metaphysical Rationalism. *Noûs* 50, no. 2: 379-418.

Dasgupta, Shamik. 2016b. Symmetry as an Epistemic Notion (Twice Over). *British Journal for the Philosophy of Science* 67, no. 3: 837-878.

Dasgupta, Shamik. 2017. Quality and Structure. In *Current Controversies in Metaphysics*, edited by Elizabeth Barnes, 7-23. New York: Routledge.

Della Rocca, Michael. 2010. PSR. *Philosopher's Imprint* 10, no. 7: 1-13.

Demarest, Heather. 2017. Powerful Properties, Powerless Laws. In *Causal Powers*, edited by Jonathan Jacobs, 38-53. Oxford: Oxford University Press.

Dorst, Chris. 2019. Humean laws, explanatory circularity, and the aim of scientific explanation. *Philosophical Studies* 176, no. 10: 2657-2679.

Dretske, Fred. 1977. Laws of Nature. *Philosophy of Science* 44, no. 2: 248-268.

Earman, John and John Norton. 1987. What Price Spacetime Substantivalism? The Hole Story. *The British Journal for the Philosophy of Science* 38, no. 4: 515-525.

Earman, John. 1989. *World Enough and Space-Time*. Cambridge: MIT Press.

Easwaran, Kenny. 2014. Why Physics Uses Second Derivatives. British Journal for the Philosophy of Science 65, no. 4: 845–862.

Emery, Nina. Forthcoming. The Governing Conception of Laws. *Ergo*.

Fine, Kit. 1994. Essence and Modality. *Philosophical Perspectives* 8: 1-16.

Forbes, Graeme. 2016. The Growing Block's past problems. *Philosophical Studies* 173, no. 3: 699-709.

Gibson, Ian and Oliver Pooley. 2006. Relativistic Persistence. *Philosophical Perspectives*

20:157-198.

Gilmore, Cody. 2008. Persistence and Location in Relativistic Spacetime. *Philosophy Compass* 3: 1224-1254.

Goff, Philip. 2019. Essentialist Modal Rationalism. *Synthese.* https://doi.org/10.1007/s11229-019-02109-9

Haslanger, Sally. 1989. Persistence, change, and explanation. *Philosophical Studies* 56, no. 1: 1-28.

Hawthorne, John and Andrew Cortens. 1995. Towards Ontological Nihilism. *Philosophical Studies* 79, no. 2: 143-165.

Hawthorne, John. 2006. Determinism De Re. In *Metaphysical Essays*, 239–243. Oxford University Press.

Hicks, Michael Townsen. 2021. Breaking the explanatory circle. *Philosophical Studies* 178, no. 2: 533-557.

Hildebrand, Tyler. 2013. Can Primitive Laws Explain? *Philosophers' Imprint* 13: 1-15.

Hildebrand, Tyler. 2014. Can bare dispositions explain categorical regularities? *Philosophical Studies* 167, no. 3: 569-584.

Hildebrand, Tyler. 2018. Natural Properties, Necessary Connections, and the Problem of Induction. *Philosophy and Phenomenological Research* 96: 668-689.

Hildebrand, Tyler and Metcalf, Thomas. Forthcoming. The Nomological Argument for the Existence of God. *Noûs.*

Ismael, Jenann and Schaffer, Jonathan. 2020. Quantum holism: nonseparability as common ground. *Synthese* 197, no. 10: 4131 - 4160.

Jacobs, Jonathan. 2011. Powerful Qualities, Not Pure Powers. *The Monist* 94, no. 1: 81-102.

Kimpton-Nye. 2021. Reconsidering the Dispositional Essentialist Canon. *Philosophical Studies* 178, no. 10: 3421-3441

Kment, Boris. 2012. Haecceitism, Chance, and Counterfactuals. *Philosophical Review* 121, no. 4: 573-609.

Kment, Boris. 2014. *Modality and Explanatory Reasoning.* Oxford: Oxford University Press.

Koons, Robert and Pruss, Alexander. 2021. Skepticism and the principle of sufficient reason. *Philosophical Studies* 178, no. 4: 1079-1099.

Lange, Marc. 2005. How Can Instantaneous Velocity Fulfill Its Causal Role?

Philosophical Review 114, no. 4: 433–468.

Lange, Marc. 2013. Grounding, scientific explanation, and Humean laws. *Philosophical Studies* 164, no. 1: 255-261.

Lange, Marc. 2018. Transitivity, self-explanation, and the explanatory circularity argument against Humean accounts of natural law. *Synthese* 195, no. 3: 1337-1353.

Lewis, David. 1980. A Subjectivist's Guide to Objective Chance. In *Studies in Inductive Logic and Probability*, ed. Richard C. Jeffrey, pp. 83–132. University of California Press.

Lukasiewicz, Jan. 1967. On Determinism. In *Polish Logic*, edited by Storrs McCall, 19-39. Oxford University Press.

