

The Power to Govern

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Abstract: I provide a new account of what it is for the laws of nature to govern the evolution of events. I locate the source of governance in the content of law propositions. As such, I do not appeal to notions of ground, essence, or production to characterize governance. After introducing the account, I use it to outline previously unrecognized varieties of governance. I also specify that laws must govern to have two theoretical virtues: explanatory power as well as a theoretical virtue I call *expansiveness*. A theory is expansive, roughly, when it can do more with less.¹

I. Introduction

The idea that laws or law-like entities govern the universe appears in a wide variety of philosophical discussions. Aristotle criticizes the idea that the universe has many “governing principles” with no first principle by claiming that “the world refuses to be governed badly” (*Metaphysics* XII.10. 1076a 3-4). In *The New Organon*, Francis Bacon illuminates what he means by “forms,” claiming: “I mean nothing more than those laws and determinations of absolute actuality which govern and constitute any simple nature, as heat, light, weight, in every kind of matter and subject that is susceptible of them.” (Book II XVII) And Nicolas Malebranche maintains that laws govern the union of the body and soul (Twelfth Dialogue, *Dialogues on Metaphysics and Religion*). Given the prevalence of the notion of governance, it is a pressing question whether and how we can understand this notion non-metaphorically. While I do not claim that these philosophers invoke the same notion of governance, I investigate whether there is a substantive notion of governance that could underwrite these various ideas.

Determining the nature of governance is important for weighing the merits of various contemporary accounts of laws of nature. One of the biggest clashes over laws of nature concerns how much power, if any, the laws have. Some “Anti-Humeans” take laws to be powerful in that they guide the

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evolution of the cosmos. The laws take initial and boundary conditions, and they *dictate* what happens next (in a deterministic world, anyway).

Humeans maintain that we should be skeptical of this talk of “dictating,” “guiding,” or “governing” the evolution of the cosmos. These are metaphors. Laws of nature are neither judge-like nor god-like; they cannot literally dictate, guide, or govern anything. After all, nobody elected the wave function to office. Laws of nature are not the right sorts of entities to govern the universe. They are more akin to cosmic summarizers.² They capture regularities and patterns found in the universe.

I argue that there is a non-metaphorical notion of governance and that laws have the power to govern. I have three objectives in providing an account of governance. First, I provide a non-metaphorical account of governance that does not rely on heavyweight metaphysical relations like those of metaphysical ground, essence, or production.³ Just because the Anti-Humean takes laws of nature to be powerful does not imply that laws need to appeal to primitive, hyperintensional notions to diagnose the source of their power. Second, I provide an account of governance that captures a genuine difference between Humeans and Anti-Humeans about laws of nature. To provide an account of governance that both camps can appeal to would not help us understand why there is such a deep divide between Humeanism and Anti-Humeanism or the philosophical source of this disagreement. My aim, instead, is to argue that there is a notion of governance that plays this demarcating role. Third, I aim for a degree of neutrality: I seek an account of governance that is not tied to a specific Anti-Humean account of laws. We can motivate the idea that laws must be powerful entities without arguing for a specific incarnation of Anti-Humeanism.

I propose that law propositions govern when they *productively necessitate* which events transpire. In sections III-V, I define “productive necessitation” and argue that many Anti-Humean laws are in a position to govern on this conception while Humean ones cannot. I use the resulting account of governance to chart new varieties of governance that are useful for metaphysicians and philosophers of science. In sections VI-VII, I demonstrate how the account delineates Humean and Anti-Humean accounts, and in section VIII, I argue for the significance of governance. In doing so, I demonstrate how my account reveals a hidden theoretical virtue, that of expansiveness.

II. The Problem with Governance

Given that Humeans and Anti-Humeans encompass the two main realist views of laws of nature, understanding whether laws govern is relevant to determining which variety of realism is most credible. Humeans claim that laws derive from the particular matters of fact comprising the Humean mosaic. While not every Humean accepts the same characterization of laws, many defend versions of the Best-Systems Account,⁴ which takes laws to be true generalizations capturing regularities in the mosaic. The laws of the Best-Systems Account are the true generalizations entailed by the ideally best

² See Loewer [2007] for discussion of law propositions providing a “scientific summary” of the universe (324).

³ For conceptions of governance that rely on ground see Emery [2019] and [forthcoming]. For an account that invokes the notion of essence, see Wilsch [2021].

⁴ See for discussion Lewis [1973], [1999], Beebe [2000], Schrenk [2006], Cohen and Callender [2009], Loewer [2012], [2020], Miller [2014], Demarest [2016], Bhogal and Perry [2016], Bhogal [2020], Dorst [2017], [2018], Hall [ms2], Jaags and Loew [2018], and Hicks [2021].

scientific theory, where the ideally best scientific theory is the one that best balances simplicity and informativeness (Loewer [2012], p. 119).

Anti-Humeans typically deny that laws are universal generalizations. John Carroll [1994] and Tim Maudlin [2007] consider laws to be primitive entities. Laws are not reducible to or grounded in other entities. Laws are fundamental constituents of our ontology, according to the primitivist. Fred Dretske [1977], Michael Tooley [1977], [1987], and D.M. Armstrong [1983] popularized another influential form of Anti-Humeanism: they argued that laws are brute necessitation relations holding between universals. Uniting these two views under the umbrella of Anti-Humeanism is the idea that the laws are able to govern, direct, or guide the progression of events.⁵

Two leading Humeans, Helen Beebe [2000] and Barry Loewer [1996], [2020], have appealed to the obscurity and metaphorical nature of governance to motivate a Humean theory of laws over Anti-Humean theories. Loewer asks, “What do these metaphors of governing and guiding come to? No one thinks that the laws literally govern events. Nor do the laws cause the events.”⁶ Beebe thinks it is difficult to spell out a notion of governance: “It isn’t just that the laws plus current facts entail future facts; rather the laws ‘make’ the future facts the way they will be: the laws are the ontological ground of the future facts.”⁷ Without providing an account of “making” or “ontological ground,” the nature of governance remains mysterious.⁸

Beebe and Loewer also suspect that the notion of governance is an evocative metaphor. Beebe emphasizes that natural laws could never govern in the sense that moral or political laws govern: agents cannot violate natural laws like they can moral or political laws, for instance. Loewer suspects that the metaphor of governance is “obscure.” According to Beebe and Loewer, it is not important for our theory of laws to preserve the Anti-Humean’s intuition that laws govern. We should not be disturbed if the laws of our theory fail to govern—since it is unclear what governance amounts to in the first place. This lends reason to resist choosing an Anti-Humean theory over an elegant, commonsensical Humean one.⁹ I propose that the Anti-Humean can provide an account of governance that is clear, well-motivated, and distinguishes Humean and Anti-Humean views.

⁵ Two other prominent Anti-Humean accounts belong to Marc Lange [2009] and Alexander Bird [2005], [2007]. Lange considers laws to be dependent on certain primitive counterfactuals, and Bird offers a dispositionalist account of laws. However, not every account of laws invoking dispositions falls wholly under Anti-Humeanism. Such accounts are often considered to fall on the Anti-Humean side of the spectrum but sometimes involve Humean aspects as well. For instance, Demarest [2017] also discusses a view that is “Anti-Humean in its ontology” because it accepts fundamental powers or dispositions, but “Humean in its laws” because it retains a Best-Systems Account of laws. It is an open question whether and which versions of these views provide governing laws, but I am unable to discuss the issue in this paper. For further developments of Anti-Humeanism, see Carroll [1994], Hildebrand [2019] [2020a], [2020b], Schaffer [2016].

