THE PROBLEM OF NOMOLOGICAL HARMONY

Brian Cutter and Bradford Saad[1]
University of Notre Dame
Utrecht University & Sentience Institute

Abstract: Our universe features a harmonious match between laws and states: applying its laws to its states generates other states. This is a striking fact. Matters might have been otherwise. The universe might have been stillborn in a state unengaged by its laws. *The problem of nomological harmony* is that of explaining the noted striking fact. After introducing and developing this problem, we canvass candidate solutions and identify some of their virtues and vices. Candidate solutions invoke the likes of a designer, axiarchic meta-laws, multiverses, essential causal powers, and Humean laws.

1. Introduction

Our universe is governed by laws that *match* its contents. There are laws about the behavior of massive bodies, and there exist massive bodies for those laws to govern. There are charged particles, and there exist laws specifying how charged particles are to behave. The point can be put somewhat more precisely in terms of a harmonious match between the states of our universe and its laws: there exist states such that applying those laws to those states yields other states. Matters might have been otherwise. The world might have been stillborn with our universe's initial conditions and Newtonian laws that do not apply to them. Or the world might have had our universe's laws but Newtonian initial conditions. Or the world might have had any of countless other kinds of law-state mismatches—laws dictating the behavior of schmarged particles with states consisting only of configurations of charged particles, laws dictating the behavior of

[1] Author order is arbitrary. Each author independently discovered the problem of nomological harmony—thanks to Dustin Crummett for bringing this to our attention.

charged particles but no states involving charged particles, and so on. As a useful analogy, we might think of the universe as akin to a game. The states of the universe correspond to configurations of pieces on the board, and the set of laws corresponds to the rulebook specifying how game-piece configurations can or must change over time. Rulebooks and game-piece configurations can be mismatched. A rulebook for Monopoly will provide no guidance for how states of a Go board are to evolve. A rulebook for chess would have nothing to say about how checkers pieces should move. A universe with mismatched laws and states would be like a game whose rulebook and piece configurations are mismatched in this way.

While familiar, the fact that laws are in this fashion harmoniously coordinated with states cries out for explanation. *The problem of nomological harmony* is that of answering these cries. This paper introduces and develops the problem of nomological harmony, canvasses candidate solutions to it, and identifies some of their virtues and vices.

2. Preliminaries

The problem of nomological harmony should be distinguished from the problem of explaining why there are laws and states at all. On the intended understanding, the problem of nomological harmony is that of explaining why, given that there are laws and states, there is some match between them rather than no match between them. The problem cannot be solved by pointing out that the laws apply recursively. The fact that laws apply to their own outputs may explain why, given that those laws match some states, they also match others. However, since that fact presupposes that laws match some states, it cannot explain why laws match some states rather than none. For

brevity, we will often put matters in terms of explaining why laws match states, taking it as read that we are concerned with explanations of the sort apt to solve the problem of nomological harmony, not with any broader sort that encompasses the just noted sort of recursive explanation.

The problem of nomological harmony should also be distinguished from the problem of explaining why our universe is orderly rather than disorderly.[2] These problems can conceivably come apart. Consider a universe that evolves in an orderly manner as a sheer accident, and another universe that evolves in accordance with chaos-inducing laws: the first exhibits order but not nomological harmony, while the second exhibits nomological harmony but not order.

We will develop the problem of nomological harmony by focusing on an important class of laws for which the problem arises in an acute and relatively straightforward way. Specifically, we will focus on *fundamental dynamical* laws, i.e. first-order laws that constrain how the universe evolves and which cannot be explained in terms of other such laws. So defined, fundamental dynamical laws might be explained in terms of something else, e.g. their instances, non-dynamical laws, or a designer. The most familiar candidates for fundamental dynamical laws are proposed laws of physics—e.g. Newton's second law, Schrödinger's equation, and the spontaneous collapse postulate of the GRW quantum theory—that constrain how the universe evolves from one physical state to another. However, there is at least conceptual room for fundamental dynamical laws that operate on or generate non-physical states, e.g.

[2]See Leslie (1989) and Swinburne (2004); cf. Wigner (1960).

experiences or reasons that defy physicalist construals.[3] In any event, the problem as it arises for fundamental dynamical laws is that of explaining why, given that there are such laws as well as states, there is a match between them.

We will mostly hereafter use 'law' as shorthand for fundamental dynamical law, though for clarity we will sometimes use the full expression. In §8, we will discuss potential differences between how the problem of nomological harmony arises for fundamental dynamical laws and how it arises for other sorts of law.

It may seem that nomological harmony is only puzzling on a governing conception of laws. If so, the puzzle might be solved (or dissolved) by adopting a non-governing conception, such as Humeanism. However, we'll see below that versions of the puzzle arise for a wide range of conceptions of laws, including non-governing views.

In the event that the universe's evolution results from applying laws to initial conditions, the problem of nomological harmony will come to that of explaining why, given that there are laws and initial conditions, laws match the initial conditions. The same goes for other sorts of boundary conditions if the universe's evolution results from applying laws to them. For vividness and ease of discussion, we will mostly discuss the problem in terms of the match between laws and initial conditions. But it should be borne in mind that the problem would still arise in our universe if it turns out not to have boundary conditions: even if, say, laws generated each state by operating on a prior state, there would be a question as to why laws match some states rather than none.[4]

[3] See, e.g., Chalmers (1996), Chalmers & McQueen (2021), Hawthorne & Nolan (2006), Nagel (2012), Pelczar (2015), and Saad (2020).

[4] Cf. Parfit (2011, p. 623).

3. Nomological Harmony is Striking

An initial motivation for thinking that nomological harmony calls for explanation is the intuition that a match between laws and initial conditions is a special outcome that would be very unlikely, absent some further explanation. Return to the game analogy. Just as most ways of pairing rulebooks with initial game-piece configurations would yield a mismatch, it seems that most conceivable ways of pairing laws with initial conditions would yield a mismatch. Presumably there are countless possible (at least conceptually possible) fundamental properties and relations, so if (as we ordinarily suppose) the initial conditions and the basic dynamical laws only involve a small set of fundamental properties and relations, it seems unlikely that there would be a match without some further story.

A match between laws and initial conditions would be reminiscent of 'cosmological fine-tuning' of physical parameters for life, which consists in the (supposed) fact that the actual values taken by physical parameters fall within the tiny region of parameter space that is life-permitting.[5] What's striking about such fine-tuning is not that physical parameters have unlikely values—that might have been true for any values they could have taken, including those that preclude life. Instead, what's striking is that they take values that yield a special outcome (namely, life) when it's improbable that they would take values that yield a special outcome. Compare with a stock example: that a monkey types a Shakespearean sonnet would be striking while its typing an equally improbable string of nonsense would not.

Similarly, any given pair of laws and initial conditions that match would be striking even if any given mismatched pair would be equally improbable. That's because

[5]See Friederich (2017) for an overview.

a match between laws and initial conditions is a special outcome, just as cosmological fine-tuning and monkey-typed poetry are. Just as the latter seem to call for explanation in virtue of seeming both special and improbable, so too does the fact that laws match initial conditions. This doesn't show that nomological harmony must have an explanation, but it suggests that it would be a theoretical cost to leave it unexplained, and it gives us reason to seek an explanation.

Now, the claim that nomological harmony is *unlikely* (absent explanation) raises delicate issues about the interpretation of probability. The situation here is reminiscent of a familiar one that arises when cosmological fine-tuning arguments are pressed into Bayesian formulations. For instance, Roger White (2011, p. 677) notes that the probabilities invoked in these arguments "cannot be understood as physical chances since we are concerned with the probabilities of the physical laws themselves." Likewise, the claim that nomological harmony is unlikely (absent explanation) should not be understood in terms of objective chance, as this judgment does not rest on the assumption that a chance mechanism underwrites these probabilities. One could instead interpret the probabilities as subjective degrees of belief, but this approach faces two difficulties. First, these might seem too subjective to have normative significance. Second, it is doubtful whether anyone has a well-defined subjective probability distribution over the relevant possibilities.

Rather than understanding the probabilities as objective chances or subjective degrees of belief, we agree with White that the probabilities "are better understood as capturing degrees of evidential support putting rational constraints on one's credences" (2011, p. 677). On this interpretation, conditional probabilities encode evidential support

relations that tell us what degrees of belief would be rationally appropriate relative to different bodies of evidence, and the unconditional probability of p can be regarded as a measure of p's "intrinsic plausibility." As Climenhaga (2023, p. 3) explains,

> These support relations are not defined in terms of or reducible to degrees of belief. Instead, degrees of support rationally constrain degrees of belief. [...A]s a first pass, the idea is that, if P(A|B) = r, then someone with B as her evidence ought to be confident in A to degree r.

These so-called "epistemic" or "evidential" probabilities are best thought of as distributed over epistemic/conceptual possibilities, which needn't correspond exactly to metaphysical possibilities. (Thus, *a posteriori* necessities like "gold has atomic number 79" will not in general have an unconditional epistemic probability of 1, and some metaphysical impossibilities will have non-zero unconditional epistemic probability.)[6]

While we have no fundamental objections to the idea of epistemic support relations that can be represented by a privileged probability function (or a limited class of probability functions corresponding to the rationally permissible ur-priors), this commitment is controversial. It raises difficult questions about what fixes, and how we can figure out, the epistemic probabilities.[7] For those uncomfortable with the notion of epistemic probability, we can motivate the claim that nomological harmony calls for explanation by invoking coincidence-avoidance norms instead of epistemic

[6] For discussion and defense of epistemic probabilities understood in terms of degrees of rational support, see Williamson (2000, ch. 10), Hawthorne (2005), and Climenhaga (2023).

