

Are Humean Laws Flukes?***

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It is widely, although perhaps mistakenly, believed that the contemporary heir to Hume's metaphysics is David Lewis. Lewis developed and defended a view he calls "Humean Supervenience" (HS) which holds, as Hume is said to have held, that there are no necessary connections in nature.¹ According to Lewis the world consists of a distribution throughout the entirety of space-time of instantiations of "perfectly natural properties/quantities."² Lewis tells us that perfectly natural properties/quantities are intrinsic to the points or point sized individuals they instantiate and are categorical. By this he means that a property instantiated in one space time region places no restriction on what properties can be instantiated in entirely distinct regions. So, any perfectly natural properties instantiated in distinct regions are co-possible. The assumption that all perfectly natural properties are categorical enables Lewis to formulate a principle of recombination according to which given a space-time every mathematically possible way of combining instantiations of perfectly natural properties to fill the space-time is a possible world and every possible world is such a

¹ Lewis called his metaphysical view "Humean Supervenience" named after Hume whom he called "the great denier of necessary connections." Galen Strawson (2015) has argued that this is a misnomer since according to him Hume didn't deny the existence of necessary connections but rather held the view that we can't know anything about them. Strawson suggests that Humean Supervenience is better thought of as Lewisian supervenience. However, the name for Lewis' view has become so entrenched in the literature that I doubt that Strawson (or anyone else) has the power to change it.

² Space- time is comprised of a collection of points and the distance relations among them. Lewis considers the possibility that in addition to points there may be point sized entities occupying points. But as Hall (2010) points out his metaphysics is better off without them.

combination.³ This is why perfectly natural properties earn the title of “the metaphysical joints of reality.”

Lewis calls the distribution of perfectly natural properties/quantities “the Humean Mosaic”(HM) and says that it is up to physics to inventory the perfectly natural properties that appear in our world. His examples of perfectly natural properties are mass, charge, and spin.⁴ Humean Supervenience (HS) further claims that the only fundamental relations are metrical and that all contingent truths at a world including truths about laws, counterfactuals, causation, objective probability, nomological necessity, the locations of mountains, and the states of economies etc. supervene on the HM. In other words, possible worlds that completely agree on their HMs also agree with respect to their laws, counterfactuals, casual connections, chances, dispositions, and so on. Lewis’ program for establishing HS is to propose and argue for accounts of laws, counterfactuals, chance, causation, and so on in terms of the space-time distribution of perfectly natural properties. Laws play the central role in these accounts. His “best system account” (BSA) says that certain true propositions are laws in virtue of their being entailed by the scientifically best systematization of the Humean mosaic.⁵ According to Lewis the scientifically best systematization is specified by axioms that are true and that optimally balance simplicity and informativeness. Laws are propositions that describe regularities and patterns entailed by the best system. According to the BSA it is in virtue of the systematizing

³ For Lewis’ principle of recombination see Lewis 1986 and 1994

⁴ There are perfectly natural properties that are not and can not be instantiated in the actual world. Lewis calls the “alien properties.”

⁵ See Lewis 1986b Introduction for his account of HS and his account of laws. Further discussion of Lewis on laws is in Loewer 1996, 2007, 2010. Lewis does not say exactly what further features a proposition entailed by the best system are needed to earn the title ‘law’ although he seems to think that laws must be generalizations and dynamical. I don’t think this is quite right since there may be restrictions on initial conditions and propositions like symmetry principles that may be entailed by the best system and play the role of laws and so should be considered to be laws.

role of laws that they are capable of performing the functions of laws e.g. explaining, supporting counterfactuals and grounding causation and so on.

The reason for appealing to simplicity and informativeness in characterizing the law determining best system is that these are among the criteria that have been employed in the history of physics to evaluate proposals for law specifying fundamental theories. Furthermore, it is evident why they are scientifically desirable features of a fundamental theory. Lewis suggests that the informativeness of a theory is measured in terms of possibilities excluded and seems to think of simplicity syntactically. While informativeness and simplicity are indeed virtues in a scientific system both need to be given characterizations that are more in tune with scientific practice than Lewis's brief accounts of them. His account of informativeness is particularly unfortunate and immediately leads to problems.⁶ Further, there are additional criteria that scientists appeal to in evaluating theories which should be added to criteria for systematizations. Later in this paper I will sketch a version of the BSA that is independent of HS and there say a bit more about criteria for law determining systems.⁷