⁶ Loewer, 192. See Schneider [2007] for skepticism about governance and Ward [2008] for discussion of governance as a metaphor.

⁷ Beebe, 257.

⁸ One may argue that the notion of ontological ground is not obscure. For characterizations of governance that appeal to notions of ground or dependence see Demarest [2017] and Emery [2019], [forthcoming].

⁹ Others, such as Hicks and Schaffer [2017] argue against “governing” conceptions of laws, but in a way that is orthogonal to this paper’s conception of governance. Schaffer and Hicks argue against a governing constraint stated as follows, “Fundamental Governing: Scientifically elite laws operate only on metaphysically elite properties to govern their distribution through space–time.” As we will see in section V, the notion of governance developed here does not appeal to elite properties. Furthermore, Humeans typically believe that we may not need to appeal to a governing theory of laws if we are motivated to do so because non-governing laws fail to support counterfactuals. They argue that Humean

III. Providing an Account of Governance

Governance captures a certain kind of relationship between laws and initial or boundary conditions on the one hand, and particular matters of fact on the other. The laws govern when they, along with initial and boundary conditions, compel or give rise to certain kinds of states of affairs.

While we should use modal tools to characterize governance, we cannot simply maintain that laws govern when they necessitate particular events. By the laws “necessitating” events, I mean that the truth of the law-propositions (together with propositions capturing the initial and boundary conditions) necessitates the truth of another proposition, where the latter depicts an event’s occurrence. I will use angle brackets ‘<’ and ‘>’ to offset propositions. If I claim that the law $(\forall x)(Fx \supset Gx)$, together with Fa , necessitates Ga , I mean the truth of the conjunctive proposition $\langle (\forall x)(Fx \supset Gx) \ \& \ Fa \rangle$ necessitates the truth of $\langle Ga \rangle$, where $\langle Ga \rangle$ represents that a has feature G . Or if I claim that the Armstrongian law $N(F, G)$ —where ‘ F ’ and ‘ G ’ pick out universals and ‘ N ’ picks out the primitive necessitation relation—together with Fa necessitates (or fails to necessitate) Ga , then I mean the proposition $\langle N(F, G) \rangle$ conjoined with the proposition $\langle Fa \rangle$ necessitates (or fails to necessitate) the truth of the proposition $\langle Ga \rangle$. It is insufficient for laws to govern that they (perhaps with initial or boundary conditions) necessitate which events occur in this sense. If all it took for laws to govern was for laws to necessitate events, it would be too easy for laws to govern. The laws of Best-Systems Account would count as governing laws as well. For instance, a Humean law proposition of the form $\langle \text{All ravens are black} \rangle$ conjoined with $\langle \text{Alfred is a raven} \rangle$ will necessitate $\langle \text{Alfred is black} \rangle$. This criterion of governance would not distinguish Humean accounts from Anti-Humean ones.

Characterizing governance in this way does not explain why Anti-Humeans would think that governance is the missing element from Humean accounts of laws. This characterization also does not shed light on how governance is related to the explanatory power of laws: the fact that laws necessitate certain events does not yet indicate that the laws explain those events. So, it cannot be “mere entailment” or necessitation that Anti-Humeans have in mind when they appeal to governance to distinguish their views on laws from Humean views.

Not everyone who uses the locution of “governance” believes that it is a distinguishing feature of Humean and Anti-Humean laws. Jonathan Schaffer [2016] suggests that laws govern when they necessitate particular states of affairs. John Roberts [2008] maintains that for laws of nature to govern is for them “to be inevitably true on account of their being laws of nature.” Roberts then cashes out this notion of inevitability with counterfactuals. This theory of governing laws can in principle be adopted by versions of Humeanism and Anti-Humeanism. But because I am searching for an account of governance that can locate a primary source of disagreement between Anti-Humean and Humean laws, I do not take Schaffer or Roberts to be providing competing accounts to mine. I will not argue against laws providing the kind of counterfactual support Roberts proposes. I leave it open that Schaffer and Roberts’ notions of governance may underwrite some appeals to governance in discussions of metaphysics and philosophy of science. There may not be a single account that can capture all governing talk. I aim to discover whether there is an account of

theories do offer counterfactual support. My discussion will not assume that governing theories of laws offer counterfactual support while non-governing theories do not. For discussion of this issue, please see Hall [ms1].

governance that captures the notion that Anti-Humean laws can guide or dictate the evolution of events while Humean laws cannot.

Given this aim, we cannot appeal solely to laws' entailing or necessitating certain events for the laws to govern; nevertheless, I doubt we need to appeal to a relation of "making" or "ontological dependence" in addition to necessitation to capture governance. Instead, I suggest that the laws of nature govern when they—with initial or boundary conditions—necessitate which events occur, and this necessitation occurs *in the right way*. The laws of nature and initial conditions will necessitate which events occur in the right way when they productively necessitate the occurrence of events.

First, we need a general gloss on the idea of productive necessitation. One proposition productively necessitates another when the truth of the former necessitates the truth of the latter, and the former does not have the entire content of the necessitated proposition as a part. In cases of productive necessitation, the content of the necessitated proposition outstrips the content of the necessitating proposition(s). One proposition non-productively necessitates another when the former necessitates the truth of the latter, and the former contains the entire content of the necessitated proposition as a part.

Examples 1-4 are (potential) cases of productive necessitation.

1. <Socrates exists> productively necessitates <The singleton set {Socrates} exists>.

And if we are physicalists who maintain that the non-physical metaphysically supervenes on (but is not identical with) the physical, we would claim:

2. <Mary is in physical state Φ at time t > productively necessitates <Mary has red qualia Ψ at time t >.
3. <Physical properties Φ_1 - Φ_n are instantiated at spacetime region $xyzt$ > productively necessitates <Donald performs a morally wrong action at spacetime region $xyzt$ >.

If the weak supplementation principle holds in mereology, the following would also be an example of productive necessitation:

4. < x is a proper part of y > necessitates <there exists a z such that z is a proper part of y and z does not overlap¹⁰ with x >.

These are examples of productive necessitation because the truth of the proposition on the left necessitates the truth of the proposition on the right, but the content of the proposition on the right outstrips (i.e., goes above and beyond) the content of the proposition on the left. When we claim that <Socrates exists> necessitates <{Socrates} exists>, the latter proposition is about something more than just Socrates; it is about sets. Likewise, in the second and third examples: if we are not identity theorists, <Mary has red qualia Ψ at time t > gives us new information—information about Mary's experiences—which is something over and above the content of the proposition depicting Mary's physical state. <Donald performs a morally wrong action at spacetime region t > also gives us further

¹⁰ x and y do not overlap when they do not share any proper (or improper) parts.

information about what is happening at t than facts about the physical properties. And in example 4, the fact that z exists and is a proper part of y is information over and above the fact that x is a proper part of y . The proposition on the left says nothing about z .

These examples of productive necessitation often accompany fruitful metaphysical explanations. Proponents of metaphysical explanations explain the existence of sets by appeal to their members, and physicalists attempt to explain mental and normative phenomena in terms of physical phenomena.¹¹ Not all cases of productive necessitation are metaphysically interesting in this way.¹² If the laws of nature productively necessitate which events transpire, they will constitute interesting examples of productive necessitation as well. Later, I will argue that we can extend the notion of productive necessitation to scientific explanation.

Contrast these cases of productive necessitation with instances of non-productive necessitation.