[7] For example, there is much controversy about whether epistemic probabilities can be coherently derived from a principle of indifference according to which evidential symmetry engenders equal epistemic probability. Note, however, that one can countenance epistemic probabilities even if one rejects principles of indifference (Greaves, 2016, fn9, §IV; Isaacs et al. 2022, p. 247, 269; Lewis 1980, pp. 289-90). For instance, one can hold that the epistemically permissible epistemic probabilities instead derive from principles concerning chances, anti-skeptical warrant, naturalness, and explanation (Lewis, 1980: 266; Wright, 2004; Bradley, 2020; Climenhaga, 2020).

probabilities. That is, we can appeal to the intuition that, without further explanation, a match between the initial conditions and fundamental dynamical laws would be a major coincidence, together with the idea that it is a theoretical vice to posit major coincidences. Coincidence-avoidance norms can be motivated by mundane examples. When two students turn in identical papers, it is typically reasonable to favor hypotheses on which the match is not a sheer coincidence (e.g., that one student copied the other, or they both copied a common source) (White 2005, pp. 2-3).

We won't attempt to give an exact analysis of the concept of a coincidence, but the rough idea is that of a striking match or correlation between independent factors or parameters, especially when (*very* roughly and intuitively) only a "small proportion" of settings that would result from independently varying the relevant parameters would yield a similarly special match. In some cases, we can give "small proportion" some mathematical precision by finding a precise natural measure over the relevant parameter values, but more often the notion must be left at a vague and intuitive level. For example, it's legitimate to claim that it would be a major coincidence if you and a friend independently had the same dream last night, even if we can't supply a precise measure over the (presumably infinite) space of possible dreams. The same goes for nomological harmony. In this respect, the intuition that (absent explanation) nomological harmony would be a major coincidence is in the same boat as coincidence intuitions invoked in many other philosophical arguments, which typically rely on an informal and intuitive notion of coincidence. This boat includes coincidence objections to idealism (Chalmers 2019, Lee 2016), which allege that the order and coherence among our experiences would be an incredible coincidence if our experiences aren't caused by

external material objects or a Berkeleyan God who wants us to experientially inhabit a common stable world. This boat also includes debunking arguments against moral realism (Street 2006, Joyce 2006; cf. Bedke 2009), mathematical realism (Field 1980), phenomenal realism (Chalmers 2018), and commonsense theories of composition (Sider 2001, p. 156), which claim that, if these views were true, our reliability about the relevant domains would be a massive coincidence.

Those who maintain that probabilities cannot be assigned to basic laws and initial conditions might also argue that basic laws and initial conditions cannot feature objectionable coincidences. In particular, they might argue that it is only a theoretical vice to posit coincidences when, and because, the coincidence is improbable. Since (they say) probabilities don't apply at the level of basic laws and initial conditions, neither do coincidence-avoidance norms.

But there are plausible counterexamples to this conclusion—plausible examples of hypotheses that we should reject precisely because they posit initial conditions or basic laws (or constants) that imply some major coincidence. In our view, one such hypothesis is that there is a single universe whose physical parameters are fine-tuned for life as a brute fact. For a less controversial example, consider the hypothesis that the universe came into being 100 years ago in just the state we take the world to have been in 100 years ago, where this initial state has no further explanation.[8] It should be uncontroversial that we should reject this "short past" hypothesis. We should reject it, not because it conflicts with our apparent memories (if you're under 100 years old, it doesn't), or because it involves an unexplained initial state (the "long-past" hypothesis presumably has one too), but because it posits an initial state involving many

[8] Cf. Russell (1921).

unexplained coincidences. For example, on the short-past hypothesis, the initial state involves many distinct (false) records of the Napoleonic Wars which more-or-less agree on their details. But there is no explanation for why all the accounts agree—no record was copied from any of the others, and the records lack a common cause. The initial state also features animal bodies whose matter is exquisitely configured to enable the performance of biologically useful functions. The vast majority of conceivable material configurations would not have this special feature, but nothing explains why the matter in animal bodies was so arranged. That the short-past hypothesis implies these major coincidences is good reason not to regard the state of the world 100 years ago as a brute fact. We should reject the idea that coincidence-avoidance norms don't apply at the level of initial conditions or basic laws.[9]

In what follows, we will consider four sorts of candidate responses to the problem of nomological harmony:

- Brutalist responses that take the match between laws and states to be a brute fact or brute necessity (§4),
- Ensemble responses that posit a vast and varied ensemble that renders the existence of matching laws and states to be expected (§5),
- Third-factor responses that countenance an entity such as God or a meta-law that (i) does not depend on fundamental dynamical laws or their inputs and (ii) explains laws and/or states in a match-inducing manner (§6),
- Prioritist responses that explain laws in terms of states or vice versa in a manner that yields a match between them (§7).

[9] Admittedly, analogous problems can be raised for some versions of the long-past hypothesis such as those on which initial conditions feature conditions that are fine-tuned for life, or entropic homogeneity between causally isolated states (Carroll, forthcoming). While such problems make the contrast between the short- and long-past hypotheses messier, they also reinforce the point that unexplained coincidences are costly theoretical posits: in discussions of cosmological fine-tuning such long-past hypotheses are often thought to require explanatory supplementation precisely because they would otherwise involve massive but unexplained coincidences.

This taxonomy plausibly exhausts the solution space. For harmony either has an explanation or it doesn't. If it doesn't, we get brutalism. If it does, then either it is explained by laws or initial conditions, or it isn't. If it isn't, we have a third-factor explanation. If it is, then it is either explained by laws or initial conditions in *our* universe, or it isn't. If it is, we have a prioritist explanation. If it isn't, we have an ensemble explanation.

4. Brutalism

According to *brutalism*, nomological harmony has no explanation, as it is either a brute necessity or a contingent brute fact. There are at least two ways of motivating brutalism. The first way relies on an "anthropic" principle to the effect that we can acquire evidence by observing P only if we could have observed ~P. This principle might suggest that nomological harmony doesn't call for explanation—or at least that our observation that nomological harmony obtains couldn't provide evidential support for any putative explanation of it—since nomological harmony is a precondition on observation. But there are many familiar counterexamples to this anthropic principle. The most famous comes from John Leslie (1989, pp. 13, 108-9). Suppose you are to be executed by 50 sharp shooters. Shots ring out. Amazingly, you find that you are still alive. If you had died, you wouldn't be around to observe this. Yet your survival calls out for explanation and gives you evidence for certain explanatory hypotheses (e.g., that the shooters intended to miss).[10]

A second, better motivation for brutalism is that, contrary to the principle of sufficient reason, explanation must end somewhere—so why not here? Why not think

[10] For other counterexamples to the anthropic principle above, see Hawthorne and Isaacs (2017), Juhl (2007), and Parfit (2011, p. 624).

that nomological harmony belongs to the set of bedrock truths that don't admit of further explanation? It's a familiar idea that the bedrock truths may include the fact that the fundamental dynamical laws are such-and-such and the initial conditions are so-and-so. It turns out there's a match here. Maybe that's just the way it is.

In response, we grant that explanation must stop somewhere and that the problem of nomological harmony would not be all that problematic if we could escape it simply by rejecting the principle of sufficient reason. But the motivations given in §3 for thinking that nomological harmony calls for explanation—for example, that a match between laws and states is both special and improbable (absent further explanation), and that it is a theoretical vice to posit major coincidences—do not depend on the principle of sufficient reason.

We can distinguish two forms of brutalism. The first is *necessitarian brutalism*, which claims that it's metaphysically necessary that laws match initial conditions, but not because one explains the other or because of a connection between them and any third factor. Thus, given that there are laws and initial conditions, a match between laws and initial conditions is guaranteed.

Necessitarian brutalism has implausible modal consequences, as we can conceive of many scenarios in which laws and initial conditions mismatch.[11] Admittedly, necessitarian brutalists need not opt for an austere construal of modal space on which there is only a single set of compossible laws and initial conditions and they match. They can allow that there are many possible matching combinations of laws and initial conditions, provided that they deny that there are any possible mismatching

[11] We here assume that conceivability is at least evidence of metaphysical possibility (Yablo, 1993), whether or not it entails metaphysical possibility (Chalmers, 2010: Ch. 6).

combinations. This more liberal form of necessitarian brutalism may to some extent avoid the counterintuitive implications of its austere rival. Still, even the liberal version of necessitarian brutalism has implausible modal consequences, as it denies the possibility of mismatches in the face of plausible candidates. Such candidates can be generated by pairing laws posited by some physical theories with initial conditions described by other physical theories. True, it may be that some physical theories do not represent genuine metaphysical possibilities. However, it's plausible that at least a small portion do. And that's enough to tell against this response—and, indeed, any version of necessitarian brutalism—since even a small portion of the mathematically specified physical theories will amount to a vast and varied space of metaphysically possible laws and initial conditions with ample room for mismatches.

