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If naturalism is true, then scientific explanation is impossible

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Abstract

I begin by retracing an argument from Aristotle for final causes in science. Then, I advance this ancient thought, and defend an argument for a stronger conclusion: that no scientific explanation can succeed, if Naturalism is true. The argument goes like this: (1) Any scientific explanation can be successful only if it crucially involves a natural regularity. Next, I argue that (2) any explanation can be successful only if it crucially involves no element that calls out for explanation but lacks one. From (1) and (2) it follows that (3) a scientific explanation can be successful only if it crucially involves a natural regularity, and this regularity does not call out for explanation while lacking one. I then argue that (4) if Naturalism is true, then all every natural regularity calls out for explanation but lacks one. From (3) and (4) it follows that (5) if Naturalism is true, then no scientific explanation can be successful. If you believe that scientific explanation can be (indeed, often has been) successful, as I do, then this is a reason to reject Naturalism.

Keywords: philosophy of religion; philosophy of science; scientific explanation; naturalism; supernaturalism; theism; atheism

Introduction: an Aristotelian insight

In his *Physics,* Aristotle famously argues for teleology in nature – that nature, at least sometimes, acts for an end, for a goal, for a purpose. Aristotle believes that these ends can serve, at least partly, to explain natural phenomena, and he adds these 'final causes' to his other three causes or explanations of natural phenomena – material, efficient, and formal. This much is well known. Less well known is that, in *Physics* II 8 (198b16–199a8), Aristotle considers an objection to his teleological view of nature, an objection tracing back to the materialist Empedocles. Here's how Aristotle puts the problem (translated by Sedley (2007), 189–190):

> There is a puzzle. What prevents nature from producing results not for a purpose or because it is best, but in the way that Zeus rains, not in order to make the crops grow, but of necessity? For what goes up must cool, and what cools must become water and come down; and when this happens, the accidental result is that the crops grow. Similarly if someone's crops rot on the threshing floor, it does not rain in order that this should happen, but it is an accident. So what prevents natural parts from being like this – for example that it is of necessity that teeth grow with the front

> ones sharp and suitable for cutting, the molars flat and useful for grinding food, because of a coincidental outcome, and not because they happened for this purpose? Likewise in the case of other parts in which purpose seems to be present: where everything accidentally turned out as it would have done also if it were coming about for a purpose, these ones were preserved, having been formed in a suitable way fortuitously, whereas those which did not turn out this way perished, and are still perishing, as Empedocles says about the 'man-faced ox progeny.'

Aristotle has in mind here a view on which all natural phenomena can be explained via a combination of natural necessity and chance, with no need for teleology, no need for final causes. The rain falls as a result of necessity: heated water must rise, 'what goes up must cool', and cooled water must fall. And it's purely accidental whether this rain results in corn growing or crops spoiling. It's just chance. Neither result explains the falling of the rain; the rain didn't fall *for the purpose of* growing the crops, or *for the purpose of* spoiling them. In a similar way, as Empedocles proposed in his proto-Darwinian theory, perhaps living things organize themselves with some degree of spontaneity, resulting in a variety of forms. Some are fitting and survive, like the arrangements of our bodies, while others are less fit and do not survive, like Empedocles' 'man-faced ox progeny'. Either way, as with the rain example, the result is explained by a combination of necessity and chance, not teleology. Our bodies are organized as they are not because it is *good* for us, nor because they were *designed* to, but, again, due to a confluence of necessity and chance. Why couldn't all natural phenomena be explained in this way? Why appeal to final causes at all? This is the puzzle Aristotle considers.

And Aristotle gives this reply (Sedley (2007), 190):

> Such is the argument which might lead to puzzlement, and there may be others of the kind. But things cannot be that way. For these things, and all natural things, come about as they do either always or for the most part, whereas none of the things that are due to luck and the fortuitous does that. For it does not seem to be due to luck or coincidence that it rains frequently in winter, but it does if it rains in midsummer. Nor do heat waves in midsummer seem due to luck or coincidence, but heat waves in winter do. If then it seems that things are either due to coincidence or for a purpose, then if it is impossible for these things to be due to coincidence or the fortuitous, they must be for a purpose.

He concludes by reaffirming his teleological world-view (translated by Scharle (2008), 149):

> But clearly all such things are by nature, as these speakers themselves would say. The 'for the sake of something', then, is in things which are and come to be by nature.

Scharle (*ibid.*, 147) calls this discussion, 'one of the most vexing and important passages in Aristotle's corpus'. It raises many questions.[1] Most importantly, for our purposes: why, in Aristotle's response, does 'necessity' not appear as a third possible explanation, in addition to coincidence and for-a-purpose?[2] This may seem odd, given the context, since Aristotle is responding to an opponent who proposes that all natural phenomena are explicable by chance *and necessity*. I agree with Falcon (2019, citing Code (1997), 127–134) when he says, 'Where there is regularity there is also a call for an explanation, and coincidence is no explanation at all . . . Aristotle offers final causality as his explanation for this regular connection . . .'[3] In other words, as I understand it, when Aristotle says, 'it is impossible for these things to be due to coincidence or the fortuitous,' he's speaking not of rain *per se*, nor of heat *per se*, nor of the growth of teeth *per se*. Rather,

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'these things' refers to the *regularity* of rain (in the winter), the *regularity* of heat (in the summer), and the *regularity* of tooth growth in humans. He's speaking of those natural *patterns*.

Aristotle is responding to the claim that all natural phenomena can be explained fully via chance and necessity. The problem Aristotle points out is that chance and necessity are themselves natural phenomena: we see them all throughout nature. So how will Aristotle's opponents explain *these* natural phenomena, chance and necessity? Chance, Aristotle seems to grant, needs no further explanation; indeed, it seems that to say something happened by chance simply is to say that there is no further explanation. But necessity – regularity – he thinks, *does* call out for further explanation. Aristotle offers final causes as explanations of regularities: teeth grow as they do *for the good of the organism*, rain falls perhaps *for the good of the crops*, etc.[4]

By contrast, the Empedoclean materialist has no theoretical resources by which to explain these necessities, these regularities, or what we would now call 'the laws of nature'. And that's because, if the Empedoclean has only chance and necessity at his disposal when explaining natural phenomena, and the necessities or regularities themselves cannot be explained by chance – as Aristotle says, 'these things, and all natural things, come about as they do either always or for the most part, whereas none of the things that are due to luck and the fortuitous does that' – then they have no explanation at all, on the Empedoclean view.[5] So, for Empedocles, something that seems to call for explanation in fact has none. That's a cost.

And that's Aristotle's insight in this passage: teleology can explain a widespread type of phenomenon – the patterns we observe in nature – that seem to need explanation, but which have no explanation on the Empedoclean view. Indeed, ultimately, teleology explains *all* natural phenomena, on Aristotle's view. In *Metaphysics* (1072b), Aristotle tells us that all nature moves for love of the Prime Mover, whom Aristotle occasionally calls 'God'. As C. S. Lewis (1964, 113) explains:

> [W]e must not imagine Him moving things by any positive action, for that would be to attribute some kind of motion to Himself and we should then not have reached an utterly unmoving Mover. How then does He move things? Aristotle answers, κινεί ὡς ἐρώμενον, 'He moves as beloved.' He moves other things, that is, as an object of desire moves those who desire it. The *Primum Mobile* is moved by its love for God, and, being moved, communicates motion to the rest of the universe.[6]

I think Aristotle is right that his view has a theoretical advantage here. Yet I believe he has underplayed his hand. We can follow the thread of his argument, and take things further. We can show that, by leaving these natural regularities unexplained, the Empedoclean leaves *all* natural phenomena unexplained. In the end, all scientific explanation fails, on this naturalistic, Empedoclean view.

The main argument

I'd like to defend the following argument:

1. Any scientific explanation can be successful only if it crucially involves a natural regularity.
2. Any explanation can be successful only if it crucially involves no element that calls out for explanation but lacks one.
3. So, a scientific explanation can be successful only if it crucially involves a natural regularity, and this regularity does not call out for explanation while lacking one.

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4. If Naturalism is true, then every natural regularity calls out for explanation but lacks one.
5. So, if Naturalism is true, then no scientific explanation can be successful.

Let's begin our defense of this argument with the first premise, defining terms as needed.