5. <Socrates exists> non-productively necessitates the truth of itself, <Socrates exists>.
6. <The sky is blue and oranges are round> non-productively necessitates <The sky is blue>.
7. <There is a black, heavy marble on the table> non-productively necessitates <There is a heavy marble on the table>.

Examples 5-7 are cases of non-productive necessitation. In 5-7, unlike 1-4, the necessitated proposition does not contain information independent of the necessitating proposition. In 5, the necessitating proposition is identical with the necessitated one; thus, the latter does not contain content independent of the former. In 6, the content of a conjunction contains the content of its conjuncts; so, <The sky is blue> does not contain any content that is independent of <The sky is blue and oranges are round>. In 7, the fact that there is a marble which is both black and heavy on the table already includes the information that there is a heavy marble on the table. Such cases of necessitation do not provide fruitful metaphysical explanations.

We do not have any metaphysically or scientifically interesting notion of “production” involved in examples 5-7, as we did in the first four cases. There is a sense in which non-productive necessitation is trivial—it gets us nothing new. The content of the necessitated proposition is already present in the necessitating proposition. As such, we do not arrive at metaphysically interesting theses by examining which propositions non-productively necessitate others.

Now we should ask, “What is it for the laws to govern the occurrence of specific events?” The answer, vaguely, is that the laws govern those events when the occurrence of those events is independent of the laws; yet, the laws compel those events to take place anyway. If we can make this idea precise, we can claim that the laws play a productive role in “directing” or “guiding” events when the laws govern. The task now is to make this idea more precise by distinguishing between productive and non-productive necessitation.

¹¹ See Fine [2012b] for discussion of Socrates and singleton sets. See Dasgupta [2014] and Goff [2017], Wilson [2016], and Schaffer [2017] for recent discussions of physicalism involving metaphysical explanation and dependence.

¹² I will return to this issue in Section V.

IV. Productive vs. Non-Productive Necessitation.

I analyze governance in terms of productive necessitation. We can understand productive necessitation by contrasting it with non-productive necessitation first:

Non-Productive Necessitation: A set of propositions Γ non-productively necessitates a proposition Φ when the conjunction of propositions in Γ ($\&\Gamma$) necessitates Φ and Φ is part of the content of $\&\Gamma$.

To formulate Non-Productive Necessitation precisely, we must understand what it is for one proposition to contain another as part of its content. In recent literature,¹³ philosophers appealed to the notion of partial content. Among other applications, these philosophers used the notion to capture verisimilitude and account for differences in confirmation.¹⁴ We can also use the notion of partial content to characterize governance.

We will provide an account of partial content using truthmaker semantics (following Fine’s [2012a], [2017] approach); however, this is not required. We could appeal to other semantic theories, such as possible worlds semantics. Truthmaker semantics uses sets of parts of possible worlds to capture the semantic content of propositions. It “tells us what it is in the world that makes the statement true if it is true or what it is in the world that makes it false if it is false.” (Fine [2012a], p. 235)¹⁵

Truthmaker semantics posits a state-space, a parthood relation over the state-space, and verification and falsification relations holding between states in the state-space and propositions: following Fine [2019], we take a state-space to be an ordered pair (S, \sqsubseteq) where S is a non-empty set of states and \sqsubseteq is the binary parthood relation. We take \sqsubseteq to be a partial order on S ; i.e., where s, t and u are states, [parthood] is such that the following three principles hold:

1. Reflexivity: $s \sqsubseteq s$
2. Anti-symmetry: If $s \sqsubseteq t$ and $t \sqsubseteq s$ then $s = t$
3. Transitivity: If $s \sqsubseteq t$ and $t \sqsubseteq u$ then $s \sqsubseteq u$

In what follows, we work with a modalized state space, which corresponds to the set of all possible states. Fine characterizes a modalized state space as $(S, S^\diamond, \sqsubseteq)$, where S^\diamond (all possible states) is a non-empty subset of S . The modalized state space obeys a closure principle:

¹³ See Fine [2012a], [2013], [2014a], [2017], Gemes [1993], [1994], van Fraassen [1969], Correia [2004], Angell [1989], Yablo [2014], Elgin [2021], Jago [forthcoming], Moltmann [2020], [forthcoming], Shumener [2019], Abreu Zavaleta [2019], [2021]).

¹⁴ See Yablo [2014], pp. 95-112, for a discussion of paradoxes of confirmation and content.

¹⁵ Truthmaker semantics is a distinct field of study from metaphysical accounts of truthmakers, like those popularized by Armstrong [2004]. For Armstrong, the truthmaking relation holds between states of affairs (conceived of as complexes of properties and objects) and sentences. It is concerned with what, in a world, makes a sentence true. Truthmaker semantics, on the other hand, does not reify states of affairs in the same way. It is a semantic theory concerned with spelling out the content of propositions or sentences. We will focus on propositions here.

Closure: A state t is a member of (\in) the set of possible states S^\diamond whenever there is a state $s \in S^\diamond$ such that $t \sqsubseteq s$.

This principle says that “parts of possible states are also possible states” (Fine [2017], p. 560). Where s and t are states, we define their fusion $s \sqcup t$ to be s and t 's least upper bound given the ordering imposed by \sqsubseteq . States s and t are compatible whenever their fusion, $s \sqcup t$, is a possible state and incompatible if their fusion is not a possible state. Using these principles and definitions, we can recapture the notion of a possible world in truthmaker semantics: a state s is a possible world (or a “world state”) when (a) it is possible, and (b) any state is either a (proper or improper) part of s or is incompatible with s .

Now we have a modalized state-space. The modalized state-space plays the role for the truthmaker semanticist that the pluriverse of possible worlds plays for the advocate of possible worlds semantics.¹⁶ We can now deploy a standard conception of necessitation: one proposition, P , necessitates another, Q , just in case every possible world in which P is true is one in which Q is true. Intuitively, we can think of states as parts of possible worlds, but truthmaker semantics remains neutral as to whether we should think of states as concrete or abstract, and if the latter, as to the nature of the abstract entities in question. Possible worlds semanticists often remain similarly neutral as to the nature of possible worlds. We appeal to possible worlds and possible states as a modeling tool allowing us to account for the content of our propositions. I will not take a position here on whether states are abstract or concrete.

Truthmaker semantics analyzes the semantic content of propositions by invoking states as “exactly verifying” or “exactly falsifying” the propositions in question. The content of a proposition is determined by the possible states that exactly verify it. States exactly verify or falsify propositions when the state is *wholly relevant* to the truth or falsity of the proposition [2014b]. For a state to exactly verify a proposition, it must necessitate the truth of the proposition. But a state’s necessitating the truth of a proposition is not sufficient for it to exactly verify the proposition. This is because states can necessitate the truth of totally unrelated propositions. For instance, the state [there is a cat in the house] necessitates the truth of <either it is sunny or it is not sunny> but the content of that proposition is unrelated to the cat’s being in the house. We cannot just look at which states necessitate the truth of a proposition to determine that proposition’s content.

¹⁶ We can now see one advantage truthmaker semantics has over possible worlds semantics. Because truthmaker semantics appeals to states rather than possible worlds, it can distinguish the content of many necessarily equivalent (and necessarily true) propositions. The possible worlds semanticist claims that the content of < $3 \times 5 = 15$ > and < $2 + 2 = 4$ > will be provided by the sets of possible worlds in which those propositions are true. Since these propositions are true in all the same worlds—because they are true in all possible worlds—such views cannot distinguish the content of these propositions. In contrast, the truthmaker semanticist maintains that the content of these propositions is given by the set of possible *states* that exactly verify the propositions. These propositions will be verified by different states. < $2 + 2 = 4$ > will be verified by an atomic state that is responsible for this arithmetical truth—a state involving the numbers 2 and 4. On the other hand, the verifier of < $3 + 5 = 8$ > will be an atomic state involving numbers 3, 5, and 8. Thus, their possible verifiers will differ, and the truthmaker semanticist can straightforwardly distinguish the content of the two propositions.