The BSA includes probabilistic laws by letting the language in which candidate theories are formulated include terms for probability functions. By specifying probabilities, a candidate system can gain a great deal of informativeness while still being relatively simple.⁸ For example, consider a long sequence of the outcomes of measurements of x-spin on y-spin electrons half of which are "u" and half are 'down". Typically, a simple description of the sequence in a language lacking probability functions will not be very informative, and an informative description will be very complicated. But the proposition that the probability of a measurement of x-spin on a y-spin electron yields an "up" result is .5 and that the measurements are independent may be both simple and informative. Lewis suggests measuring the informativeness of a theory that assigns probability in terms of "fit" which he identifies with the probability of the actual history of the world given the theory.⁹ The BSA may include laws that entail both dynamic and initial condition probabilities and so allows for probabilities

⁶ The immediate problem is the threat of trivialization. If Fx is a predicate true of all and only actual entities and if individuals are world bound as Lewis holds then $\forall xFx$ is true only at the actual world and so is maximally informative. Since it is also simple it is the best systematization of the actual world and since it entails all truths it makes all general truths laws. Lewis' response is to restrict the language in which candidate systems are formulated to include only predicates and functions that refer to perfectly natural properties. For better ways of responding to the problem see Loewer (2020) and the last section of this paper.

⁷ See Loewer (2020), Loew and Jaag, and Hicks for more science sensitive accounts.

⁸ Lewis says "Consider deductive systems that pertain not only to what happens in history, but also to what the chances are of various outcomes in various situations - for instance, the decay probabilities for atoms of various isotopes. Require these systems to be true in what they say about history....Require also that these systems aren't in the business of guessing the outcomes of what, by their own lights, are chance events; they never say that A without also saying that A never had any chance of not coming about. (1995 p.480). Lewis proposes evaluating the informativeness of a probabilistic theory in terms of the "fit" of the world on the theory i.e. the likelihood of the world on the theory. This is problematic since it is plausible that the likelihood of the actual world on any plausible candidate theory is infinitesimal. For an alternative proposal see Loewer 2001)

⁹ This may not be the best way of measuring the informativeness of a probabilistic theory. Probabilities inform by guiding credences and the informativeness of a credence may be assessed by its accuracy.

whether the laws are indeterministic or deterministic.¹⁰

Opposed to Humean accounts of laws like Lewis' Humean BSA are accounts that in some way involve necessary connections. There are two main varieties of anti-Humean accounts- i) governing views and ii) powers views. Each of these employ necessary connections although differently.¹¹

While talk of "governing" echoes the theological birth in the 17th century of the concept of scientific law few of its contemporary philosophical defenders make an overt appeal to theology to explicate it.¹² Rather, they understand laws to be features of reality over and above occurrent events that necessitate them by in some way governing them.¹³ "Governing" is meant to be a relation that makes laws responsible for the regularities they govern. Some proponents of governing views go a bit further saying that a dynamical law governs by taking the state of a system (or the state of the entire universe) at a time (or on a Cauchy surface) and evolving it to subsequent states thus forging necessary connections between the earlier and

¹⁰ It is a very attractive feature of Lewis' BSA account that can accommodate objective probabilities. At one-point Lewis claimed that genuine chances are incompatible with determinism. Lewis (1986). This was because he was thinking of genuine chances as dynamic probabilities. However, the BSA is very naturally extended to systems with deterministic laws by construing probabilities over possible initial conditions or possible histories. See Loewer (2001)

¹¹ Governing accounts are associated with Armstrong (1980), Dretske (1979) and Tooley. A related primitivist view is Maudlin's (200x). Powers views are associated with Shoemaker, Ellis, and Bird. A third view on which laws involve necessary connections is Marc Lange's counterfactual account on which lawful propositions are those that are stable under certain conditions. Lange 2009. For discussions of Lange's view see Loewer (2011)

¹² See Harrison (2019) for a discussion of the theological origin of the concept of laws of nature. Two philosophers who do make the connection between theology and governing explicit but for different reasons are John Foster (2005) and Nancy Cartwright (2004). Foster in *The Divine Law Maker* argues that God's will is required to make sense of the governing role of laws and Cartwright in "No God No Laws" appeals the connection between laws and theology in her argument that there are no laws of nature and for a return to a more Aristotelian account of science.

