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ON POWERS BSAs

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Can the desire for efficiently systematised theories in science be explained from within a powers metaphysics? It is plausible that the traditional 'Powers Theory of Laws', endorsed by many friends of powers, does not alone provide such an explanation. This has led a number of recent authors to argue that a 'Powers Best System Account' of laws would be a preferable alternative. This account borrows a method for determining laws from the Humean and applies it to a reality of powers. Here I claim, to the contrary, that this account is both internally unworkable and, anyway, completely undermotivated when compared with the traditional view. Apart from some brief suggestions for alternative accounts, I'll conclude that the powers theorist still has their work cut out to explain systematising in science.

Keywords: best systems account, powers, laws of nature, powers theory of laws, systematising in science.

I. INTRODUCTION

Scientists systematise. That is, they look for generalisations that have enormous generality and are relatively simple to express. As Cohen and Callender (2009: 3) remark, 'virtually every science textbook contains frequent appeal to simple principles that cover a vast array of phenomena in the field'. 'Even philosophers skeptical of laws,' they claim, 'recognise that scientific theorising is a process of carefully balancing simplicity and strength'.

This feature of scientific practice is woven into the constitutive nature of laws for the 'Best Systems Account' (BSA). According to the account, laws just are those generalisations that feature in the deductive systematisations of (at least) the actual world's history that are best at balancing simplicity and strength (and potentially also further desiderata).[1] Hence, the BSA 'achieves continuity with actual scientific practice by sticking close to the scientific understanding

[1] Some authors have suggested that systematisations may be tied for best if, for example, they concern different classes of property (Cohen and Callender 2009) or if they differ only in non-lawlike axioms (Friend 2022). I will ignore this complication and assume that there can be only one best system for any domain.

of laws and by ensuring the epistemic accessibility of the laws via scientific methods, which [are] good at discovering strong, simple statements about the world' (Kimpton-Nye 2021b: 3438).

The BSA is accepted by most Humeans, who endorse a metaphysical picture of the world free of necessary connections (see especially Lewis 1983, 1994). What gets systematised according to these Humean interpretations of the BSA is a world whose properties share no non-trivial modal dependency relations. Their metaphysics is therefore directly opposed to that of the powers theorist, who does endorse these relations. Traditionally, powers theorists have also opted for a very different route to laws, inferring them directly from those necessary non-trivial modal natures of dispositional properties, 'powers' from hereon (Bird 2005, 2007; Chakravartty 2003; Swoyer 1982).[2]

In recent years, however, powers theorists have expressed an interest in adopting the BSA too (Demarest 2017; Katzav 2005; Kimpton-Nye 2017, 2021b; Vetter 2015; Williams 2019).[3] The basic idea behind each variant 'Powers BSA' ('PBSA' from hereon) is that the laws are theorems of a superlative systematisation of distributions of properties that are already modally imbued. Where PBSAs tend to differ from one another is over what 'portion of modality' is to be systematised. Some believe we should only systematise the actual world (Williams 2019), as Humean approaches invariably do. Others think it is some collection of worlds related by shared properties which must be systematised (Demarest 2017; Kimpton-Nye 2017, 2021a,b).

Awareness of the differences among PBSAs will be relevant for the discussion to come. However, their shared aim is my main target. For each PBSA which has been proffered is motivated by the thought that without following from a suitably efficient axiomatisation of the behaviour of powerful properties, the laws will fail to exhibit the systematicity that they evidently do have. As we will see, defenders of PBSAs back this claim up by drawing attention to a number of ways in which the traditional approach to accounting for laws from within a powers framework either over- or under-generates laws. Hence, they argue, it is appropriate to reach out for alternative techniques for determining the laws, such as those of the Humean.

The aim of this article is to demonstrate the implausibility of this response to laws' systematicity. I'll begin (Section II) by showing that there are principled reasons concerning sources of explanation and reflected in the practice of

[2] I also assume that the notion of 'power' covers the full range of more specific metaphysical views, including those which take it to denote properties which are essentially dispositional (Bird 2007; Chakravartty 2003), qualitative properties which ground dispositions (Kimpton-Nye 2021b; Tugby 2012), and powerful qualities (Ingthorsson 2013; Jacobs 2011). No harm should be done by conflating such terminology here.

[3] Two of these authors stop short of an endorsement of the idea. Vetter only suggests that laws might be conceived this way if a less realist approach to laws is to be favoured. Katzav raises the idea as a potential response to certain worries on behalf of powers theorists but is, in fact, highly critical of powers ontologies (see also Katzav 2004).

science why a BSA and powers metaphysics don't mix well. As I'll show, the problem has its source in what the PBSA defender can say about the explanatoriness conferred on laws by virtue of being in the best systematisation of some or other worlds. I'll then turn to show that there are also no good reasons to think a PBSA is more likely to accurately determine the laws than a traditional 'Powers Theory of Laws' ('PTL' from hereon). I do this by first isolating a particular 'regularity version' (PTL_{RV}) of PTL and showing that this regularity version is already consistent with taking laws to be theorems of a system (Section III). I'll then (in Section IV) describe in more detail the basic complaint that PBSA defenders have with PTLs. If any PBSA is to have a competitive edge over PTL_{RV}, then the system defined by the latter cannot be 'best'. I interpret this as the claim either that the PTL_{RV}'s system under-generates laws (due to a lack of strength) or over-generates laws (due to a lack of simplicity). I'll argue (respectively in Sections V and VI) that both are poor motivations for adopting a PBSA. Granting that PBSAs therefore fail to provide powers theorists with a better explanation of why scientists systematise than does the traditional PTL, I'll briefly suggest some alternative strategies for the powers theorist before concluding (Section VII).

II. CAN THE POWERS OF PHYSICS BE MEANINGFULLY SYSTEMATISED?

The ability to cohere with the extant systematising in science is what attracts defenders of PBSA to borrow from the Humean. But the very idea of doing so raises questions of plausibility. At the very least, it would be a mistake to think that BSA can be cleanly re-applied within a powers metaphysics without leaving out some of the uses Humeans put it to. For the Humean, any explanatory power laws have over the ongoings of the world is attributed to the systematic characteristics of the theories from which they're derived. On the very same page that Callender and Cohen emphasise—and Williams and Demarest reference with approval—the unquestionable drive to systematise in science, they say that

> recognizing in science the attempt to produce small sets of basic principles as a result of balancing simplicity and informativeness is the central and powerful insight that motivates MRL [read 'BSA'] *(and also, we believe, the unificationist theory of explanation)*. (Ibid., my emphasis)

For the Humean, then, it is by being part of a unified deductive systematisation of the world that allows laws to explain ongoings within it (see also Loewer 1996). By contrast, defenders of PBSA should deny, or at least play down, the idea that laws provide such explanations.

