Accept no substitutes: Against best-system theories without naturalness*

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The best-system theory of lawhood is understandably popular (especially in the philosophy-of-science wing of metaphysics), above all because it avoids the metaphysical excesses of more inflationary competitors. But some regard its best-known version, namely, David Lewis's, as still being too inflationary. "Lite" versions have been developed that attempt to avoid Lewis's reliance on a distinction between natural and non-natural properties.

The concerns about naturalness are misguided. Lewis's theory doesn't introduce a problematic gap between the metaphysics of laws and the aims of physics. And lite best-system theories (which come in different flavors) have their own troubles. Accept no substitutes! The best best-system theory is the original, still with 100% naturalness.[1]

1. The best-system theory

To determine what the laws are, Lewis said, you hold a competition.[2] The competitors are "systems": sets of true sentences that are closed under logical implication. Systems compete for being *strong*—saying a lot about the world—and being *simple*—having a syntactically simple axiomatization. As Lewis points out, simplicity without strength is easy to achieve (for instance, by saying nothing more than that "everything is self-identical"), as is strength without

*Thanks to Verónica Gómez, Barry Loewer, Ezra Rubenstein, Jonathan Schaffer, Erica Schumener, and the participants of my 2024 seminars at Rutgers University and the Hamburg/Vienna Summer School for helpful feedback.

[1]Lewis's account of lawhood is developed in Lewis (1973, pp. 73–4; 1983, pp. 366–8; 1986, pp. 121–4; 1994); see also Hall (2015*a*). Critics of Lewis's reliance on naturalness include Cohen and Callender (2009); Demarest (2017); Eddon and Meacham (2015); Loewer (1996, 2007, 2020*b*, 2024); Taylor (1993); van Fraassen (1989, Chapter 3). Others pushing the account in a "pragmatist" direction include Dorst (2019); Halpin (2003); Hicks (2018); Hoefer (2007); Loew and Jaag (2018); Roberts (1999). For criticism of these trends see Bhogal (forthcoming); Gómez Sánchez (2023); Hildebrand (forthcoming).

[2]You don't literally *hold* this competition. Systems are abstract entities, which have their strength, simplicity, and balance values independently of being considered by us. See below.

simplicity (for instance, by including an exhaustive point-by-point specification of field values); but the goal of the competition, which is nontrivial to achieve, is to be as strong as possible without sacrificing too much simplicity. The winner of the competition is the system that strikes the best *balance* between strength and simplicity—the "best" system. The members of this system (or perhaps only its universal generalizations) are the laws of nature.

The best-system theory is schematic until a particular trio of measures of strength, simplicity, and balance—a "measure", for short—is introduced. One might attempt to specify a measure by studying the standards that scientists (or physicists, at least) actually use in theory choice. This would draw the metaphysics of laws close to its epistemology; and the possibility of doing so is seen as an advantage for the best-system theory.[3] But Lewis worried about a disadvantage: that tying the measures too closely to scientific practice would introduce unwanted mind-dependence into the notion of law. For instance, flat-footedly *defining* the measure in terms of scientific practice (*viz*, "to be a law is to be a member of the system that best balances the virtues of strength and simplicity by the measure operative in physics departments on Earth in the year 2024") would imply that there would have been no laws of nature if there hadn't been any physics departments. One could wriggle using familiar tricks, for instance by replacing the description 'the measure operative in physics departments on Earth in the year 2024' with a proper name of a specific measure whose reference is fixed by that same description; but as Lewis says, a maneuver like this "doesn't make the problem go away, it only makes it harder to state" (Lewis, 1994, p. 479).

In my view, the residual problem is one of objectivity, understood in a certain way.[4] Suppose there are fifty different measures, $M_1, \ldots M_{50}$, that physicists could have used, resulting in fifty different best-system theories, and thus fifty different notions of law; and suppose that these notions differ substantially, in that the laws$_i$ are very different from the laws$_j$ when $i \neq j$ (though of course they are all true statements). For each i, the facts about lawhood$_i$ are mind-independent: the laws$_i$ would still have been laws$_i$ regardless of the behavior of physicists (since lawhood$_i$ is defined directly in terms of the measure M_i rather than by reference to physicists). Nevertheless, the fact that quite different truths count as laws$_j$ for forty-nine other js undermines the objectivity of the facts about lawhood$_i$. Suppose the correct semantics for 'cool song' assigns to

[3] But see Gómez Sánchez (2023) for a corresponding critique.

[4] See also Carroll (1990, pp. 201–2); Roberts (1999, pp. S503–4).

each subculture k in Brooklyn a certain sonic property of sounds, S_k, namely, the sonic property common to all and only songs preferred by that subculture. Despite the fact that the proposition expressed by 'that is a cool song' within each subculture is mind-independent, there is an important sense in which coolness of songs fails to be objective, since what each subculture expresses by those sentences is a projection of their aesthetic preferences. The failure of objectivity in lawhood after the wriggling is parallel.[5]

Lewis's solution to the problem was the belief, or hope, that in the actual world, lawhood coincides for all "reasonable" measures.[6] This hope would deliver objectivity in lawhood, in the sense of 'objectivity' just introduced: although there are multiple notions of lawhood, corresponding to multiple measures, those notions do not differ in extension.

The objectivity of the laws is contingent, under this conception, since there are possible circumstances—in which "nature is unkind"—in which the various notions of lawhood$_i$ would indeed diverge substantially. And it could come in degrees, if there is minor extensional variation amongst the notions.

Even if nature is kind, there will be perverse measures M_p under which the laws$_p$ differ wildly from the laws. Lewis is excluding those measures as "unreasonable"; and objectivity must be so-understood that truth values of 'law' sentences under unreasonable measures are irrelevant to the objectivity of lawhood. We can distinguish two sorts of unreasonable measures. One sort bears no relation whatsoever to what we ordinarily think of as lawhood (such as the trivial measure that counts *any* two sets of sentences as balancing strength and simplicity equally well). I take the exclusion of these to be matter of linguistic convention.[7] A community of "physicists" attaching the word 'law' to an unreasonable measure (or a subculture of "hipsters" attaching 'cool song' to an unreasonable sonic property) would simply be talking about another subject matter; they would be like a group of people who used the term 'law of nature' to refer to jokes. Variation of truth value over alternate semantic values of *this* sort is nothing more than the familiar fact that meaning is conventional rearing its head, and does not constitute a failure of objectivity. The second sort is "mathematically grueified" measures, such as a measure that behaves like

[5] See Sider (2011, chapter 4) for more on this conception of objectivity.

[6] The hope is more justified if we define the laws as Lewis did, as the *theorems* of the best system rather than its axioms under the simplest axiomatization. One might be more willing to admit a certain degree of failure of objectivity in the question of which laws are "fundamental" and which are "derivative". But see Belot (2011, chapter 3) for an important critique.

[7] See the discussion of "linguistically alien" communities in Sider (2011, pp. 49–50).

a reasonable measure when applied to every system except for one exception, namely, the system that correctly lists the actual field values at every spacetime point, which the measure rates as being maximally good. These Lewis should exclude using his notion of naturalness, which we will discuss in a moment.

Thus the Lewisian reply to the concern about mind-dependence is as follows. In the actual world, there is a system that counts as best under a large class of measures.[8] Our concept of lawhood is defined in terms of one of the measures in this class (or, more likely, is vague over some subclass). The existence of such a class of measures is a substantial, contingent fact about our world, guaranteeing that concepts of lawhood like ours are robustly successful and objective.[9]

The systems in the competition are, we said, sets of sentences. But sentences in what language? This is where naturalness comes in. For as Lewis pointed out, if we are allowed to pick predicates that have any meanings whatsoever, we could choose a language in which the sole nonlogical predicate F is true of all and only objects in possible worlds that are exactly like the actual world in every way, and formulate a bogus system that consists solely of the sentence $\forall x F x$ together with all of its logical consequences in that language. This system is extremely simple (it is axiomatized by the single sentence $\forall x F x$). Moreover, Lewis understands the strength of a system as its *modal strength*, which is defined as being inversely proportional to the "size" (under some suitable measure) of the set of worlds in which the system is true. Thus the bogus system is as strong as can be (since it is true only in possible worlds that are exactly like ours). So it would seem to count as the best system. As a result, every true proposition would count as nomologically necessary—as being a modal consequence of the laws of nature.