Premise 1: naturalism on the sea of scientific explanation

Naturalism

I propose we begin by defining *Naturalism*. Here, there is disagreement. Rea (2002) says Naturalism is best understood not as a proposition but as a *research programme* that treats the methods of science, and those methods alone, as basic sources of evidence. Others, like Armstrong (1978, 265) and Danto (1967, 448), take Naturalism to be the claim that the universe is causally closed. Quine (1995, 257) and Devitt (1998, 45) say it's the view that only scientific inquiry produces knowledge, echoing Sellars's (1963, 173) Protagorean mantra that 'science is the measure of all things: of what is that it is and of what is not that it is not'. Plantinga (2008) defines Naturalism as a vague metaphysical thesis: 'Naturalism is the idea that there is no such person as God or anything like God; we might think of it as high-octane atheism or perhaps atheism-plus.' Aristotle, the Stoics, and Hegel may have claims to be atheists, Plantinga says, but Aristotle's Prime Mover, the Stoics' *Noûs*, and Hegel's Absolute exclude them from the halls of Naturalism.[7]

I believe we can harmonize these answers by taking 'Naturalism' to name a collection of views and attitudes that are often held together.[8] As Oppy (2018, 21) puts it, 'naturalism is the view that: (a) science is our touchstone for identifying the denizens of causal reality; and (b) there *are* none but natural causal entities with none but natural causal powers'. The success of the natural sciences may prompt one to adopt, as a research programme justified pragmatically, the austere metaphysical landscape that Plantinga, Armstrong, and Danto describe, as well as the broadly empiricist epistemology that Quine, Devitt, and Sellars endorse, a landscape in which there are none but natural causal entities with natural causal powers. This general package, admittedly vague, is a fair approximation of what philosophers mean when they speak of Naturalism.

The nature and structure of scientific explanations

Now, I wish to support premise 1 in my Main Argument: *Any scientific explanation can be successful only if it crucially involves a natural regularity.* To see this, let's think about the nature and structure of scientific explanations. A major and still influential contribution to this discussion is Carl Hempel's and Paul Oppenheim's (1948, reprinted in Hempel 1965) Deductive-Nomological Model of scientific explanation. On this model, a scientific explanation consists of two parts: *explanandum* and *explanans*. The *explanandum* is a proposition describing the scientific phenomenon to be explained. The *explanans* comprises a set of propositions that entail the *explanandum*, and which must be true for the explanation to succeed. Hence, '*Deductive*-Nomological' model. And the model is 'nomological' because, according to Hempel, for a scientific explanation to succeed, a law of nature must feature crucially in the *explanans*, that is, it must be essential for the deduction to be valid. In a nutshell, the idea is that science explains a phenomenon by showing how prior (physical) conditions entail that phenomenon, via bridge principles. These bridge principles are, according to this model, laws of nature.

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Woodward (2019) gives us this example of a scientific explanation on the Deductive-Nomological Model:

> [C]onsider a derivation of the position of Mars at some future time from Newton's laws of motion, the Newtonian inverse square law governing gravity, and information about the mass of the sun, the mass of Mars and the present position and velocity of each. In this derivation the various Newtonian laws figure as essential premises and they are used, in conjunction with appropriate information about initial conditions (the masses of Mars and the sun and so on), to derive the explanandum (the future position of Mars) via a deductively valid argument.

In subsequent decades, there ensued debate over the necessity and sufficiency of the conditions proposed by the Deductive-Nomological Model. Many of these concerns focused on the problem of explanatory asymmetries[9] as well as explanatory irrelevancies.[10] Attempts to solve these problems all assume that laws of nature – or at least exception-less universal generalizations – will feature crucially in scientific explanation.[11] Since it is so important for our purposes, it bears repeating that not one of these proposals challenges the *necessity* of laws of nature for successful scientific explanations.[12] So, let us turn now to the idea that laws of nature are not in fact *necessary* for successful scientific explanations, nor are even exception-less universal generalizations necessary.

Woodward (2000, 2019) points out that there are at least some explanations offered in the social sciences appealing to generalizations that admit of exceptions, for example Mendel's Law of Segregation.[13] To accommodate this suggestion, we'll use the term 'natural regularity' to refer to any of these: a law of nature, an exception-less universal generalization describing natural phenomena, or a law-like principle of the special sciences, even if it admits of exceptions. Premise 1 claims only that any successful scientific explanation must feature some natural regularity or other. These regularities may be inviolable laws of nature, or simply exception-less universal generalizations describing natural phenomena, or even, perhaps, principles of the special sciences that admit of exceptions. As for whether the regularity has a further explanation, at present it makes no difference. The point, so far, is simply that, after much philosophical work on the structure of scientific explanation, it seems clear that any scientific explanation must feature some natural regularity or other. The entire scientific enterprise, you might think, is to unearth the deep patterns of the universe, to order the future and the past in the relation of *expectation*. And the natural regularities are what link the past to the future in this way.

Premise 2: the hole in Naturalism's hull

We've established that any scientific explanation can be successful only if it crucially involves a natural regularity. Let's move now to our second premise in the Main Argument: *Any explanation can be successful only if it crucially involves no element that calls out for explanation but lacks one.*

First, what is it for something to 'call out' for explanation? Recall that Aristotle seemed to think that any natural regularity 'calls out' for explanation: it's not the sort of thing that requires no further explanation – because it's obvious, or self-explanatory, etc. – it *can* be further explained, and *ceteris paribus* it is a deficiency of a theory if the theory leaves it unexplained.[14]

Now, with regard to premise 2, our general question is this: for any phenomenon P, could any putative explanation E of P be successful if E crucially involves some element that calls out for explanation but lacks one?[15] We will wonder below about the particular case in which the phenomenon is a natural regularity. But, with regard to the general

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form of the question, I believe the answer turns on our judgments concerning cases like this. Imagine we lived in a pre-scientific age, and we wondered how the Earth remained stationary beneath our feet. Why isn't it falling, or rising, or otherwise moving around? One possibility is that there is no explanation of this fact; the Earth is stationary, and that's the end of the story. Our inquiry finds no satisfaction here. But suppose we meet a man who offers this explanation: the Earth is stationary because it rests on the back of a stationary turtle. Now, it may *seem* as though this would explain why the Earth is stationary: it's held in place by that stable turtle, bless him. But, evidently, *it depends*. Whether this turtle explains why the Earth is stationary depends on whether there's any explanation of how this turtle remains stationary. For suppose the man says, 'No, there is no further explanation. The turtle rests on nothing.' I suggest that the promise of an explanation of the stationary Earth has merely been deferred, but ultimately not fulfilled. A bit of argument in support of this suggestion goes like this: insofar as there's a connection between explanation and understanding – as Woodward (2019) puts it, 'One ordinarily thinks of an explanation as something that provides understanding' – this explanation has failed, since we're not in a position to understand why the Earth is stationary. So, if there's no explanation of the turtle's stable position, it turns out that we have, in the end, no explanation of the Earth's stable position. For the same reason, adding another turtle to hold up the first turtle won't help, if that second turtle's position has no further explanation. And this goes no matter how many turtles we put down there, at least so long as that number is finite. (For the infinite case, see below.)

Again, the general principle we're considering in this section is this: for any phenomenon P, any putative explanation E of P can be successful only if E does not crucially involve any element that calls out for explanation but lacks one.[16] And it looks as though, in this case at least, the putative explanation (the support of the turtle) of the phenomenon (the stationary Earth) fails, because the putative explanation crucially involves some element that is itself unexplained (in this case, the turtle's stable position).[17] There seems to be nothing unusual about this instance of the general principle currently under consideration, and the reader can easily supply more. So, we have here the makings of a proof for the universal generalization that is our second premise. If such a principle can be shown to hold with any randomly chosen example, it holds for any example. Of course, my failure to find counterexamples is no guarantee there are none. But what can I do beyond trying my best, and then leaving it to the reader to decide?[18]

So far, we've supported our first two premises:

1. A scientific explanation can be successful only if it crucially involves a natural regularity.
2. Any explanation can be successful only if it crucially involves no element that calls out for explanation but lacks one.

From these premises, it follows that:

3. A scientific explanation can be successful only if it crucially involves a natural regularity, and this regularity does not call out for explanation while lacking one.

Now, let us turn to our fourth and final premise.

Premise 4: Naturalism takes on water

Our fourth premise says that, *if Naturalism is true, then every natural regularity calls out for explanation but lacks one.* To prove this, let's begin by thinking about natural regularities,

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and possible patterns for their explanation. Take perhaps a law of physics, like the Einstein Field Equations, or Maxwell's Equations. Or take a principle of the special sciences, like Mendel's Law of Segregation, or the Second Law of Thermodynamics, or the Ideal Gas Law, all of which admit of exceptions.[19] Or take even a principle of the folk sciences, like Aristotle's regularity that 'what goes up must cool, and what cools must become water and come down', or that it rains frequently in winter. Whichever regularity you choose, let's call it 'R'. Recall that Aristotle seemed to think that regularities 'call out' for explanation: they *can* be further explained, as they are on his view, and *ceteris paribus* a theory that explains them is better than one that doesn't. Why would a Naturalist agree? Well, recall that many natural regularities actually *do* have deeper explanations, on Naturalism. For any natural regularity you choose – even laws that *appear* to be fundamental, on Naturalism – it is in principle possible to find a further explanation of this law, perhaps in terms of deeper laws, or perhaps by abandoning Naturalism and appealing to supernatural entities. So, for any natural regularity you choose, deeper explanation is at least *possible*, on Naturalism. And, *ceteris paribus*, deeper explanation is better.