Magidor, Ofra. 2016. Endurantism vs Perdurantism?: A Debate Reconsidered. *Noûs* 50, no. 3: 509-532.

Markosian, Ned. 2004. A Defense of Presentism. In *Oxford Studies in Metaphysics Volume 1*, edited by Dean Zimmerman, 47-82. Oxford University Press.

Markosian, Ned. 2013. The Truth About the Past and the Future. In *Around the Tree: Semantic and Metaphysical Issues Concerning Branching Time and the Open Future*, edited by Fabrice Correia and Andrea Iacona, 127-141. Springer.

Maudlin, Tim. 2007. *The Metaphysics within Physics*. Oxford University Press.

Melia, Joseph. 1999. Holes, Haecceitism and Two Conceptions of Determinism. *The British Journal for the Philosophy of Science* 50, no. 4: 639-664.

Merricks, Trenton. 1995. On the incompatibility of enduring and perduring entities. *Mind* 104, no. 415: 521-531.

Norton, John. 2019. The Hole Argument. *The Stanford Encyclopedia of Philosophy* (Summer 2019 Edition), edited by Edward Zalta.

Peirce, Charles. 1934. *Collected Papers of C.S. Peirce*. Harvard University Press.

Poisson, Eric. 2004. *A Relativist's Toolkit: The Mathematics of Black-Hole Mechanics*. Cambridge: Cambridge University Press.

Pooley, Oliver. 2013. Substantivalist and Relationist Approaches to Spacetime. *The Oxford Handbook of Philosophy of Physics*, edited by Robert Batterman, 522-586. New York: Oxford University Press.

Pruss, Alexander. 2006. *The Principle of Sufficient Reason: A Reassessment*. Cambridge University Press.

Schaffer, Jonathan. 2013. The Action of the Whole. *Aristotelian Society Supplementary*

Volume 87, no. 1: 67-87.

Segal, Aaron. 2014. Causal essentialism and mereological monism. *Philosophical Studies* 169, no. 2: 227-255.

Segal, Aaron. Forthcoming. Humeanisms: metaphysical and epistemological. *Synthese*.

Shoemaker, Sydney. 1980. Causality and Properties. In *Time and Cause*, edited by Peter van Inwagen, 109-35. Dordrecht, Holland: Reidel.

Shoemaker, Sydney. 1998. Causal and Metaphysical Necessity. *Pacific Philosophical Quarterly* 79: 59-77.

Shumener, Erica. 2019. Laws of Nature, Explanation, and Semantic Circularity. *British Journal for the Philosophy of Science* 70, no. 3: 787-815.

Sider, Theodore. 2001. *Four Dimensionalism: An Ontology of Persistence and Time*. Oxford University Press.

Sider, Theodore. 2020. *The Tools of Metaphysics and the Metaphysics of Science*. Oxford University Press.

Teitel, Trevor. 2019. Holes in Spacetime: Some Neglected Essentials. *Journal of Philosophy* 116(7): 353-389.

Teitel, Trevor. 2021. How to Be a Spacetime Substantivalist. Forthcoming in the *Journal of Philosophy*.

Thomason, Richmond. 1970. Indeterminist Time and Truth-value Gaps. *Theoria* 36: 264-281.

Thomson, Judith. 1983. Parthood and identity across time. *Journal of Philosophy* 80, no. 4: 201-220.

Tooley, Michael. 1977. The Nature of Laws. *Canadian Journal of Philosophy* 7, no. 4: 667-698.

Tooley, Michael. 1997. *Time, Tense, and Causation*. Oxford University Press.

Tugby, Matthew. 2017. The problem of retention. *Synthese* 194: 2053–2075.

Tugby, Matthew. 2021. Grounding theories of powers. *Synthese* 198, no. 12: 11187-11216.

Turner, Jason. 2011. Ontological Nihilism. In *Oxford Studies in Metaphysics Vol. 6*, edited by Karen Bennett and Dean Zimmerman, 3-54. Oxford: Oxford University Press.

Turner, Jason. 2017. Can We Do Without Fundamental Individuals? In *Current Controversies in Metaphysics*, edited by Elizabeth Barnes, 24-42. New York: Routledge.

Van Cleve, James. 1985. Three Versions of the Bundle Theory. *Philosophical Studies* 47,

no. 1: 95-107.

Van Inwagen, Peter. 2015. *Metaphysics* (4th edition). New York: Westview Press

Wilson, Alastair. 2013. Schaffer on Laws of Nature. *Philosophical Studies* 164, no. 3: 653-667.

Wilson, Jessica. 2010. What is Hume's Dictum, and why believe it? *Philosophy and Phenomenological Research* 80, no. 3: 595-637.

Wilson, Mark. 1987. What is a law of nature? (book review). *The Philosophical Review* 96, no. 3: 435–441.

Zimmerman, Dean. 2011. Presentism and the Space-Time Manifold. In *The Oxford Handbook of Philosophy of Time*, edited by Craig Callender, pp. 163-246. Oxford University Press.