Lewis's solution to the problem was to require that all systems in the competition be formulated in a language in which every predicate refers to some "perfectly natural" property or relation. The notion of perfect naturalness was one that Lewis had come to see as indispensible to systematic philosophy

[8] What about the boundaries of the class? We could evaluate the distinction between reasonable and unreasonable measures for objectivity, by asking whether different reasonable choices of meaning for 'reasonable measure' would result in substantially different extensions for that predicate. The question would be about the objectivity of the objectivity of laws of nature. This question could iterate. "Realism" about lawhood demands only objectivity, not objectivity^n for $n > 1$.

[9] Indeed, I would argue that this fact plays a role in the metaphysics of norms of theory choice. The reasonableness of pursuing systems with ideal balance is partly constituted by the contingent fact that across a wide range of nearby possibilities, such strategies are successful.

(Lewis, 1983). In my view, 'perfectly natural' should be seen as an undefined posit, whose reference is fixed (though not in any particularly rigid way) by the totality of ways we appeal to it in theorizing, much as a theoretical predicate in physics lacks reductive necessary and sufficient conditions but nevertheless has its reference fixed by its theoretical role (Sider, 2011, chapter 2). But the intuitive core of the notion of naturalness is this: the perfectly natural properties and relations are the "fundamental" properties and relations whose distribution constitutes the fundamental facts about the world.

Although Lewis doesn't quite say it explicitly, it's clear that the "language" in which systems must be formulated isn't meant to be a natural language, and that predicates in this language don't "refer to" natural properties in the sense of natural-language reference.[10] (There could have been laws even if no natural-language users had referred to natural properties!) Rather, he is using 'language' and 'reference' as they are used in mathematical logic: "languages" and other syntactic entities are simply abstract entities, with stipulated syntactic forms; an "interpreted" language is simply a pair of a language and a function that maps "words" in the language to appropriate worldly entities (such as entities and properties and relations); and to say that a predicate in such a language "refers to" a natural property means nothing more than that the function paired with the language maps that predicate to the natural property.

2. A gap between science and metaphysics?

Many authors have argued that Lewis's reliance on naturalness opens up an unacceptable gap between metaphysics and science. According to this worry, "metaphysical" laws could come apart from "scientific" laws. The former are given by the Lewisian best system, which is constrained by the "metaphysical" facts about naturalness; the latter are what scientists regard as laws; and there is no guarantee that the two will coincide. Bas van Fraassen (1989, p. 53) pressed this worry in an influential early discussion; and Jonathan Cohen and Craig Callender (2009, p. 12) vividly describe a specific scenario of this sort:[11]

[10] What he does say is this: "Whatever we may or may not ever come to know, there exist (as abstract objects) innumerable true deductive systems: deductively closed, axiomatizable sets of true sentences." (1973, p. 73).

[11] See also Elgin (1995); Demarest (2017, section 2.2) on the "mismatch problem"; and Loewer (2020*b*, pp. 1077), who writes that "Physics aims to find nature's scientific joints, but these may not coincide with her metaphysical joints".

> ...consider the case of Murray Gell-Mann and others organizing mesons and baryons into octets—now seen as representations of SU(3) symmetry—in what became famous as the Eightfold Way. The theory relies on the positing of new fundamental properties, in particular, fractional charge. The Eightfold Way seems to scientists the on balance strongest and simplest systematization of the relevant phenomena. Is it a law (or at least a corollary of a law)? Of course, it might fail to be because further experiments might reveal more phenomena that demand a better system, or because someone keener than Gell-Mann might come along and systematize the field even better. Stipulate for the sake of argument, however, that Gell-Mann reasoned impeccably and had all the facts available to him; given the kinds he [chose], the Eightfold Way really is the best systematization of the relevant facts. Even granting this much, [Lewis] cannot guarantee that the Eightfold Way is a law (law corollary); for there is nothing to guarantee that fractional charge is one of the properties enshrined as perfectly natural.

Now, a natural response is that it just *is* possible that physicists follow the best scientific methodology and yet are wrong in their conclusions, so it is unproblematic that Lewis's theory commits us to this possibility. What Cohen and Callender are imagining is akin to the scenarios on which traditional skeptical arguments in epistemology are based. It is a scenario in which physicists' evidence is misleading—a scenario in which (by stipulation) all available evidence supports a theory that isn't true. If the argument is based on the premise that such a scenario is impossible—that the truth about laws could not possibly come apart from ideal scientific practice—then no "scientific realist" should accept the premise.[12]

It's also unclear whether Cohen and Callender's scenario can be adequately fleshed out. Suppose, for example, that although the Gell-Mannian properties, such as fractional charge, are not *perfectly* natural, they nevertheless have reasonably simple definitions in terms of the perfectly natural properties.[13] Then Gell-Mann's system presumably *does* consist of Lewisian laws of nature after all (or at least, of "law corollaries"); the imagined gap between metaphysics and science wouldn't exist. For if we begin with Gell-Mann's system $\phi(T_1, \ldots, T_n)$, and then substitute, for each of his terms T_i, its definition $d(T_i)$ in terms of

[12] See also Dorr (2019, section 4.6); Hall (2015*b*, section 5.7). Unlike van Fraassen himself, most of the participants in this debate are, in the relevant sense, "scientific realists".

[13] Lewis's account of relative naturalness is questionable, particularly when it comes to special-science properties (see Gómez Sánchez (2021)), but this isn't relevant here.

perfectly natural properties, the resulting system $\phi\big(d(T_1),\ldots,d(T_n)\big)$ would surely win the Lewisian competition: it is nearly as syntactically simple as the original system (since the definitions are simple) and just as strong. The original system $\phi(T_1,\ldots,T_n)$ would be analogous to Newton's equation $F = ma$ under the assumption that position and time rather than acceleration are fundamental: although the winning entry in the Lewisian competition will not include the very sentence '$F = ma$' (since the predicates in competitors must stand for fundamental properties and relations), it will include a definitional equivalent of that sentence, namely, the result of replacing the expression for acceleration in that sentence with an expression for the second time-derivative of position.[14] But if, on the other hand, the Gell-Mannian properties have only *extremely* complex definitions (or infinite definitions, or no definitions at all) in terms of perfectly natural properties and relations, then it isn't clear how Gell-Mann's terms could ever have referred to them. These are *theoretical* terms, after all, introduced to stand for whatever physical properties satisfy the theory (near enough).[15] If no physical property fits the theory associated with such a term, that term is semantically empty, like 'phlogiston'. And according to Lewis's metaphysics, "physical properties" are just natural properties (whether perfectly natural or merely very natural) that play a role in the laws of physics (see below). So if the example is to be dialectically effective, there must be some intermediate way of understanding what the Gell-Mannian properties are supposed to be, distant enough from the natural properties so that Gell-Mann's theory doesn't give the Lewisian laws after all, but close enough to allow the Gell-Mannian terms to refer to them.

But rather than wrangle further over details, I would like to shift to the big picture. Behind objections like these there is, I think, a widespread, primordial, vague sentiment: namely, that Lewisian natural properties are the wrong sort of subject matter for physics, because they are *metaphysical*. Physics isn't about metaphysics or metaphysical properties; it is about *physical* properties.[16]

There are a variety of reasons for viewing this sentiment as being central to the thinking of many critics. For one, the appeal of scenarios like Cohen and Callendar's turns on it. If it is conceded that natural properties *are* what physics

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[14] One might object, following Hicks and Schaffer (2017), that the original system should not be seen as being metaphysically second-class in any way; but this does not seem to be Callender and Cohen's concern. (And see Sider (2020, p. 19, note 30) for a reply.)

[15] This point doesn't require an appeal to Lewis's controversial doctrine of "reference magnetism", according to which naturalness plays a role quite generally in securing reference.

[16] Loewer's "metaphysical problem" (2007, p. 322) is a clear statement of this objection.

is about, then my analysis of the scenario and its variants (the scenario is a skeptical hypothesis; the Gell-Mannian properties are not "physical" and hence not referred to by theoretical terms if they have only an extremely complex basis in the natural properties) seems apt; whereas if one pictures natural properties as "metaphysical", in a way that's opposed to the subject matter of physics—as "arcane", "scholastic", "theological" even—then my analysis will have no appeal. For another, the writings of the naturalness-skeptics are full of rhetoric that makes clear that they are indeed conceptualizing naturalness as "metaphysical" in a sense that is opposed to "physical" or "scientific". It is because naturalness is metaphysical that Lewis's account is insufficiently scientific in status.