¹³ This type of account of laws was developed by Armstrong, Dretske and Tooley in the 1980s

later states and connecting their account of laws with accounts of time.¹⁴ The resulting necessary connections between states at different times are said to be nomologically necessary rather than metaphysically necessary since laws are contingent. However, the fact that a law implies its associated regularity is supposed to be metaphysically necessary.¹⁵

According to powers accounts properties are or possess powers whose instantiations produce necessary connections among events and laws are regularities that hold in virtue of the exercise of these powers. Since these regularities hold in virtue of the natures of the properties they connect, they are metaphysically necessary although which powers are instantiated is contingent. Not all laws can be the result of the activity of powers since there are also laws that describe how powers compose to specify how systems evolve. For example, electrons have both gravitational and electromagnetic powers which combine in interactions with other electrons. These composition principles are in addition to the powers possessed by properties.¹⁶

Proponents of governing and powers views can agree with Lewis that as a matter of fact the lawful truths of our world can be systematized by a Lewisian best system and that looking for a systematization is a good way to look for laws. But unlike Lewis' BSA they do not think that a proposition's place in a best systematization is what makes a proposition express a law. Instead, they hold that it is the fact that laws *govern* or *produce* necessary connections that makes

¹⁴ Tim Maudlin (2007) proposes an account along these lines. The account also forges a connection between accounts of laws and accounts of the nature of time. This connection is discussed in Loewer (2012).

¹⁵ Lewis raised the question of why a governing law necessarily implies its associated regularity since they are distinct matters. He famously quipped that calling the relation between properties "contingent necessitation" no more supports this connection than calling someone "Armstrong" makes him have strong biceps.

¹⁶ See Andreas Hutterman (2014) for a discussion of this point.

them laws. Anti-Humeans maintain that it is because laws involve necessary connections that they are able to account for the world's patterns and regularities and to play the role of laws in explanation, supporting counterfactuals, and induction.

Most of the recent literature on the metaphysics of laws concerns arguments pro and con Humean and anti-Humean views. In this paper I will discuss two of the most persistent objections against Humean accounts and especially against Lewis' BSA. The first objection is that Humean laws are too weak to play the explanatory role that laws play in science. The second is that Humean metaphysics makes it surprising that our world contains regularities that are systematizable by a Lewisian best system. In Galen Strawson's words on Humean metaphysics "it would be a fluke" for the world is systematizable or for there to be lawful regularities at all. Those who make these objections typically think that they are related since it is the absence of necessary connections is responsible both for the alleged explanatory deficiency of Humean laws and for the apparent flukiness of laws on Humeanism. Furthermore, both objections are claimed to create problems for squaring Humeanism with the rationality of inductive inferences thus connecting Humean views about laws with Hume's famous problem of induction. Some necessitarians believe all these problems are resolved by adopting either a governing or powers account of laws.¹⁷

Nina Emery formulates the worry that Humean laws are explanatorily deficient in this way:

It seems plausible, then, to think that the mosaic, in some sense, explains the laws. Why are the laws what they are? Surely, for the Humean the answer to this question must be: because the mosaic is the way it is. But again, one of the key roles of laws in science, is to explain both particular features of and patterns across the mosaic. So it seems that the Humean is committed to an explanatory circle: the laws explain features of the mosaic and the mosaic explains the laws.

¹⁷ See Armstrong

Tim Maudlin succinctly puts the objection as follows:

If the laws are nothing but generic features of the Humean Mosaic, then there is a sense in which one cannot appeal to those very laws to explain the particular features of the Mosaic itself: the laws are what they are in virtue of the Mosaic rather than vice versa. (Maudlin 2007, *The Metaphysics within Physics* p. 172).

The “circularity argument” advanced by Emery and Maudlin is that since Humean laws are regularities that are made true by their instances and the fact that they are true and lawful is made true by the HM which includes their instances the Humean laws cannot turn around and explain these very instances. That would be circular explanation. They conclude that on Humean accounts laws don’t explain their instances. But since they hold that laws do explain their instances they conclude that Humean accounts are defective.