While we cannot provide a rigorous definition of what it is for a state to be “wholly relevant” to the truth or falsity of a proposition, we can illuminate the idea. For instance, <there are three cats in the house> will be exactly verified by the fusion of the states [Felix is in the house], [Garfield is in the house], and [Tigger is in the house]. It will not be exactly verified by the fusion of the states above along with the state [Mr. Ed the horse is in the house]. The latter state is not part of an exact verifier of <there are three cats in the house> because it involves a horse. But the fused state [Felix, Garfield, and Tigger are in the house] does not contain any extraneous creatures, which allows it to serve as an exact verifier for the proposition. This is the sense in which an exact verifier is wholly relevant to the truth of the proposition in question. Similarly, <grass is blue> will be exactly falsified by the state [grass is green]. It will not be exactly falsified by the fusion of states [grass is green] and [the popcorn machine exploded] because that fusion contains irrelevant content about the popcorn machine.

We can now provide notation for when a state exactly verifies a proposition. Where lowercase letters (s, t, u, \dots) represent states, and (A, B, C, \dots) represent individual propositions, we say:

State s exactly verifies $A =_{df} s \models_v A$

And,

State s exactly falsifies $A =_{df} s \models_f A$ ¹⁷

An atomic proposition is exactly verified by any possible state s whose obtaining is wholly relevant to the truth of P . And an atomic proposition is exactly falsified by any possible state s whose obtaining is wholly relevant to the falsity of P . Following Fine ([2012a], [2017]), we show how truthmaker semantics handles Boolean operations. I will focus on clauses for verification; I will not employ the clauses for falsification. These clauses demonstrate how states exactly verify truth-functional conjunctions, disjunctions, and negations:

- (i) $s \models_v \neg B$ if $s \models_f B$
- (ii) $s \models_v B \wedge C$ if for some states t and u , $t \models_v B$, $u \models_v C$, and $s = t \sqcup u$
- (iii) $s \models_v B \vee C$ if $s \models_v B$ or $s \models_v C$

Here are a few examples of propositions and the states exactly verifying them: the proposition, <Mollusks are invertebrates and crocodiles live in Florida> is exactly verified by the fusion of the state [Mollusks are invertebrates] with the state [Crocodiles live in Florida]. The state [Crocodiles live in Florida] exactly verifies the proposition <Crocodiles live in Florida or apples are fruit>. Negations of the form $\neg P$ are exactly verified by the states that exactly falsify P . For instance, <it is not the case that polar bears are black> will be exactly verified by states that exactly falsify <polar bears are black>, such as the state [polar bears are white].

We can extend this discussion to universal and existential generalizations:

- (v) $s \models_v (\forall x)\varphi(x)$ if s is the fusion of verifiers of $(\forall x)\varphi(x)$'s instances: $\varphi(a_1), \varphi(a_2), \varphi(a_3), \dots$

¹⁷ We discuss verification conditions below. We can also add clauses for falsification conditions, but I will refrain from doing so as they will not be relevant in our discussion.

It is difficult to fully account for the verification conditions for universal generalizations, and perhaps the fusion of states verifying the instances of a generalization is not sufficient for exact verification of the generalization: we may also need something similar to a totality state, a state that ensures that there are no other Fs that have been left out of the verifiers for the instances (see Yablo ([2014], pp.45-54), and Fine [2012b]) for a discussion of totality states). We can include a totality state as part of the exact verifier of the universal generalization in addition to the states that verify the instances of the generalization. There are different ways to characterize this kind of state, but whether and how we incorporate totality states does not impact the points made here.

(vi) $s \models_v (\exists x)\varphi(x)$ if s verifies one of $(\exists x)\varphi(x)$'s instances: $\varphi(a_1), \varphi(a_2), \varphi(a_3), \dots$

Existential generalizations like $\langle (\exists x)(x \text{ is the teacher of Plato}) \rangle$ will be verified by the state [Socrates is the teacher of Plato]. And $\langle (\exists x)(x \text{ is the set containing Socrates as its sole member}) \rangle$ will be verified by the state [{Socrates} is the set containing Socrates as its sole member]. Universal generalizations like $(\forall x)x = x$ will be verified by the fusion of the verifiers of its instances: $\langle \text{Gladys Knight} = \text{Gladys Knight} \rangle$, $\langle \text{The Eiffel Tower} = \text{Eiffel Tower} \rangle$, and so on, possibly together with a totality state.

Following (Fine [2014], p.11), we can now define what it is for one proposition to contain the content of another as a part.

C is part of the content of A if and only if:

1. Every possible state that exactly verifies A contains a possible state that exactly verifies C.

And,

2. Every possible state that exactly verifies C is contained in a possible state that exactly verifies A.

The first clause is satisfied if every exact verifier of A has an exact verifier of C as a part, and the second clause is satisfied if every exact verifier of C is part of at least one exact verifier of A. When both clauses are satisfied, C is part of the content of A. For instance, $\langle \text{Mollusks are invertebrates and crocodiles live in Florida} \rangle$ has $\langle \text{Mollusks are invertebrates} \rangle$ as part of its content. The first clause is satisfied because every state that verifies $\langle \text{Mollusks are invertebrates and crocodiles live in Florida} \rangle$ is a fusion of the states that verify $\langle \text{Mollusks are invertebrates} \rangle$ and $\langle \text{Crocodiles live in Florida} \rangle$. Such states contain an exact verifier of $\langle \text{Mollusks are invertebrates} \rangle$ as a proper part. The second clause is satisfied because every state that verifies $\langle \text{Mollusks are invertebrates} \rangle$ will be a proper part of at least one possible state that is a verifier of the conjunction. On this account of partial content, whenever C is part of A, A necessitates the truth of C, but not every proposition necessitated by A will be part of the content of A.

Now that we have our account of content parthood, we can clearly characterize productive and non-productive necessitation.

Non-Productive Necessitation: A set of propositions Γ non-productively necessitates a proposition Φ when Γ necessitates Φ and Φ is part of the content of Γ .

This means that every possible state that exactly verifies the conjunction of the propositions of Γ contains an exact verifier for Φ . And every possible exact verifier for Φ is contained in an exact verifier for the conjunction of propositions of Γ . If the conjunction of propositions of Γ necessitates the truth of Φ but (at least) one of the two conditions of partial content above fails, then we have a case of productive necessitation:

Productive Necessitation: A set of propositions Γ productively necessitates a proposition Φ when Γ necessitates Φ and Φ is not part of the content of Γ .

In the next section, I demonstrate how to use the notion of productive necessitation to formulate a criterion for governance and distinguish between different varieties of governance.

V. Varieties of Governance

Laws govern events when the corresponding law propositions, together with propositions capturing initial and boundary conditions, productively necessitate the corresponding event propositions. In other words, I conceive of governance as a relation between law propositions together with propositions capturing initial and boundary conditions on the one hand and event propositions on the other. In this way, the governing power is not located solely in the law propositions, but in them *taken together* with propositions capturing initial and boundary conditions.