First, it is part of powers-metaphysics orthodoxy that the explanatory resources available to the Humean do *not* permit laws to explain worldly regularities (Bird 2007; Harré and Madden 1974; Molnar 2003; Mumford 2004; Williams 2019). To go back on that claim would bring into question a significant justification for the more weighty posits of a powers metaphysics over the Humeans' relatively lightweight framework.

Second, it is part of powers-metaphysics orthodoxy (defended by the same theorists) that the resources available to them due to the commitment to powers *does* licence explanation of worldly regularities. So it had better not be that the new proposal concerning the laws of nature clashes with this fact.[4] Yet it is part of the motivation for PBSA that it improves on the traditional powers-based approach to laws (see below), according to which laws simply reflect those modal characteristics of powers directly. And as we will see, such motivations have typically been attempts to show that the traditional approach either under-generates or over-generates laws. Hence, if the PBSA defender maintains the Humean's claim that laws gain explanatory power through being theorems of a deductive axiomatisation, then there is the very real prospect of competing explanatory sources.

For instance, if the PBSA contains a law L that the traditional approach doesn't (because the traditional approach is seen to under-generate), then some events covered by L may have no explanation according to the modal character of the powers involved and yet will nevertheless be nomically explained according to the PBSA view. Conversely, and perhaps more alarming, if the PBSA doesn't contain a generalisation G, which does follow from the modal nature of powers (i.e., G will count as a law according to the traditional powers-based approach to laws), then behaviour referenced in G, and which is explained by the the modal character of powers, will not fall within the scope of nomic explanation according to the PBSA view. Either kind of result is liable to make a mess of scientific explanation, since it will mean that the existence of a nomic explanation is not indicative of whether or not there is an explanation in terms of the powers themselves.

Notice that it's no use the PBSA proponent trying to ensure that the explanatory affordances of the PBSA and the traditional approach will perfectly match because both theories determine exactly the same generalisations to be laws (say, by making sure just the right amount of worlds are systematised in just the right way) since that would undermine the motivation for

[4] Kimpton-Nye (2021b: 3430–3) argues that Molière-style failures of explanation of the laws themselves, and of the corresponding regularities, occur when powers are understood to have modal characters as their essences, as per dispositional essentialism (see also Barker and Smart 2012). He also argues that a view whereby powers ground dispositional behaviour (e.g. 'QDE', Kimpton-Nye 2021b; Tugby 2012) avoids this issue. This debate is orthogonal to whether or not laws need to be reconceived as theorems of a system as opposed to following directly from the modal characters of powers, since dispositional essentialism and QDE are both compatible with the traditional and PBSA conception of laws (see Section III).

PBSA in the first place. Systematisation would have been found but through a completely ad hoc procedure of tailoring the Powers Best System to precisely match whatever the PTLs says are laws. Indeed, and as will become clearer below, PBSAs are motivated precisely in order to offer a theory of laws which identifies a distinct class of generalisations as laws, one which is supposedly more systematic. Moreover, if the explanatoriness of a generalisation could itself be explained by reference to both the modal character of powers *and* the fact that it was a theorem of the PBSA, then there would then be a question over which really showed why the generalisation was explanatory. I doubt any powers theorist would be willing to prioritise the latter explanation over the former.

Perhaps an option for the defender of PBSAs would be to suggest that scientific explanations are disunified, with some explanations coming from the laws and some from the powers, where there is no principled reason to expect the two kinds of explanation to match up. That's a plausible enough idea as it stands. But as a friend of powers, one should reasonably wonder where the explanatoriness of nomic explanation comes from if not from the powers themselves. If explanatory power is conferred purely through being part of a deductive system then the initial issue is raised once more that it becomes no longer clear what motivates a powers ontology over the more light-weight Humean view.

It is no surprise, therefore, that defenders of PBSAs avoid emphasising the laws' ability to explain worldly regularities gained through being theorems of a system. Like all powers theorists, they hold rather that it is the character of powers themselves, independently of the laws, which 'makes the world tick' (Williams 2019: 220), and that powers are 'fully capable of determining their own distributions, in accordance with their modal profiles' (Kimpton-Nye 2017: 13). Laws will then be understood only to gain explanatory power, if they have any, through reflecting these features of powers, however indirectly.

But if that's what PBSA defenders believe, why do they think scientists systematise? Demarest doesn't say much more than to point out that this is what they, in fact, do (*ibid.* 40, 52). Williams and Kimpton-Nye offer us a little more. Williams mentions the 'practical' benefits of 'packaging the world up into something more manageable' (*ibid.*, 220). Kimpton-Nye writes in a similar vein of the practical benefits of systematisation on our 'cognitive wiring', that is, 'features of sentient beings including, but not limited to: visual apparatus, intelligence, practical and scientific interests, etc.' (Kimpton-Nye 2021a: 14; see also Kimpton-Nye 2021b: 3437–39).

I suppose the idea that there is practical benefit to packaging the world up in a manageable form, or identifying its 'real patterns', as Kimpton-Nye puts things, hardly requires an extended defence. Like the data compression of a bitmap, a summary of some series of events in terms of brief generalisations can enable tractable predictions and efficient communication. But for all the

pragmatic benefits of having a systematisation of the world, it is dubious that this captures the full extent of why scientists pursue systematic theories, at least within physics.

Arguably the most impressive systematic features of contemporary physics are the use of symmetries. Symmetry-reasoning was used initially by Einstein to develop his relativity theories and later by Gell-Mann to formulate the Baryon decouplet, which enabled the prediction of the Ω^- baryon. Symmetries have also been used to define the exchange statistics of identical particles in bosons and fermions. As Gross remarks,

> In the latter half of the 20th century symmetry has been the most dominant concept in the exploration and formulation of the fundamental laws of physics. Today it serves as a guiding principle in the search for further unification and progress. (1996: 14256)

The explanatory value of symmetries in physical reasoning is also emphasised by their relevance in developing new physical theories.