I have argued previously that the correct Humean reply to the circularity objection is to distinguish two kinds of explanation, “metaphysical” and “scientific.”¹⁸ The Humean mosaic *metaphysically* explains laws since Humean laws supervene on the mosaic. But this doesn’t preclude Humean laws from playing the role that laws play in *scientific* explanation. This distinction removes the circularity that is alleged to undermine explanation by Humean laws. On the face of it there are important differences between metaphysical and scientific explanations. Metaphysical explanations connect explanans with explanandum by metaphysical

¹⁸ This reply to the circularity objection was originally made in Loewer (2012) and subsequently received much criticism and defense Loewer (2102), Miller, Marshall, Hicks, Bhogal, Lange, Emery

necessity and are synchronic.¹⁹ Scientific explanations can connect explanans with explanandum contingently and are often diachronic. My response depends on how laws scientifically explain.

While Anti Humeans and Humeans may have similar views concerning metaphysical explanation they have very different views about how laws scientifically explain. According to both types of anti-Humean accounts laws or the properties involved in laws explain by being in some sense responsible for regularities.²⁰ On the governing account laws are responsible for events by producing or constraining them.²¹ On powers views the instantiation of one power is responsible for another instantiation. Since according to Lewis' Humean account the HM is responsible for which regularities are laws and causality it is no surprise then that from the anti-Humean position explanation by Humean laws seems circular. Humeans have a very different account of how laws scientifically explain. While Humeans say that laws entail conditionals involving their instances they do not produce or constrain them. According to Humeans there are two main ways that laws are involved in scientific explanations. One is explanation by unification and the other is explanation by backing causal relations and counterfactuals.

Explanation by unification works like this: Particular events are unified by lower level laws that describe a salient pattern they exhibit and lower level laws are unified by more general

¹⁹ Some philosophers (e.g. Schafer, Fine) add that certain metaphysical explanations claim that the explanans *ground* the explanandum. In this case the mosaic grounds the laws.

²⁰ Some anti-Humeans think of laws as themselves *causes* of associated regularities. John Foster writes "the only way of making sense of the notion of law...is by construing a law as the causing of the associated regularity" Foster (2001). This echoes the theological origin of the notion of laws on which God enforces lawful regularities.

²¹ "The laws can *operate* to *produce* the rest of the Mosaic exactly because their existence does not ontologically depend on the Mosaic." (Maudlin, 175) This makes the relation between a law and the events it governs seem to be something like causation.

laws which in turn are unified by even more general laws. I don't have a general account of unification but examples are easy to find.²² Kepler's laws unify the motions of the planets, Galileo's law of the pendulum unifies certain periodic motions, Newtonian laws of motion and gravitation unifies the motions of celestial and terrestrial objects e.g. projectiles and pendula, and a quantum theory of gravity, if there is one, will unify (and correct) Newtonian theory and quantum mechanics. The best system of the world is the system that best scientifically unifies the whole world.²³

The second way laws are involved in scientific explanations is by backing causal relations that explain one event in terms of others. For example, the breaking of the window may be explained by the fact that the throwing of a rock caused the window to break. The causal relation between the throwing and the breaking is backed by dynamical laws. The analysis of causal claims is a controversial matter but everyone agrees that causation in some way involves laws. As long as an account of causation is compatible with HS, as Lewis' account is, Humean laws can scientifically explain by backing causal explanations. Neither their roles in unification or causation require laws to govern or be responsible for their instances so the circularity argument is defanged.

On Lewis' BSA there is no further scientific explanation of the axioms of the world's Best System.²⁴ Humeans have to accept that scientific explanation ends there. But there is a

²² Accounts of unification can be found in Kitcher (1981) and Friedman (1974)

²³ See Callum (2020) and Bhogal (2021) for excellent discussion of the circularity argument and for how understanding scientific explanation as unification provides a response.

²⁴ A non-Humean can say that the fundamental regularities are explained by non-Humean laws that make them true but Humeans reject this as a kind of *virtu dormitus* kind of "explanation" and in any cases raises the question of what explains the existence of these non-Humean laws (or the powers that underlie them).

metaphysical explanation of why a particular axiom system is best. In a classical mechanical world Newton's laws are best because they are components of an axiom system that best scientifically systematizes the Humean mosaic of that world. The HM metaphysically explains the laws. The laws scientifically explain events in the HM by unifying them and backing causal explanations. I don't think that my reply will quell all worries about circularity. Some anti-Humeans have responded to my defense by rejecting the distinction between scientific and metaphysical explanation or by providing examples in which they claim that scientific explanation is transmitted across metaphysical explanation so as to restore the circularity.²⁵ Later in this paper I will sketch a descendent of Lewis' BSA that avoids the circularity objection in a different way.