Another general difficulty for necessitarian brutalism is that it responds to one striking coincidence (the match between laws and states) by positing a similarly striking coincidence between metaphysically possible laws and metaphysically possible initial conditions.[12] The difficulty here is analogous to one that applies to necessitarian brutalist responses to other apparent striking coincidences. If we want to know why two pieces of paper have matching ink patterns, it is unsatisfying to be told simply that the match is necessary. Not only is this modal claim independently implausible, but making it responds to one coincidence by positing a similar unexplained coincidence between metaphysically possible ink patterns. The same goes for attempts to address cosmological fine-tuning by construing the match between obtaining physical parameter values and those that permit life as metaphysically necessary. Thus,

[12] Cf. Barnes (2012, p. 531), Parfit (2011, p. 645), and White (2005, pp. 6-7).

necessitarian brutalism incurs costs by way of its modal commitments but fails to yield explanatory progress.

Contingentist brutalism says that it's just an unexplained contingent fact that laws match the states of our universe. It didn't have to be this way, but we got lucky. Insofar as nomological harmony seems to cry out for explanation, this is an unsatisfying response. What makes the response unsatisfying will depend on the ratio between matching and mismatching worlds. The higher the proportion of mismatching worlds, the luckier it will be that we just happen to be in a matching world. On the other hand, the higher the proportion of matching worlds, the more contingentist brutalism will come to resemble necessitarian brutalism in positing a striking but unexplained coincidence between laws and initial conditions in modal space.

5. Ensemble Explanations

Ensemble solutions to the problem of nomological harmony posit a vast and varied ensemble of pairings between laws and initial conditions and maintain that, given the ensemble, a match between laws and initial conditions is to be expected. This response takes its cue from an approach to accounting for cosmological fine-tuning. The approach in question contends that our universe belongs to a vast multiverse and that there is variation in physical parameter values across the universes it contains. As a result, it's to be expected that a small portion of those universes contain physical parameters whose values fall within the small ranges of values that are life-permitting.[13]

Ensemble solutions to the problem of nomological harmony come in several versions. Each solution posits a different sort of ensemble to account for nomological harmony—either an ensemble of laws, universes, or both. *The law ensemble solution*

[13] See, e.g., Leslie (1989) and Parfit (2011); cf. Isaacs et al. (forthcoming) and Saad (forthcoming*a*).

holds that there is a vast and varied ensemble of laws that prevail in our universe. *The initial conditions ensemble solution* holds that there is a vast and varied ensemble of universes, each with its own initial conditions, and a single set of laws that holds for every member of the ensemble. *The law-conditions ensemble solution* holds that there is a vast and varied ensemble of universes, each with its own initial conditions and laws. The second and third ensemble solutions can be classified as *multiverse* solutions, since they postulate multiple universes, while the first and third can be classified as *multi-law* solutions, since they postulate multiple sets of laws.

One potential virtue of the initial conditions ensemble and law-conditions ensemble solutions is that they promise to explain both nomological harmony and cosmological fine-tuning in a single theoretical stroke. Or at least this is so if any set of laws would be life-conducive on some set of initial conditions. In the event that some sets of laws would preclude life no matter what initial conditions obtained, the initial conditions ensemble would account for nomological harmony but not cosmological fine-tuning. It is an advantage of the law-conditions ensemble solution that its ability to account for both nomological harmony and cosmological fine-tuning is not hostage to any such liability. In contrast, the law ensemble solution is of no help with cosmological fine-tuning: while it predicts that the universe will feature matching laws and initial conditions, it provides no reason to think that any matching laws will be fine-tuned for life. To account for cosmological fine-tuning, proponents of the law ensemble solution might appeal to law-conditions ensemble or third-factor explanations. But in that case, it would seem more natural to simply explain both

cosmological fine-tuning and nomological harmony with the latter explanations, leaving the law ensemble solution by the wayside.

The law-conditions ensemble solution also faces a law-conditions pairing problem: that of explaining why a given set of obtaining laws is paired with one obtaining initial condition rather than another, and likewise of explaining why a given obtaining initial condition is paired with one obtaining set of laws rather than another. To appreciate the problem, notice that on the initial conditions and law ensemble solutions it is natural to hold that laws apply indiscriminately, i.e. to all initial conditions that obtain—hence there is no need to explain contrastive facts about why, among the obtaining laws and initial conditions, there are certain pairings but not others. This problem is analogous to what is perhaps the most serious challenge to substance dualism: the pairing problem[14] of explaining why certain immaterial minds are paired with certain physical objects. However, many proposed solutions to the pairing problem for substance dualism cannot generally be extended to solve the law-condition pairing problem. For example, consider the co-location solution that takes immaterial minds to be paired with physical objects via spatial overlap:[15] the analogous solution to the law-condition pairing problem would implausibly require laws to spatially overlap with initial conditions that they do not apply to.[16] Or consider the kindling hypothesis that brains are paired with exactly the minds they generate:[17] an

[14]See Foster (1968; 1991), Kim (2005), and Saad (2018).

[15]See, e.g., Bailey et al. (2011, §4) and Lycan (2009, p. 558).

[16]In contrast, such an analogous solution is available to proponents of a law-conditions ensemble explanation of *cosmological fine-tuning*: they can (i) maintain that the obtaining law-condition pairs match and (ii) embrace a Humean view of laws that co-locates the laws of each universe with their instances in that universe. This move fails on a law-conditions ensemble account of nomological harmony because it requires non-matching laws and these resist Humean treatment.

[17]Cf. Bailey et al. (2011, fn12) and Unger (2005, p. 336).

analogous solution would require fundamental dynamical laws to generate initial conditions or vice versa. Adopting this sort of solution to the law-condition pairing problem would put proponents of the law-condition ensemble solution under pressure to take on third factorist or prioritist resources in order to explain how initial conditions generate laws or vice versa. But such posits harbor the potential to solve the problem of nomological harmony and so threaten to render the law-conditions ensemble solution redundant as a solution to that problem. Thus, there is reason to think that the law-conditions pairing problem is more severe than one of the more daunting problems for substance dualism.

A challenge for the law ensemble solution is that of explaining why the ensemble is free of conflicting laws that prevent nomological harmony: why are the laws that in fact match our universe's initial conditions not accompanied by other laws (or would-be laws) that dictate an incompatible evolution from those conditions? Or, if there are such laws, why does this nomological conflict not prevent the universe's evolution?

To reconcile such nomological conflict with nomological harmony, a proponent of the law ensemble might posit a third factor that settles which laws take precedence in the event of conflict. However, if one is going to use a third factor to solve the problem of nomological conflict, it would be more natural to appeal directly to a third factor solution rather than invoking the law ensemble solution and then appealing to a third factor to defend it from a challenge.

Alternatively, the proponent of the law ensemble solution might try to avoid the noted nomological conflict by maintaining that the ensemble is small enough for it to be unlikely that there would be laws that dictate incompatible evolutions. However, the

posited ensemble should not be too small, lest it fail to render a match to be expected. And it should not be of a size that is strikingly suited to avoid the twin pitfalls of being too large for nomological conflict to be unexpected and too small for matching laws to be expected—lest it replace the problem of explaining why laws match initial conditions with a similarly striking explanandum of why our universe is associated with a law ensemble of a size in the special range prone to yield non-conflicting matching laws.

Some of the foregoing difficulties might be overcome by a *hybrid ensemble solution* that combines the posits of the law ensemble and initial conditions ensemble solutions. On the resulting picture, a multiverse would contain a vast and varied ensemble of initial conditions along with a single ensemble of laws that apply indiscriminately to those conditions. This is in contrast to the law-conditions ensemble solution on which different laws are paired with different initial conditions. As a result, the pairing problem does not arise for the hybrid ensemble. The hybrid ensemble solution may also overcome the conflicting law problem that afflicts the law ensemble solution: the proponent of the hybrid ensemble solution can (i) grant that the law ensemble usually fails to yield matching laws because when applied to most initial conditions the law ensemble dictates incompatible evolutions, (ii) note that which laws, if any, dictate incompatible evolutions depends on the initial conditions they are applied to, and (iii) maintain that, given the vast and varied ensembles of initial conditions and laws, the law ensemble unsurprisingly yields non-conflicting matching laws for at least a small

portion of initial conditions.[18] Similarly, the law ensemble solution might be extended to explain cosmological fine-tuning with the plausible auxiliary hypothesis that at least a small portion of *those* initial conditions should be expected to evolve into life-supporting universes, given the vastness of and variation within the posited ensembles of initial conditions and laws.

On the other hand, all multiverse solutions face a battery of objections. One is that they at best account for why *some* universe has laws that match its initial conditions, not why *our* universe has such laws.[19] Another is that they risk generating a 'Boltzmann brain' problem: if the realizers of our current experiences figure in candidate initial conditions and most sorts of initial conditions obtain with overwhelming frequency in stillborn universes rather than in universes with matching laws and initial conditions, then constraints on self-locating belief invite the implausible conclusion that we are in such a stillborn universe with misleading evidence to the contrary.[20] All of the above concerns have been raised against multiverse

[18] However, the posited collection of laws should not be too vast. To see this, consider a plenitudinous view on which the ensemble contains every metaphysically possible law. On this view, it's plausible that for every law that matches an initial condition, there is another law that also matches that condition but conflicts with the first law—meaning that the resulting multiverse would be devoid of universes with laws that match but don't conflict. Still, the hybrid ensemble solution tolerates larger collections of laws than the law ensemble solution: whereas the former need only avoid positing a quantity of laws that would engender conflict at every universe in the multiverse, the latter needs to avoid positing a quantity of laws that would engender conflict in a single universe. For this reason, the worry that the posited collection of laws would—in order to avoid the conflicting law problem—need to be of a striking size is less urgent on the hybrid ensemble solution.