> Most exciting is the speculation concerning new kinds of symmetry, which could explain some of the most mysterious features of nature. Foremost among these is *supersymmetry* that has the ability to unify bosons and fermions into a single pattern, to unify matter and force, and to help explain the mysterious fact that the mass scale of atomic and nuclear physics is so much smaller than the scale determined by gravity (the hierarchy problem). (Ibid.: 14259)

If the importance of unifying symmetries in contemporary physics is exemplary of the systematising efforts of physicists in general, then it seems that systematisation has more to do with a desire to identify an explanatory source (e.g. a symmetry constraint) for the world (e.g. via the dynamical laws) than a desire to 'package the world up into something more manageable'. Following a challenge to do so from Lange (2011), Humeans have offered specific treatments of symmetries, which aim at reflecting this characteristic, at least with regards to global external symmetries like the Poincaré group. For instance, Hicks (2019) argues that symmetries are theorems of a different system than the best system, chosen by a re-calibrated balance of the desiderata which emphasises simplicity over strength. Friend (forthcoming) raises some concerns about Hick's account and offers an alternative according to which the symmetries are descriptions of the purely structural (i.e. independent of the world's material contents) features of the actual world's 'world-making relations' (traditionally thought to be spacetime relations), which connect all and only regions of the actual world. In either case, the symmetries are systematic features of our theories because they, like the dynamical laws of the best system, are general features of the world which unify the behaviour going on in it. They are categorically not features of our theories put in place to make them more pragmatically manageable.[5] By contrast, PBSA defenders can't seem to

[5] A rather different Humean view on symmetries, which does come closer to a pragmatic justification for them is that of Dorst (2019), who suggests that requirements for symmetry should

admit any of this. For them, systematisation can be no more than a pragmatic crutch on pain of coming into conflicts of explanation like those described above.

Ultimately, it seems that powers metaphysics and systematising strategies for determining the laws just do not mix well. Both provide independent reasons for accounting for the explanatory features of laws, and attempting to have them both work together is liable either to make for inconsistencies or to miss the real reason that scientists systematise. Admittedly, my focus on motivation for systematising has been specifically on physics (using the particular example of symmetries). But physical theories are widely, if often only tacitly, treated as the make-or-break case-studies in the debate over the metaphysics of laws. Moreover, if the PBSA can't make sense of systematising in physics, then it certainly won't provide a thoroughgoing alternative to the traditional powers approach. Given that capturing scientists' motivation for systematising is a central goal for PBSA proponents, their project does not seem to be off to a very good start.

All the same, we should grant that the traditional powers-based approach can't seem to make sense of the systematising efforts of scientists either. It would therefore still be significant if PBSA strategies were more likely to exactly determine the laws than the traditional powers-based approach (whether or not they've gotten scientists' motivations right). The rest of this article aims to show that they do not.

III. POWERS THEORIES OF LAWS

The traditional idea that laws of nature might be determined by the natures of properties themselves goes back at least to Swoyer (1982), who argued for a 'property theory of laws'.

> The leading idea of property theories of laws is that 'all Gs are Fs' expresses a law (when it does), not because of a mere regularity, but because there is something about a thing's being G that is responsible for its being F. Minimally, a property theory holds that there is some relation, let us call it *nomic implication* [...], that holds between properties just in case anything exemplifying the first exemplifies the second as well. (1982: 207–8)

The view is naturally associated with an ontology of properties as causal powers, i.e., necessarily dispositional properties. After all, that is the view of properties which confers upon them natures capable of the sorts of non-trivially modal, 'nomic' implications Swoyer talks of. Chakravartty has described a property view of laws explicitly in these terms.

enter into the desiderata for the best system in order to make the system more predictably useful for 'creatures like us'. The view has been roundly criticised for drawing on such pragmatic grounds in Friend (2022) and by Hicks (2022) (see also Demarest, MS).

> So what is this understanding of the nature of causal properties that immediately yields conclusions about laws of nature? As a rough opening sketch: to say that an object has a particular causal property is to say that it is disposed to behave in particular ways in particular circumstances, and that all objects having this same property are likewise so disposed. [...] Some of the interactions elicited by these circumstances are experienced by us in the form of detected regularities. These regularities unfold in accordance with systems of laws which we attempt to map with linguistic expressions, often in the form of mathematical formulae. Causal laws are relations between causal properties. [...] The conjunction of all causal laws thus specifies the natures of all causal properties. (2003: 394)

There are five things worth noting about property—or *powers*—theory(ies) of laws (PTL(s)) that are relevant to our current concerns. First, the identification of laws with *in re* relations is optional. Both Chakravartty and Swoyer endorse PTLs according to which laws are objective facts or relations between properties themselves. Statements of the form 'all Fs G' are consequently characterised at best as only *expressing* a law. This view runs counter to an intuition shared by some powers theorists that there are no laws *in* nature (Mumford 2004). Indeed, it has been this intuition that has, on occasion, motivated theorists to offer a PBSA instead (e.g. Vetter 2015: 289, Williams 2019: 220). But it is important to recognise that the view of laws as objective facts/relations in nature is not essential to PTLs in general, and so the approach can't be faulted for being committed to a spurious metaphysical interpretation of laws. Bird, for example, describes a 'regularity version' of PTL ('PTL_{RV}' from hereon) according to which laws are statements with truth-values.

> According to the regularity version of dispositional essentialism (read 'PTL') about laws, laws are those regularities whose truth is guaranteed by the essentially dispositional nature of one or more of the constituent properties [...]. Regularities that supervene on such laws will also be laws. (2007: 46–7)

Bird also offers an example of the way such guarantees are conferred (*ibid.*, 46). We start with a characterisation of the necessary modal features of a single arbitrary single-track power P,

(I) $\quad \Box(Px \rightarrow (Sx \Box\!\!\rightarrow Mx))$.

Then we consider any world w and any case where some x in w possesses P and S, i.e.,

(II) $\quad Px \ \& \ Sx$.

By I and II we have

(III) $\quad Mx$.

Discharging II we have

(IV) $\quad (Px \& Sx) \rightarrow Mx$.

And since x is arbitrary we may generalise:

(V) $\forall x((Px\&Sx) \rightarrow Mx)$.

Moreover, Bird shows (*ibid.*, 48) that since V holds in an arbitrary world w it is necessary:

($V_{\Box}$) $\Box\forall x((Px\&Sx) \rightarrow Mx)$.

Hence, we have a lawlike generalisation (a statement of a necessary regularity) guaranteed by the essentially dispositional nature of one or more of the constituent properties, viz *P*.