I believe this objection to be fundamental to the thinking of many skeptics about Lewis's account (and indeed, to the thinking of many skeptics of metaphysics itself). But at the risk of sounding too grand, I think it is based on a misunderstanding of what metaphysics is.

Critics sometimes have a picture of metaphysics deriving from Plato: that metaphysics is about some distinctive realm, separate from (and perhaps superior to) the ordinary material realm that we experience and which science studies. But metaphysics isn't like this at all; or at any rate, it needn't be. There is just one realm; and metaphysics is trying to say something about it. We encounter various parts of this realm in daily life and in science, such as objects, properties, time and space. In metaphysics, we try to say something systematic about those parts—to embed them in general theories. I don't mean to say that metaphysicians *can't* posit completely new stuff or even a new realm; they can (and have). But it isn't the job description of a metaphysician to do so.

The notion of physically fundamental properties plays a central role in the philosophy of physics (sometimes under the guise of a distinction between "physical" and "conventional" phenomena). These are the properties we are trying to discover in physics; we often guess that there are new ones (such as spin) if theories using the properties we already posit aren't adequate; we use the notion to characterize genuine from coordinate-dependent features of space and time; and so on. This isn't some alien concept; it is a concept rooted in the practice of physics.

There is then a question of how to think about the notion metaphysically—how to embed it in a more general account of the nature of reality. Lewis's posit of the notion of naturalness is, in part, an answer to this question. What are physicists talking about, when they talk about "physical" properties? Lewis has an answer: to be a physical property is just to be a natural property that plays a role in the laws of physics—a role in the laws of that science whose job is (to use a common delimiter) to account for matter in motion.[17] Obviously physicists wouldn't put it that way; and Lewis says much more about natural properties than physicists would say about physical magnitudes. But the point is that Lewis isn't introducing a *different subject matter*—a new kind of stuff, or a different realm—when he brings in natural properties.

Repudiating this mistaken picture of metaphysics won't pull the rug out from under *all* of the critics, since for some, the ultimate target may simply be naturalness itself, or even metaphysics itself. More sweeping critiques of naturalness or metaphysics are certainly worthy of consideration; and a truly comprehensive defense of Lewis's best-system-theory ought to include—book-length, presumably—defenses of the metaphysics of natural properties and of the legitimacy of metaphysics. But such sweeping critiques are very different from an objection that *grants* the metaphysics of naturalness, and tries to show that it doesn't succeed on its own terms (because it opens up a gap between metaphysics and science).

Because this issue is so important, let's pursue it further. Consider the following analogous dialectic. Some philosophers of physics—notably, Tim Maudlin—think that specifying an *ontology*—specifying what entities exist—is an essential part of providing a physical theory. These philosophers think, for example, that a desideratum on any acceptable quantum theory is that it give some kind of answer to the question "what kinds of entities does the physical world contain, and what are they like?", rather than simply giving a mathematical model which generates correct predictions (Maudlin, 2018, introduction). And they regard questions such as "Is the correct ontology of quantum mechanics that of three-dimensional particles, or is it instead that of a single 'marvelous particle' moving in a high dimensional space?" (Albert, 1996) as being genuine. Of course, if the meaning of some predicate F is unclear then the question of whether Fs exist will itself be unclear; compare the question of whether points of spacetime exist in a general-relativistic setting.[18] But

[17] Or anyway, this is a first approximation of a Lewisian definition of 'physical property'. As Erica Schumener pointed out to me, even though terms for logical properties occur in statements of laws of physics, one might not regard logical properties as being physical properties. This strikes me as an occasion for Chisholming; and here is my first stab at a better definition: "a property is physical when it is natural and plays a role *only* in physical laws (and not, e.g., also in logical laws)". (I don't see the need for Chisholming as a sign that we're on the wrong track; the lines between "physical property", "chemical property", "logical property", and so on might well be somewhat shallow and/or conventional.)

[18] See North (2018) for an overview of the concern, and a way to resuscitate the dispute.

assuming that F itself is clearly defined, the question of whether *there exist* Fs is in good standing.

Now, within metaphysics proper there is a lively debate over whether ontological questions are genuine. The status quo, I suppose, is that they are; but there is an important group of renegades who think that ontology is *not* an important part of inquiry into the nature of reality. For instance, Eli Hirsch and Amie Thomasson argue, in different ways, that the answers to the ontological questions that metaphysicians have traditionally asked (such as about statues and lumps of clay) are mere projections of our conceptual scheme. And there is an analogous position in the philosophy of physics, which has been most clearly articulated by David Wallace.[19]

The debate between the Maudlins and Wallaces of the world is an important one, and is absolutely worth having. But it would be bizarre to accuse the Maudlin camp of, on their own terms, introducing a bifurcation between "metaphysical ontology" and "scientific ontology", or to argue that their account is unacceptable because it implies that physicists who follow correct methodology might posit the existence of quarks (say) and yet be mistaken because there don't "really", or "metaphysically" exist quarks. For Maudlin's view is that physics just is about ontology. That is the subject matter of physics. There is no gap between metaphysical and physical existence. There is just: existence, which physics strives to discover, just as for Lewis there is no gap between "metaphysically" and "physically" fundamental properties; there are just: fundamental (a.k.a. natural) properties, which physics strives to discover.

For a final illustration of this point, consider the most primordial metaphysical debate of them all, the debate over whether there exists an external world which exists independently of us. Imagine an external-world antirealist, who refuses to distinguish the real existence of the external world from appearances due to the deceptions of a Cartesian demon, accusing an external-world realist of opening an unacceptable gap between science and metaphysics. "According to your view", so the accusation goes, "even if certain laws are scientifically true, they might not be 'really' or 'metaphysically' true, since the alleged 'real world' might differ from the appearances". The accusation is mistaken, and not just because the accuser is wrong to reject external-world realism. It's mistaken because according to the external-world realist, "being scientifically true" just *is* "being true in the external world", which is to say, being true.

[19] Hirsch (2011); Thomasson (2007, 2015); Wallace (2012, section 8.8, 2019; 2022).

3. The package-deal account

Lite best-system theories are therefore not forced on us. Lewis's "full-fat" best-system theory does not introduce a bifurcation between science and metaphysics. It succeeds on its own terms, in that we can recognize, in its proposed conception of laws, what science has all along been trying to discover.[20]

But even if they are not forced on us, lite best-system theories might be preferable, if they can be made to work. They have the dialectical advantage of neutrality, since they can be accepted even by skeptics about naturalness. And they might be preferable on grounds of parsimony.

In fact there are many different possible varieties of the lite best-system theory. In the remainder of the paper, I'll critically examine some of them. Rather than following the letter of extant proposals, I will examine several views that are in their vicinity but with certain details filled in. My hope is that moving the debate into a more fine-grained phase will be useful to both partisans and critics.

Let's begin with Barry Loewer's idea that the choice of which properties and relations are to be the meanings of predicates should be incorporated into the Lewisian competition.[21] Thus an entry into the competition is a "package deal", to use Loewer's phrase: a system together with an interpretation of its language. That is (to spell it out a bit), a package deal is a pair $\langle S, I \rangle$, where:

> S is a system (set of sentences closed under entailment);
>
> I is an interpretation of the language of S (an assignment of referents to names, and properties and relations to predicates);
>
> Every member of S is true under I;
>
> No constraints on I are made (predicates needn't stand for natural properties and relations since we are avoiding the use of naturalness);
>
> The strength of the package is inversely proportional to the "size" of the set of possible worlds in which S is true as interpreted by I; and

[20] Assuming that it can also survive the objection (which won't be considered here) that Lewisian laws are too *de*flationary to be considered laws. See Armstrong (1983, chapter 5, section 4); Carroll (1994, chapters 2–3); Emery (2022); Maudlin (2007); Gómez Sánchez (2023).

[21] Loewer (2020*b*, 2024). See Bhogal (forthcoming) for a critique.

> The simplicity of the package is a syntactic feature of S alone—it is unaffected by I.

(As with Lewis's theory, 'language', 'interpretation', and 'reference' here are understood as in mathematical logic—as having nothing to do with natural language.)

If no restrictions are placed on the packages, every true statement will again turn out to be nomically necessary, since a package $\langle\{\forall xFx,\dots\},I\rangle$, where F is a one-place predicate, $\{\forall xFx,\dots\}$ is the set consisting of the sentence $\forall xFx$ and all its logical consequences (in its language—i.e., in the language whose only nonlogical expression is F), and where I is an interpretation assigning to F a property had only by objects in worlds exactly like ours, will be a winning package.