[19] Cf. White (2000).

[20] For discussion of Boltzmann brain problems for multiverse hypotheses, see, e.g., Collins (2005), Dorr & Arntzenius (2017), and Saad (forthcoming*b*). A suggestion for solving the Boltzmann brain problem at hand: hold that mentality depends on *sequences* of states; therefore, stillborn universes would merely contain Boltzmann brain states, not Boltzmann observers—cf. Carroll (2020: 11). A potential liability of this solution: undermining support for multiverse hypotheses from mundane qualitative evidence—see Isaacs et al. (forthcoming).

accounts of fine-tuning. But multiverse explanations of nomological harmony face the further concern that there aren't arguments from physics and cosmology for the sort of multiverse that would account for nomological harmony—nor are there well-developed and testable scientific models of such a multiverse, as there are for a multiverse that would account for fine-tuning.

Another class of worries about ensemble solutions concerns their offenses against parsimony. Multiverse solutions offend against quantitative parsimony (which concerns the number of individuals posited by a theory) by positing a vast number of universes.[21] Arguably, all ensemble solutions also offend against qualitative parsimony (which concerns the number of basic *kinds* of entities posited). Each solution countenances mismatching laws. Since reductive views of laws tend to explain laws in terms of their instances, ensemble views therefore naturally go with a view that construes laws as an irreducible kind of entity, a kind whose postulation offends parsimony and which might be avoided by nomologically reductive rival solutions.[22] The multiverse solutions may commit a further offense against qualitative parsimony by positing an enormous number of fundamental kinds or properties beyond those recognized by current physics. For example, on the most straightforward versions of these solutions, there will be mismatched universes where things with schmass and schmarge (and countless other fundamental properties) are paired with laws about mass and charge.

[21]This offense will be indirect in the event that the relevant notion of individuals applies to constituents of universes but not to universes themselves. If the notion applies to laws, then the law ensemble will also offend quantitative parsimony.

[22] For non-reductive accounts of laws, see, e.g., Lange (2009) and Maudlin (2007).

Although it is less often discussed than quantitative and qualitative parsimony, another important theoretical ideal—which we might call "nomological parsimony"—is that of keeping the set of basic laws simple.[23] Nomological parsimony can be seen as reflecting a special case of a plausible general parsimony principle that connects simplicity with explanatory power: keep the set of unexplained explainers simple.[24] The same cannot be said of quantitative or qualitative parsimony, since individuals and (the instantiation of) basic kinds may be explained via laws and other individuals or kinds. Thus, there is arguably reason to regard offenses to nomological parsimony as more costly than offenses to quantitative or qualitative parsimony.[25] Insofar as multi-law solutions posit an extremely large number of basic laws, they offend nomological parsimony. Perhaps this offense could be avoided by positing a third-factor that explains the laws that multi-law solutions posit, thereby rendering those laws non-basic. However, as we will see in §6, third-factors harbor the potential to independently explain nomological harmony. So invoking them to clear a multi-law solution of the charge that it offends nomological parsimony would threaten to render the solution redundant.

6. Third Factor Responses

Third-factorism responds to the problem of nomological harmony by claiming that a 'third-factor'—something that does not depend on fundamental dynamical laws or their inputs—biases sampling from the space of laws and from the space of initial conditions toward yielding a match.

[23] See Adams (1987: 257), Chalmers (1996: Ch. 6), and Sider (2020).

[24] Cf. Schaffer (2015, §5).

[25] Sider (2020: 102) similarly argues that "what is most important in parsimony is keeping the laws simple."

Third-factor views vary along two dimensions: what third-factor they posit and how the third factor explains the match. The main candidates for a third factor are a designer or a meta-law,[26] i.e. a law that constrains or takes as input first-order laws. These candidates are familiar from their appearance in proposed third-factor explanations of cosmological fine-tuning for life. A virtue that third-factorism shares with the multiverse explanation is the potential to explain both matching laws and cosmological fine-tuning in one theoretical stroke. One might be tempted to dismiss this approach on the grounds that third-factor hypotheses aren't testable. This temptation should be resisted for several reasons. For one, if a hypothesis can account for an otherwise puzzling phenomenon like nomological harmony, this can be a point in its favor even if it doesn't make novel experimental predictions. Moreover, some third-factor hypotheses may be testable in the weak sense that they make certain observations more or less likely (given, as always, suitable auxiliary hypotheses)—for example, observations concerning the existence of evil, various forms of psychophysical luck, cosmological fine-tuning, and hypothetical observations of apparent miracles or divine communication (e.g., the observation of bible verses written in the stars would presumably be empirical evidence for theism).[27] Finally, in whatever sense that third-factor explanations are untestable, other explanations considered in this paper would also seem to be equally untestable—so it would be a mistake to dismiss third-factorism in favor of one of these alternatives on the basis of the former's untestability.

[26]See Armstrong (1983), Lange (2009), Parfit (2011).

[27] See Benton et al. (2016), Chalmers (2020), Saad (forthcoming*b*), Leslie (1989, p. 16), and Parfit (2011, p. 625).

A third factor could ensure a match in one of three ways: (1) selecting matching laws, given initial conditions, (2) selecting matching initial conditions, given laws, or (3) selecting a matching pair of initial conditions and laws. A third factor such as a designer or meta-law might secure a match in one of these ways without explicitly dictating that there be a match. For instance, a benevolent designer or axiarchic meta-law might dictate that the obtaining laws and initial conditions be whichever candidate laws and initial conditions jointly maximize goodness, theoretical virtue, or some other axiological quantity.[28] Presumably, a match would result, as such a quantity would be maximized only if laws matched initial conditions.

One could also accept a third factor that is explicitly aimed at securing a match. This could simply be a meta-law directly stating that laws and states must match, but there are less flat-footed options as well. For instance, one might posit a "trial and error" meta-law that generates states that come increasingly close to matching laws until it yields a state that matches them. Or one might posit a "failsafe" meta-law to the effect that whenever laws hold but fail to match any state, a state that would match those laws will be randomly selected to obtain at the next time. Such third factors might secure nomological harmony even in worlds with initial conditions or laws that are incompatible with the realization of value. Thus, such third factors may yield a more modally robust explanation of harmony than would axiological third factors. However, at least in our world, such third-factors would arguably have less explanatory power than third-factors with an axiological component. For example, the latter but not the former are suitable for explaining cosmological fine-tuning, as well as other basic

[28]Defenders of axiarchic views include Leslie (1989) and Rescher (2013); cf. Parfit (2011).

features of the physical universe that may demand explanation, such as the beauty, simplicity, and intelligibility of the laws of physics.

For any posited third factor, we can ask why it obtains rather than something else that would not have explained why the laws match initial conditions. In light of this, it might seem that third-factorism cannot yield explanatory progress. This is not so. Since the noted sorts of third factors need not themselves involve a striking coincidence, they may be less striking than what they are invoked to explain. Granted, *some* third-factor explanations may involve a similarly striking coincidence. Perhaps this is true of design hypotheses that regard our universe as a simulation implemented on a computer in a distinct law-governed universe "one level up."[29] These views face the problem of explaining why the more fundamental universe exhibits the nomological harmony required to implement a computer simulation.[30] But there is no reason to think that all third-factor explanations will involve similar striking coincidences. For example, traditional theism (with a God who creates, but is not subject to, laws of nature) or axiarchic meta-law views would not obviously be committed to any such coincidences.

One might think that God's deciding to bring about nomological harmony would be just as coincidental, just as much in need of explanation, as nomological harmony occurring as a brute fact, since God could just as well have decided to produce any of

[29] For discussion of this sort of design hypothesis, see Bostrom (2003) and Chalmers (2022).

[30] This marks a difference between the problems of nomological harmony and cosmological fine-tuning: we're able to tell, conditional on our universe being simulated, that the problem of nomological harmony arises in a more fundamental universe but not that any such universe exhibits cosmological fine-tuning. This suggests two morals. One is that simulation hypotheses are better suited to explain cosmological fine-tuning than nomological harmony. The second is that no matter how well simulation hypotheses explain cosmological fine-tuning *taken on its own*, their inability to explain nomological harmony puts them at a disadvantage relative to design hypotheses that can explain both cosmological fine-tuning and nomological harmony.

the many possible non-harmonious universes. But on a theistic account, God's decision to create a harmonious universe will presumably admit of further explanation, specifically an intentional or reasons-based explanation in terms of the valuable outcomes that can only be realized within a harmonious universe. Since a stillborn universe plausibly precludes most valuable outcomes (life, consciousness, enjoyment, friendship, knowledge, etc.) it's not hugely surprising that God would choose to create a nomologically harmonious universe. This intentional explanation doesn't obviously introduce any striking coincidences. It's part of the theistic hypothesis that God is perfectly good, and it wouldn't be coincidental or even surprising for a perfectly good being to have an interest in realizing valuable outcomes. Nor is it clear why the mere existence of a perfectly good being must involve any problematic coincidence. (This wouldn't obviously involve any striking alignment between independent parameters.) Roger White (2015, p. 47) makes a similar point in response to an analogous objection to the fine-tuning argument: "The existence of living creatures has value in a way that other possible outcomes do not," Although God could have set the physical parameters to any of the many non-life-permitting values, "the creation of life is a plausible purpose that a rational agent might have, [so] theism may provide a satisfactory explanation of the fine-tuning of the constants, one that is far more satisfying than supposing it just happened by accident" (*ibid*: 48).