Governance can come in different strengths. Let's start with the limited idea that the laws of nature— together with initial and auxiliary conditions—govern individual events. ' Δ ' signifies the conjunction of the law propositions, and ' δ ' signifies the conjunction of propositions depicting the auxiliary conditions, including the initial and/or boundary conditions along with *ceteris paribus* clauses (if applicable). '<E_x>' is a true proposition of the form '<Event x occurs>'.

In the characterizations below, we outline what it is for laws to govern in a particular possible world w . These characterizations presuppose that the law propositions, auxiliary propositions, and event propositions in question are all true at w . I will not state this requirement explicitly within the definitions for ease of reading.

To say that laws govern events is to reveal a relationship between propositions. Laws of nature will govern if and only if law propositions (together with auxiliary propositions) productively necessitate event propositions. For example, the laws of nature govern the event of Paul Revere's taking a midnight ride on April 18, 1775 when the conjunction of law propositions capturing the laws of nature, together with propositions capturing initial and auxiliary conditions, productively necessitates the proposition <Paul Revere takes a midnight ride on April 18, 1775>.

Individual Governance: The laws of nature govern a specific event n in world w iff the conjunction of the law propositions Δ and δ productively necessitates the event proposition <E_n>.

In other words, the laws of nature will govern an individual event n when the law propositions (conjoined with auxiliary propositions) productively necessitate <event n occurs>.

Individual Governance captures a relationship between law propositions, auxiliary propositions, and event propositions. Following Kim's [1976] conception of events, events take the form of triples involving at least one object, the properties and relations they instantiate, and a time instant or interval. For example, two hadrons' colliding at 2pm on September 14th, 2022, will count as an event, and Bob the Raven's instantiating blackness at 7am on April 4th, 2022, will also count as an event. What I say below does not hinge on adopting this conception of events, but understanding events in this liberal way will help clarify how this view operates. Event propositions have the form $\langle \text{Two hadrons collide at 2pm on September 14}^{\text{th}} \text{ 2022} \rangle$ and $\langle \text{Bob the Raven is black at 7am on April 4}^{\text{th}} \text{ 2020} \rangle$.

Unfortunately, we are not typically interested in Individual Governance. It would be incorrect to state that the laws govern in an intuitive sense just in case the law propositions productively necessitate at least one event proposition. Given a liberal account of events, it would be easy for the law-propositions to productively necessitate at least one event proposition. For instance, suppose there are "trivial" properties such as *being green or not being green*. Any law proposition along with the initial condition $\langle a \text{ has 5gms of mass at } t \rangle$ will productively necessitate $\langle a \text{ is green or not green at } t \rangle$. This is because $\langle a \text{ has 5gms of mass at } t \rangle$ will necessitate $\langle a \text{ is } G \text{ or not } G \text{ at } t \rangle$, and the former proposition will not contain the latter as part of its content. But presumably, the fact that law propositions can productively necessitate an event-proposition like this shouldn't lead us to conclude that laws have true governing power in any intuitive sense. $\langle a \text{ is green or not green at } t \rangle$ does not capture the kind of event we want our laws of nature to govern.

Individual Governance does not provide an adequate account of governance. At the other extreme, we can characterize what it would be for laws to govern *every* event (outside of those found in the auxiliary conditions). It would be for the conjunction of law propositions, together with initial and auxiliary conditions, to productively necessitate every event proposition:

Global Governance: The laws of nature govern every event x in world w iff the law propositions Δ (in conjunction with δ) productively necessitate $\langle E_x \rangle$, for every true proposition of the form $\langle E_x \rangle$.¹⁸

Similarly, we can characterize what it would be for law propositions of a certain *type*, such as the physical or biological laws, to globally govern events:

Type-Global Governance: The laws of nature of type M govern every event x in world w iff the law propositions Δ_m (in conjunction with δ) productively necessitate $\langle E_x \rangle$, for every proposition of the form $\langle E_x \rangle$.

Type-Global Governance may be useful if, say, we think that laws of physics have overarching governing power. In this case, we would use Type-Global Governance to capture the laws of physics governing the universe. Type-Global Governance is relevant to capturing the kind of relation that free will theorists believe physical laws have in a deterministic universe. For instance, when depicting determinism, van Inwagen maintains that determinism obtains when physical laws (which

¹⁸ Although, there is still an important restriction on $\langle E_x \rangle$, it cannot be an event proposition that captures events found in the auxiliary conditions (δ). Just as laws cannot govern themselves, laws and auxiliary conditions cannot govern themselves. This restriction will apply to $\langle E_x \rangle$ as well as the event propositions ($\langle M_x \rangle$, $\langle C_x \rangle$, and $\langle CM_x \rangle$), in the formulations below.

exclude psychological laws) necessitate events or states of affairs.¹⁹ Type-Global Governance captures what it would be for a specific subset of law propositions to have the power to necessitate event propositions at every level.

While Individual Governance is in danger of making it too easy for laws to govern, Global Governance and Type-Global Governance may render it difficult for laws to govern. More often, we are not interested in whether laws of nature govern a single event or all events, but instead events of a certain type. For instance, we may be interested only in whether laws of nature govern events of microphysics. $\langle M_x \rangle$ is the proposition that event x of type M occurs. Here is a first formulation of a criterion of governance for type-specific events.

Global-Type Governance: The laws of nature govern every event of type M in w iff the law propositions Δ (in conjunction with δ) productively necessitate $\langle M_x \rangle$, for each true proposition $\langle M_x \rangle$.

The type signifies whether we are interested in physical events, chemical events, biological events, etc. The laws govern when they (with initial and boundary conditions) productively necessitate which events belonging to type M occur. And if we want laws of a particular type to govern laws of that same type:

Type-Type Governance: The laws of nature of type M govern every event of type M in w iff the law propositions Δ_m (in conjunction with δ) productively necessitate $\langle M_x \rangle$, for each true proposition $\langle M_x \rangle$.

We have governance when the law propositions and auxiliary conditions productively necessitate the propositions in the purview of the laws. In other words, the necessitated propositions must involve the same types of properties and relations featured in the laws. For instance, for the physical laws to govern physical events, they must productively necessitate which physical events occur. The physical events will be the ones involving exclusively physical properties.

It is difficult to make the notion of “same subject matter” or same “types of properties” precise; nevertheless, in many classic examples, we can follow determinable-determinate structure: if laws involve determinable properties, such as mass, the event propositions they necessitate will involve those same properties or properties falling under those determinable properties, such as determinates of mass.

Type-Type Governance is a useful notion. The law propositions of biology may not productively necessitate event propositions involving the instantiation of microphysical properties. But we would not claim that the laws of biology fail to govern on that basis. Intuitively, biological law propositions need to productively necessitate only biological event propositions to govern. Likewise, physics law propositions need to productively necessitate only physical event propositions in order to govern. The biological laws govern when their corresponding propositions (with the initial/boundary conditions and *ceteris paribus* clauses) productively necessitate propositions concerning which *biological* events occur and which do not. Physical laws govern when their corresponding propositions productively necessitate propositions concerning which *physical* events will occur and which will not. Type-Type

¹⁹ van Inwagen [1975].

Governance allows us to determine whether laws of a certain kind govern or not. This is the variety of governance we will discuss.

While our focus will be on whether deterministic, exceptionless laws have the power to govern, we can also modify the characterization to accommodate indeterministic laws and laws with *ceteris paribus* clauses. We can accommodate *ceteris paribus* laws by modifying the auxiliary conditions. For instance, if biological laws govern only with a *ceteris paribus* clause, the criterion for governance will be that law propositions, auxiliary and *ceteris paribus* conditions together productively necessitate certain event propositions.