Since scientists never consider sentences with such a simple syntax as $\forall xFx$ to be serious candidates for lawhood, one might think to place some sort of syntactic constraint on systems in the competition. But this wouldn't help if the interpretations remain unconstrained, since we can still choose interpretations of the predicates and names in S's language so as to again make S true only in the actual world. This can always be done, despite any imposed syntactic constraints, so long as S is consistent and satisfies a couple of other conditions (see the next paragraph). The argument for this conclusion uses some elementary model theory in a way that is familiar from various philosophical contexts; and I will present it in detail since we'll be using the same argumentative strategy again below.

Suppose (first condition) that S has a model whose domain is the size of the set $D_@$ of actual concrete objects. By a "model" I mean the standard notion of a model from model theory: a domain that is a set of any objects whatsoever, including abstract entities, together with an assignment of referents and extensions drawn from this domain to names and predicates in S; and by a model *of* S I mean that every member of S is true in the model. Whether such a model exists depends only on purely syntactic features of the sentences in S (holding fixed the set-theoretic universe!); it is a question, so to speak, of whether their logical form is consistent with the cardinality of $D_@$. This is a very weak condition; no scientifically serious system would be logically incapable of truth in a universe the size of ours. Now, since the model's domain has the same size as $D_@$, there exists some one-to-one function from its domain onto $D_@$; we can then "image" the model through the function to obtain a "concrete" model $M_@$ of S: a model in which every member of S is true whose domain is the set of actual concrete objects.[22] Next suppose (second condition) that for no cardinality is S true in every model whose domain has that cardinality. This too is a very weak condition. No scientifically serious theory would be so weak as to have its truth logically guaranteed by some possible proposition about the universe's cardinality. Then for each possible world w other than the actual world, there is a model M_w of S's language in which S is not true (that is, in which not every sentence in S is true), whose domain is the set of concrete objects at w. Now let I be the interpretation which assigns, to any predicate Π in S's language, a relation whose extension in any world w is the extension of Π in M_w.[23] Under I, S is true in @ but not in any other world. (If strength is so measured that being true only in the actual world doesn't automatically make a system maximally strong, the extensions could presumably be converted to intensions in some other way, resulting in a theory that is as strong as one likes, given the proposed measure.)

We can then use these mathematical facts to argue against the syntactic solution, as follows. Suppose for reductio that the current version of the package-deal account yields some "reasonable" winning package deal $\langle S, I\rangle$. S must surely satisfy the two constraints; so there is another package deal in the competition, $\langle S, I'\rangle$, such that S under I' is true only in the actual world. No reasonable package would be as strong as $\langle S, I'\rangle$ (under it, every truth is nomically necessary); thus $\langle S, I'\rangle$ is stronger than $\langle S, I\rangle$. But the simplicity scores of $\langle S, I\rangle$ and $\langle S, I'\rangle$ are identical (since simplicity is a function purely of the system of a package, and these packages share the same system); therefore $\langle S, I'\rangle$ is a better package than $\langle S, I\rangle$; and therefore, $\langle S, I\rangle$ isn't a winning package after all.

This sort of argument isn't particularly tied to the assumption that the

[22]That is, where f is the function and M is the original model, $M_@$'s domain is $D_@$; the referent of a name in $M_@$ is the value of f for its referent in M; and the extension of a predicate in $M_@$ is derived from its extension in M by replacing each member of each n-tuple in that extension by its value under f. $M_@$ is thus "isomorphic" to M via f; and it's an elementary fact from model theory that the same sentences are true in isomorphic models (referents and extensions have the same "pattern" in isomorphic models, and the truth of a sentence in a model is just a matter of this pattern). One might think that there is no need for the imaging part of the strategy, since any model, even one whose domain consists of abstract entities, would serve the argument's purposes. But the package-deal account might impose a restriction to "concrete" entities; and also, on some approaches in the philosophy of mathematics, talk of abstract entities is not taken at face value, as literally being about entities. However exactly that ladder is to be kicked away, something like the concrete model $M_@$ will remain.

[23]I won't try to eliminate this problematic "possibilist" quantification.

theories in the competition are first-order. If they are stated in a second- (or higher-) order language, then the argument is pretty much the same (although the first condition isn't quite as weak). It isn't even deeply tied to the assumption that the systems are stated using predicate logic. Without going into details, even if physical theories are understood as being about "quantities" rather than properties and relations, one can still construct interpretations corresponding to "quantity-theoretic models", so long as we assume appropriate principles of plenitude for quantities, analogous to the principles of plenitude for sets that are built into standard set theory (and analogous to principles of plenitude for "abundant" properties and relations)—principles such as "for any n-place function, f, from concrete objects to real numbers, there exists some quantity q such that for any concrete entities $x_1, \ldots, x_n$, $q(x_1, \ldots, x_n) = f(x_1, \ldots, x_n)$". Rejecting such principles would amount to treating quantities as being "sparse" rather than "abundant", and thus would seem to be a tacit appeal to naturalness.

This style of argument—imaging an interpretation through an arbitrary one-to-one function to yield a bizarre interpretation in which the same sentences are true—is most familiar from its use by Hilary Putnam (1978, part IV; 1980; 1981, chapter 2) in his model-theoretic argument against realism. But there is an important difference between that context and the present one. Putnam's question was one of "metasemantics", of what determines the meanings of words as used by people. This question—which concerns natural language, and natural-language reference—is that of when an interpretation of the language of a flesh-and-blood linguistic community is "correct"—when it gives the actual truth-conditions of sentences used by speakers of that community.[24] (His argument used claims like this one: "the only constraint on when an interpretation is correct is that every sentence in a certain set must come out true in that interpretation".) But the present argument has nothing to do with metasemantics or correctness. Its target is a proposal (namely, the package-deal account with no restriction on packages except for some syntactic constraint on systems) which (like all proposals I will discuss) is solely about the nature of lawhood, and takes no stand on metasemantics. 'Language', 'interpretation', and 'reference', as used in the statement of that proposal, are intended only in their mathematical-logic senses. The "interpretations" I in package deals $\langle S, I \rangle$ have nothing to do with meaning in linguistic populations, and need not

[24] In the terminology of Lewis's "Languages and Language", it is the question of which of various "languages" in the sense of abstract mappings from syntactic items to meanings is "used" by a given population.

be "correct". They are simply functions that map words to objects, properties, and relations.[25] (One *could*, I suppose, consider a version of the package-deal account that defines the laws as being given by the best system of all competitors $\langle S, I \rangle$ in which the language of S is used by some linguistic community, and in which I is a correct interpretation of that language as used by that community. But in addition to reversing the intuitively correct order of dependence between lawhood and metasemantics, it has the apparently absurd implication that there could not exist laws of nature without language users.)

3.1 Strength as logical consequences about micro-distances

Although Lewis's sentence $\forall x Fx$ *modally* implies every truth, it doesn't *logically* imply anything that we care about, or that physics cares about. So perhaps we could solve the $\forall x Fx$ problem by defining strength in terms of logical consequences about some particular fixed subject matter.[26] Put schematically, we could introduce some set, X, of properties and relations, which constitutes this subject matter; define an "X-sentence" as any sentence all of whose predicates refer (in the mathematical-logic sense) to properties and relations in X; and define the strength of a package deal, $\langle S, I \rangle$, as the modal strength of the set of X-sentences that are logically implied by S.[27]

Here is one particular view of this sort:

> X contains just one quantitative relation, D, which gives the spatial distance between any pair of particles at any instant of time as a certain real number, measuring meters (say): *the distance between particle x and particle y at instant t is d meters*. In any package deal $\langle S, I \rangle$, the system S must contain a time-dependent distance predicate; and I must assign D to this predicate; but S may also contain further predicates, whose I-interpretations are unconstrained (so long as every member of S is true under I). The strength of the package is the modal strength of the set of sentences that are logically implied by S that only contain the time-dependent distance predicate.

[25] Where "words" are understood as purely mathematical objects, which needn't be used by any speaker.

[26] Compare Loewer (1996, p 110; 2007, pp. 324–5).

[27] We may take "logical" implication in its customary, model-theoretic sense: a set of sentence Γ logically implies a sentence S if and only if in any model of the usual sort in which every member of Γ is true, S is true as well.