It's important to emphasise the fact that the derivation I–V is just an *example* of how laws might be derived according to PTL_{RV}. As Bird remarks, the view is that, laws are those regularities which are entailed (or supervene on entailments) by the essential nature of one *or more* constituent properties (*ibid.*, 47). This means there is no particular restriction on the logical form laws can take, other than being a regularity. So, a second thing to notice is that PTLs can't in general be faulted for assuming any particular logical form of laws.

To give an example of how a law with a different logical form than that of V could supervene on generalisations more directly inferred from the modal character of powers, it could be that our most prized quantitative functional laws in physics are derived from the essential nature of continuum many single-track powers, each specific to some exact quantitative value. That would appear to be the way Bird (2007: 21–4) conceives things. Nevertheless, nothing about PTL_{RV} *per se* requires that powers be single-track. Perhaps, after all, some fundamental powers are quantitatively *multi*-track, licencing an inference to the quantitative laws individually. So, a third thing to notice is that the PTL approach can't be faulted in general for being constrained to a particular view about the number of 'tracks' associated with a power (cf. Vetter 2012, 2015; Ioannidis *et al.* 2021).

A fourth thing to note about PTL_{RV}, or indeed any version of PTL, is that to endorse it, it is not necessary to also accept that powers are *identified* by the implicating relations they bear to one another. The latter 'causal powers identity thesis' was famously proposed by Shoemaker (1997) and is endorsed by a number of defenders of PTLs (including Bird and Chakravartty). But it is consistent with PTLs that the nomic implication relations only account for some aspects of the constitutive natures of the involved properties or even that the nomic implication relations are grounded in the properties rather than essentially constitutive of them (as in Coates 2019; Kimpton-Nye 2021b; Tugby 2012). This means PTLs cannot be faulted in general for being committed to a particular metaphysics of powers. We can see this at once by noticing that Bird's derivation of V comes from a statement about the necessary implication of *P*'s non-trivial modal character rather than any explicit statement about its identity or nature. In what follows, I remain neutral on the status of the

causal powers identity thesis by talking of powers' non-trivial modal *character* as opposed to their identity, nature or essence.

The fifth and final thing I'll note about PTLs is that they can be consistent with the idea that laws are theorems of a system. In particular, according to PTL_{RV} the laws are those generalisations entailed and supervenient on ('guaranteed') by the non-trivial modal character of powers. The descriptions of powers' modal character (e.g. of the form I) therefore supply the axioms of a deductively closed system where at least some of the laws are theorems of that system (other laws will be supervenient on that system). Consequently, PTLs in general, and PTL_{RV} in particular, can't be criticised for failing to take laws to be part of a deductive system, as PBSA defenders are advising. Indeed, PTL_{RV} takes laws to be exactly the theorems of a system, which I'll refer to as the 'PTL_{RV} system'.

Given the foregoing, it's a good thing that defenders of PBSA don't criticise PTLs for failing to show that laws can be theorems of a system *per se*. Indeed, insofar as PBSA defenders endorse the expressibility of powers' modal characters, they must endorse the truth of the PTL_{RV} system as much as any PTL defender does. But with the foregoing clarifications in hand, we may proceed to consider better what PBSA defenders' basic complaint with PTLs really is.

IV. THE BASIC COMPLAINT

As we have seen, PBSA proponents agree that it is the character of powers that 'makes the world(s) tick'. But like the Humean, they claim that the system all of whose theorems that are generalisations are the laws, should be one that can be thought of as *systematising* some of those worlds (Demarest 2017: 48–9; Kimpton-Nye 2017: 12–3; Williams 2019: 222–3; Kimpton-Nye 2021a: 5–8; Kimpton-Nye 2021b: 3428–30; see also Katzav 2005: 339–40 and Vetter 2015: 289). This idea—that something (a portion of modal space) needs systematising—goes beyond the ideas that underlie any PTL. For Bird, as with other defenders of PTLs, the laws are a direct consequence of the necessary modal characters of whatever powers there are and so are at least conceptually independent of the histories of our world, or indeed any world.

Now, if the aim of getting the laws via a systematisation of possible worlds was just to produce a theorem for every regularity entailed by (or supervenient on) the essential nature of powers, then the procedure advised by PBSA proponents would be needlessly circuitous. Why say the laws are retrieved from a systematisation of modal space when they can be determined without reference to possible histories or a systematisation of anything? The reason, for PBSA defenders, is that it's the only way to ensure that the law-giving system is *best*.

In its native setting, the notion of 'best' in BSA is taken to imply some superlative balance of comprehensiveness (or 'strength') and simplicity (Lewis 1973), though it might also be considered wise to factor in other desiderata, such as statistical fit to certain data (Lewis 1994), considerations of locality (Dorst 2019), computational tractability, etc. (though see Friend 2022, for a criticism of some of these additions). Clearly nothing about PTL_{RV} suggests that laws are theorems of a system with *these* benefits, and any simplicity and comprehensiveness of the PTL_{RV} system is a matter beyond the theory's ability to explain. Yet it is these further features that PBSA proponents claim the law-giving system must have. Following on from the intuitions voiced so effectively by Humeans like Lewis (1994), Loewer (1996), Cohen and Callender (2009), PBSA defenders have come to see it as necessary to do 'justice to scientific practice, according to which there are simple, repeatable, and downright practical laws of nature—those which many scientists are in the business of finding' (Williams 2019: 220).

> In the scientific quest to discover the laws of nature, scientists routinely look for simple formulas that predict a wide range of phenomena. This emphasis on simplicity and informativeness is mirrored in the desiderata for the best system account, which lends the BSA additional credibility. (Demarest 2017: 40)

> The laws are efficient summaries ['optimal strength/simplicity trade-off' (p. 18)] of the facts about possible distributions of those potency instances, where the possible distributions of potencies at [a world] *w* are determined by those potencies' modal profiles. (Kimpton-Nye 2017: 13).

We've already seen (Section II) reasons to be sceptical of the PBSA's ability to make sense of the explanatory reasons for scientists' systematising endeavours. Nevertheless, it remains coherent that PBSAs can at least reflect that systematicity; it might, for instance, exactly determine the laws while bungling their explanatory power. The question is, then, whether or not the ability of PBSAs to do so, if they can, clearly improves on the efforts of PTLs.

To set the scene a little, it's worth saying something briefly about what PBSAs would have to show if they are to improve upon PTLs, and PTL_{RV} in particular. I will assume from the outset that if there is a preferable system to the PTL_{RV} system at all, then it is one with different truth-conditions. We shouldn't, for instance, presume that the PTL_{RV} system can be bettered because it is expressed in an inefficient language or because it contains redundancies of expression. Like Humean employments of the BSA, I assume—and assume PBSA proponents assume—that competitions for best system involve only systems expressed in the same language and which are rendered as concise as possible in their expression.