We can also formulate parallel criteria for governance for indeterministic laws. We can claim that laws govern in an indeterministic world when the law propositions productively necessitate the likelihood of an event's occurrence. In that case, we will have analogues of the above characterization of governance.

Suppose that n is an event, and $\langle C_n \rangle$ stands for a true proposition of the form $\langle \text{The chance that } n \text{ occurs is } \phi \rangle$. We now have:

Indeterministic Individual Governance: Laws of nature govern a specific event n in w iff the law propositions Δ in conjunction with δ productively necessitate $\langle C_n \rangle$, where $\langle C_n \rangle$ has the form $\langle \text{The chance that } n \text{ occurs is } \phi \rangle$.

Indeterministic Global Governance: Laws of nature govern every event x in w , iff law propositions Δ in conjunction with δ productively necessitate $\langle C_x \rangle$, for every $\langle C_x \rangle$ of the form $\langle \text{The chance that } x \text{ occurs is } \phi \rangle$.

Indeterministic Global-Type Governance: Laws govern every event of type M in w iff law propositions Δ in conjunction with δ productively necessitate $\langle CM_x \rangle$, (where $\langle CM_x \rangle$ depicts that an event of type M has chance ϕ of occurrence), for every true proposition of the form $\langle CM_x \rangle$.

Indeterministic Type-Type Governance: Laws of type M govern every event of type M in w iff law propositions Δ_m in conjunction with δ productively necessitate $\langle CM_x \rangle$, (where $\langle CM_x \rangle$ depicts that an event of type M has chance ϕ of occurrence), for every true proposition of the form $\langle CM_x \rangle$.

Given these distinctions among types of governance, we can address an objection. In the previous section, I maintained that productive necessitation often accompanies interesting explanations while non-productive necessitation does not. We should now note that some cases of productive necessitation are not relevant to scientific governance. Propositions will productively necessitate disjunctions which have them as a disjunct: $\langle P \rangle$ productively necessitates $\langle P \vee Q \rangle$ since the content of $\langle P \vee Q \rangle$ outstrips the content of $\langle P \rangle$ (at least in many cases). Nevertheless, we wouldn't typically claim that $\langle P \rangle$ governs $\langle P \vee Q \rangle$. $\langle \text{Mercury is the closest planet to the Sun} \rangle$ doesn't govern $\langle \text{Mercury is the closest planet to the Sun or Sean Connery is the best James Bond} \rangle$ even though the former productively necessitates the latter. Such productive necessitation is scientifically trivial.

Because there are scientifically trivial cases of productive necessitation, you may wonder if productive necessitation is really the appropriate notion to capture governance. After all, I claimed that we want law propositions to necessitate event propositions in a non-trivial way to distinguish governing laws from non-governing ones. This concern can be met by appealing to the instances of productive necessitation appearing in Type-Type Governance. The fact that one proposition productively necessitates another does not by itself guarantee that the necessitation is the kind of non-trivial necessitation we think is involved in nomological governance. Productive necessitation is not a relation found only in discussions of governance; in other cases, it may not track any scientifically interesting or substantive types of necessitation. What's important is that productive necessitation—when restricted to the particular relata needed to govern—is not trivial.

And it is not trivial. In Type-Type governance, law propositions must productively necessitate all of the event propositions of that type. To clarify: the kind of triviality that the inference from $\langle P \rangle$ to $\langle P \vee Q \rangle$ exhibits does not appear in cases of productive necessitation concerning law propositions and event propositions. Let's turn to why entailments like those from $\langle P \rangle$ to $\langle P \vee Q \rangle$ seem trivial. One potential source for the triviality is that you can disjoin any proposition to $\langle P \rangle$ you wish, no matter how irrelevant the content of $\langle Q \rangle$ is to the content of $\langle P \rangle$. The necessitation from $\langle P \rangle$ to $\langle P \vee Q \rangle$ is not trivial in the sense in which the content of the latter is contained in the former. It is trivial in the sense that any disjunction with $\langle P \rangle$ as a disjunct follows from $\langle P \rangle$.

In Type-Type Governance, when law propositions productively necessitate event propositions, we do not face triviality arising from other sources: the proposition being necessitated does not contain irrelevant information like the necessitated propositions in the previous paragraph. We can spell this out positively. The reason that productive necessitation is non-trivial in Type-Type Governance is that the law propositions involve the same kinds of properties as the necessitated event propositions involve. This is why we must specify *which* propositions must be productively necessitated by the law propositions in order to have governance.

One may be concerned that there will be some trivial event propositions of the same type as the law propositions. For example, perhaps the physical law propositions (together with auxiliary propositions) will necessitate the proposition $\langle \text{Electron } e \text{ has the property of either being located at region } S \text{ or not being located at region } S \rangle$. Maybe so, but this will not be problematic for the account in question because we would only have Type-Type governance if the law propositions necessitate *every* physical event proposition (apart from the ones capturing events found in the auxiliary conditions). The physical law propositions will not govern solely by necessitating the proposition above. They must also necessitate the proposition $\langle \text{Electron } e \text{ is in region } S \rangle$ or $\langle \text{Electron } E \text{ is not in region } S \rangle$. To avoid triviality, it's important that governance is understood as a relationship between collections of law propositions (and auxiliary propositions) and collections of event propositions.

Still, we should ask whether productive necessitation can characterize governance if there are inferences that count as productive necessitation but do not count as instances of governance. It's true that productive necessitation has a life of its own outside of discussions of governance, but I take this to be an advantage rather than a problem. Consider a comparison. Philosophers of mind and meta-ethicists often appeal to supervenience or ground to characterize the relationship between normative or mental facts on the one hand and physical facts on the other—even though there are many instances of supervenience and ground that do not concern mental and normative facts. Rather

than taking this as an indicator that supervenience and ground aren't apt to characterize physicalism, this indicates that the relations of supervenience and ground have wide-ranging application and flexibility. They are philosophical tools which can be tailored and appealed to in specific discussions. We should think of productive necessitation similarly: while not every instance of productive necessitation is one of governance, appealing to productive necessitation in the context of laws of nature allows us to distinguish trivial and non-trivial relationships between law propositions and event propositions.

VI. Which Laws of Nature Govern?

Humean laws cannot govern whereas certain Anti-Humean laws can govern.

A. Humean Laws do not Govern.

Let's see why Humean law propositions do not govern event propositions. We're now going to consider the Best-Systems Account which takes laws to be true universal generalizations appearing as axioms of the best system. Humean law propositions, together with auxiliary conditions, will necessitate event propositions. Here's an oversimplified example. Consider a law that takes the form: $\langle (\forall x)(\text{if } x \text{ is a raven then } x \text{ is black}) \rangle$ or $\langle (\forall x)(Rx \supset Bx) \rangle$, along with the auxiliary condition that Alfred is a raven $\langle Ra \rangle$. Together, the conjunction of the universal generalization and $\langle Ra \rangle$ will non-productively necessitate $\langle Ba \rangle$.