Still, just by positing a third factor, third-factorism detracts from parsimony. It's not obvious whether it's less parsimonious than ensemble solutions. Multi-law ensemble solutions require far more basic laws, so they score worse on the dimension of nomological parsimony. And multiverse ensemble solutions posit a large number of

universes, which include a large number of extra basic kinds of individuals, so these solutions seem to score worse on the dimensions of quantitative parsimony and qualitative parsimony. On the other hand, some third-factor explanations, such as the theistic design hypothesis, posit more kinds of individuals than law ensemble solutions (which posit a large set of laws, but needn't posit extra kinds of individuals). It's unobvious how these flavors of parsimony should be traded off one another, but it's at least arguable that third-factor explanations exhibit greater overall theoretical parsimony. In the next section we'll consider candidate solutions to the problem of nomological harmony that seek to explain why laws match initial conditions without incurring ontological inflation.

7. Prioritism

Prioritism claims that laws match initial conditions because laws help explain initial conditions (thereby achieving explanatory priority over them) or vice versa, but not because of any third factor. Prioritism comes in different versions.

On *nomological prioritism*, laws explain initial conditions. Nomological prioritism offers a plausible solution to the problem of nomological harmony as it arises for some fundamental *non*-dynamical laws. Suppose there are fundamental non-dynamical laws that specify or constrain the initial conditions, and thereby help explain them. (A potential example is the past hypothesis—that the universe started in a low-entropy state—which some take to have the status of a law.)[31] This fact would explain why there is a match between those laws and initial conditions.

[31] For discussion of the past hypothesis and its status as a law, see, e.g., Albert (2000: ix, Ch. 4), Loewer (2020), and Chen (2020); cf. Feynman (1965).

In contrast, nomological prioritism seems unpromising as a solution of the sort we are seeking, namely one that solves the problem of nomological harmony as it arises for fundamental dynamical laws. Such a solution would need to explain initial conditions in terms of fundamental dynamical laws—any other sort of law would here qualify as a third factor and so deprive the solution of its prioritist credentials. However, fundamental dynamical laws seem inapt to explain initial conditions.[32]

Still, it might be thought that a view that prioritizes fundamental *non*-dynamical laws could be leveraged into a solution to the problem of nomological harmony as it arises for fundamental dynamical laws. The trick would be to posit a fundamental non-dynamical law that both helps explain initial conditions and constrains them to match the fundamental dynamical laws. On reflection, however, this solution is unsatisfying, as it generates a variant of the original problem: why does the posited non-dynamical law harmonize with the fundamental dynamical laws? In other words, why does the non-dynamical law constrain the initial state to be one such that applying fundamental dynamical laws to it prompts the universe to evolve? It's unclear how this question could be answered without collapsing the view into a non-prioritist solution. For example, we might propose that the relevant non-dynamical law explicitly specifies that the initial conditions must match the dynamical laws, but this would yield a meta-law solution to our puzzle. Or we might explain the harmony between the initial-condition-specifying law and the dynamical laws by postulating a large and varied multiverse, but this would yield an ensemble solution. Or we could treat this

[32] At best, fundamental laws might yield a future-to-past explanation of initial conditions by operating on later states. However, this sort of explanation will not touch the canonical formulation of the nomological harmony problem, namely why do fundamental laws match some states rather than no states.

harmony as a brute fact, but this wouldn't differ significantly from the brutalist response to our original puzzle.

A more promising option is *initial conditions prioritism*, on which initial conditions explain laws. Initial conditions prioritism itself comes in different versions. On the *Humean* version, laws are just informative summaries of patterns in spacetime and so nothing over and above their instances.[33] Given that there are initial conditions and laws, on Humeanism it is natural to expect that they will match, as laws require instances and, when laws have instances, it's to be expected that instances will encompass any initial conditions that obtain. But even if Humeanism offers an easy solution to the puzzle of nomological harmony, it's doubtful whether this fact gives its opponents much reason to convert. Many reject Humeanism because it seems to be committed to an unexplained cosmic coincidence: the same basic patterns recur throughout the Humean mosaic, yet no deeper explanation is given for why the various parts of space and time are so strikingly alike.[34] Those sympathetic to this objection are likely to see the Humean solution to the puzzle of nomological harmony as taking us out of the frying pan and into the fire.[35] It avoids one unexplained coincidence (an unexplained match between laws and states) by positing a bigger one (the unexplained uniformity of the Humean mosaic).

The cosmic-coincidence objection concerns the puzzle of why there are (reasonably simple and uniform) laws at all, which is distinct from the puzzle of

[33]See Lewis (1983). For a recent overview of Humeanism about laws, see Bhogal (2020).

[34]See, e.g., Strawson (1987)). Note, however, that taking law-like regularities as brute is not the only option for Humeans—see Loewer (2012) for an alternative.

[35] For Humeans, e.g. Smart (1985), who are already in the business of taking law-like regularities as brute, it may not seem like much of a cost to accept as a further brute posit the fact that we are in a universe that evolves from its initial condition in accordance with laws.

nomological harmony. The objection raises several tricky issues. First, there are the delicate questions about probability mentioned in §3, which would arise for versions of the cosmic-coincidence objection that claim that it is *unlikely* that the universe would exhibit lawful patterns if the Humean mosaic is a brute fact. "Unlikely" can't mean "low objective chance," at least given the common assumption that objective chances depend on the (basic) laws and not vice versa. Those who formulate the cosmic-coincidence objection in probabilistic terms often treat the probabilities as epistemic probabilities that correspond to the credences of an ideally rational agent.[36] The typical motivation for assigning a low credence to lawful regularity conditional on Humean metaphysical commitments is that, as Hildebrand and Metcalf (2022, p. 454) put it: (i) on Humeanism, there are "vastly more disorderly (or irregular) worlds than orderly (or regular) worlds and (ii) the ontology seems to require a uniform probability distribution across Humean possible worlds."

But this argument can be resisted. First, while it is relatively straightforward to show that a uniform probability measure favors irregular worlds within simplistic finitary models (e.g., where we assume the mosaic has a fixed and finite number of spatiotemporal locations that can each be qualified by a finite number of properties), technical challenges arise in trying to extend a uniform measure to the infinite case.[37] Second, and more importantly, even in the finite case it isn't obvious that a uniform measure is rationally appropriate. It's a familiar idea that it's rational to have an *a priori* bias in favor of simple worlds (Lewis 1986, p. 121), and a Humean can argue that what it is for a world to be simple is for it to be describable with simple generalizations (Smart

[36] See, e.g., Filomeno (2019) and Hildebrand and Metcalf (2022, pp. 444-5).

[37] For discussion of some of the relevant technicalities, see Eagle (2010).

1985). As Sider (2020, p. 19) writes, "an a priori bias towards simple patterns" within a Humean mosaic "is as reasonable as an a priori bias towards simple [non-Humean] laws; each is a precisification of the vague bias toward the world being simple." However, this response will likely require an *extremely* strong *a priori* bias toward orderly mosaics, since disorderly mosaics will tend to outnumber orderly ones by a fantastically large factor. In order to render lawful order remotely probable, the *a priori* bias would need to favor orderly mosaics over equally specific disorderly mosaics by at least a similar factor.[38] We won't try to settle the issue here, except to note that *if* the above response to the cosmic-coincidence objection succeeds, then the fact that Humeanism seems to provide a ready explanation for nomological harmony may be regarded as an important advantage of Humeanism over some non-Humean accounts of laws. (Here it's worth noting that a bias toward simple *non-Humean* laws (e.g., governing laws) doesn't seem to predict harmony, since simple laws are no more likely to match the initial conditions than complicated ones.)

However, Humeanism may not fully explain nomological harmony, since Humeanism seems to be compatible with laws failing to match initial conditions. To see this, consider Humean stillborn worlds in which initial conditions obtain and nothing happens thereafter (that is, worlds in which the initial state is the only state). On Humeanism, these worlds arguably feature a law dictating as much. After all, the fact that nothing happens after the initial conditions seems to be a simple and extremely informative generalization, ruling out all but one possibility for how things will proceed

[38] This point illustrates that the cosmic-coincidence objection does not require anything nearly as strong as Hildebrand and Metcalf's uniform probability assumption (claim (ii) above) or the indifference principles that are sometimes invoked by proponents of this objection (Filomeno 2019).

after the initial state (though perhaps a Humean could adopt further conditions on membership within the "best system" that would prevent this generalization from qualifying as a law). If this is a law, it qualifies as a dynamical law, since it sets constraints on the world's temporal evolution—by ruling out any temporal evolution. These Humean stillborn worlds would therefore be worlds in which the dynamical laws fail to match initial conditions. That is, in these worlds, it's not the case that there are dynamical laws and initial conditions such that applying those laws to those conditions yields other states. Hence, Humeanism may not fully explain why, given that dynamical laws and initial conditions obtain, they also match. That said, inasmuch as Humeanism excludes many conceivable types of mismatch while allowing for all manner of conceivable matches, Humeanism may render this fact less surprising.