We'll discuss this more below, but for now let's grant that, at least *prima facie*, regularities call out for explanation. If a regularity like R has no further explanation, then R is what we'll call 'brute'. It's not merely that we don't *know* what the explanation is; on this possibility, there literally is no explanation to be had for R. If, on the other hand, R has some further explanation, then there are three possible options.

The first option is that this regularity R has some further explanation, and this chain of further explanation eventually terminates. Perhaps the explanation of R is a scientific explanation – a derivation of R in terms of other, more fundamental natural regularities – and this process of further scientific explanation eventually terminates.[20] Or perhaps non-scientific explanation is involved, for example in terms of God. In any event, on this possibility, the chain of explanation eventually ends. Let's call this 'Explanatory Foundationalism', or 'Foundationalism' for short. Another possibility is that this process of further explanation continues forever, without repeating. We'll call this 'Explanatory Infinitism', or 'Infinitism' for short. A final possibility is that this process of further explanation continues forever, but by looping back on itself, as it were, perhaps to include the original regularity, R. We'll call this 'Explanatory Coherentism', or 'Coherentism' for short.

Within Foundationalism, there are two possibilities. When the chain of scientific explanation of our natural regularity R terminates, the final scientific explanation features a final regularity – call it 'R_f' – that has no further *scientific* explanation. But we might ask whether this final natural regularity R_f – the natural regularity that must feature in the final scientific explanation of R, according to premise 1 – has *any* further explanation at all. Such an explanation of R_f might take the form of an Aristotelian 'final cause', in terms of the good, or perhaps a personal explanation in the tradition of Plato's *dēmiourgos*, from the *Timaeus*, the Divine Craftsman, the 'maker and father of the universe' (*Timaeus* 28c, Cooper (1997), 1235). That is, following Aristotle, we may immediately explain R_f in terms of the good, as the *Primum Mobile* moves for love of the Prime Mover, itself the ultimate good. Or, following Plato, we may explain R_f in terms of the plans and intentions of a Divine Craftsman, which are then, ultimately, explained in terms of the good.[21] So that's one possibility, on Foundationalism: the final scientific explanation of our regularity, R, has no further scientific explanation, but the natural regularity featuring in that final scientific explanation of R – R_f – has a further explanation nonetheless. As this explanation is ultimately teleological, we'll call this option 'Teleological Foundationalism'.[22]

The alternative is that, though R begins a chain of further scientific explanation, the chain eventually terminates with a final scientific explanation, and this final scientific

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explanation of R has no further explanation at all. And this would be true even though, *qua* scientific explanation, this final scientific explanation features another regularity R_f, which *prima facie* calls out for further explanation, as we've said. Nonetheless, this regularity R_f featuring in the final scientific explanation of R is genuinely brute, on this alternative. We'll call this alternative 'Brute Foundationalism'. I propose that we also include under this banner the option on which our regularity R has no further explanation at all, and is *itself* genuinely brute. R is itself R_f, the foundation, on this option, and therefore is the limit case of Brute Foundationalism. However, if we need a name for it, we might call it 'Simple Brute Foundationalism', as opposed to 'Extended Brute Foundationalism', on which our regularity R has further scientific explanations until we hit the foundational scientific explanation, featuring a distinct, final brute regularity R_f.

The space of possibilities, therefore, looks something like this, where arrows represent the (putative) explanation relation (Figure 1):[23]

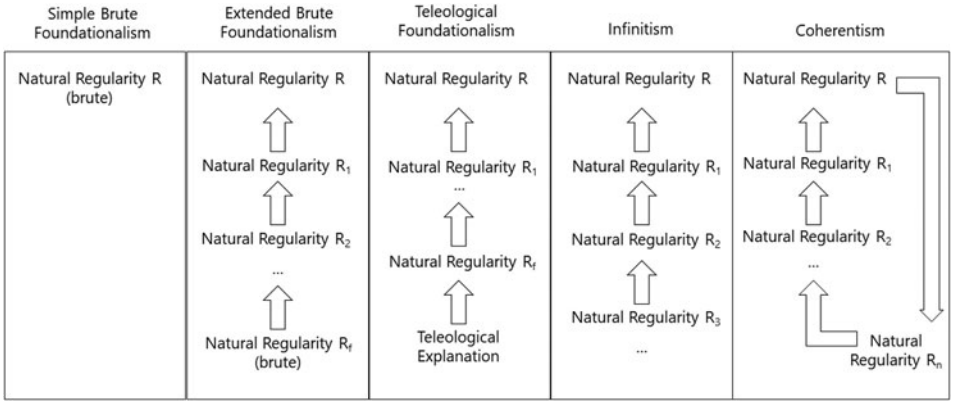

Figure 1. Possible structures of explanation for natural regularities.

So it looks as though we're in a position to affirm that, if Naturalism is true, the pattern of any putative explanation for any natural regularity must end with something brute, or go on forever, or involve a loop. The only option left out in the consequent here is Teleological Foundationalism. So the claim is that Naturalism is consistent with any pattern of putative explanation for natural regularities, except Teleological Foundationalism. Why think that's true?

Well, we've defined Naturalism as a positive attitude toward the sciences, together with – on the propositional side – a somewhat vague association of the austere metaphysics of, for example, Quine and Armstrong, and a broadly empiricist epistemology.[24] Naturalists, as Plantinga put it, don't believe in God, or anything at all *like* God. Though Naturalism is vague, it clearly seems to rule out a Platonic view on which a Divine Craftsman (very much like God) not only exists, but figures into the explanation of natural regularities. Plantinga also thought it ruled out Aristotle's Prime Mover, the non-physical *Noûs* that lies beneath and explains the physical world, and this seems right to me.[25] Naturalism also finds it hard to square *knowledge* of these sorts of teleological explanations with empiricism, and the widely alleged banishment of final causes during the Scientific Revolution attests to this. If that's right, then Teleological Foundationalism – either of the Aristotelian or the Platonic variety – is not available for the Naturalist. This leaves, then, either Simple Brute Foundationalism, Extended Brute Foundationalism, Infinitism, or Coherentism. When it comes to explaining natural regularities, those patterns are the only possibilities available to the Naturalist.

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Natural regularities call out for explanation, yet cannot explain themselves

Let's think about Brute Foundationalism, either of the Simple or Extended variety. Both patterns feature natural regularities with no further explanation. Would this be acceptable? Or do natural regularities call out for further explanation, being unable to explain themselves? To answer this, we can divide theories of laws of nature – or natural regularities in general – into two broad categories. On a Humean view, so-called 'laws of nature' simply are patterns of constant conjunction, patterns of spatio-temporal succession, and there's nothing beyond these patterns that lies behind and explains them. On this view, as Maudlin (2007, 172) put it, 'the laws are nothing but generic features of the Humean Mosaic'. And these regularities are somewhat paradoxical, on the Humean view: very familiar, and yet immediately mysterious. Scratch the surface of any commonly observed pattern in nature, which constitutes a law, on this view, and you'll find no explanation – not because of any limitation on your part, but because there literally is no explanation for these laws.[26] Yet these laws call out for explanation: why are they this way, rather than some other way?[27] At least, Aristotle thought so, and you might as well.[28]

On Non-Humean views, by contrast, there *is* something that lies behind and explains the patterns of constant conjunction that Hume noticed, and these – not the patterns themselves – are what are properly called 'laws of nature'. On some Non-Humean views, laws of nature are analysable; on other non-Humean views, they are un-analysable. Perhaps the most prominent theory on which laws of nature are analysable comes from Armstrong (1983), Dretske (1977), and Tooley (1977). On this view, laws of nature are analysable in terms of nomic necessitation relations between universals. Yet this necessity is merely 'nomic', not metaphysical or logical. As to why the actual nomic necessitation relations hold between universals rather than other relations, no answer is given – at least, not by the Naturalist. These relations could have been different, and yet they aren't. So, on this view, one can see that laws of nature – understood as contingent nomic necessitation relations between universals – are mysterious. These relations may seem apt to help explain the natural regularities that we observe, yet these relations do not explain themselves, even though they seem to be the sort of things that could have an explanation, and indeed call for one.

On another Non-Humean view (e.g. Harré & Madden, 1975), laws of nature are analysable in terms of substances' causal powers, and liabilities to exercise those powers under certain conditions.[29] As Swinburne (2010, 217) puts it, 'That heated copper expands is a law is just a matter of every piece of copper having the causal power to expand, and the liability to exercise that power when heated.' For our purposes it is important to note, as Swinburne (*ibid.*) continues, 'As a matter of contingent fact substances fall into kinds, such that all objects of the same kind have the same powers and liabilities.' So, on this type of view, laws of nature are analysed in terms of the powers and liabilities of substances. But, either it's a contingent fact that each substance-type has the powers and liabilities that it does, or, if each substance-type has those powers and liabilities essentially, it's a contingent fact that our universe has *those* substance-types rather than others, and it's a contingent fact that any particular object is the type of substance that it is. In other words, to take a particular example, either *heated copper expands* is a contingent truth, since copper could have had different powers and liabilities, or *heated copper expands* is a necessary truth about copper, yet it's a contingent fact that *heated copper expands* is true of anything our universe, let alone this particular object before me. (Though it may be necessary that copper expands when heated, it's contingent that this object be copper, and this fact calls out for explanation.) Either way, laws of nature would, on this view, call out for further explanation: either, 'Why is copper this way rather than some other way?' or 'Why do laws about copper describe anything in our

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universe, rather than laws about schmopper, which is just like copper but with different powers and liabilities?'[30] Likewise with the powers and liabilities in terms of which the laws are analysed or explained: they do not explain themselves, and indeed they call out for further explanation.