The content of $\langle \text{Alfred is black} \rangle$ is part of the conjunction of the law $\langle (\forall x)(\text{if } x \text{ is a raven then } x \text{ is black}) \rangle$ and $\langle \text{Alfred is a raven} \rangle$. To see why, we consider which states are supposed to exactly verify universal generalizations. The most natural candidates for exact verifiers of a universal generalization are the fusions of verifiers for the generalization's instances; this is what the clause \vee says in section II. With this in mind, let's consider the following universal generalization: $\langle (\forall x)(Rx \supset Bx) \rangle$ and one of its instances, $\langle Ra \supset Ba \rangle$. Since ' \supset ' is a material conditional, it is logically equivalent to $\langle \neg Ra \vee Ba \rangle$. We have no reason to think that the content of the material conditional differs from the content of the logically equivalent disjunction. The exact verifier of this disjunction will be the states that verify either or both of its disjuncts. So, on this characterization, the exact verifier of $\langle (\forall x)(Rx \supset Bx) \rangle$ is the state which is the fusion of all the states that verify the disjunctive instances.

We can now show how Humean laws lack the power to govern. As we will see, the content of $\langle Ba \rangle$ is contained in the content of $\langle (\forall x)(Rx \supset Bx) \ \& \ Ra \rangle$. $\langle Ra \rangle$ is straightforwardly verified by the state $[Ra]$. And the state verifying $\langle (\forall x)(Rx \supset Bx) \rangle$ includes the fusion of states that exactly verify instances of the following disjunction: $\langle (\forall x)(\neg Rx \vee Bx) \rangle$. This is just the original universally-quantified material conditional rewritten as a universally-quantified disjunction. So the verifiers of $\langle (\forall x)(Rx \supset Bx) \ \& \ Ra \rangle$ will be the verifiers of $\langle (\forall x)(\neg Rx \vee Bx) \ \& \ Ra \rangle$. Since generalizations are verified by their instances, an exact verifier of $\langle \neg Ra \vee Ba \rangle$ is part of the verifier for the universal generalization. But the first disjunct is false in this case since a is a raven. Recall that the state $[Ra]$ is also part of the verifier for the conjunction. So the exact verifier of the conjunction must include a verifier for the right disjunct. And the exact verifier of the right disjunct is $[Ba]$. This state is the same one that serves as the exact verifier for the $\langle Ba \rangle$. $\langle Ba \rangle$ is part of the content of $\langle (\forall x)(Rx \supset Bx) \ \& \ Ra \rangle$. Every exact verifier for the conjunction includes a verifier for $\langle Ba \rangle$. And every verifier for

$\langle Ba \rangle$ is included in a verifier for the conjunction. Thus, the laws and initial conditions non-productively necessitate which events transpire on this Humean approach.

B. The Governing Power of Anti-Humean Laws

I will now demonstrate that Anti-Humean laws can productively necessitate event propositions. I will focus on primitivist Anti-Humean accounts, which take laws to be primitive entities and law propositions to have the form $\langle \text{LAW}(\Phi) \rangle$ where LAW is an unanalyzed primitive operator. For instance, the primitivist will represent the proposition that it is a law that all Fs are Gs as $\langle \text{LAW}((\forall x)(Fx \supset Gx)) \rangle$. I will show that Armstrongian laws of nature count as governing laws. The Armstrongian maintains that laws of nature involve necessitation relations between universals. Armstrongian law propositions of the form $\langle N(F, G) \rangle$ can productively necessitate event propositions.

Primitivist and universals-based accounts of laws are governing accounts. For the Anti-Humean who takes laws to be necessitation relations holding among universals, $\langle N(F, G) \rangle$ and $\langle Fa \rangle$ will together necessitate $\langle Ga \rangle$. The exact verifier of the conjunction $\langle N(F, G) \ \& \ Fa \rangle$ will be the state [F-ness and G-ness stand in the nomic necessitation relation] along with the state [Fa]. If we take universals to exist as abstracta, then the state [F-ness nomicly necessitates G-ness] need not contain any material objects, including a. This follows from a general pattern concerning propositions about universals. Propositions like $\langle 5\text{kg mass is more similar to } 10\text{kg mass than it is to } 30\text{kg mass} \rangle$ and $\langle \text{Blueness is a color} \rangle$ are other examples of propositions concerning universals and relationships among universals that do not have verifiers involving the bearers of these universals.²⁰ The state [F-ness nomicly necessitates G-ness] only has three constituents, the universals F-ness, G-ness, and the nomic necessitation relation. Since the state [Fa] does not have [Ga] as a part, the fusion of the states [F-ness nomicly necessitates G-ness] and [Fa] does not contain [Ga] as a part. When the law proposition $\langle N(F, G) \rangle$ necessitates the event proposition $\langle Ga \rangle$, it does so productively.

The primitivist will also appeal to productive necessitation. Suppose the primitivist wants to explain $\langle Ga \rangle$. The primitivist posits a primitive law with a corresponding law proposition of the form $\langle \text{LAW}((\forall x)(Fx \supset Gx)) \rangle$. This proposition along with $\langle Fa \rangle$ will productively necessitate $\langle Ga \rangle$. Although a universal quantifier appears in it, the proposition $\langle \text{LAW}((\forall x)(Fx \supset Gx)) \rangle$ is not a universal generalization, and the state [Ga] is not a (proper or improper) part of a verifier of $\langle \text{LAW}((\forall x)(Fx \supset Gx)) \ \& \ Fa \rangle$. The primitivist takes laws of nature to be brute facts in the world. Such a primitive state does not have proper parts. Thus, states involving the behavior of particular entities do not appear as verifiers. A more likely verifier for the law proposition would just be the primitive state $[\text{LAW}((\forall x)(Fx \supset Gx))]$. And that state fused with [Fa] comprise the exact verifier for

²⁰ The point isn't that we couldn't construct an account upon which the verifiers for these propositions include the bearers of the universals. The point is that the Anti-Humean isn't forced to do so. While I believe that certain universals-based accounts of laws of nature can govern, it's not clear that these will capture all of Armstrong's worldview. In the example above, I have in mind an account where universals are taken to be platonic rather than immanent (as Armstrong would prefer).

the conjunction. So, at least two Anti-Humean accounts of laws will appeal to productive necessitation to account for the relationship between law propositions and event propositions.²¹

VIII. The Significance of Governance.

Why should we care about a governing account of laws? There are two primary reasons: (1) governing theories exhibit a certain theoretical virtue that non-governing theories do not exhibit, that of *expansiveness*; and (2) governance is necessary for explanatory power.

A. Governance and Expansion

When a governing theory productively necessitates event propositions, it necessitates propositions whose content it does not contain. When a theory non-productively necessitates event propositions, it only necessitates propositions whose content it already contains. In productively necessitating event propositions, governing theories yield a variety of new consequences that are not included in the theory.

Governing theories are more *expansive* than non-governing theories because the former can necessitate non-trivial phenomena (event propositions) that go beyond the content of the theory itself. This feature of a governing theory—expansiveness—is theoretically virtuous. One may question whether productively necessitating event propositions is a virtue of a theory. After all, as long as a theory can necessitate event propositions—either productively or non-productively—isn't that enough? When a theory productively necessitates, it can do more; it can non-trivially necessitate a wider variety of event propositions than its non-governing rivals. When calculating what a theory productively necessitates, we determine how much more the theory can tell us about the universe. Consider an oversimplified case. Suppose we have two theories Theory 1 and Theory 2, and A, B, and C are event propositions (I drop the angle brackets for ease of reading):

Theory 1 consists of the proposition P. P necessitates A, B, and C, but does not contain the content any of them in the content of P.

Theory 2 consists of the conjunctive proposition (A & B) & C. Theory 2 necessitates A, B, and C and contains the content of A, B, and C as parts.