The idea is that systems may introduce any properties they like, with the goal of systematizing the history of inter-particle distances. This is akin to Michael Esfeld and Dirk-André Deckert's "Super Humeanism" (although see below).[28]

There is a certain irony in appealing to this view in the present context. The point of the package-deal account (and other Lite best-system theories) is to avoid the inflationary metaphysics of naturalness. But there is a tradition of regarding the appeal to a distinguished notion of distance as also being overly "metaphysical". Metrical conventionalists (like Reichenbach (1958, chapter 1)) object to the idea that space has intrinsic metrical structure precisely because that notion is too metaphysical, too distant from observation. There are many functions from points of spacetime to real numbers, or time-dependent functions from pairs of particles to real numbers, with the right formal features to count as distance functions, and which "mesh" with our procedures for measuring distance (in a way that I won't try to make precise). Which of these is **the distance function**, the function that gives the allegedly intrinsic metrical features of space or the collection of particles? Conventionalists regard this question as unanswerable, and claim that the notion of distance cannot simply be taken for granted, but rather must be operationalized, with the result that apparently competing theories about spatial structure and dynamics (such as Euclidean geometry combined with one dynamics and some nonEuclidean geometry combined with another dynamics) are in fact equivalent. Metrical realists, on the other hand, accept a distinguished notion of distance, and brush off the conventionalist's concerns as being rooted in an overly aggressive empiricism. Indeed, the realist about natural properties will regard the "distinguished" (or "intrinsic", or "physical") distance relations as simply being the perfectly natural relations over points with the appropriate formal features to count as distance relations (and perhaps whose role in the laws has certain features).

Still, the opponent of naturalness might be using the epithet 'metaphysical' in a subtle way. They might view the posit of a distinguished distance function as being justified by its explanatory added value in physics, while being skeptical that positing naturalness has comparable added value.

In any case, this irony is not the only concern. Another derives from how the view hardwires spatial relations at times into its account of lawhood, its apparent commitment to a fundamental ontology of particles, to space and time being fundamental, and to a fundamental separation between time and space. To be sure, a description of Minkowski spacetime, or of a curved spacetime,

[28] Esfeld (2017); Esfeld and Deckert (2017). See also Hall (2015*b*, section 5.2).

might be part of the best system, and thus might have the same status as the Super-Humean takes properties like mass and charge to have (Esfeld, 2017, p. 1898). Still the inter-particle distances at times retain a foundational importance in the theory, since lawhood itself is based on them. If physics continues to be relativistic, we would have a bizarre disconnect: our foundational account of lawhood would be employing a notion that physics is telling us is not physically significant. (There would be a similar disconnect if quantum gravity tells us that time is not physically fundamental, if quantum mechanics tells us that particles aren't physically fundamental, or if David Albert (1996) is right that ordinary space isn't physically fundamental given quantum mechanics.)

3.2 Strength as logical consequences about macro-distances

Instead of the inter-particle-distance relation, one might include in X properties and relations concerning "macroscopic" distances, in hopes of avoiding contentious physical assumptions about particles or the nature of time.

Loewer's own version of the package-deal account is somewhat along these lines. In an earlier paper he suggested that the strength of a system be measured in a way that "puts a premium on" what it says about "the positions and motions of paradigm physical objects", where these objects include such things as planets and projectiles.[29] More recently he has written:[30]

> Unlike super-Humeanism, the [package-deal account] doesn't fix a one-size-fits-all fundamental ontology of propertyless particles, but rather leaves the ontology and fundamental properties up to physics. However, it accepts super-Humeanism's (and for that matter, Descartes's, John Bell's, and others') claim that the first job of physics is to account for the positions and motions of material bodies and how these positions record the measurements of other quantities.

[29]Loewer (1996, p. 110). There he also counted particles as being "paradigm physical objects"; avoiding the commitments of Super-Humeanism has since become a goal. Note also that "paradigm physical objects" had better not include things like shadows, whose motions don't obey the usual laws of physics (Hudson, 2002). And subtlety will be needed even for planets and projectiles, if these objects have the persistence conditions we ordinarily understand them to have. Suppose a chunk of a projectile instantaneously breaks off from the whole, so that the projectile continues to exist but abruptly loses the chunk as a part. The projectile in a sense moves discontinuously: its shape changes discontinuously, as does its center of mass. (Compare Hirsch (1982, pp. 12–15).)

[30]Loewer (2024, chapter 7); see also Loewer (2007).

Although it may not be exactly what Loewer had in mind, the view I will consider in this section is a package-deal account in which the strength of a system is measured by what it logically entails about macro-distances. In terms of the schematic form introduced at the beginning of the previous section, the idea is to take the set X to contain macroscopic spatiotemporal properties and relations over ordinary macroscopic objects like planets, projectiles, and pendulums.

What, exactly, are these "macroscopic spatiotemporal properties and relations"? One question is how "fine-grained" they are. For instance, does X contain precise, real-valued relations of distance that hold between macroscopic objects? This will be difficult to maintain. Macroscopic entities are extended in space, have irregular shapes, and have vague boundaries, so it's unclear what it would mean to say, for example, that Mars and Venus are precisely 74.4691 million miles apart. Understanding such objects as being precise collections of point-sized particles, so that the distance between a pair of them could be understood as the minimal distance between some particle of one and some particle of the other, would forfeit neutrality on whether material objects are composites of such particles. And it's hard to see how time could be brought into the mix while maintaining neutrality. For instance, the relations attributed in both 'Mars is 74.4691 million miles from Venus at instant t' and 'Mars is 74.4691 million miles from Venus 2.53 seconds after it is 68.4668 million miles from Venus' seem to presuppose a nonrelativistic conception of time.

Suppose instead that the properties and relations in X are "coarse-grained", so that they are more like traditional observational properties and relations. They might, for instance, contain relations like *this projectile is clearly longer than that one*, or *the period of this pendulum is clearly longer than the period of that one*, where these relations aren't sufficiently structured to enable real-valued representation (perhaps their negations aren't transitive). Or they might be vague and/or incorporate error tolerance, such the property of *being approximately one meter long, plus or minus two centimeters*.[31]

Even with coarse grain, it isn't clear that neutrality can be achieved on scientifically open questions such as the nature of time. But there is a further problem: a coarse-grained X will place less of a constraint on package deals. A fine-grained X (such as one containing real-valued inter-particle distance

[31] On a linguistic approach to vagueness, it is predicates rather than properties that are properly said to be vague; so the proposal in question is that we use a vague predicate in our definition of 'X', and thus in our account of lawhood.

relations) might well call for a uniquely best systematization, but the totality of coarse-grained facts—about, say, a finite collection of measuring rods and clocks, each with error tolerance—may well leave the laws undetermined: quite different package deals might tie for first place in the competition. (Indeterminacy would also creep into all notions connected to lawhood, such as causation; and consequently, to all notions connected to causation. See section 4 below.) It's not problematic, from a scientific realist's point of view, that our *evidence* wouldn't yield a decisive verdict about what the laws are; what is problematic is that the *facts* about lawhood would be undetermined. And it isn't only facts about lawhood that threaten to be undetermined. The package-deal account will surely be paired with a view about what fundamental physical properties are: they are the properties assigned by the interpretation I in the winning package deal $\langle S, I\rangle$. Thus indeterminacy in which package deal wins the competition will yield indeterminacy in what the fundamental physical properties are. Thus we have indeterminacy, not only in which statements about "the mosaic" count as laws, but also, in a sense, about what the mosaic is.

There is a big further issue, which does not turn on whether X is coarsely or finely grained. In the previous section, each package deal $\langle S, I\rangle$ was required to contain a predicate for the sole member of X (in addition to other predicates whose interpretation by I is unconstrained). But here we cannot make any such requirement, since physical theories don't contain observational (macroscopic, vague) predicates. Thus systems S in packages with a chance at winning the competition won't logically imply any (nontrivial) X-sentences at all.[32]

It is therefore natural to consider "bridge laws". Loewer (2020*b*, p. 1082) writes: "a fundamental theory needs to be [supplemented] with principles that underlie connections between fundamental and macroscopic and other non-fundamental sentences". The idea, then, will be to define the strength of a package deal in terms of the X-sentences that are logically implied by the package's system together with some bridge laws.

[32]In the literature on the best-system theory, one can discern two different uses of the term "systematize", as it occurs in the slogan "the laws are those statements that best systematize such-and-such". For Lewis, 'systematize' meant *summarize*, since for him, the such-and-such getting summarized was the facts about the perfectly natural properties and relations, and the systems doing the summarizing contained predicates for those same perfectly natural properties and relations. But for the current best-system theory, as well as some of the theories considered elsewhere in the literature, 'systematize' seems to mean something different, since the such-and-such getting systematized concerns properties and relations that differ from those expressed by the predicates in systems. Indeed, 'systematize' sometimes seems to mean something epistemic, such as *is supported by*.