On a third Non-Humean view (cf. Maudlin, 2007), laws of nature lie behind and explain the patterns of spatio-temporal succession that we observe in nature, and yet these laws are not analysable in any deeper terms. They are primitive. The laws are mysterious 'frozen accidents', to use Davies's (2013) evocative expression: constant through time and space, but metaphysically contingent, with no deeper analysis or explanation. They could have been different, and *perhaps* they even were different at some time in the past. Again, on this view, the laws of nature are posited to help explain the natural regularities that we observe, and yet the laws of nature do not explain themselves. They call out for explanation, but have none.

I think we are now in a position to affirm that natural regularities call out for explanation, and yet no natural regularity can explain itself. This is true of any *bona fide* fundamental law of nature, and *a fortiori* true of any principle or regularity of the special sciences. It follows, then, that any natural regularity with no *further* explanation is left *unexplained*, and this is a deficiency. The natural regularity calls out for explanation, and cannot explain itself. This will apply, on Simple and Extended Brute Foundationalism, to that final link in the chain of explanations for any natural regularity. For Simple Brute Foundationalism, there's only one link in the chain, and so it follows that, on this pattern, the natural regularity in question calls out for explanation, and yet is unexplained. But let's see if Extended Brute Foundationalism fares any better. Could a natural regularity be explained by an extended chain of explanations in terms of more fundamental natural regularities, if this chain eventually terminates in something brute?

Extended Brute Foundationalism

As we've said, for any scientific explanation you choose, there will feature some natural regularity – call it 'R'. On Extended Brute Foundationalism, R will call out for explanation, and yet will not explain itself (as we've shown above), but instead will have some deeper scientific explanation, featuring some further natural regularity R_1. This pattern continues until we hit some final, fundamental explanation, featuring some natural regularity R_f. On Extended Brute Foundationalism, R_f is brute; it has no further explanation, and, as we argued in the last section, it cannot explain itself. Now, the question before us is: could R be successfully explained by a pattern like this?

Before answering that question, let me just quickly say that I believe many Naturalists subscribe to scientific explanation in the pattern of Brute Foundationalism, either of the Simple or Extended variety, depending on the regularity. Here's Carroll's (2012, 193) impression of the state of the field: 'Granted, it is always nice to be able to provide reasons why something is the case. Most scientists, however, suspect that the search for ultimate explanations eventually terminates in some final theory of the world, along with the phrase "and that's just how it is".'[31]

The alternative to Brute Foundationalism, for the Naturalist, is that there are no fundamental laws of nature: either there are ever more fundamental laws, but no bottom, or the laws circle back on themselves in a loop of explanation. We'll look at reasons against Infinitism and Coherentism below. For now, let's just say that many Naturalists accept Brute Foundationalism, perhaps because they believe that there are some truly fundamental physical particles, and, so, the laws governing them will also be truly fundamental, with no further explanation.[32] In a classic work on this question, Oppenheim and Putnam (1958, 9) place a finitude of levels as one of the 'conditions of adequacy' of any

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proposal to unify the sciences via reduction. They appeal to theoretical virtues (*ibid.*, 12ff.) when commending their layered model of the sciences, with elementary particles as the fundamental level, just beneath atoms, which are just beneath molecules, and so on through cells and living things.[33]

So, as I say, many Naturalists seem to think of scientific explanation – in particular, the explanatory status of natural regularities that feature therein – along the lines of Brute Foundationalism. Simple Brute Foundationalism for the fundamental laws, Extended Brute Foundationalism for every other natural regularity.

Now, the main question of this section is: on Extended Brute Foundationalism, would any natural regularity R featuring in some scientific explanation be explained? On this view, R is meant to have some further explanation in terms of a deeper regularity R_1, and so on to some fundamental natural regularity R_f, and R_f is truly brute, truly unexplained. I believe we can work backwards, as it were, to see that, on this pattern, R would not be explained. For consider a case with three steps, where R is meant to be explained in terms of R_1, and R_1 in terms of R_2, and R_2 in terms of a final, fundamental natural regularity, R_f. Focus on the last step, where R_f is posited to explain the immediately prior natural regularity R_2. And now recall premise 2, according to which any explanation can be successful only if it crucially involves no element that calls out for explanation but lacks one. Premise 2 entails that, since R_f calls out for explanation but lacks one, and R_f figures crucially in the purported explanation of R_2, this purported explanation of R_2 fails. R_2, it turns out, calls out for explanation, and yet is unexplained (by itself, or by R_f). This argument extends, of course, to R_1, and then further to R itself.

In the end, we conclude that, on Extended Brute Foundationalism, R calls out for explanation, and yet is unexplained. The putative deeper explanations merely offered promissory notes, and the bruteness of R_f means these promissory notes cannot be redeemed. The mystery of the original regularity R is only amplified by these further putative explanations, not diminished, just as we saw with the example above involving a turtle supporting the Earth. So much, then, for explanation of natural regularities in the pattern of Extended Brute Foundationalism.

Infinitism

Let's turn now to Infinitism. Start again with any scientific explanation, which, we've argued, must involve some natural regularity, R. According to Infinitism, R will not explain itself, but instead will have some deeper scientific explanation, featuring some further natural regularity R_1. This pattern continues forever. According to Infinitism, every natural regularity has an explanation in terms of a deeper regularity, and there is no final, fundamental regularity. Now, the question before us is: could R be successfully explained by a pattern like this?

Schaffer (2003) gives a spirited defence of 'infinite descent', that is, the idea that there is no fundamental level of reality, at least not one comprised of physical *atoms*, though his final position seems to be agnosticism (*ibid.*, 505–6).[34] Schaffer (2003, 499–500; 2007, 183–184) and Block (2003, 138) cite various scientists expressing support for the possibility of infinite descent, which also counts for something. And Leibniz seems to have actually endorsed the idea, which perhaps counts for more.[35]

Now, we saw above some reasons from Hempel, Oppenheim, and Cameron to think that there *is* a fundamental level, and, so, the process of scientific explanation *does* not go on forever. These reasons had to do with the theoretical virtues of this view as compared to Infinitism. Cameron (2008, 12) reports the intuition against infinitely descending chains of dependence, and denies that this intuition 'can be justified by any more basic

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metaphysical principle'. Schaffer (2010, 62) does perhaps a bit more, saying that, if endless dependence were true, '[b]eing would be infinitely deferred, never achieved'.

But our question is whether any natural regularity could be explained according to the pattern we call Infinitism. We're not presently concerned with whether there is a fundamental level of physical reality, or even metaphysical dependence. We're wondering, at least with respect to natural regularities, whether there could be an infinite descent of *scientific explanation*, in terms of ever more basic regularities. There are intuitions in this case analogous to those expressed by Cameron and Schaffer. And I myself am a big fan of intuition.[36] But I think we can go further and give good reason to think that Infinitism is impossible, and not merely theoretically vicious in some way. Explanation of natural regularities simply cannot work the way that Infinitism alleges.

One reason to think so borrows from Kim's (1998) and Block's (2003) thoughts on 'causal drainage'. Kim (*ibid.*, 81) worries that, if there is no bottom level of physics, his famous Causal Exclusion Argument entails that 'causal powers would drain away into a bottomless pit and there wouldn't be any causation *anywhere*'. Block agrees there is a tension here, putting it this way:

> If there is no bottom level, and if every (putatively) causally efficacious property is supervenient on a lower 'level' property . . ., then (arguably) Kim's Causal Exclusion Argument would show, if it is valid, that any claim to causal efficacy of properties is undermined by a claim of a lower level, and thus that there is no causation. (*ibid.*, 138)

Now, Block (*ibid.*, 139) goes on conclude that Kim's Causal Exclusion Argument must be invalid, on the grounds that 'It is an open question whether there is or is not a bottom level, but it is not an open question whether there is any causation.' And his reason for thinking that it is an open question whether there is or is not a bottom level is that it is considered to be an open question by at least several prominent physicists (*ibid.*, 138).

With all due respect to those several prominent physicists and their opinions on philosophical questions outside their area of expertise, may I suggest that Block's solution to this tension is not the only one available, or even the most plausible? Another possibility is that Kim's Causal Exclusion Argument is in fact valid, and it does show that, if there is no bottom level of physics, then there would be no causation anywhere, and yet, since there is obviously causation, there must be a bottom level of physics. The fact that physicists have an open mind on this metaphysical question is certainly not conclusive evidence that any argument to the contrary *must* be invalid. But let me translate these thoughts about causal drainage into terms relevant for our discussion of natural regularities and explanation.