The second anti-Humean argument attempts to show that if Humeanism were true it would be a cosmic accident for the world to be systematized by a Lewisian system and so for there to be any laws at all. Arguments along these lines have been suggested by John Foster and Galen Strawson. Foster makes the point this way:

What is so surprising about the situation envisaged – the situation in which things have been gravitationally regular for no reason – is that there is a certain select group of types, such that (i) these types collectively make up only a tiny portion of the range of possibilities, so that there is only a very low prior epistemic probability of things conforming to one of these types when outcomes are left to chance. (Foster (2004) p 68.)

²⁵ For example, Lange (2013) has argued that Loewer's defense is a distinction without a difference.

According to him, Humeanism about laws still leads to circular explanation because scientific explanation are in some cases transmitted across metaphysical explanation. Lange's argument is rebutted by Dorst and Hicks (2020)

And Strawson says:

“One is presented with all these massy physical objects, out there in space-time, behaving in perfectly regular ways, and then one is told that there is, quite definitely, no reason at all for this regularity; absolutely nothing about the nature of reality which is the reason why it continues to be regular in the particular way in which it is regular, moment after moment, aeon after aeon. It is, in that clear sense, a pure fluke. It is, at every instant, and as a matter of objective fact, a pure fluke that state n of the world bears precisely the relation to the previous state of the world that one would expect, in line with the previous pattern of regularity.” (Galen Strawson (2014) p. 30)

Foster and Strawson are arguing that if there is no non-Humean law responsible for a regularity then it is a fluke that the regularity obtains and if one thinks that there are no non-Humean laws then one should assign very low prior probability to any regularity with unexamined instances. If it really were a consequence of Humeanism that allegedly lawful regularities are flukes then it does seem to follow that candidate Humean laws with infinitely many instances should have 0 prior probability and so they would not be confirmable by their instances. The consequences for inductive inference are even more dire than this. It is not just, as Armstrong claimed, that on Humean accounts of law induction is not rational but that it is positively irrational. Strawson claims that if a regularity is a fluke the fact that so far observed instances conform to it provides no reason to expect the regularity to continue. In fact, if one thinks that a regularity is a fluke then one has reason to expect the regularity not to continue.

Strawson seems to think that if there are no necessary connections among fundamental properties they are randomly distributed in space-time. It is correct that if fundamental property instantiations are randomly distributed it would be a fluke for those regularities we think of as laws to hold. But it is a mistake to think that Humeanism implies that fundamental property instantiations are randomly distributed and a mistake to think that Humean laws are

flukes. A fluke is a sequence of events that form a pattern that is unlikely without an explanation. An example is the proverbial gorilla randomly hitting a typewriter key board and types the first act of Hamlet. If we think that typing each letter is probabilistically independent of typing another then it is enormously unlikely that the text of Hamlet results. And if we believed that the gorilla is striking keys at random and discover that he typed the first scene we would have no reason to think he would next type scene. But if there is an explanation; for example, the typist is not a gorilla but a theater professor in a gorilla suit, then we no longer consider the event a fluke and we would have reason to expect that if the "gorilla" continued typing it is likely he would type scene 2. Strawson thinks that in a Humean world the existence of an apparently lawful regularity is like a gorilla typing the first act of Hamlet. A regularity that is a fluke doesn't explain its instances and doesn't inductively support generalizing it beyond its instances. It is not a law.

But Strawson's claim that Humean laws are flukes is defective. It confuses metaphysical independence with probabilistic independence. Humeans hold that fundamental property instantiations are metaphysically independent but that is no reason to believe that they are probabilistically independent or even that they possess probabilities. The best system for a particular HM might entail laws that assign probabilities to instantiations of fundamental properties. But this probability distribution over the HM need not and typically will not entail that fundamental property instantiations are probabilistically independent. So, the fact that property instantiations are metaphysically independent does not entail that there is an objective probability distribution on which they are probabilistically independent. And if the fundamental laws do imply that the instances of a regularity are not probabilistically

independent then of course that regularity is not a law of the BSA. The conclusion is that the distribution of properties in the HM is not a fluke and neither are the regularities entailed by its best system.