It's also worth noting that, while Humeanism may (partially) account for our central explanandum—the fact that some laws match some states—it cannot readily explain nearby forms of harmony that some might find plausible. Consider, for example, the stronger claim that *every* (fundamental) state matches some law. A corollary of this claim is that there are no fundamental "fugitive" states, i.e. instances of properties that fall under no lawful regularities. Granted, it's not obvious that we have reason to accept this stronger claim. The fact that we haven't discovered fundamental fugitives isn't significant evidence against them, since fugitive states, by definition, would not lawfully interact with our sense organs or measuring equipment. Still, we suspect many philosophers are tacitly inclined to accept this stronger form of harmony. So, it is worth noting that the Humean solution does not readily account for it (though perhaps the idea mentioned above, that there is a rational *a priori* bias in favor of orderly Humean

mosaics, can help here as well).[39] One might say that every world will have a Humean law stating that the fundamental properties are all and only those on such-and-such list, since this would be a reasonably simple and informative generalization about the world. If so, it's guaranteed that every fundamental property will be mentioned by some law. But this wouldn't address the substance of the challenge, which is to explain why (as we ordinarily assume) every fundamental property figures in some interesting spatiotemporal pattern or regularity rather than being haphazardly sprinkled across the mosaic.

The second version of initial conditions prioritism is the *Armstrongian* version, which relies on a pair of metaphysical theses held by David Armstrong.[40] The first is that laws are relations between universals. The fact that it is a law that all Fs are Gs consists in the fact that a relation of nomological necessitation holds between the universals F-ness and G-ness.[41] The second is that universals can only exist (and thus, can only stand in the nomological necessitation relation) if they are instantiated. These two Armstrongian metaphysical commitments might seem unrelated (they're certainly logically independent), but taken together, they may provide a prioritist explanation of nomological harmony. According to this account, laws are partially explained by universals (because a universal must exist in order to stand in the nomological necessitation relation), and universals in turn have their existence explained by their

[39] Cf. Lewis (2009, 2012). There is a notable symmetry here with the law ensemble solution, which can explain why some law matches some state, but cannot account for a stronger form of harmony that many are inclined to accept: that *every* law matches some state. However, as with the converse claim that every state matches some law, it is unclear whether we have justification to accept this stronger form of harmony as a datum.

[40] See, e.g., Armstrong (2016 [1983]; Ch. 6).

[41] For similar views, see Armstrong (1978), Dretske (1977), and Tooley (1977).

instances. In this way, instances of universals in the initial conditions can (partially and indirectly) explain the laws. The explanation guarantees that there will be no laws pertaining to uninstantiated properties. For example, there couldn't be a law about mass in a universe with no mass-involving states. This would explain why, given that there are laws and states at all, there must be a degree of harmony between them.

A potential concern with the Armstrongian solution is that there may be good reasons to accept uninstantiated universals. For example, they might be justified by their theoretical utility in semantics, where they can serve as semantic values for unsatisfied predicates (e.g., "is a golden mountain"). Or they might be needed in the philosophy of perception, where some have argued that sensible qualities like colors exist as constituents of perceptual content, though they are nowhere instantiated in reality.[42] The Armstrongian view also faces some awkwardness concerning the possibility of laws about universals with only non-initial instances, as well as laws about universals that are instantiated in the initial state but not at every time thereafter. If presentism or the growing-block theory is true, the Armstrongian view seems to imply that initially holding laws can never involve universals that are only instantiated after the initial state. And if presentism is true, the view seems to imply that if there is a law about a universal instantiated at the initial state, that universal must remain instantiated at all times, or else the relevant law will cease to hold. These commitments could impose severe and empirically unmotivated constraints on physical theorizing. Perhaps these worries can be sidestepped by adopting eternalism, but there would remain a problem about explanatory circularity. Suppose there is a law about a universal with only non-initial instances, where these instances ground the existence of the universal,

[42] See Pautz (2014); cf. Chalmers (2010: Ch. 12) and Cutter (2021).

and thereby indirectly and partially explain why there is a law involving that universal. That law may itself figure in the scientific explanation of the relevant non-initial instances, yielding an explanatory circle.[43]

Moreover, on reflection, the Armstrongian solution is (like the Humean solution) compatible with stillborn universes. Suppose there is a law that Xs increase their distance from Ys iff Xs are Zs. Such a law can hold, on the Armstrongian view, given that X-ness, Y-ness, and Z-ness (and distance) are instantiated. But suppose we have initial conditions in which all the Zs happen to be non-Xs. In that case, the law will fail to induce temporal evolution. Hence, the Armstrongian solution doesn't fully explain why, given that there are laws and states at all, the laws match the states so as to induce temporal evolution (though, like Humeanism, it may render this fact somewhat less surprising). Furthermore, for those inclined to accept the stronger form of harmony mentioned above—that every (fundamental) state matches some law—it's worth noting that the Armstrongian solution would not account for this. As with the Humean solution, nothing in the Armstrongian solution rules out fundamental fugitive states.

Finally, there is what we regard as the most promising version of prioritism: *powers prioritism*. On this view, properties have their causal powers essentially and distributions of properties and their powers ground laws.[44] Powers prioritists can say

[43] This circularity worry is closely analogous to a common objection to Humean accounts of laws, which contends that Humeanism leads to a similar kind of explanatory circle: laws feature in the scientific explanation of particular events, which (partially) metaphysically explain those very laws. For a presentation of this objection to Humeanism and an overview of the surrounding dialectic, see Bhogal (2020: §1.1).

[44]For proponents of views on which properties have their causal powers essentially, see e.g. Shoemaker (1980) and Mørch (2017). For such a view that explains laws in terms of powers, see Bird (2005); cf. Strawson (1987). For a view on which properties have their nomological profiles essentially, see Swoyer (1982).

that laws match initial conditions because any possible initial conditions would feature a distribution of properties and powers that grounds laws that match those conditions and some such conditions obtain.

Powers prioritism is largely free from the noted problems with the foregoing proposals. Unlike brutalism, powers prioritism does not seem to generate a striking coincidence in its attempt to respond to the match between laws and initial conditions. The indexical and Boltzmannian objections to the multiverse explanation do not apply to powers prioritism. Moreover, powers prioritism is more parsimonious than ensemble explanations and third-factor responses. And unlike nomological prioritism, powers prioritism does not face a dearth of entities that are apt for the sort of explanation it proposes.

On the other hand, like the Humean and Armstrongian solutions, powers prioritism faces the challenge of explaining why our universe is not stillborn, since powers prioritism is consistent with stillborn universes. Even if a universe has an initial state constituted by properties with certain essential causal powers, these powers will only induce temporal evolution if their stimulus conditions are met, which requires a kind of harmony with the other properties and relations involved in the initial state. To illustrate, suppose the initial state involves Xs, and Xs essentially have (only) the power to move nearby Ys. In that case, the universe may be stillborn if there are no Ys around. Or suppose Xs have the power to move Ys when they stand in some relativistic spatial relation. Then even if both Xs and Ys figure in the initial conditions, the universe may be stillborn if the Xs and Ys find themselves in a non-relativistic spatial arena. Powers prioritism therefore faces an explanatory puzzle somewhat analogous to the problem of

nomological harmony, which we might call *the problem of power harmony*: why are the powerful properties and relations that constitute the states of our universe harmoniously related to one another so as to induce temporal evolution?[45]

Powers prioritism may also face a related problem if some ways of arranging powers would entail incompatible things about the future. Consider, for example, a timeslice with an X and a Y, where Xs have an (indefeasible) power to move toward Ys and Ys have an (indefeasible) power to move away from Xs, or where each has the power to annihilate the other while itself continuing to exist. Of course, we shouldn't find it surprising that there aren't states that entail contradictions, but if many ways of filling timeslices involve conflicting powers, there may be a puzzle about why there are any power-filled timeslices at all.

Many natural responses to the problem of power harmony mirror the responses to the puzzle of nomological harmony. For example, we might take power harmony to be a brute fact. Or we might offer an ensemble explanation. This might involve a multiverse large and varied enough that it's unsurprising that some universe features harmoniously coordinated powers, or it might involve positing that each basic particular instantiates a large and varied collection of powerful properties, so it's unsurprising that some of these end up in harmonious correspondence. Alternatively, we might give a third-factor explanation for power harmony. Many of the objections raised above to the corresponding responses to nomological harmony will apply to these

[45] This problem is somewhat analogous to a problem noted above for Armstrongian prioritism—that it does not rule out stillborn universes. The stillborn scenarios associated with the Armstrongian view can likewise be construed as scenarios in which the causal powers of things are not coordinated in a manner that induces temporal evolution (though the Armstrongian allows that those causal powers are grounded in contingent laws, not essential features of the relevant first-order properties).

as well. And some of these responses to the problem of power harmony, such as multiverse or third-factor solutions, would jeopardize powers prioritism's appeal as a response to the problem of nomological harmony by expanding its ontology to include entities that can independently solve the problem. Indeed, these responses to the problem of power harmony would arguably make powers prioritism collapse into a version of one of the other responses to the problem of nomological harmony. For example, if nomological harmony is proximately explained by harmoniously coordinated powers, but God or a multiverse explains why these powers are harmoniously coordinated, then the ultimate explanation for nomological harmony would arguably qualify as a third-factor or multiverse explanation.