I propose that we modify Kim's Causal Exclusion Argument for our current purposes, and call the result 'the Explanatory Exclusion Argument against Infinitism'. As we've shown, in any case of a purported scientific explanation, some natural phenomenon, P, is explained in part by some natural regularity or other, R. For simplicity of illustration, let's assume a basic version of the Deductive-Nomological Model of scientific explanation is correct, and R together with some initial conditions are what explain P. Now, if Infinitism is true, then R has a further explanation. It is derivable from one or more deeper, more fundamental natural regularities. Call that natural regularity 'R_1' (or, if there be more than one, conjoin them and call the conjunction 'R_1'). R_1, in turn, will have a deeper explanation in terms of a more fundamental natural regularity R_2, and so on, forever, with no repetition. Using arrows to represent the (putative) explanation relation, things look like this (Figure 2):

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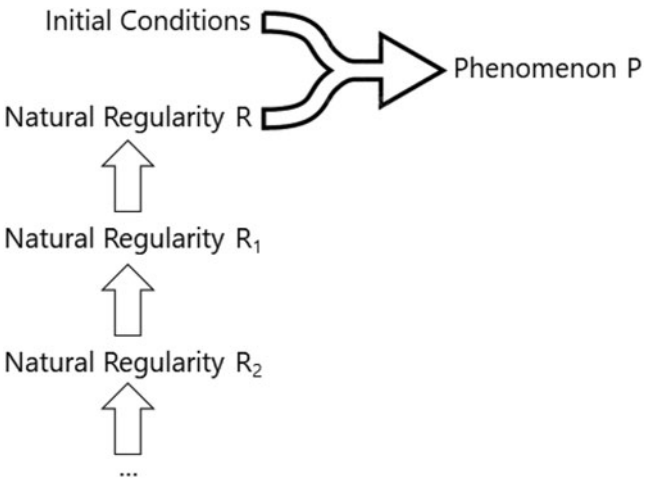

Figure 2. The structure of a scientific explanation of a phenomenon, according to Infinitism.

Let's adapt Block's worry to the case at hand. We'll start with the phenomenon P, but we'll extend the reasoning to R. If P is as it is (partly) because of R, and R is as it is because of R_1, then it looks as though R's claim to (partly) explain P is undermined by a lower level, namely by R_1 – R's explanatory role 'drains away' to R_1. *Really*, it's R_1 that, together with the initial conditions, explains P.[37] To take a simple example, suppose we wonder why it's frequently raining, and we're given, in reply, Aristotle's folk regularity that it rains frequently in winter, along with the reminder that it's currently winter. A satisfying explanation, at least for common purposes. But, this folk regularity is amenable to deeper explanation in terms of the principles of contemporary meteorology, the angle of Earth's axis relative to the sun, the angle of incidence of the sun's rays to our location during our winter, and so on. And, so, it looks as though *these* principles (conjoined into a large R_1), together with the initial conditions, are the *real* explanation of why it's frequently raining. Insofar as there's an explanation here, it's R_1 rather than R that does the explanatory work.

So it goes with the phenomenon P. Yet our question concerned R. Could R be explained by an infinitely descending chain of more fundamental regularities? The same line of reasoning from the previous paragraph applies here. If, on this view, the principles of contemporary meteorology that we're calling 'R_1' are explained by even more fundamental natural regularities (call them 'R_2'), ideally *bona fide* physical laws of nature, then it seems like *those* deeper regularities are the real explanation of R, not the 'higher level' R_1 regularities of contemporary meteorology. Indeed, you might think the purpose and glory of science is to uncover deeper, 'more real' explanations of natural phenomena, in terms of increasingly more fundamental natural regularities.

So, since R_2 is a deeper, 'more real' explanation of R than is R_1, R_2 has a better claim to be the true explanation of R. And perhaps now one can see the problem for Infinitism loom into view. If Infinitism is true, every claim of a natural regularity, like R_1, to serve as the explanation of a higher-level natural regularity, like R, is undermined by the claim of a deeper natural regularity, like R_2, which looks to have a better claim to explain R than does R_1. But since, on Infinitism, this undermining goes on forever, we never reach a real, or true, explanation of R. It's turtles all the way down, and a vicious regress: infinite pre-emption, and no explanation. For any regularity you choose as a potential explanation of R, that regularity cannot be the true explanation, since a deeper regularity has a better claim to be R's explanation. Explanation 'drains away', on this view,

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down a bottomless pit. In that case, on Infinitism, no natural regularity explains itself (as we've shown), and no natural regularity is explained by an infinite non-repeating regress of natural regularities. On Infinitism, R calls out for explanation, and yet is not explained by itself, nor by any deeper natural regularity, nor by anything at all.[38]

Coherentism

If the Explanatory Drainage Argument of the previous section works against Infinitism, it can be redeployed in a straightforward way against Coherentism. On Coherentism, our natural regularity R has a further explanation, and indeed the chain of explanation goes on forever, but in virtue of it looping back upon itself at some point. If the loop includes R itself, the situation would look like this, again with arrows representing the (putative) explanation relation (Figure 3):

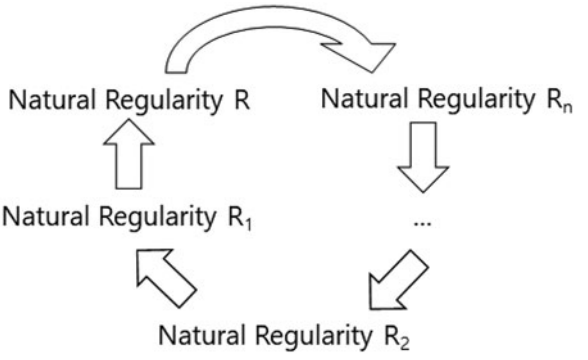

Figure 3. The structure of explanation of a natural regularity R, on Coherentism.

Yet if, as we said before, R_1's claim to explain R is undermined by R_2, then this will continue back through the loop. As with Infinitism, this means that the undermining goes on forever, and we never reach any real, or true, explanation of R. (Indeed, if we did, and if R is itself included in the loop, then R would have as much of a claim to explain itself as any other regularity in the loop would, which is absurd.[39]) I conclude, then, that, on Coherentism, no natural regularity explains itself (as we've shown), and no natural regularity is explained by an infinite repeating loop of natural regularities.

The final step

Given the foregoing arguments, we're now in a position to affirm premise 4 of our Main Argument: *If Naturalism is true, then every natural regularity calls out for explanation but lacks one*. On any theory of the laws of nature, they call out for explanation: any natural regularity, however fundamental it seems, could in principle have a deeper explanation, and deeper explanation is better. And, for Naturalism, on any possible pattern of explanation for any natural regularity R, R has no explanation. It's either brute (Simple Brute Foundationalism), or it stands in relations to further regularities in the pattern of Extended Brute Foundationalism, Infinitism, or Coherentism. Yet on none of these patterns can these further regularities successfully explain R.

The final inference in our Main Argument combines this premise 4 with our earlier observations concerning the success conditions for any scientific explanation, in particular the condition that a successful scientific explanation must crucially involve a natural regularity, and yet crucially involve no element that calls out for explanation while having

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none. Since we now know that, on Naturalism, every natural regularity calls out for explanation but lacks one, we can safely conclude that, on Naturalism, any attempt at scientific explanation fails. That's an interesting result in itself, but especially in light of the enthusiastic attitude towards science that's characteristic of Naturalists, along with their propensity to offer the success of science as reason in favour of Naturalism. If the arguments of this article are sound, then, on the contrary, the remarkable success of science entails that Naturalism is false.

Conclusion

In this article, I've defended the following argument: scientific explanations must involve natural regularities. But no explanation can succeed if it involves an element that calls out for explanation but lacks one. So, a scientific explanation can succeed only if it involves a natural regularity, and this doesn't call out for explanation while lacking one. Yet, on naturalism, every natural regularity calls out for explanation but lacks one. So, if Naturalism is true, then no scientific explanation can be successful. As you might expect, I invite you to run a modus tollens on that conclusion. At least some scientific explanations succeed, obviously. So, it follows that Naturalism is false.

One question lingers: how *is* scientific explanation possible? How can natural regularities be explained? We've cast doubt upon Brute Foundationalism, both Simple and Extended, as well as Infinitism and Coherentism. The only remaining option we've discussed is Teleological Foundationalism. But how does this account fare better than its rivals?