Question: are the bridge laws freely chosen as part of the choice of a package deal? And if they are, do they affect the simplicity of the package deal?

Suppose first that bridge laws *are* freely chosen, but that they do *not* affect the simplicity of the package deal. That is, suppose that a package is now a triple $\langle S, I, B\rangle$, where:

> S is a system—set of sentences closed under entailment—with any vocabulary whatsoever;
>
> B is a set of sentences in a larger language whose vocabulary includes the vocabulary of S but also a unique predicate for each property and relation in X;
>
> I is an interpretation of this larger language that assigns any properties and relations whatsoever to predicates in S, but which assigns to each of the new predicates its associated property or relation in X
>
> Every member of S and every member of B is true under I;
>
> The strength of the package is the modal strength of the set of X-sentences[33] that are logically implied by S together with B; and
>
> The simplicity of the package is a function solely of S.

This view is unacceptable. For any S whatsoever and any interpretation of its vocabulary under which it comes out true, one can simply choose B as the set of all true X-sentences, resulting in a system that is maximally strong (or rather, is as strong as the actual array of X-facts permits). Thus simplicity will be the sole determiner of lawhood, regardless of the contingent nature of the world.

Suppose next that the bridging theory B is again freely chosen, as part of the choice of a package deal, but that B's simplicity *does* enter into the calculation of simplicity.[34] That is, let package deals be understood as above, but with the final sentence changed to "The simplicity of the package is some function of S and B taken together". This still doesn't yield an attractive view. It amounts to a kind of instrumentalism, which can be seen as follows.

Let w_1 and w_2 be any possible worlds in which the same X-sentences are true, and which are such that some one-one function f from w_1's domain onto

[33] I.e., sentences in the larger language that contain only the new predicates, as interpreted by I—as standing for their associated members of X).

[34] Compare Loewer (2020*b*, p. 1082, note 45).

w_2's domain sends the extension in w_1 of each property or relation in X to its extension in w_2. We can show that:

> For any entry $\langle S, I_1, B\rangle$ in the competition for w_1, there is an I_2 such that $\langle S, I_2, B\rangle$ is an equally-scoring entry in the competition for w_2.

Let I_1^E be the extensional version of I_1; then image I_2^E through f to obtain an extensional interpretation I_2^2 in which the same sentences are true; and then let I_2 be any property interpretation that matches I_2^E extensionally in w_2 and assigns to each of the new predicates its associated member of X. $\langle S, I_2, B\rangle$ is an entry in the competition for w_2.

Moreover, the entries $\langle S, I_1, B\rangle$ and $\langle S, I_2, B\rangle$ score equally well: i) the simplicity of an entry $\langle s, i, b\rangle$ is determined by syntactic features of the set $s + b$, which is the same for our two entries; and ii) the strength of $\langle s, i, b\rangle$ at a world is a function of the set of true-at-w X-sentences that are logically entailed by $s + b$; but $s + b$ is again the same for our two entries, so they logically entail the same X-sentences; and the same X-sentences are true in w_1 and w_2.

So whatever the winning entry $\langle S, I_1, B\rangle$ is for w_1, the corresponding entry $\langle S, I_2, B\rangle$ will be the winning entry for w_2, since its score is the same and it faces exactly the same competition. (If $\langle S, I_2, B\rangle$ were defeated by some entry e in w_2, $\langle S, I_1, B\rangle$ would be defeated by e's image e^{-1} in w_1.)

But this means, to put it roughly, that the laws are determined solely by the macro-facts and the world's cardinality. Nothing about the microscopic realm, beyond its cardinality, is relevant. This is surely too close to instrumentalism for comfort.

Finally, suppose that the bridging theory is *not* freely chosen, but rather is "given". That is, the strength of a package deal (which now takes the simpler form $\langle S, I\rangle$, with no B included) is now defined as the modal strength of the set of X-sentences that are logical consequences of its system together with the *true* bridging theory. But what is the "true bridging theory"?

It can't be defined as the set $S + X$ of all truths in the language whose vocabulary combines those of S and predicates for members of X, since $S + X$ includes the set of all true X-sentences as a subset; each system will have the same strength, namely, the modal strength of the set of all true X-sentences. Instead, it must consist of a restricted subset of $S + X$. The problem then is how to specify that subset.

One might invoke certain metaphysical notions to specify it. But not just any metaphysical notions will do. One couldn't, for example, define the bridging theory as the set of all "micro-macro" conditionals—conditionals whose antecedent is in S's language and consequent uses only predicates for members of X—where the antecedent *metaphysically necessitates* the consequent (under the package's interpretation of the antecedent). For where ϕ is any true X-sentence and F is Lewis's predicate, interpreted by I as being true only of actual individuals, the micro-macro conditional "if $\forall x F x$ then ϕ" is necessarily true. The package deal $\langle\{\forall x F x\}, I\rangle$ would therefore be extremely simple, and it would also be maximally strong since it would logically entail, via the currently proposed bridging theory, every true X-sentence.

One might instead define the bridging theory as the set of all micro-macro conditionals where the antecedent (nonfactively) *grounds* the consequent.[35] But surely the fan of the package-deal account won't want *that*: grounding will surely be seen as no less metaphysically inflationary than naturalness. (It may well be possible to define naturalness in terms of ground, perhaps thus: "a property p is natural iff for some x that has p, the proposition that x has p isn't grounded by any proposition".)

However, perhaps some lite cousin of ground might suit the tastes of our package-deal theorist. The notion of ground common within metaphysics is an ambitious one, meant both to connect the macroscopic with the microscopic (the traditional province of "bridge laws") and also to underwrite "in-virtue of" talk within metaphysics, as in the Euthyphro question: is something pious in virtue of being loved by the gods, or is it (somehow) loved by the gods in virtue of being pious? (And: "do quantified statements hold in virtue of their instances?"; "Do sets exist in virtue of their members?"; etc.) It is only the latter aspect, perhaps, that rubs the package-deal-proponent the wrong way; perhaps a scaled-back notion of ground, incorporating only the first aspect, could be introduced. Still, even this scaled-back notion of ground will need to be pretty metaphysically discriminating. Even though a completely specific physical characterization of a pair of planets will be said to lite-ground facts about the macroscopic distance between them, a completely specific physical characterization of the entire world must *not* lite-ground macroscopic facts, on pain of reintroducing Lewis's $\forall x F x$ problem.

There is one further potential problem, even if some notion of ground is admitted.[36] No reasonable system will logically imply grounds of any *atomic* X-sentences (you can't derive any particular claim about the distances between

[35] See Fine (2012); Schaffer (2009) on grounding.

[36] The problem might go away once statistical-mechanical chances are added to the picture. See Albert (2015); Loewer (2020*a*).

planets from the laws of physics, even given bridge laws). Nor will reasonable systems logically imply grounds of X-generalizations, since macro-level generalizations are typically defeasible. It isn't always true that "if you drop two objects from the Tower of Pisa, neither will land clearly before the other": there might be a strong current of air on one but not the other; a meteorite or bird might interfere; and so on. All that is true is that "if you drop two objects from the Tower of Pisa *and nothing interferes*, then…". But there may not be any way to fill in "and nothing interferes" using only X-vocabulary. (This is a much-discussed issue about the special sciences; ceteris paribus conditions may not be stateable without resort to physics.[37]) So it isn't clear that a reasonable system will logically imply any X-sentences at all, even given ground-theoretic bridge laws.

I call this problem merely potential because I see a potential solution. Our current definition of the strength of a package $\langle S, I\rangle$ is the modal strength of the set of X-sentences (which are purely macroscopic) that S plus certain micro-macro conditionals logically entails. But one might instead define strength as the modal strength of the set of conditionals, in the language of S (which are purely *micro*scopic), that are logically implied by S alone, and whose consequents express propositions that (non-factively) ground some proposition (which may not be true) that is expressed by some X-sentence. Roughly speaking: the strength of a system depends on how many physically sufficient conditions for physical realizations of macro-propositions it implies. It feels a bit ad-hoc, but perhaps it works.