A final general challenge facing all forms of prioritism is that of explaining cosmological fine-tuning without compromising its parsimony advantage over the multiverse and third-factor solutions. This challenge is pressing because the latter solutions to the problem of nomological harmony naturally extend to explain cosmological fine-tuning while prioritism does not. Of course, prioritists could invoke a multiverse, designer, or meta-law explanation to explain cosmological fine-tuning. But—as with similar explanations of power harmony—this would jeopardize prioritism's appeal as a response to the problem of nomological harmony by expanding its ontology to include entities that can independently solve the problem.

8. Conclusion

We've focused on the problem of nomological harmony as it applies to fundamental dynamical laws. But versions of the puzzle can also be raised for other laws, including non-fundamental dynamical laws, fundamental laws specifying boundary conditions,

meta-laws, principles of mereology, grounding, and normativity. These versions of the problem would have a somewhat different character.

For instance, the harmony problem for non-fundamental dynamical laws—that of explaining why such laws match states—is plausibly parasitic on other manifestations of the problem. In particular, solving the problem for non-fundamental dynamical laws plausibly depends on solving it for fundamental dynamical laws and, in the event that fundamental laws concerning boundary conditions help explain dynamical laws, the variation of the problem concerning the match between fundamental dynamical laws and fundamental laws concerning boundary conditions.

Some versions of the problem are less forceful because the types of law they concern are more controversial. Indeed, all of the above candidates for non-dynamical laws are more controversial than fundamental dynamical laws. Other versions of the puzzle are less forceful because they are easily solved or the match they posit is less striking. In the cases of fundamental laws concerning boundary conditions, meta-laws, and mereological principles, there are independently plausible "domain general" candidates that would match under a wide range of conditions. For instance, the past hypothesis is often conceived as a fundamental boundary condition that unconditionally constrains the initial state of the universe. Or consider the mereological universalist principle that any plurality of objects composes a further object—if this principle held, there would be no mystery as to why, given that there are objects, there are entities of the sort that the principle takes as inputs. Arguably, meta-laws of the sort considered in §6 fall into this category as well.

Posing the problem for normative principles raises some complications. One is that the strikingness of the match between normative principles and states may depend sensitively on whether we evaluate the match relative to the space of conceptual possibility or, instead, relative to a more constrained space of epistemic possibility. For while it may be conceptually possible for normative principles to apply to any sort of state, it may be a priori that they concern entities such as agents, experiences, actions, and the like. In the latter case, given that our world contains such entities, it would not be striking that normative principles match states in our world. Another complication is that, given that normative principles concern such entities, a component of the match—namely the entities in question—may be more puzzling than the match *per se*. Other complications arise from the availability of anti-realist responses to the harmony problem for normative principles. On the face of it, such views are well-positioned to solve or avoid the problem, since they eliminate normativity or explain it in terms of our attitudes (maneuvers that have little appeal in the case of descriptive laws). However, the matter is not clear cut, as some anti-realists seek to vindicate normative realist talk while eschewing attendant metaphysical commitments. Whether this split can be achieved is a matter of debate, as is whether preserving realist talk suffices to saddle anti-realists with the explanatory burdens of realism.[46]

Finally, one notable version of the puzzle applies specifically to fundamental psychophysical laws, laws that generate experiences from physical states or assign experiences effects. If these laws are construed as fundamental dynamical laws, this version of the problem is a special case of the one we have focused on throughout the paper. This version is significant because it poses an overlooked problem for dualists

[46] See Dreier (2012) for discussion.

about experience, who are typically committed to such laws. It is unclear how severe of a problem this is for dualism. That depends partly on the extent to which dualists can co-opt solutions to the problem of nomological harmony as it arises for fundamental dynamical laws in general. It also depends on the extent to which rival views require corresponding non-fundamental psychophysical laws and the severity of the harmony problem any such laws raise. However exactly these issues pan out, the nomological harmony problem for psychophysical laws may prove fruitful as a constraint in theorizing about such laws.

At least in the case of fundamental dynamical laws, the problem of nomological harmony invites candidate solutions from various quarters, ranging from brutalist and ensemble responses to third-factor and prioritist solutions. For what it's worth, we tentatively favor a third-factor solution. Third-factor explanations may offend against parsimony, but in our view, the alternatives either violate powerful modal intuitions and shirk a legitimate demand for explanation (brutalist responses), or commit even graver offenses against parsimony (ensemble responses), or involve commitments which themselves invite explanation in terms of a third factor suitable for solving the original problem (prioritist responses). However, our goal has not been to justify this tentative preference, but to introduce the puzzle of nomological harmony and explore the virtues and vices of candidate solutions. None of the candidates are cost free. Which offers the best bargain is an open question.

ACKNOWLEDGEMENTS

For helpful feedback on earlier versions, we are grateful to Frederick Choo, Hedda Hassel Mørch, Brian Leftow, Avi Sommer, Dean Zimmerman, participants in the Rutgers 2021 Philosophy of Religion Group, anonymous reviewers, and, with special thanks, to Daniel Berntson. For helpful discussion, we are also grateful to Nevin

Climenhaga, Dustin Crummett, Daniel Rubio, Philip Swenson, Jeffrey Tolly, Michael Rota, audience members of a philosophy department colloquium at Northern Illinois University, and audience members at the 2021 Princeton-Rutgers Philosophy of Religion Virtual Incubator.

REFERENCES

Armstrong, D.M. (1978). *A Theory of Universals*. Cambridge University Press.

Armstrong, D.M. (2016). [reprint of 1983]. *What is a Law of Nature?*. Cambridge: Cambridge University Press.

Adams, R. M. (1987). *The virtue of faith and other essays in philosophical theology*. Oxford: Oxford University Press.

Albert, David Z. (2000). *Time and Chance*. Cambridge: Harvard University Press.

Armstrong, D. M. (1983). *What is a Law of Nature?*. Cambridge: Cambridge University Press.

Arntzenius, F. & Dorr, C. (2017). Self-locating priors and cosmological measures. In K. Chamcham, J. Barrow, S. Saunders & J. Silk (eds.), *The Philosophy of Cosmology*. Cambridge: Cambridge University Press.

Bailey, A. M., Rasmussen, J., & van Horn, L. (2011). No pairing problem. *Philosophical Studies*, 154(3),349–360. doi:10.1007/s11098-010-9555-7

Barnes, L.A. (2012). The fine-tuning of the universe for intelligent life. *Publications of the Astronomical Society of Australia*, 29(4), 529-564. doi: 10.1071/AS12015

Bedke, M. (2009). Intuitive non-naturalism meets cosmic coincidence. *Pacific Philosophical Quarterly*, 90(2), 188-209. doi: 10.1111/j.1468-0114.2009.01336.x

Beebee, H. (2000). The Non-Governing Conception of Laws of Nature. *Philosophical and Phenomenological Research* 61 (3):571-594. doi: 10.2307/2653613

Benton, M., Hawthorne, J., & Isaacs, Y. (2016). Evil and evidence. *Oxford studies in philosophy of religion*, 7, 1-31. doi: 10.1093/acprof:oso/9780198757702.003.0001

Bhogal, H. (2020). Humeanism about laws of nature. *Philosophy Compass* 15 (8):1-10. doi: 10.1111/phc3.12696

Bird, A. (2005). The dispositionalist conception of laws. *Foundations of Science*, 10(4):353-370. doi: 10.1007/s10699-004-5259-9

Bostrom, N. (2003). Are we living in a computer simulation?. *The philosophical quarterly*, 53(211), 243-255. doi: 10.1111/1467-9213.00309

Bradley, D. "Naturalness as a constraint on priors." *Mind* 129.513 (2020):179-203. doi: 10.1093/mind/fzz027

Carroll, S.M. (2020). Why Boltzmann brains are bad. In *Current Controversies in Philosophy of Science.* (pp. 7-20). Routledge.

Carroll, S.M. (forthcoming). In What Sense Is the Early Universe Fine-Tuned? In B. Loewer, B. Weslake & E. Winsberg (eds.), *Time's Arrows and the Probability Structure of the World*. Cambridge: Harvard University Press.
Chalmers, D. (1996). *The Conscious Mind: In Search of a Fundamental Theory.* OUP.
Chalmers, D. (2010). *The Character of Consciousness*. OUP.
Chalmers, D. (2018). The Meta-Problem of Consciousness. *Journal of Consciousness Studies*, 25(9-10), 6-61.
Chalmers, D. (2019). Idealism and the Mind-Body Problem. In William Seager (ed.), *The Routledge Handbook of Panpsychism*. New York: Routledge. pp. 353-373.
Chalmers, D. (2022) *Reality+: Virtual Worlds and the Problems of Philosophy*. W. W. Norton & Company.
Chalmers, D. & McQueen, K. (forthcoming). Consciousness and the Collapse of the Wave Function. In Shan Gao (ed.), *Consciousness and Quantum Mechanics*. Oxford: Oxford University Press.
Chen, E. (forthcoming). The Past Hypothesis and the Nature of Physical Laws. In B. Loewer, E. Winsberg & B. Weslake (eds.), *Time's Arrows and the Probability Structure of the World*. Harvard University Press.
Climenhaga, N. (2023). Epistemic Probabilities are Degrees of Support, not Degrees of (Rational) Belief. *Philosophy and Phenomenological Research*. doi: 10.1111/phpr.12947
Collins, R. (2005). The many-worlds hypothesis as an explanation of cosmic fine-tuning: An alternative to design?. *Faith and Philosophy*, 22(5):654-666. doi: 10.5840/faithphil200522526
Cutter, B. (2021). Perceptual illusionism. *Analytic Philosophy*, 62 (4):396-417. doi: 10.1111/phib.12233
Dreier, J. (2012). Quasi-Realism and the Problem of Unexplained Coincidence. *Analytic Philosophy*, 53(3), 269-287. doi: 10.1111/j.2153-960X.2012.00567.x
Dretske, F., (1977). "Laws of Nature," *Philosophy of Science*, 44: 248–268. doi: 10.1086/288741
Eagle, A. (2010). Chance versus Randomness. *Stanford Encyclopedia of Philosophy*.
Feynman, R., (1965) *The Character of Physical Law*. Cambridge, Mass.: MIT Press.
Foster, J. (1968). Psychophysical causal relations. *American Philosophical Quarterly*, 5, 64–70.
Field, H. (1980). *Science Without Numbers: A Defence of Nominalism*. Princeton, NJ, USA: Princeton University Press.