This qualification effectively blocks a PBSA proponent preferring a system over the PTL_{RV} system despite having 'perfect congruence between the BSA

laws and the natures of the powers' (Williams 2019: 224).[6] No PBSA is motivated on the grounds that some system can say exactly the same thing as the PTL_{RV} system only more compactly or in a more elegant form. This means that if PBSAs are to be motivated on pragmatic grounds, as some PBSA proponents suggest, this must be because there is a system with the right qualities that says something different from the PTL_{RV} system.

Another thing I will assume is that if there is a preferable system to the PTL_{RV} system, it is not preferable for simply ignoring some properties that the PTL_{RV} system mentions. For instance, it may be coherent that there are properties that are not even in principle empirically accessible. Alternatively, it may be coherent that there are 'alien' properties that do not appear in our world despite entering into non-trivial modal relations with properties that do appear. In either case, we could never hope to discover the unique regularities these properties enter into. The coherency of such possibilities might give one reason to suspect the word 'law' should be reserved for those regularities that are at least in principle discoverable. Nevertheless, I take it that any PBSA is to be motivated on less sceptical grounds.

I don't think PBSA proponents should have any issue with these qualifications. Their reasons for motivating PBSAs have invariably been that the PTL_{RV} is bettered by a system with different truth-conditions and which concern regularities that are, for all anyone has claimed, discoverable. Clearly, if truth-conditions are to differ, then the best (law-giving) system must at least either say something more or something less than the PTL_{RV} system about discoverable regularities in the world. Both claims can be identified in proponents' motivations for PBSAs corresponding, respectively, to a presumed lack of strength or lack of simplicity in the PTL_{RV} system. The former claim amounts to the thought that the theorems of the PTL_{RV} system (and supervening propositions) *under*-generate laws, i.e., fail to include generalisations which are laws. The latter claim amounts to the thought that the theorems of the PTL_{RV} system (and supervening propositions) *over*-generate laws, i.e., include generalisations, which are not laws. I discuss each motivation in the following two sections.

V. DOES PTL_{RV} UNDER-GENERATE LAWS AND DOES THIS MOTIVATE PBSAs?

Let's begin with the complaint with PTLs that first motivated a PBSA: that it under-generates laws, i.e., there are laws that PTLs, including PTL_{RV}, fail to

[6] Although Williams infers that Demarest's (2017) account has this feature, I presume it cannot on the foregoing grounds. That Kimpton-Nye (2021a) explicitly provides an account structurally similar to Demarest's while also emphasising the best system's different truth-conditions, indicates that Williams's inference cannot be correct.

entail are laws. In that case, the PTL_{RV} system is in some sense not suitably strong, and this might give us reason to suppose there is motivation for some or other PBSA.

Drawing on the discussion by Everitt (1991), Katzav (2005) points to known regularities concerning the conservation over time of persisting objects' dispositions. Such regularities, he claims, go beyond any generalisations determined by the relations mediating powers themselves because laws derived from the nature of powers can only concern the relationships *among* powers and not between powers and things which instantiate them.[7] If that's right, then the PTL_{RV} system will fail to extend to the conservation laws.

A different issue for the system's ability to capture these laws comes from Williams (2019), who points out that conservation laws' associated symmetry principles are non-causal. The received wisdom seems to be that the basic modal relations among powers are exclusively causal (Bird 2010; McKitrick 2010; Mumford and Anjum 2011). But if causal relations are essentially diachronic (as many also think), then the symmetries cannot be derived from them because they describe exclusively *synchronic* relations. Williams also suggests that something similar goes for kind-generalisations, such as 'all ravens are black'. Kind generalisations describe non-causal, synchronic correlations between a kind and set of powers (or a qualitative property) and hence cannot feature in the PTL_{RV} system if the latter is limited to diachronic generalisations. Nevertheless, we might think that some candidate laws are kind generalisations.

Katzav, Williams and Kimpton-Nye each suggest that an efficient systematisation of modality may, by contrast, stand a good chance of retrieving these 'non-causal' laws. Strangely, none of the authors explain how exactly it is supposed to achieve this. But it should be obvious that if these further laws are to be retrieved from a systematisation, then more data are needed. If the best system were just a re-systematisation of the same modal facts that result purely from the modal character of powers, then it certainly couldn't provide necessary regularities that go beyond these, as it is argued conservation laws, their symmetries and kind generalisations do. So, if the further problematic laws are supposed to highlight the under-generation of the PTL_{RV} system, then there must be more to modal space than that defined by powers alone.

As an opening observation, this conclusion would seem to put many of the proponents of PBSA in a bind. For it entails the falsity of *Modal Dispositionalism*, which claims that powers' modal characters are all there is to modality. Many powers theorists have expressed an interest in defending this thesis (see Bird 2007; Borghini and Williams 2008; Jacobs 2010; Vetter 2015), which makes it

[7] Ioannidis *et al.* (2021) raise the further problem that conservation laws concern *systems* of objects, rather than the nature of individually intrinsically instantiated powers of objects. Like their other concerns, I think they fail to fully understand the scope of PTL. So long as the nature of systems supervenes on the natures of individual powers, it is plausible that laws about systems will be included in the PTL_{RV} system.

all the more alarming that none of the foregoing motivations for PBSA have been qualified by the evident conflict with it.[8]

Details are also thin (more precisely, non-existent) on just what exactly the further data to be systematised are supposed to be. And these may not be such an easy thing to provide. Arguably, the symmetries aren't grounded in anything. Internal local symmetries like those of the Yang–Mills gauge theory, are quite plausibly redundant features of representation (Ismael and van Fraassen 2003), they don't reflect anything 'out there' in the world. By contrast, global external symmetries may ultimately concern features that the spacetime structure of the world *lacks* (Greaves and Wallace 2014; Friend forthcoming). The invariance of rotational translations for example, indicates that the rotation of a system throughout space results in no change at all, except with respect to the orientations of other systems, if there are any. Going by these interpretations, there just isn't anything that *could* be systematised so as to give rise to symmetry theorems. Symmetries would therefore be trivial consequences of powers' modal characters, which certainly provides no support for the preference of PBSAs over PTL. Along the same lines, some powers theorists are explicit in rejecting kinds as a further ontological entity whose characteristics could be brought into consideration for systematisation (Hawley and Bird 2010). So again, it's not obvious that there would be anything to systematise beyond the powers themselves.