The problem also threatens the view of the previous section. The strength of a package deal $\langle S, I\rangle$ was there defined as the modal strength of the set of sentences logically entailed by S that contain no nonlogical vocabulary other than the predicate of inter-particle distance. But no such atomic sentences will be entailed by S, nor will be any universal generalizations if ceteris paribus conditions cannot be defined using only the predicate for inter-particle distance. The potential solution could again be employed; but in this case, a better

[37] Redefining strength in terms of the set of sentences that can include both S- and X-vocabulary which are logically entailed by the system would land us back in the fire: the package deal $\left\langle\{\forall x F x, \ldots\}, I\right\rangle$, where F is Lewis's predicate, will again win the competition. For the set of sentences used to determine strength can now contain the sentence $\forall x F x$ itself, which follows, via the true bridge laws, from sentences in the system $\{\forall x F x, \ldots\}$. (If we're understanding strength in terms of Fine's (2012) "strict" ground, then the argument could be modified by noting that the sentence $\forall x F x \wedge \forall x F x$ is strictly grounded by sentences in $\{\forall x F x, \ldots\}$.)

solution is available: the Super-Humean-inspired view could be reformulated so that it is not an instance of the package-deal account at all. Rather than understanding predicates other than D as being predicate constants interpreted by a freely-chosen paired interpretation I, those predicates can be understood as existentially quantified variables, so that the system's laws take the form: "there exist properties $P_1, \dots$ such that the history of inter-particle distances satisfies such-and-such constraints", where the constraints are described using the predicate variables $P_1, \dots$. The strength of a system can then be understood in the old way, as the modal strength of the system itself. I suspect that this formulation is closer to Esfeld and Deckert's intention.[38] (This maneuver is not available in the present context, since the laws of physics cannot be understood as taking the form "There exist properties $P_1, \dots$ such that the history of macroscopic distance relations obeys such-and-such constraints". For it is physically contingent that there are any such things as macroscopic objects at all; the actual laws of physics place meaningful constraints on arrangements of microscopic objects—such as in the early history of the universe, or after its heat death—that don't constitute the existence of macroscopic objects.)

4. Relativism

The problem we have been discussing is one of choice: how to choose the vocabulary in systems? We could avoid having to make that choice by treating lawhood as being relative. For any set S of properties and relations, define a system-relative-to-S ("system$_S$") as a set of true sentences all of whose predicates express properties and relations in S, and define a law-relative-to-S ("law$_S$") as any logical consequence of the system$_S$ that best balances strength and simplicity (or: best balances$_S$ strength$_S$ and simplicity$_S$, insofar as these three notions were understood, in the original theory, in terms of naturalness). According to lawhood relativism, there is no such property as being a law—that is, being a law *simpliciter*. There is only the relation of being a law-relative-to, which holds between sentences and sets of properties and relations. This is Cohen and Callender's (2009) preferred view.[39]

Relativism can be attractive in other contexts in which we face analogous

[38] They cite Huggett (2006) as an inspiration, who proposes a relationalist account of Newtonian mechanics according to which the dynamical laws are existentially quantified: "there exist some frames of reference in which Newton's equations of motion hold".

[39] See also Halpin (2003); Taylor (1993, section VIII).

choices. How to choose which aesthetic standards determine what is beautiful? There is no need to choose, according to aesthetic relativism, because there is no such property as being beautiful. Rather, there is a relation, being beautiful-relative-to, holding between aesthetic objects and standards.

Relativism about lawhood will lead to relativism about a great many other matters.[40] For example, it is usually assumed that counterfactuals are closely connected to lawhood. The exact nature of the connection is debated, but whatever it is, relativism about lawhood will induce relativism about counterfactuals.

One simplistic argument for this conclusion runs as follows. Counterfactuals are defined in terms of lawhood. That is, there is some true sentence of the form:

$$\text{If it had been that } A \text{ then it would have been that } B =_{\text{df}} \phi$$

where ϕ contains the predicate 'is a law'. So if lawhood on the right-hand-side is relative to sets of properties and relations, so are counterfactuals.

This is too simplistic. If lawhood and counterfactuals are relative, then the displayed sentence could not be true since it would be ill-formed; both its left-hand-side and every occurrence of 'is a law' on its right-hand-side would have unfilled argument places.

A better argument is this: whatever our evidence was for accepting the original definition, that evidence will support, when combined with the information that lawhood is relative, the conclusion that i) counterfactuals are also relative, and ii) are defined by the obvious modification of the original definition, namely:

$$(\text{If it had been that } A, \text{ it would have been that } B)_S =_{\text{df}} \phi_S$$

where S is a free variable, and where ϕ_S is the result of beginning with the original definiens, ϕ, and replacing all references to lawhood with references to lawhood$_S$ (as well as, perhaps, making certain other correlated replacements).

One might object that if lawhood really is relative, then since counterfactuals are obviously *not* relative, counterfactuals are not after all defined in terms of lawhood. But how else would they be defined?

As stated, the argument relies on a notion of "definition". But similar arguments could be given in other terms. For instance: "We have a certain body of evidence, which we normally take to support a class of statements of the form 'if the laws are such-and-such then so-and-so counterfactuals are true';

[40] See also Eddon and Meacham (2015, p. 124).

combined with the information that lawhood is relative, this body of evidence supports correspondingly relativized conditional statements."

One way or another, then, if lawhood is relative, so are counterfactuals.

This dialectic recurs for all notions that are appropriately connected to lawhood. The list of such notions is not short, because of the conceptual centrality of one of its key members, namely, causation, which is normally thought to be closely connected to, well, pretty much everything: rationality, action, freedom, personal identity, morality, consciousness, etc.[41] Not to mention more mundane concepts like being a chair. Practically every concept would be relative to sets of properties and relations. This is hard to stomach.

It wouldn't be hard to stomach if the relativity were merely around the edges. For most of us already accept something similar: that 'cause' is vague around the edges, and that there is corresponding vagueness in, well, pretty much everything. The vagueness in 'cause' that most of us already accept is "around the edges" in the sense that although this vagueness in 'cause' *can* lead to vagueness in *some* sentences about causation, it doesn't lead to vagueness in the everyday sentences about causation that form the backbone of our conceptual lives, sentences such as 'my being hungry caused me to eat'. Such sentences retain their truth values under any sharpened meaning of 'cause' that is consistent with that predicate's conventional meaning.

The proposed relativity in lawhood is not "around the edges" in this sense. *No* interesting sentences about lawhood will be true relative to every set S. The reason is that there is to be no restriction on the sets of properties and relations S to which lawhood is relativized. These sets don't only include rival "scientific" conceptions of what properties and relations are to be utilized in physics. They also include, for instance, the set $\{F\text{-ness}\}$, where F is Lewis's predicate; relative to this set, every true sentence is a law. They also include the set containing, for each possible individual, the property of being that very individual, relative to which any system with any reasonable amount of strength would be hopelessly complex. Therefore no laws, no causation, no anything.[42]

[41] In this vein see Hawthorne (2001, 2004).

[42] Any given macroscopic causal fact is presumably compatible with a range of underlying laws of nature. Thus the relationship between the variation in truth values of causal sentences and the variation in truth values of sentences about lawhood, as the sets of properties and relations vary, will likely be complex. Causation might even be argued to not require any strict laws at all, in which case "no laws, so no causation" would be too quick. A full discussion of this issue would take us far afield; here I'll say only this: an account of causation that doesn't make reference to laws will surely need to make reference to natural properties; and if relativism is

The proposed relativity is thus drastic as well as pervasive. Practically nothing we ever say about the physical world—that grass is green, that the sky is blue, that we ourselves exist—is true simpliciter. All such statements are true relative to some sets of properties and relations and false relative to others.

Some will have heard enough. But for those who wish to linger until the end of the show…

The relativist might argue that even though lawhood (and practically everything else) is relative, we humans (or: we humans in the twenty-first century; or: we members of the scientific community) always employ the same *relatum*; we always relativize to the same set of properties and relations. Thus our discourse about laws (and everything else) enjoys a sort of local objectivity. All that is missing is a cosmic objectivity whose existence is doubtful anyway, since it is objectionably metaphysical in the same way that Lewisian naturalness is.

Now, it's worth noticing that the notion of employment (as it occurs in the statement that members of the scientific community all employ the same set of properties and relations) is an intentional/semantic notion, and thus is causal in nature. So it, too, will be relative.