Both Theory 1 and Theory 2 will necessitate A, B, and C. But Theory 1 necessitates in a more expansive way than Theory 2. In Theory 2, the theory is itself built up of the disparate phenomena that it's trying to necessitate. Theory 1 is different: it uses a single, semantically distinct proposition P to necessitate a wide variety of phenomena (the event propositions A, B, and C).

Expansiveness reveals a way in which Theory 1 is stronger than Theory 2: Theory 1 can go beyond its own content to necessitate event propositions whereas Theory 2 only necessitates propositions by containing them. There is a sense in which every theory can do what Theory 2 does. Every theory will necessitate the truth of its individual conjuncts. Theory 1 necessitates its own content parts as well

²¹ This is not to say that every account of Anti-Humean laws will secure this result. It is more difficult to detect whether counterfactual and dispositional laws, such as those of Lange and Bird, are capable of governing as well. Whether such laws govern will depend on how we understand the content of counterfactual and dispositionalist propositions.

as other scientifically informative propositions. And a theory that necessitates its own content as well as additional, non-trivial content is stronger than a theory that can only necessitate its own content. An expansive theory is stronger than a non-expansive one because it can do more with less.

Humean theories, by invoking universal generalizations, are more akin to Theory 2 than Theory 1. Instead of a conjunction containing its conjuncts as parts, we now have a universal generalization containing its instances as parts. Anti-Humean theories better resemble Theory 1 than they do Theory 2. Just as P necessitates A without containing A as part of its content, laws like $\langle N(F,G) \rangle$ or $\langle LAW(P) \rangle$ (together with auxiliary propositions) are supposed to necessitate $\langle Ga \rangle$ without containing the latter as part of its content. Governing theories—as long as they can necessitate event propositions—are more expansive than their non-governing rivals.

B. Governance and Explanatory Power

1. The Circularity Charge against Humeanism

I have argued elsewhere that laws (together with initial and boundary conditions) must be able to productively necessitate events to have explanatory power [Shumener (2019)]. While I cannot delve into all the details of my argument here, I will provide the overall structure.

Governance allows laws to have explanatory power. This is not to say that an account of governance will automatically lead to an account of scientific or nomological explanation. Instead, the laws' possessing governing power is a necessary condition for their playing a key role in successful scientific explanations in that if laws were non-governing, they would not have explanatory power.

Non-productive necessitation leads to explanatory triviality. If laws only non-productively necessitate which events occur, the content of the explanandum would be contained in the content of the explanans. This leads to a kind of explanatory triviality because the following principle should be satisfied:

CON: If the content of a proposition E is part of the content of a set of propositions Γ , then an explanation of E in terms of Γ is unsuccessful.

The content of Γ is the content of the conjunction of the members of Γ . I take CON to provide a plausible constraint on explanations. The plausibility of this constraint rests upon the following two principles:

P1. If Γ explains E, and the content of P is part of the content of Γ , then P helps explain E.

P2. A proposition capturing only the content of explanandum E cannot explain—even partially or indirectly—itsself.

If we accept P1 and P2, then we should accept CON. A familiar monotonicity constraint on explanation supports P1: If a set of propositions Γ fully explains E, we can't just add propositions to Γ ($\Gamma+$) and expect $\Gamma+$ to explain E. This is because $\Gamma+$ can contain information that's either irrelevant (at best) to the explanation of E or (at worst) undermines the explanatory aspects of Γ .

The motivation behind this monotonicity constraint also serves as a motivation to accept P1. Explanations should not contain irrelevant information: content that does not help explain the explanandum. One proposition helps explain another when the former at least partially explains the latter. If P1 were false, there would be propositions whose content would be part of the explanans Γ that do not help explain E. If this content does not help explain E, why does Γ contain such extraneous content? If Γ did contain such extraneous content, we should suspect there to be another conjunction of propositions, call it Γ^- , that contains only the non-extraneous content of Γ . Γ^- should then be the genuine explanation of E. Propositions—and collections of propositions—are easy to come by: if Γ contains content that is not explanatorily relevant to E, there should be no barrier to uncovering collections of propositions with just the relevant content.

P2 is a straightforward irreflexivity constraint on explanations. The explanandum of an explanation should not be used to explain itself, either partially or indirectly. Together, P1 and P2 imply CON. To see this, we will suppose the truth of the antecedent of CON and then demonstrate that P1 and P2 yield the consequent of CON. Assume the truth of the antecedent of CON: the content of a proposition E is part of the content of a set of propositions Γ . Now we consider whether Γ can explain E. Given that Γ contains the content of the explanandum E, then (by P1) we should expect a proposition that includes only the content of E, proposition E itself, to help explain E. This is because all of the content of the explanandum Γ should help explain E, and the content of E is included in Γ . But by P2, E cannot help explain itself. Thus, we can establish the consequent of CON: explaining E in terms of Γ is unsuccessful.

If what we have said about Humean laws is correct, then propositions of the form $\langle (\forall x)(Fx \supset Gx) \rangle$ & $\langle Fa \rangle$ will non-productively necessitate ones of the form $\langle Ga \rangle$. This leads to trouble when we have an explanation of the following form:

Explanans: $\langle (\forall x)(Fx \supset Gx) \rangle$ & $\langle Fa \rangle$ Explanandum: $\langle Ga \rangle$

The content of $\langle Ga \rangle$ will be contained in the explanans, the conjunction $\langle (\forall x)(Fx \supset Gx) \rangle$ & $\langle Fa \rangle$. This exhibits circularity in the same way as attempting to explain $\langle \text{It is raining} \rangle$ by $\langle \text{It is raining and it is snowing} \rangle$. When the content of the proposition being explained is fully contained in the propositions doing the explaining, we have violated CON and do not make explanatory progress. We have not explained why the explanandum is true on independent grounds.

There is much more to be said about the circularity charge against the Humean, including a myriad of Humean responses.²² While I cannot explore those responses here, we have established that—if my version of circularity charge is persuasive—only governing theories of laws have the power to explain events.

²² For further discussion of the circularity charge against Humeanism, see Hempel and Oppenheim [1948]; Armstrong [1983]; Bird [2007] Maudlin [2007]; Loewer [2012]; Lange [2013]; Paul [2013]; Hicks and van Elswyk [2014], Hicks [2021], Miller [2014]; Marshall [2015], Bhogal [2017], [2020a], [2020b], Kovacs [2020], Emery [2019], Hall [ms1], [ms2], Roski [2018], Shumener [2019], and Dorst [2019].

IX. Conclusion

We now have an account of governance that makes precise what it is for the laws of nature to guide or direct the evolution of events. In doing so, I have shown that understanding governance in terms of productive necessitation is well-motivated, does not invoke additional metaphysical primitives, and distinguishes Humean accounts of laws from Anti-Humean accounts.

I do not expect this to end the debate between Humeanism and Anti-Humeanism. Humeans may respond that Humean laws do not need to govern in my sense to be explanatory nor do they need expansive power. Even Anti-Humeans may have held such sympathies because of considerations that are unrelated to discussions of governance.

But I trust that my paper can be helpful for those who are undecided between the two camps and question whether it is worthwhile to adopt Anti-Humeanism, wondering what Anti-Humeanism can achieve that Humeanism cannot, and whether the additional ontological commitments of an Anti-Humean theory are worth the cost. I have shown that we can capture a special relationship between Anti-Humean law propositions and event propositions. Furthermore, we do not need to posit a special notion of essence, ground, or production to achieve this governing power. If the primitivist or nomic necessitation theorist's laws can necessitate event propositions, then we need only look to the content of the law propositions to uncover their governing power.

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