But suppose there is some further information beyond the axioms of the PTL_{RV} system that needs to be taken into account if one is to generate a system whose theorems include (or have supervening on them) all the laws. We might reasonably suspect such further information would concern basic relations beyond those mediating powers (i.e., relations that give rise to the symmetries, conservation laws and kind-generalisations). In that case, the PTL defender should certainly revise their beliefs about the source of laws and expand their view to incorporate these further relations. But does that count as a victory for PBSA? I doubt it. Defenders of PTL_{RV} may have to ultimately concede that there is a gain in strength to be had by adding some more axioms, which concern regularities involving *non-powers* alongside the axioms already in the PTL_{RV} system (call this exanded system the 'PTL_{RV} + system'). However, their key insight will still be true that it is *by virtue of being derived from the modal character of powers* that makes at least some generalisations laws. The realisation that some further non-causal relations give rise to further, non-causal laws is a world away from the idea that *all* the laws need to be gleaned from an optimum systematisation of anything, as advised by PBSA defenders.

Could there be any further benefit gained from a systematisation of some one or many worlds in order to retrieve the non-causal laws? It's hard to see why there would be. Given the assumption that there are certain laws derivable

[8] Needless to say, the thesis has come under significant scrutiny (Wang 2015; Yates 2015).

from non-powers, there is nothing yet to suggest that a system which doesn't derive from a set of axioms of which those in the PTL_{RV} system are a proper subset (like the axioms of the PTL_{RV} + system) would be any more efficient. PTL_{RV} might not itself be quite right, but the extreme alternative proposed by defenders of PBSA is not yet motivated as a reasonable alternative. Moreover, there is a very real danger that in giving up on the PTL method for determining the causal laws in order to find a novel way to determine the non-causal laws, the PBSA defender will risk failing to account for some portion of the former. For as was already noted (Section II), PBSAs provide no assurance that any of the generalisations that follow directly from powers' modal character will be maintained in the best system.

Ultimately, the existence of further, basic relations in the world may be enough to show that the PTL_{RV} system under-generates laws, and hence that PTL needs revising to some extent (although I have my doubts). But nothing has been done to show that such relations warrant the kind of explicit systematising approach of PBSAs. Indeed, there is even reason to think that such a radical departure from PTL will cause more problems than it solves.

VI. DOES PTL_{RV} OVER-GENERATE LAWS AND DOES THIS MOTIVATE PBSAs?

If PBSA isn't motivated on the grounds that the PTL_{RV} under-generates laws, then perhaps it can be motivated on the grounds that the PTL_{RV} system *over*-generates them. That is, maybe there are generalisations that are theorems of the PTL_{RV} system—and so are laws according to PTL_{RV}—that are in fact *not* laws. This is arguably the insight which drives defenders of PBSA the most and is also clearly connected with the pragmatic motivations for systematicity voiced at the start. Williams, for example, talks of the 'unwieldiness' of laws under PTLs.

> [A]s the powers-based laws [i.e., laws according to PTLs] start to multiply and get more and more specific and unwieldy, the less well suited they seem as a replacement for the very general and navigable laws found in science. (Williams 2019: 220)

Kimpton-Nye is of a similar view, drawing an analogy between the scientific identification of laws and the benefits of identifying 'real patterns', in Dennett's (1991) sense, in highly complex information.

> Laws/real patterns are useful for us insofar as we want to make sense of the "blooming, buzzing confusion" [Dennett (1991: 36)], and there is nothing to rule out the possibility that the most useful pattern-making perspective for us will be a lossy one. (Kimpton-Nye 2021a: 11)

The idea from both authors (see also Demarest 2017) goes back to the observation made at the start, that scientists seem to feel the imperative to systematise

their theories efficiently. This systematicity has, for both authors, its source in the pragmatic scientific goal of balancing strength and simplicity (cf. Hall 2015). It is this goal, they claim, which warrants shedding some of the 'unwieldy' generalisations, which are derivable from the modal character of powers. As I also noted, there is nothing in PTLs to suggest that the laws determined directly from the modal characters of powers will licence such a loss of information. The question, then, is whether it really is plausible that the system that entails all the laws does exhibit such a loss. I think the answer is a resounding 'no'.

There are two obvious kinds of loss that the best (law-giving) system might conceivably exhibit with respect to the PTL_{RV} system.

(1) The PTL_{RV} system gives determinate circumstances under which some regularity occurs but the best system only offers a probability for the regularity holding; e.g. the PTL_{RV} system says *all and only Fs which are H will G* but the best system says nothing more determinate than that *most Fs G*.
(2) The PTL_{RV} system predicts behaviour for some class of objects, but the best system fails to do so; e.g. the PTL_{RV} system says *all Fs G*, but the best system doesn't provide any description of F-behaviour at all.

In either of these cases, the best system—the one which gives us the laws—'looses' some of the true generalisations which follow from the PTL_{RV} system; otherwise put, the PTL_{RV} 'over-generates' laws. I think the possibility of both these kinds of loss may be motivating PBSA defenders. However, there is arguably also another sense of loss at play. In describing the project of asserting laws, Williams claims that

> we take our best stab at what those internal rules might be, based on the information at hand. The most promising way of doing this is to systematize and unify our understanding of the generalities. That is, we should employ the BSA as our best guess at the nature of the powers. (Williams 2019: 223)

Presumably, if the laws are a result of a 'best guess', then they are very liable to be false. The idea is corroborated by Kimpton-Nye's employment of the analogy of the best system with a lossy data compression, an idea present both in the analogy he draws with Dennett's real patterns and with Braddon-Mitchell's (2001) own account of 'lossy laws' as theorems of a system best at trading verisimilitude for strength and simplicity. We should therefore also consider a third way in which the best system might be lossy.

(3) The best system is strictly false; e.g. it says *all Fs are Gs* when in fact only some Fs G.

Although not obviously an example according to which the PTL_{RV} system over-generates laws, one may assume the idea is that, where the best system makes a simple but strictly false generalisation, the PTL_{RV} makes some generalisations

which, though strictly true, are overly complex (e.g. it says that *all and only Fs which are H will G*).

None of the foregoing kinds of loss are plausible motivators for PBSAs, or so I will argue. To begin with, notice that it seems to be a basic feature of the practice that none of these three potential kinds of loss are to be tolerated at within fundamental physics.