On Teleological Foundationalism, when the chain of *scientific* explanation of our natural regularity R terminates – which may be immediately, with R itself – the final scientific explanation features a final regularity – call it 'R_f'. R_f has no further *scientific* explanation, but it does have an explanation, perhaps in the form of an Aristotelian 'final cause', in terms of the good, or perhaps a personal explanation in the tradition of Plato's *dēmiourgos*. Even on the latter option, natural regularities are explained, ultimately, in terms of the good. Paraphrasing Socrates from the *Phaedo*, if one wishes to know the cause of any thing, why it comes to be or perishes or exists, one has to find what was the best way for it to be. Or, if there be no single *best* way, at least a *good* way.[40]

Explanations therefore, on this view, terminate with necessary truths about the good. If such truths are discoverable by reason, and reason teaches us that these truths do not stand in need of further explanation (either because they're obvious in themselves and so need no further explanation, or, if you prefer, because they explain themselves), then Teleological Foundationalism does not succumb to the same worries that beset the other possible patterns of explanation.[41] This bears repeating: on Teleological Foundationalism of a Platonic or Aristotelian variety, scientific explanation ultimately rests on foundations that do not call out for explanation. The foundations – necessary truths about the good – are either obvious or self-explanatory. Either way, they do not call out for further explanation. And, so, these necessary moral facts provide a satisfactory stopping point for the scientific enterprise. If you weren't antecedently inclined towards this view of moral facts, perhaps the dim prospects of the alternatives will invite you to take another look at this charming view.

You may have doubts about the possibility of a necessary truth explaining contingent facts. How could a truth of the form *it is good for such and such to be* explain the fact that such and such is the case? The Aristotelian answer comes quite close to animating the universe, in the literal, etymological sense of 'animate' – the *Primum Mobile* moves *for love of* the Prime Mover. I admit that this form of Teleological Foundationalism is less clear to me than a broadly Platonic version, on which, to paraphrase Socrates again, 'it

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is Mind that directs and is the cause of everything'. For notice that, when it comes to so-called 'personal' explanations, which are as familiar and common as the air we breathe, it seems perfectly satisfactory to end an explanation with a necessary truth about the good. For example, I wrote this article in order to better know important truths, and I aim to know important truths because it's good to do so. If, at the bottom of everything, reality is teleological, intentional, goal-oriented, then we should not be surprised to find a similar pattern of explanation underlying all natural phenomena. I believe that Aristotle and Plato were right: this is indeed what we do find. Without it, scientific explanation is impossible.

Notes

1. Here's one: does Aristotle in fact think rain falls for some end, e.g. for the good of the crops? Some say no, others say yes. Proponents of the non-teleological-rain interpretation include Ross (1936), Charlton (1970, 120–123), Nussbaum (1978, 94), Balme (1987), Gotthelf (1987), Irwin (1988, 102–107), and Judson (2005, 345–348). Proponents of the teleological-rain interpretation include Cooper (1982), Furley (1985, 179–181), Sedley (1991; 2007), Wardy (1993), Code (1997), Scharle (2008), and Leunissen (2010).

I agree with those who say that, for Aristotle, rain falls for some end, at least during the winter. Indeed, Aristotle seems clearly to say as much in the last two sentences, especially when he says that, 'all such things are by nature', where 'all such things' seems to include the winter rain. See also Aristotle's *On Parts of Animals* I 1 (641b10–23), where he says 'nature does everything for a purpose'. Quoted and translated by Sedley (2007, 194). And see Sedley (*ibid.*, 194–202) for more evidence of Aristotle's cosmic teleology.

2. For discussion, see Leunissen (2010, 29ff.) and Charlton (1970, 120).

3. See also Sedley (2007, 191): 'Aristotle's conviction that what is merely fortuitous cannot be the basis of regularity owes more to his deep teleological convictions than to any technical argument about the true meaning of the terms "luck" and "fortuitous".'

4. Though see Scharle (2008, 169) for a theory about what the end of rainfall really is, on Aristotle's view. Basically, for Aristotle, rainfall is explained in terms of the end of *water*, which end is water's 'natural place', and the cyclical movement of water imitates the Prime Mover to the highest degree possible for water. This cyclical movement is the highest perfection of the nature of water. So, to borrow C. S. Lewis' charming way of putting things (see below), it's perhaps not too far of a stretch to say that, for Aristotle, water falls on the Earth for love of the Prime Mover.

5. In dismissing the teleological argument, physicist Alan Guth (Pararajasingham, 2017) expresses the situation this way, in passing: 'I'll freely admit I have no idea why the laws of physics are what they are, and I also have no idea how to go about approaching that question. But to me just saying that there was a designer doesn't seem to help at all.' I suspect he says he has no idea how to approach that question, because he was assuming that he would have to approach it as a Naturalist, and it's hard to see how a Naturalist could give a scientific explanation – featuring a law, generalization, or regularity – for a *truly fundamental* law of nature. Aristotle would be pleased with Guth's concession here.

6. In the Aristotelian view, the universe is comprised of nested, moving, concentric spheres. The innermost sphere is moved by the next innermost, and so on, until one reaches the final, outermost sphere, the *Primum Mobile*, that which is moved first. And this *Primum Mobile* is moved by the *Primum Movens*, the Prime Mover. As Lewis says, this transfer of motion cannot be due to motion within the Prime Mover himself, since the Prime Mover is posited to end the chain of causation as an *unmoved* mover. Hence, Aristotle's proposed solution here: the *Primum Mobile* is moved by its love for the Prime Mover, its natural inclination to imitate the Prime Mover to the degree possible given its nature. Likewise for all natural things, even for the planets, the rain, and we ourselves.

7. Plantinga seems to think that Aristotle's Prime Mover is impersonal, and, therefore, it cannot really be God. But see note 25 below for evidence that Aristotle's Prime Mover is at least a thing that thinks.

8. Plausibly these views are often held together because they are congruous with each other, or even mutually supporting. But whether that's actually the case, we'll leave outside the scope of this article.

9. See e.g. Salmon's (1989, 47) flagpole/shadow example: 'a flagpole of a certain height causes a shadow of a given length and thereby explains the length of the shadow'. And yet, 'the shadow does not cause the flagpole and consequently cannot explain its height', even if one could construct a derivation that would seem to count as a successful explanation on the Deductive-Nomological Model.

10. See Salmon's (1971, 34) example of a male who takes birth control pills and fails to get pregnant. Though a derivation citing this exceptionless universal generalization – males who take birth control pills do not get pregnant – may seem to have the structure of a successful explanation according to the Deductive-Nomological

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Model, the birth control pills are irrelevant and therefore should not, you might think, feature in a successful explanation of why this male fails to get pregnant. Salmon (1971) proposes a Statistical Relevance model to try to pin down the notion of explanatory relevance as, in a nutshell, probability-raising. Salmon (1984) supplants this with a Causal Mechanical Model, in an attempt to capture notions of causation missing in mere probability-raising, refined further in Salmon (1994, 1997). For our purposes, it is important to note that neither proposal challenges the role of natural regularities in the structure of scientific explanation.

11. Notable attempts include Wesley Salmon's (1971) Statistical Relevance Model, Salmon's (1984) Causal Mechanical Model, Salmon's (1994) Conserved Quantity Theory of Causation, Kitcher's (1989) Unificationist Account of Explanation, and Michael Streven's Kairetic Account of Explanation. For Kitcher, the laws will be expressed as generalizations by at least some 'schematic sentences' in a completed scientific theory, or 'patterns of derivation' in successful scientific explanations. For Strevens, the laws will be preserved among the *explanans* of a successful scientific explanation after the process of abstracting away all superfluous information in the *explanans.* Here's how Lange (2018, 192) puts Strevens' view:

> In the simplest case, Strevens says, an explanandum arises from various causes, laws, and conditions that logically entail it through a deductive argument that 'mirrors' the causal process that produces it. An explanandum can have many such 'causal models,' and when a model is optimally pruned, according to Strevens, it is transformed into an explanation. Strevens" basic rationale for excising part of a model is that without it, the model still manages to entail the explanandum.

12. Similarly with 'pragmatic' theories of explanation (see e.g. van Fraassen, 1980; Achinstein 1983), which are at least neutral on the question of whether laws are necessary for successful explanation. These theories may even require laws – or at least generalizations – to appear in scientific explanation, given that psychological experiments seem to indicate that people are more satisfied with explanations that cite stable relationships (cf. Lombrozo, 2010) and appeal to descriptions that maximize expectation of the *explanandum* on the *explanans* (cf. Lien & Cheng, 2000).

13. Mendel's law states that, for diploid organisms, the process of meiosis results in gametes, each of which contains one copy of each gene from the parent cell, segregated at random.

14. But what if the theory is not intended to explain the relevant phenomenon? Could it really be a deficiency of a theory that it doesn't do what it was never intended to do? For example, is it really a deficiency of the theory of evolution that it fails to explain the movement of quarks? Well, *yes*, I would say that it is. And you can see that by considering how the theory of evolution would be stronger, better, if – somehow! – the theory were also to explain the movement of quarks.