So far, I have argued that Humean laws can scientifically explain their instances and that Strawson's argument that they are "flukes" fails due to its confusing metaphysical independence with probabilistic independence. Recently Dustin Lazarovici proposed an interesting argument related to Strawson's that also aims to show an incompatibility between Humeanism and the existence of BSA laws. According to Lazarovici it would be surprising for a Humean mosaic to be systematizable and so to have BSA laws. He claims that this is because *typical* Humean mosaics fail to have simple informative systems.

It is typical for Humean worlds to have no Humean laws. Almost all Humean worlds are too complex to allow for any systematization. The challenge to the Humean theory is thus not to account for why we find these particular laws in our universe but why we find any laws at all. Conversely, if we live in a world that is regular enough to be described by laws of nature, the best explanation is the existence of something in the fundamental ontology that makes it so.

Lazarovici suggests that while it might be a mistake to claim that if Humeanism is true then it is unlikely (objectively or subjectively) that the actual Humean mosaic is systematizable it is nevertheless the case that systematizable mosaics are atypical and that is a problem for Humeanism. "Atypical" is a technical term adapted from work in the foundations of statistical

mechanics where it refers to a behavior or property that is very infrequent.²⁶ An example is that violations of the second law of thermodynamics in isolated systems with sufficiently many degrees of freedom are atypical. Lazarovici argues that systematizable mosaics are atypical in the class of all mosaics since there are uncountably many mosaics (every distribution of fundamental quantities at space time point is a mosaic) but that there are at most only countably many scientific systems. He seems to think that this means that there are only countably many systematizable mosaics. If this were so, then he claims that that it is a problem for Lewis' BSA. Lazarovici invokes a principle which says that if a theory entails that a condition or phenomenon is atypical then it incurs an explanatory deficit and that is a reason to reject it if there is a competing theory that explains the condition or phenomenon. I think that this principle is plausible when applied to scientific theories but less clear that it holds for metaphysical theories. In any case, he concludes that since on the BSA mosaics that are scientifically systematizable are atypical the BSA should be rejected at least if there is an alternative metaphysics on which the world's being systematizable is not atypical. He thinks that there are anti-Humean views for which this is the case.

Lazarovici's argument like Strawson's expresses the thought that the existence of lawful regularities in Humean worlds would be a fluke. Ingenious as his argument is, I think it is no more successful. One problem with it is that it doesn't follow from the fact that there are only countable many systems that there at most countably many scientifically systematizable

²⁶ The notion of typicality has recently been invoked in statistical mechanics and other theories in physics in order to provide an account of explanation in such theories. For example, entropic behavior is typical among energetically isolated systems. A property or behavior is typical in a reference class if almost all members of the class have the property or behavior. It is not a probability but rather a "counting" notion. See Wilhelm (2019) for further discussion of typicality.

worlds. For example, there are uncountably many worlds (think of all possible initial conditions) systematized by classical mechanics.²⁷ One can reply, as defenders of typicality do in statistical mechanics, that when comparing uncountable sets, one has to apply an appropriate measure. So, for example, on the Liouville measure the set of worlds that satisfy thermodynamics has much greater measure than the set of anti-thermodynamic worlds even though they are both uncountably infinite. There are measures relative to which the set of unsystematizable HMs is much greater than the set of systematizable HMs but there are also measures on which the reverse holds. In the case of statistical mechanics there are reasons to hold that the Liouville measure is the appropriate one for evaluating typicality because of its relationship to the fundamental dynamics but no reason like this is available to select a measure on HMs.

Furthermore, the situation with respect to atypicality of the world having a best systematization seems at least as bad for non-Humean as for Humean accounts of laws. On governing views there is a possible world corresponding to every distribution of properties and every collection of governing laws as long as the properties are distributed so that the laws are not violated. But just as systematizable HMs are said to be atypical in the class of HMs systematizable worlds that may have governing laws are atypical in the class of all worlds that may have governing laws. This class includes all the Humean worlds that lack governing laws and in addition includes worlds with constraining laws that are enormously complicated and gerrymandered. For example, there is a member of the class that consists of an HM identical to

²⁷ Systems that include probabilistic laws can also systematize uncountably many worlds. Lazarovici address the issue of probabilistic theories but so far as I can see he doesn't show that a probabilistic theory can't systematize uncountably many mosaics.

the actual world's except this world also contains the constraining law that all emeralds are grue. The situation at first seems a bit better on a powers metaphysics. If fundamental properties are powers then it is typical for a world to exhibit regularities. But it doesn't follow that typical worlds are systematizable since powers interacting with one another can produce arbitrarily complicated patterns of events. Of course, it is possible to avoid this consequence if it is required that the world only contains powers that combine to produce systematizable worlds, but a Humean could likewise just posit that the actual world is scientifically systematizable. It seems that non-Humean metaphysics has no advantage over Humean metaphysics when it comes to explaining why the world is systematizable.