At first glance, one might think foundational physics has already made its peace with lossiness due to its incorporation of probabilistic laws like the Born rule. But the probabilistic 'lossiness' of fundamental physics conferred by the chanciness of the Born rule is not the right sort of loss to motivate PBSAs. It is entirely consistent with PTL_{RV} that there is such a loss so long as the chanciness derives from the modal character of fundamental powers themselves. If the aim is to stick with the current consensus in quantum mechanics (e.g. the so-called 'Copenhagen interpretation' or an objective collapse theory such as GRW), a powers theorist should really attribute the chanciness involved in the Born rule directly to the powers. Of course, some physicists believe that the Born rule is in fact *not* fundamental and that there are underlying non-chancy generalisations which (together with facts about initial conditions or arbitrary choices of the state space) imply probabilistic generalisations at a less fundamental level. But so long as everyone is willing to grant that *if there are such deeper generalisations* (e.g. if Bohmian mechanics or Everettian theories are true), then *those generalisations* will provide the fundamental laws, nothing will have been done to undermine PTL_{RV} as an account of the laws of fundamental physics.

Lossiness by way of ungoverned behaviour (as per the second kind of loss) is similarly avoided in fundamental physics. (I use the term 'ungoverned' for want of a better phrase; I do not intend to imply by it that powers theorists are committed either way to a metaphysically loaded notion of governing laws.) Einstein, for instance, remarked that

> It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible *without having to surrender the adequate representation of a single datum of experience.*[9] (Einstein 1934: 165, my emphasis)

Physicists have, of course, repeatedly come up against behaviour they don't even have a generalisation for, let alone a true one. A recent stark example of this is the cosmological behaviour of galaxies' rotation. This phenomenon has motivated the hypothesis of a kind of matter unknown to current physics: dark matter. But the acknowledgement of dark matter does not present a case for fundamental physicists' willingness to accept ungoverned behaviour.

[9] Obviously, the reference to 'experience' here shouldn't be taken to be too empirically loaded. Einstein certainly wasn't promoting phenomenalism, nor was he suggesting that we have no reason to perform experiments that expand our data set.

Physicists are not happy about their inability to bring dark matter within the bounds of known physics and it is today considered one of, if not the, central issue of cosmology. If anything, the way dark matter is grappled with in contemporary physics shows, as with the way any of the other-mentioned behaviour for which we at one time had no behavioural generalisation, that physicists deplore ungoverned behaviour.

Finally, lossiness by way of falsity is also out of favour in fundamental physics. Of course, our current best theories do exhibit known inconsistencies, such as that between the General Theory of Relativity (GTR) and quantum field theory (QFT). At least one of these theories must be false. But no practicing physicist expects both GTR *and* QFT to provide the fundamental laws of physics *precisely because* of the inconsistency. And indeed, there is much ongoing work to find an appropriate superseding theory—of quantum gravity or of the classical grounds of quantisation—which avoids inconsistency and thereby (potentially) also falsity. The threat of falsity is exactly the reason physicists keep theorising.

Now, a PBSA defender might respond to these observations that it isn't fair to object to a lossy best system on account of the way physicists expect future generalisations of their discipline to be like. But what's the alternative? We certainly should *not* be assessing the lossiness of whatever system provides the laws for us by taking as our data the statements called 'law' throughout the history of physics. For one thing, what has been treated as a law (or principle, rule, theorem, etc.) throughout history is temporally contingent. Yet, like any metaphysical account of laws, the aim of PBSA is to give a once-and-for-all assessment of what the laws are. Moreover, it's anyway hard to see how these historical generalisations can be said with any confidence to fit into a system. Indeed, part of the motivation for scientists looking to supersede these historical 'laws' is their failure to be suitably systematised, due to mutual inconsistencies and the like.

Of course, we have only been focusing on the laws according to fundamental physics. And arguably, the laws of fundamental physics do not exhaust the laws of nature to be philosophically accounted for. Beyond the laws of fundamental physics we should also plausibly want to take account of the laws of the special sciences (e.g. the laws of thermodynamics, ecology and geology). Yet, special science laws do not provide any clear reason to think the best system is a lossy one either. Although the special sciences certainly don't have the same aspirations of generality that fundamental physics has, many think that their laws are either entailed by or at least supervene on the laws of fundamental physics. That's presumably why Bird put the supervenience claim in his definition of laws according to PTL_{RV}. Granting this, there is no way for the PBSA defender to establish that the laws in general follow from a system with one or other of the three kinds of loss. Specific laws may be 'lossy' in the sense that they don't cover all behaviours or in the sense that they concern macro probabilities, and

that may especially be the case for special science laws, but the presence of such laws in the best system doesn't entail that the system itself will be lossy, so long as its axioms are those of a final, fundamental physics.

Admittedly, the laws of the special sciences wouldn't (perhaps) supervene on the laws of fundamental physics if the latter were true but the former were false.[10] That would mean special science laws would have to be added in as further axioms alongside those of fundamental physics if they were to be counted as laws at all. As we acknowledged earlier with respect to the conservation laws and kind generalisations, PTL theorists might have to consider adding in the special science laws as further axioms (to form a PTL_{RV} + system). But again, however, the case for total re-axiomatisation as the PBSA defender recommends remains unjustified.

In any case, the inclusion of false special science laws alongside true fundamental laws arguably puts the entire system at risk of inconsistency, which would trivialise its theorems. This is a consequence of the composite nature of the entities referred to in special science laws. For instance, if the fundamental laws say truthfully that a system of microdynamical entities (e.g. subatomic particles) will break apart, whereas the special science laws say falsely that the entity composed of such a microdynamical system (e.g. an organism or ecology) will persist as an interconnected whole, the laws in total may predict incompatible outcomes. If PBSA defenders' intuition that the laws follow from a lossy system has its source in the belief that some special science laws are false, then they would have to first explain why the inclusion of such laws in a system doesn't undermine the whole best systems approach. Until they've done that, there seems to be no threat to the losslessness of the entire law-giving system as a consequence of (potentially individually lossy) special science laws.