15. By 'but lacks one', I don't mean merely that we don't *know* what the explanation for this element would be, or that it's not *available* to us, or some such constraint on our epistemic access to an explanation. I mean that there is literally no explanation to be had. To see the difference, consider Collins' (1998) case of finding a biosphere on Mars. (Plantinga (2007) presents a similar case involving finding tractor-like machines on an alien planet.) We may be perfectly satisfied with an explanation of this biosphere in terms of heretofore unknown intelligent extraterrestrial life, even if we are *not given* further explanation of those beings (yet we're free to assume that there would be). Fair enough. But if these beings are offered as an explanation of the biosphere, yet it's *given* that there's *no* further explanation of these beings, then, I think, things are rather different, and the explanation fails. The proposed explanation only *increases* the mystery involved in finding this biosphere, by appending these unexplainable aliens to the story. It's like this true story: when my daughter was much younger, she sneezed. Like a good father, I said, 'God bless you.' It was the first time she'd heard that, so naturally she wondered why I said it. Without much reflection, I answered, 'Oh, people always say that when someone sneezes.' A natural regularity, a *Sneeze Law*. Far from diminishing the mystery in her mind, her eyes got wider: 'But why do people *always* say *that*?' Of course, further explanation of the Sneeze Law can in fact be given. But if it had been true that the Sneeze Law is brute, admitting of no further explanation, that regularity would not have helped my daughter understand my statement. Indeed, it would only have vastly increased the mystery.

16. Notice that this principle – our second premise in the Main Argument – does not entail anything closely resembling a Principle of Sufficient Reason, namely any principle that says, roughly, that any contingent fact *must have* a cause, reason, or explanation. For it's consistent with our second premise that explanations commonly, even always, fail. If we lived in a world in which any proposed explanation crucially involved some element that called out for explanation but lacked one, the right thing to conclude, I would say, is that we live in a world in which, ultimately, nothing could be explained. We would live in a deeply and irredeemably mysterious world. As unsavory as that sounds, it is possible. In fact, I will argue, a committed Naturalist must accept that we actually inhabit such a deeply and irredeemably mysterious world, a world impervious to scientific investigation.

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17. In this section, I discover that I'm repeating (though, I hope, further developing and defending) an idea expressed by Feser (2014, 160–161), who agrees that,

> it is no good to say: 'The operation of law of nature C is explained by the operation of law of nature B, and the operation of B by the operation of law of nature A, but the operation of A has no explanation whatsoever and is just an unintelligible brute fact'. The appearance of having 'explained' C and B seems completely illusory if A is a brute fact, because if there is neither anything about A itself that can explain A's own operation nor anything beyond A that can explain it, then A has nothing to impart to B or C that could possibly explain their operation.

Feser's thought here is certainly provocative, and I attempt here to provide further argument and mapping of the territory.

18. Objection: Suppose a full-grown, pregnant mare appears before you, from nothing, with literally no explanation. The mare foals a colt. Surely, you can successfully explain the origin of the colt in terms of the pregnant mare, even if the pregnant mare herself has no explanation, yet calls out for one. This is a counterexample to premise 2. Or suppose a meal appears before you, from nothing, with no explanation. You eat it, satisfying your hunger. Surely, you can now successfully explain your satiety by reference to the meal you ate, even if that meal itself has no explanation, yet calls out for one. This is another counterexample. Response: I deny that I would have a successful explanation of the colt or of the satiety. Recall the link between explanation and understanding. A successful explanation can produce in us understanding of the phenomenon, an understanding of why or how it's happening. But if there's part of a proposed explanation that *cannot* be understood, because it's brute – how can it produce in us understanding of why or how the phenomenon is happening? Yet if it cannot produce in us that understanding, then it isn't a successful explanation. In each of these cases, there is a part of the proposed explanation that cannot be understood – in the first, the mare, in the second, the meal – and, so, in neither case do we have a successful explanation. To put it another way, to understand why (or how) is to understand an acceptable answer to the relevant 'Why?' (or 'How?') question. But if part of that answer is unintelligible, unable to be understood, totally mysterious, then one cannot understand the answer. And, in that case, one cannot understand why (or how) the phenomenon is happening. But, if so, then these answers cannot be successful explanations. In that case, they are not counterexamples to premise 2, despite appearances.

But why do they *appear* to be counterexamples? I believe these cases are attractive because they feature *explanans* that are of types with which we're very familiar, and we're tempted to assimilate these cases to our background knowledge and experience of similar cases. We're familiar with eating, and we're familiar with birth. In ordinary cases of explanation – including cases of eating, and cases of birth – we tend to cut short our explanations, with an implicit 'and so on' clause. Why am I at this very moment satiated? I just ate quinoa and salmon. It's presupposed, in the vast majority of conversational contexts, that such a meal would have an ordinary provenance, and so, for convenience and efficiency, the explicit explanation ends there. 'And so on, in an ordinary way', we tacitly assume. My suggestion is that we mistakenly carry this habit with us when considering the proposed cases above. When we hear the colt came from the mare, we're inclined to think this is a sufficient explanation, because in ordinary cases, where ordinary presuppositions are met, it would be. Ordinarily, we could perfectly well understand a pregnant mare, or a meal on a table before us. But these are not ordinary cases. They feature *explanans* that are brute, that literally have no explanation, and that, therefore, cannot be understood. These unintelligible *explanans* create, as it were, mysterious gaps, or holes, in their respective proposed explanations, gaps that our minds are disposed to fill in so as to resemble ordinary cases, just as our minds fill in the blind spots in our visual fields, created by our optic nerves. But make this unintelligibility more explicit, more salient, and the temptation to think we have a successful explanation diminishes. For example, a high-velocity brick appears out of nowhere, for no reason, and flies through a window: do we really understand why the window is broken? I don't think so. A falling domino materializes from nowhere, for no reason, and knocks over a second domino. Do we really understand why that second domino fell? Again, I don't think so. A world where things like this happened regularly would be a mysterious world, a regularly inexplicable world. But this is the sort of thing that is happening with the mare and the meal. And, so, as I said above, these are not cases of successful explanation, and therefore not counterexamples.

I am grateful to an audience at Thomas Aquinas College for raising the colt objection, particularly Blaise Blaine and John Baer, and also to an audience at the University of Georgia, particularly Jack Boczar, who raised the satiety objection.

19. Mendel's Law of Segregation is violated when there is 'meiotic drive' (see e.g. Charlesworth, 2013). The Second Law of Thermodynamics is violated in small systems at very short time scales (see e.g. Wang et al., 2002). The Ideal Gas Law is violated by actual, non-ideal gases, at low temperatures and high pressures.

20. There are cases, in science, of the laws of one field being explained or derived by or grounded in the laws of another field. (Strevens (2011, Part III) shows how his account handles explanations of statements of regularities,

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including laws.) For example, consider the derivation of the laws of thermodynamics by more fundamental postulates and principles of statistical mechanics. For a couple recent examples, see Swendsen (2017), as well as Masanes and Oppenheim (2017).

21. Here's how Timaeus (29d–30a, Cooper (1997), 1236) puts it early in his eponymous dialogue:

> Now why did he who framed this whole universe of becoming frame it? Let us state the reason why: He was good, and one who is good can never become jealous of anything. And so, being free of jealousy, he wanted everything to become as much like himself as was possible. In fact, men of wisdom will tell you (and you couldn't do better than to accept their claim) that this, more than anything else, was the most preeminent reason for the origin of the world's coming to be. The god wanted everything to be good and nothing to be bad so far as that was possible, and so he took over all that was visible – not at rest but in discordant and disorderly motion – and brought it from a state of disorder to one of order, because he believed that order was in every way better than disorder.

In the *Phaedo* (97c–d, Cooper (1997), 84), Socrates shares his attraction to a view like this:

> I heard someone reading, as he said, from a book of Anaxagoras, and saying that it is Mind that directs and is the cause of everything. I was delighted with this cause and it seemed to me good, in a way, that Mind should be the cause of all. I thought that if this were so, the directing Mind would direct everything and arrange each thing in the way that was best. If then one wished to know the cause of each thing, why it comes to be or perishes or exists, one had to find what was the best way for it to be, or to be acted upon, or to act.

Socrates (*Phaedo* 98c, *ibid.*, 85) goes on to express disappointment with the thought of Anaxagoras when he 'went on reading and saw that the man made no use of Mind, nor gave it any responsibility for the management of things, but mentioned as causes air and ether and water and many other strange things'.

22. The idea, on this view, is that whatever features in this final teleological explanation will have no further explanation, but also will not 'call out' for explanation the way natural regularities do. Either because it needs no explanation, or because it is self-explanatory.

23. N.B. the number of explanations in each pattern but Infinitism and Simple Brute Foundationalism may be as few as one. For Infinitism, there must be infinitely many explanations in the series. For Simple Brute Foundationalism, there is no further explanation of R. For Coherentism, the loop may include the original natural regularity, or it may not.

24. Some have made their peace with this vagueness. Others, like Williamson (2011), go so far as to say, 'I don't call myself a naturalist because I don't want to be implicated in equivocal dogma.'

25. According to Tredennick (1933, 149), in *Metaphysics* 1072b, Aristotle identifies the Prime Mover with pure thinking. Tredennick says, 'Since the prime mover is pure actuality, and has or rather is the highest form of life, Aristotle identifies it with the highest activity – pure thinking.' This seems very much like God. And, pretty clearly, far too much like God to be consistent with Naturalism.