Foster, J. (1991). *The immaterial self: A defense of the Cartesian dualist conception of mind*. London: Routledge.
Friederich, S., "Fine-Tuning", *The Stanford Encyclopedia of Philosophy* (Winter 2018 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2018/entries/fine-tuning/>.
Filomeno, A. (2019). Are non-accidental regularities a cosmic coincidence? Revisiting a central threat to Humean laws. *Synthese* 1:1-23. doi: 10.1007/s11229-019-02397-1
Hawthorne, J. (2005). Degree-of-belief and degree-of-support: Why Bayesians need both notions. *Mind* 114 (454):277-320. doi: 10.1093/mind/fzi277
Hawthorne, J. & Nolan, D. (2006) What would teleological causation be?, in Hawthorne, J. (ed.) *Metaphysical Essays*. OUP. doi: 10.1093/acprof:oso/9780199291236.003.0015
Hawthorne, J. & Isaacs, Y. (2017). Misapprehensions about the Fine-Tuning Argument. *Royal Institute of Philosophy Supplement* 81:133-155. dio: 10.1017/s1358246117000297
Isaacs, Y.; Hawthorne, J. & Russell, J.S. (2022). Multiple Universes and Self-Locating Evidence. *Philosophical Review* 131 (3):241-294. doi: 10.1215/00318108-9743809
Hildebrand, T. & Metcalf, T. (2022). The nomological argument for the existence of God. *Noûs* 56 (2):443-472. Doi: 10.1111/nous.12364
Joyce, R., (2006) *The Evolution of Morality*, Cambridge, MA: MIT Press.
Kim, J. (2005). *Physicalism, or something near enough*. Princeton: Princeton University Press.
Kleinschmidt, S. (2014). Reasoning Without the Principle of Sufficient Reason. In *The Puzzle of Existence*. Routledge.
Lange, M. (2009). *Laws and Lawmakers Science, Metaphysics, and the Laws of Nature*. OUP.
Lee, G. (2016). Worlds, Voyages and Experiences: Commentary on Pelczar's Sensorama. *Analysis* 76(4):453-461. doi: 10.1093/analys/anw049
Leslie, J. (1989). *Universes*. Routledge.
Lewis, D. (1980) "A Subjectivist's Guide to Objective Chance", in R.. Jeffrey (ed.), *Studies in Inductive Logic and Probability, Volume II*, University of California Press. 263–293. doi: 10.1093/0195036468.003.0004
Lewis, D. (1983). New work for a theory of universals. *Australasian Journal of Philosophy* 61 (4):343-377. doi: 10.1080/00048408312341131
Lewis, D. (2009). Ramseyan humility. In David Braddon-Mitchell & Robert Nola (eds.), *Conceptual Analysis and Philosophical Naturalism*. Cambridge: MIT Press. pp. 203-222.
Lewis, D. (1986) *On the plurality of worlds*. Oxford: Blackwell.

Loewer, B. (2012). Two accounts of laws and time. *Philosophical Studies* 160(1):115-137. doi: 10.1007/s11098-012-9911-x

Loewer, B. (2020). "The Mentaculus Vision" in Allori, V. (Ed.) *Statistical Mechanics and Scientific Explanation: Determinism, Indeterminism and Laws of Nature*. World Scientific.

Lange, M. (2009). *Laws and Lawmakers*. Oxford: Oxford University Press.

Lycan, W. (2009). Giving dualism its due. *Australasian Journal of Philosophy*, 87(4), 551–563. doi: 10.1080/00048400802340642

Maudlin, T. (2007). *The metaphysics within physics*. Oxford: Oxford University Press.

Maudlin, T. (2012). *Philosophy of Physics: Space and Time*. Princeton: Princeton University Press.

Mørch, H. H. (2017). The evolutionary argument for phenomenal powers. *Philosophical Perspectives*, 31(1), 293-316. doi: 10.1111/phpe.12096

Nagel, T. (2012) Mind and Cosmos: *Why the Materialist Neo-Darwinian Conception of Nature is Almost Certainly False*. Oxford: Oxford University Press.

Oppy, G. (2014). Ultimate naturalistic causal explanations. In *The Puzzle of Existence: Why Is There Something Rather than Nothing*? ed. T. Goldschmidt, 46–63. London: Routledge.

Parfit, D. (2011). *On What Matters: Vol. 2*. Oxford: Oxford University Press.

Pelczar, M. (2015). *Sensorama: A phenomenalist analysis of spacetime and its contents.* Oxford: Oxford University Press.

Rescher, N. (2013). *On explaining existence*. Walter de Gruyter.

Russell, B. (1921). *The Analysis of Mind*. London: Allen & Unwin.

Saad, B. (2018). Indeterministic causation and two patches for the pairing argument. *Pacific Philosophical Quarterly*, 99(4), 664-682. doi: 10.1111/papq.12200

Saad, B. (2020). Two solutions to the neural discernment problem. *Philosophical Studies,* 177(10), 2837-2850. doi: 10.1007/s11098-019-01341-w

Saad, B. (2022) Harmony in a panpsychist world. *Synthese* 200.6:497. doi: 10.1007/s11229-022-03974-7

Saad, B. (forthcoming*a*) Fine-Tuning Should Make Us More Confident that Other Universes Exist. In *American Philosophical Quarterly.*

Saad, B. (forthcoming*b*) "Lessons from the Void: What Boltzmann Brains Teach" in *Analytic Philosophy*.

Shoemaker, S. (1980). Causality and properties. In P. van Inwagen (ed.), *Time and Cause*. Reidel. pp. 109-35.

Simon, J. (2015) Review of Michael Pelczar's Sensorama. *Notre Dame Philosophical Reviews*.
Schaffer, J. (2015). What not to multiply without necessity. *Australasian Journal of Philosophy*, 93(4), 644-664. doi: 10.1080/00048402.2014.992447
Sider, Theodore (2001). *Four Dimensionalism: An Ontology of Persistence and Time*. Oxford University Press.
Sider, T. (2020). *The tools of metaphysics and the metaphysics of science*. Oxford: Oxford University Press.
Smart, J.J.C. (1985). Laws of nature and cosmic coincidences. *Philosophical Quarterly* 35(140):272-280. doi: 10.2307/2218906
Strawson, G. (1987). Realism and causation. *Philosophical Quarterly* 37 (148):253-277. doi: 10.2307/2220397
Street, S. (2006) A Darwinian dilemma for realist theories of value. *Philosophical Studies* 109-166. doi: 10.1007/s11098-005-1726-6
Swinburne, R. (2004). *The Existence of God*. Oxford: Oxford University Press.
Swoyer, C. (1982). The nature of natural laws. *Australasian Journal of Philosophy*, 60(3):203-223. doi: 10.1080/00048408212340641
Tooley, M. (1977) "The Nature of Laws," *Canadian Journal of Philosophy*, 7: 667–698. doi: 10.1080/00455091.1977.10716190
Unger, P. (2005). *All the Power in the World*. Oxford: Oxford University Press.
Weinstein, S. & Rickles, D. "Quantum Gravity", *The Stanford Encyclopedia of Philosophy* (Winter 2020 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2020/entries/quantum-gravity/>.
White, R. (2000). Fine-tuning and multiple universes. *Noûs* 34 (2):260–276. doi: 10.1111/0029-4624.00210
White, Roger (2005). Explanation as a guide to induction. *Philosophers' Imprint* 5:1-29.
White, R. (2011). What fine-tuning's got to do with it: a reply to Weisberg. *Analysis* 71 (4):676-679. doi: 10.1093/analys/anr100
White, R. (2015). The argument from cosmological fine-tuning. In Rosen, G., A. Byrne, J. Cohen, S.V. Shiffrin (eds.), *The Norton Introduction to Philosophy*. Norton.
Williamson, T. (2000). *Knowledge and its Limits.* Oxford: Oxford University Press.
Wigner, E. (1960). The unreasonable effectiveness of mathematics in the natural sciences. *Communications in Pure and Applied Mathematics* 13:1-14. doi: 10.1002/cpa.3160130102

Wright, C. (2004). Warrant for nothing. *Proceedings of the Aristotelian Society*, Supplementary Volume, 78, 167–212. doi: 10.1111/j.0309-7013.2004.00121.x
Yablo, S. (1993). Is conceivability a guide to possibility? *Philosophy and Phenomenological Research* 53 (1):1-42. doi: 10.2307/2108052

Funding: This work was supported by the Sentience Institute, University of Notre Dame, Utrecht University, and the John Templeton Foundation. The views expressed are the authors' and do not necessarily reflect those of funders.
Conflicts of interest: none