But if our world is systematizable as fundamental physics apparently assumes it to be it does appear to be a profound mystery that this is so. I don't think that there can be any metaphysical guarantee that dispels this mystery. However, there is an account of laws and properties that, I think, makes the systematizability of the world a little less mysterious and has a number of other advantages over both Humean and non Humean accounts. The account I have in mind is "the Package Deal Account of Laws and Properties" (PDA) that I have developed in a number of prior papers.²⁸ The PDA is a descendent of Lewis' Humean BSA though, as we will see, it differs in a number of important respects. Here I will sketch it and explain how it handles the two objections to Humean accounts that were discussed earlier and then how it helps alleviate the mystery that the world is systematizable.

²⁸ Loewer (2007) and Loewer (2020)

In Lewis' metaphysics perfectly natural properties/quantities and their distribution are metaphysically fundamental. Candidates for a law determining system are formulated in a language whose atomic predicates refer to what he calls "perfectly natural properties." Which properties are perfectly natural is a matter of metaphysics prior to physics although it is the job of physics to discover them. Lewis posits metaphysically prior perfectly natural properties in order to avoid trivialization of his BSA. In contrast, the PDA does not appeal to the existence of metaphysically prior perfectly natural properties. Its basic idea is that the world can be described in terms of many different languages that contain different predicates that claim to refer to fundamental properties/quantities. Given a candidate for a fundamental language and the totality of truths in that language candidates for best system are compared with respect to simplicity, informativeness and other criteria for a fundamental theory that are derived from the aims and practice of physics. The law determining best system of the world is the package of fundamental predicates and the system formulated in terms of the language including them that optimally satisfies these criteria. Laws are generalizations entailed by this best system.²⁹

Because the PDA doesn't start with a preferred language in which to formulate candidates for best system some other account of what the best system is aiming to systematize is needed. The basic idea is that a fundamental theory is aiming to systematize macroscopic truths and regularities especially regularities formulated in the languages of special sciences like thermodynamics and chemistry as well as truths it counts as fundamental.³⁰ To accomplish this

²⁹ If there are ties among candidate systems then what counts as a law is system relative.

³⁰ An account of special science laws similar to the PDA has been proposed by Callender and Cohen (2009). Their view is that in a special science predicates and systematization of truths employing those predicates are selected together with the aim of optimizing the satisfaction of criteria determined by the special science.

a candidate for an optimal language must contain predicates that refer to properties whose distribution throughout space time can serve as a supervenience base for macroscopic truths and special science truths e.g. truths of thermodynamics, chemistry, biology etc. The distribution of properties referred to by the fundamental predicates of the optimal language play the role that perfectly natural properties play in Lewis' account. The difference between the PDA and Lewis' account is that where Lewis begins with a collection of metaphysically prior perfectly natural properties and asks for the best systematization of the distribution of their instantiations the PDA compares alternative packages of proposed fundamental properties and systematizations of their distributions and selects the best package. The best package is the one whose distribution of fundamental properties both serves as a supervenience base for other truths and is systematizable by a theory that best satisfies the criteria for a fundamental physical theory. As on Lewis' account these criteria include informativeness and simplicity but as physicists actually evaluate them. There are additional criteria involved in selecting the best language system pair. One is that it counts in favor of a proposed package to the degree with which it systematizes special sciences. Another one is that laws are invariant under a variety of spatial and temporal transformations. For example, the same laws apply in distinct regions of space-time. A third is that a good fundamental theory provides the basis for relatively simple accounts of how the macroscopic emerges from or is grounded in the fundamental and provides explanations of special science regularities. We should be able to understand, at least roughly if not in detail, how arrangements of fundamental properties/quantities behaving in conformity with the fundamental laws give rise to macroscopic phenomena and laws. Fourth, while a good fundamental theory may depart from our ordinary folk concepts and beliefs about

the world such departures should be justified by satisfying the other criteria. For example, special relativity departs from our ordinary folk beliefs by claiming that there are pairs of events such that there is no fact of the matter as to whether they are simultaneous. This departure is justified by special relativity satisfying other criteria for a fundamental theory especially empirical adequacy. There are plausibly further criteria that a fundamental theory aspires to that might be learned from examining the history of proposals for fundamental theories. Of course, the extent or whether these criteria can be satisfied for the actual world is open.