Besides our consideration of actual laws (fundamental and special), there is a more principled reason to doubt that the best system should be lossy in any of the above-mentioned senses. According to each kind of considered loss, there is a certain class of behaviours among possible objects which is either not fully, not entirely, or not accurately explained by a law. Yet, of course, a PBSA proponent will nevertheless believe that all behaviour is fully, entirely and accurately (up to fundamental indeterminacy) explained by the modal character of the involved powers. But because of its source in powers' modal characters, this latter form of explanation is metaphysically necessitating. A consequence of this is that the system that for the PBSA defender provides the laws (i.e., which is in some sense lossy) will be consistent with histories that are not metaphysically possible. As far as I'm aware, this renders PBSA accounts

[10] It's natural to think that *A*'s supervenience on *B* is truth-value preserving, although nothing in the rough and ready definition of supervenience—'no change in *A* without a change in *B*'—entails this.

the *only* ones in philosophical history that predict a broader space of nomic possibility than metaphysical possibility.

This consequence has either gone unnoticed by its proponents or else has been suspiciously repressed.[11] But its consequences are serious. Say the generalisation that *all As are Bs* follows from the modal character of *A*s and *B*s, and hence is a regularity in the PTL_{RV} system. Nevertheless, suppose also that it is one of the generalisations that fails to feature in the (lossy) best system, e.g. the behaviour of *A*s is 'ungoverned' according to the best system, or enters only into a probabilistic or false law. This all means that the regularity supports counterfactual inferences, is invariant under all kinds of intervention, and can be used to plan effective strategies, make precise predictions, etc. and yet, according to PBSA, it is not a law. Indeed, it's not even law*like*, since it features nowhere in the best system. That sounds strange to say the least. Turn things around, and this distribution of physical and metaphysical possibility sounds even stranger. For it is a commonplace—some would say a *definitive*—characteristic of laws that they provide the inferential support for counterfactual reasoning. But when we look to the laws we can draw no justifiable inference that all *A*s must be *B*s. Hence, if we had good but fallible reason to suppose that some physical system was not *B*, then there is no combination of the knowable laws, taken as a whole, which could justify us in supposing otherwise given that we know it is *A*. That the laws can't provide us with this detail is arguably to take the notion of 'law' beyond its conceptual limits.

The defender of a PBSA that takes the laws to be theorems of a systematisation of the actual world only (e.g. Williams) might appear to have a response available to these complaints. If there are in fact no *A*s, then it might not seem to be nearly so disastrous if the laws failed to talk about them. Perhaps, but we have already dismissed the idea that PBSAs are to be motivated on the grounds that the PTL_{RV} system concerns alien powers, for it assumes too sceptical an attitude to be of serious consideration. An alternative response, also only available to defenders of this particular PBSA, is that *A*s are physical systems comprising a co-instantiation of actual (non-alien) powers, which in fact never get to be co-instantiated. In this case, only the co-instantiation would be 'alien', rather than the properties themselves. But a system that fails to capture the behaviour of merely possible co-instantiations of, say, the powers *P* and *S* from Bird's derivation (see p. 8–9) still fails to support all the counterfactuals we should expect. It won't, for instance, give us any reason to think that if *P* and *S were* co-instantiated, then their manifestation *M* would follow,

[11] The only place where its explicit mention has been made is Kimpton-Nye (2018: 165–7). There Kimpton-Nye claims that it is only metaphysical modality that is the objective *alethic* modality, owing its existence to the necessary character of powers. Nomic modality, Kimpton-Nye argues, can instead be understood in the epistemic terms of consistency with scientific knowledge of what is possible.

despite that being as robust an inference as there could possibly be. So, if you pondered whether you could have *P*, *S* and not *M*, nothing that the laws tell you, according to this understanding of PBSA, would say you couldn't. Nor, more alarmingly, could the laws tell us that putting *P* and *S* together would be a way of achieving *M*. For anyone who thought it was part of the business of laws to licence such inferences—something not even the Humean denies—the outcome of an account of the laws just described will be just grounds for dismissal. Moreover, the fact that physicists seem so bent on avoiding ungoverned behaviour in their end system suggests that they understand this as fully as anyone else.

In sum, it no more seems plausible that PBSAs can be motivated due to an improvement over PTLs on account of the latter's over-generation of laws as with their under-generation. In particular, the idea that the best system should be a 'lossy' one does simply not stand up to scrutiny.

VII. CONCLUSION

We started, as a number of powers theorists have done, with the observation that scientists are keen on developing systematic theories. Why not, then, adopt a view of the laws of nature which takes them just to be theorems of the best systematisation of the world? This is what many Humeans have been doing for some time and to great effect. For them, it raises a set of regularities from pure contingency to generalisations with pragmatic and explanatory power. In more recent years, a number of powers theorists have tried to do the same from within their own metaphysical framework. The result has been a load of Powers BSAs.

As we've seen, powers theorists can't just adopt this view of laws from the Humean to the same effect. A powers metaphysics and best systems view of laws just don't mix well when it comes to getting the explanatory import of systematisation in science right (Section II). Moreover, defenders of this strategy have completely failed to provide plausible reason to think that a systematisation of powers is more likely to generate exactly the laws than any traditional Powers Theories of Laws (Sections IV–VI). That doesn't yet mean the traditional view (some or other PTL) is right. For it seems powers theorists are indeed in a poor position when trying explaining scientists' willingness to systematise on either account.

So, what is a powers theorist to say about the reason scientists systematise? I briefly offer three alternatives none of which have been worked out to any significant degree. First, the powers theorist could 'go meta', understanding there to exist higher-order powers which systematise the necessary connections among first-order powers. This view has a nice simplicity about it, but one

might reasonably be doubtful of the existence of higher-order powers that systematise first-order powers in the right way.

Second, the powers theorist could 'go structuralist', understanding the necessary connections among powers' behavioural characteristics as deriving from some more basic unified structure. Such a move would only really work for dispositional *essentialists*, who take the necessary connections among powers to be part of their essence and would be a massive concession to ontic structural realists. Under such a perspective there would seem to be no good reason to deny that powers are emergent from an underlying modal structure of the world (French 2014; Ladyman 2007).

Third, the powers theorist could 'go rogue' and reject that scientists should put any explanatory value behind systematisation. For instance, while symmetry assumptions have been useful in the twentieth century for theorising new physics, powers theorists could argue that there is no deep reason to think that the reasoning is anything other than a pragmatic or epistemic crutch to get at the potential underlying chaos of the world. This last option seems to be in line with remarks from both Williams and Kimpton-Nye and perhaps even justified on methodological grounds (Hossenfelder 2018). But the view is certainly atypical within physics.

I'm not sure whether any of the foregoing strategies are plausible, nor whether there may be others, but there clearly still remains the goal for powers theorists to reconcile themselves with the systematising endeavours of contemporary science. I hope to have shown at least that no PBSA has gotten us any closer to that goal.[12]

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