Incidentally, this marks a structural difference between lawhood relativism and more familiar forms of relativism. According to typical forms of aesthetic relativism, for example, although beauty is relative to community standards, individual uses of that term are meant to be in accordance with the standards that are employed in that community; those uses are judged for correctness on that basis;[43] and the notion of the standards "employed" by a given community is *not* a relative matter. (Though it is no doubt vague around the edges.) Thus for typical forms of relativism, the operative value of the relatum is, in any given case, fixed nonrelatively. This isn't true for lawhood relativism.

So when the relativist says that members of the scientific community all employ the same set of properties when talking about lawhood, causation, and related matters, the predicate 'employ' must be relativized to some set of properties and relations. Moreover, this set must surely be the very set that is claimed to be employed by all scientists (since employment is a causal notion

adopted about that notion of natural properties, the relativity of causal statements would be immediate.

[43] On one view about the semantics of words whose metaphysics is relativist, utterances of 'beautiful' in community C express the property of being beautiful-relative-to-s_C, where s_C are the standards of community C. On another view, sentences containing 'beautiful' express "propositions" whose truth-values are relative to standards; judgments in C are correct if and only if their propositions are true relative to s_C. We may remain neutral about such issues.

and hence one of the "related matters"). Thus the claim must be, with respect to some set of properties and relations, S, that all scientists employ$_S$ S when talking about lawhood and related matters; that our judgments about lawhood are correct if and only if they are true of lawhood$_S$; that when we wonder what the laws are, we wonder what the laws$_S$ are; and so on. (Similarly for causation, and everything else.)

The alleged problem for Lewis's theory, to put it in a nutshell, was that it opens an epistemic gap. We could not know what the natural properties are, and thus could not know what the Lewisian laws are. But does the shift to relativism help? Is it any easier to know when our judgments about lawhood are correct—that is, are true of lawhood$_S$?

There is a temptation at this point to analogize to typical forms of relativism. We have straightforward (more or less) access to the correctness of judgments about beauty, since such judgments concern the standards of beauty that are employed by our community; to a first approximation, those standards are some sort of function of the shared aesthetic feelings of the members of our community; so we can tell what those standards are by ordinary empirical methods. Similarly, one might think, we have (relatively) straightforward access to the correctness of judgments about lawhood, since such judgments concern lawhood$_S$; S is the set of properties and relations that are employed by our community; and we can tell what properties and relations our community employs by simply examining scientific practice—perhaps simply by noting the theoretical predicates that scientists actually write down.

But the analogy doesn't hold. The standards whereby aesthetic judgments are evaluated for correctness are constitutively related to aesthetic feelings. But the standards of correctness for judgments about lawhood are not constitutively related to facts about what predicates physicists use. The relationship is evidential, not constitutive. So lawhood relativists—those who want to be scientific realists, anyway—cannot claim that judgments about lawhood are evaluated for correctness in terms of the set of properties that are in fact "employed" by scientists. Scientists can make mistakes, after all. Our repertoire of scientific predicates at any point in time is a posit. We justifiably hope that it contains properties that figure in correct judgments about laws, but there is no guarantee that it does.

5. Lawhood by list

Pretend that the laws are Newton's. According to Lewis, this is because i) Newton's laws are the best systematization of the facts about mass and the spatiotemporal relations, and ii) mass and the spatiotemporal relations are all and only the natural properties and relations. But one might wonder why ii) is needed. Why not i) alone?

Freed from the pretense that Newton's view is correct, the proposal is this: there is a certain set of properties and relations, S, such that what it is to be a law is to be the best systematization of the properties and relations in S. How do we figure out which properties and relations these are? Follow the same advice that a Lewisian would give for figuring out which properties and relations are natural: look to predicates of well-confirmed scientific theories.

If I myself accepted a "lite" best-system theory, it would be this one.

Cohen and Callender (2009, section 3) discuss a related view, and it may even be the same view, except that they describe it as saying that we "stipulate" which properties and relations the laws must systematize. It's unclear what that means, but in any case, the view I mean to discuss has nothing to do with stipulation or any other speech act. It is a purely metaphysical view: to be a law just *is* to be entailed by the best systematization of S.

Two objections come immediately to mind. First, the view is inconsistent with the modal status of lawhood: it is metaphysically possible that there exist properties and relations other than those in S (properties that are "alien" to the actual world), which figure in the laws of physics. Second, the view is inconsistent with the epistemic status of lawhood. Supposing one of the members of S to be the property of spin, Newton believed that it was a law that $F = ma$, but he didn't believe that "$F = ma$" is part of the best systematization of any set that includes spin.[44] Both objections are weighty, but neither is decisive.

The modal objection will be decisive for many. It isn't for me, since in my view, modal considerations don't carry weight in this domain.[45] But let's set this issue aside.

[44] Though I won't analyze them in detail, some of Cohen and Callender's objections seem to be variants of the epistemic objection, and some others seem to involve both that objection and considerations arising from taking "stipulation" seriously (for instance: "the concept of lawhood is plausibly agnostic between particular choices of [S]", p. 17).

[45] Sider (2011, chapter 12). I did give modal arguments in a couple places above, but they could be recast in terms of explanation.

The epistemic objection is problematic because epistemic contexts are "opaque". One can believe that one is in pain without believing that one's C-fibers are firing, even if pain = C-fibers firing. To be sure, it is an open question how to theorize this opacity. But it is much too quick to reject the view solely on this basis. If the argument were correct, it could be used to refute *any* reductive theory of lawhood: "I could believe that such-and-such is a law without believing that such-and-such is a ϕ; therefore lawhood $\neq \phi$".

There is a third, more powerful, objection: that there must be some explanation for why the particular properties in S play the role that they do in an account of the laws of nature. Such an explanation can be provided by Lewis: those properties play the role that they do because they are the natural properties. But for the view under discussion, no explanation can be given.

Not every fact has an explanation. Lewis himself has no answer to the question of why naturalness is part of a constitutive account of lawhood. That is simply what lawhood is, Lewis must presumably answer; but one could make a similar answer on behalf of the members of S.

Thus the objection must rest on a judgment about the comparative explanatory merits of two theories. Each is a theory of a range of phenomena centered on lawhood: facts about lawhood, causation, counterfactuals, and other matters. One theory explains all of these phenomena by reference to the members of S; the other theory explains them by reference to naturalness; and the judgment behind the objection is that latter theory is explanatorily better.

One could regard the view under discussion as being, not a way of doing without naturalness, but rather, a way of reductively defining naturalness: to be natural is to be a member of S—to be mass or charge or spin or spatiotemporal separation, perhaps. Naturalness is given by list.[46] Now, Lewis's view was that naturalness is the basis for theorizing about an even wider range of phenomena, encompassing not only lawhood, causation, and counterfactuals, but also semantic and mental content, intrinsicality, materialism, and practically everything else he thought about after the early 1980s.[47] For a fan of Lewis's program, the third objection rests on a judgment about the relative explanatory merits of the following two theories: Lewis's own, which is centered on a non-list-like notion of naturalness, and a theory like Lewis's but in which 'natural' is replaced by 'is mass or charge or spin or spatiotemporal separation' (or whatever the members in S happen to be).

[46] See Sider (2011, 138–41) for more discussion of this idea.
[47] See also Sider (2011).

"Explanations by list" typically aren't explanations at all. One cannot explain the fact that everyone attending my party was a philosopher by citing the fact that my party was either party_1 or party_2 or …[listing all and only parties that are in fact attended only by philosophers], and the fact that each of these was attended only by philosophers. But perhaps the fact that the very same list recurs throughout the Lewisian constellation of explanations—lawhood is a matter of mass or charge or spin or spatiotemporal separation, and so is causation, and so is mental content, and so is…—turns what otherwise would be a bad explanatory strategy into a good one.[48]

It is no accident where our discussion has landed. A great many metaphysical debates, especially those between more and less "inflationary" outlooks, turn on whether a given posit is explanatory. Indeed, the debate over the best-system theory itself is an instance. Lewis's critics (like Armstrong (1983, chapter 5)) regard his view of laws as being too anemic, and argue that without positing robust laws, genuine explanation is impossible, whereas Lewis regards the extra posits as having no explanatory added value. And the natural home for opposition to naturalness is the view that it, too, has no explanatory added value. Perhaps it can be replaced, in Lewisian explanations, by a list, or perhaps the Lewisian program itself lacks explanatory value. But for fans of the Lewisian program who reject these list-like explanations, Lewis's original best-system theory, the one with naturalness, the OG BST, remains the best reduction of lawhood.

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[48]See also Dorr and Hawthorne (2013, pp. 65–8) for a critique of the present line of thought.

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