The properties in the optimal package earn their title of “fundamental” by being a supervenience base that “grounds” instantiations of non-fundamental properties.³¹ For example, an ontology of classical particles whose fundamental properties are mass and inter particle distances and whose distribution is systematized by Newton’s laws and a law of contact looks at first (if one doesn’t look too closely) promising as such a theory. Macroscopic objects and their motions are identified with configurations of particles and their motions. Of course, a lot more needs to be said to develop and defend this proposal to make it plausible that metaphysically prior fundamental properties can be dispensed with and that the PDA yields credible candidates for fundamental properties and laws. Steps in that direction are taken in Loewer (2020)

One important difference between the PDA and Lewis’ BSA is that the PDA doesn’t include a requirement that fundamental properties are categorical. It may turn out that the optimal package includes predicates that refer to properties whose instantiations in one region

³¹ Exactly what it is for the instantiation of one property to ground another has recently been the subject of much discussion. See Schaffer (2016) Sider (2020).

exclude the instantiations of other properties in disjoint regions. Necessary connections among properties are allowed but not required by the PDA. This enables the account to accommodate properties and quantities that refer in theories in contemporary physics that seem to be individuated in terms of their connections with other properties. For example, the standard model of elementary particles and forces plausibly individuates types of particles in terms of their relations to each other.³² Thus, the PDA is not committed either to Humeanism or to Lewis' recombination principle. The PDA laws don't involve necessary connections even though permit them. Although this violates the letter of Lewis' Humeanism it does so in a way that should not offend Humeanism. It shares with the Humean BSA that it is in virtue of its role in systematizing not in virtue of necessary connections that a proposition expresses a law. We might say that the view is half-Humean.

It is worth examining, at least briefly, how the two objections to Humean accounts of laws apply to the PDA. The first, recall, was that Humean laws are incapable of sustaining explanations of their instances since those instances play a role in explaining the laws. According to proponents of this objection this renders proposed explanations by Humean laws defective because circular. My response was to distinguish scientific from metaphysical explanation and scientific explanation and claim that laws scientifically explain their instances while instances metaphysically explain the laws. There is no circularity since different kinds of explanation are at issue. Those who don't accept this distinction or the way it was employed

³² See McKenzie (2014) for examples of fundamental theories whose properties are apparently not categorical.

may still find it interesting that the objection is a non-starter according to the PDA. On the PDA even though the laws supervene on the totality of fundamental truths including its instances this totality does not metaphysically explain the law. Rather, the laws and the fundamental truths are determined together as a package. Since the mosaic as characterized by the optimal language doesn't metaphysically explain the laws there is no circularity in the laws scientifically explaining aspects of the mosaic.

The second objection to Humeanism was that since most Humean Mosaics are unsystematizable it would be an accident or fluke if the actual mosaic is systematizable. But because the PDA is not committed to metaphysically prior categorical perfectly natural properties and a principle of recombination this argument doesn't get a foothold. First, some of the properties deemed fundamental at a world by the PDA may not be categorical and so cannot be combined in arbitrary fashion in other worlds. Moreover, even if the fundamental properties at one world are categorical it doesn't follow that these very properties will be counted as fundamental at other worlds. So, the fact that the perfectly natural properties at w may not be systematizable at another world w^* doesn't show that there aren't other properties whose instantiations are systematizable at w^* . Because the ontology/properties and the system/laws are determined together as a package there is room to make adjustments in the fundamental language/properties to aid systemizing. This makes the existence of a system of the world a bit less mysterious than the rival views, both Humean and non Humean. I admit though it falls short of dispelling the mystery entirely. It doesn't follow that on the PDA the world is guaranteed to be systematizable, even if it does mitigate to an extent the feeling that we should be surprised that our world has laws.

** Thanks to David Albert, Harjit Bhogal, Eddy Chen, Chris Dorst, Mike Hicks, Jenann Ismael, Siegfried Jaag, Dustin Lazarovici, Christian Loew, Elizabeth Miller, and Isaac Wilhelm

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