26. Objection: According to David Lewis (1973, 73), a Humean about laws of nature, these laws *do* have a further explanation: what makes something a law is that it belongs to all the true deductive systems with a best combination of simplicity and strength. Reply: The fact that, *when this candidate law is featured as an axiom, my system is very simple and strong*, might teach us *that* a candidate law is indeed a law. But this fact comes too late to explain why it is indeed a law, or tell us why it's true. The fact Lewis points to may be evidence that the candidate law is a law, but it's not what *makes* it a law.

27. Hildebrand and Metcalf (forthcoming) put the point this way:

> Humeanism stipulates that the actuality of our world, as opposed to any other Humean world, is simply a brute fact. In denying that there are necessary connections between distinct existences, Humeanism commits itself to a recombination principle concerning particular matters of fact: any distribution of properties is possible. The result is an extremely large class of epistemically possible Humean worlds, the vast majority of which do not contain widespread and systematic regularities. Nothing in the Humean ontology suggests that we should assign a higher prior probability to some worlds (namely, the ones with regular property distributions) than others (namely, the irregular ones). Thus, P(R|H) [the probability of these regularities conditional on Humeanism] is extremely low, because regularities occur in only a miniscule proportion of Humean possible worlds.

28. Objection: Look, I *might* agree with Aristotle here, but also I *might not*. And you can't make me. Reply: Sure, I cannot make you, or any Naturalist, agree that laws of nature call out for explanation. The best I can say is that

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nobody is married to Naturalism, and reflecting on the extreme contingency of the laws of nature, together with the fact that some ('higher-order') laws of nature themselves have explanation, may lead one to cut ties with Naturalism here. I recommend it.

29. Harré and Madden (1975, 86) define causal power in terms of a disposition to behave in certain ways under certain conditions because of a thing's intrinsic nature: '"X has the power to A" means "X will or can do A, in the appropriate conditions, *in virtue of its intrinsic nature*".' Here's how Swinburne (2010, 217) expresses the view:

> The alternative to thinking of the physical necessity involved in laws of nature as separate from the objects governed by it is to think of it as built into those objects. The way in which this is normally developed is what we may call the substances-powers-and-liabilities (SPL) account of laws of nature. The 'objects' which cause are individual substances – this planet, those molecules of water. They cause effects in virtue of their powers to do so and their liabilities (deterministic or probabilistic) to exercise those powers under certain conditions, often when caused to do so by other substances. Powers and liabilities are thus among the properties of substances. Laws of nature are then just (logically) contingent regularities – not of mere spatio-temporal succession (as with Hume), but of causal succession, regularities in the causal powers (manifested and unmanifested) of substances of various kinds.

This debate between locating causal power in the things themselves, rather than in the laws of nature, seems to recapitulate and continue the debate between Descartes and the Aristotelian background of the Middle Ages, from which Descartes departed. See Ott (2009), especially chapter 5.

30. Also, with regard to the suggestion that laws of nature are metaphysically necessary, see Korman (2005).

31. Russell (in Russell and Copleston [1957] 1964, 177) probably had something like this in mind, when he said, 'I do think the notion of the world having an explanation is a mistake.' The idea, it seems, is that, eventually, explanations come to a stop with the world (and, presumably, the laws of nature that govern it).

32. Kim (1993, 337) says,

> The Cartesian model of a *bifurcated* world has been replaced by that of a *layered* world, a hierarchically stratified structure of 'levels' or 'orders' of entities and their characteristic properties. It is generally thought that there is a bottom level, one consisting of whatever microphysics is going to tell us are the most basic physical particles out of which all matter is composed (electrons, neutrons, quarks, or whatever).

See also Raven (2013) for a defence of the view that reality is hierarchically arranged.

33. In a similar way, Cameron (2008, 12) offers increased explanatory power as a reason in favour of the intuition that metaphysical explanations must bottom out somewhere, with some fundamental explainers: as Cameron puts it, if the intuition is correct, not only does everything that needs an explanation have one, but also there is an explanation of everything that needs explaining. Yet such appeals to theoretical virtues, as Cameron admits, would prove only that there *is* a fundamental level of explanation – or at least that we ought to *believe* there is – but certainly not that there *must* be.

34. Schaffer (2003, 501–502) does argue that, 'infinite division allows greater *explanatory scope* in that the workings of every single entity is [sic] explicable in terms of the workings of its parts, and infinite division yields a more *elegant hypothesis* in that the pattern of division embraces the whole structure of nature'. But when it comes to metaphysical *dependence*, Schaffer (2010) is what he calls a 'metaphysical foundationalist', accepting that there are 'fundamental independent entities that serve as the ground of being' (*ibid*., 33). If you sense a tension here, note that Schaffer endorses monism, the view that the whole is prior to the parts. So, the whole is the ground of being, even if the parts are endlessly divisible.

35. Leibniz, from a letter to Foucher: 'Thus I believe that there is no part of matter which is not – I do not say divisible – but actually divided; and consequently the least particle ought to be considered as a world full of an infinity of different creatures' (quoted in Schaffer (2003), 498).

36. I think Kripke (1980, 42) was right when he said, 'I think having intuitive content is very heavy evidence in favor of anything, myself. I really don't know, in a way, what more conclusive evidence one can have about anything, ultimately speaking.' On the other hand, Bliss and Priest (2018, 10) say,

> we . . . firmly believe that intuitions are no replacement for arguments. That intuitions have been allowed to play the role they have in the dependence/fundamentality debates thus far is, in our view, why alternative views have been so poorly explored, and why actual arguments in defence of the view have been allowed to be so bad.

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37. Notice, this is not here a problem for the claim that explanation (or metaphysical dependence) is a transitive relation. What I mean to call into question is whether R_1 explains R at all. This is not meant to be a case in which R_2 explains R_1, and R_1 explains R, yet R_2 does not explain R. The idea is rather that, given the relationships between these three natural regularities, any appearance that R_1 has to be the explanation of R is illusory. The explanation of R is, really, R_2.

38. A helpful reviewer for this journal encourages me to consider Kim's reasons for rejecting Block's causal drainage argument, to see whether it would apply just as well to this version of the argument, which applies to explanatory drainage. Kim (2003) rejects the causal drainage argument, since, as Kim says (*ibid*., 176), 'for downward causal drainage to occur, the reduction option must be ruled out for purely physical levels, including microphysical levels, and that it is far from obvious that this can be done'. The idea seems to be that, if the entities featuring in higher-level causal explanations *just are* entities featuring in lower-level causal explanations (e.g. the way that water = H_2O), then the causal power of these higher-level entities cannot 'drain away' to the lower-level entities, since they are one and the same. So, if the lower-level entities have causal powers, so do the higher-level entities.

For our purposes, it is important to remind the reader that, in the present case, we are considering an 'explanatory drainage' version of the argument, focusing on the case where a natural regularity R featuring in a scientific explanation has a further explanation in terms of a 'deeper' natural regularity R_2, and so on forever (R_3, R_4, etc.), with no 'deepest' regularity. Now, either $R = R_2 = R_3 = \ldots$, or not. That is, either these explanations cite the same law at a 'deeper' level of description, or these explanations cite different, 'deeper' laws. If the latter, then Kim's response to the causal drainage argument cannot avail us here. If the former, then, while the case *appears* to have the structure of Infinitism, the structure is really just Brute Foundationalism, of the Simple or Extended variety. There is, in the end, only a finite number of natural regularities 'down there', and the final one has no further explanation. It's brute. And so, in that case, what I say above about explanation failure on Brute Foundationalism will apply here.

39. As Bliss and Priest (2018, 12) put it, 'It is a plank in much of the literature on explanation that reflexive explanations are trivial, uninformative, and explanatorily useless.' Though they're less sure that the same goes for metaphysical dependence, I'm inclined to think that, if there is a tight connection between explanation and dependence, then we're *prima facie* justified in thinking that, if explanation is irreflexive, so too is dependence.

Some (e.g. Lewis, 1979) propose 'causal loops' involving time travel as cases where A (partly) explains B, and yet B (partly) explains A. For example, an older time traveller may visit the past to give the blueprints for the time machine to his younger self. In that case, it's suggested, the young man's possession of the blueprints may partly explain the existence of the time machine, and yet the existence of the time machine partly explains the young man's possession of the blueprints. But, following Marshall (2015, 3150–3151, n. 12), it's plausible that a suitably clarified and restricted prohibition on explanatory loops would not fall prey to such cases, which are not on their face obviously possible. A restriction, for example, to *complete* explanation, rather than partial explanation. The young man's possession of the blueprints does not *completely* explain the existence of the time machine (he also had to build it), and the existence of the time machine does not *completely* explain the young man's possession of the blueprints (he also had to use it).

40. Dawes (2009) considers arguments for the conclusion that theistic explanations are impossible. For example, he quotes Charles Darwin (*ibid*., 14), who says that citing a divine will 'has not the character of a physical law', and is therefore 'utterly useless' and 'foretells nothing'. But I agree with Dawes (*ibid*., 16) that '[w]e can reconstruct religious explanations in a form that resembles the kinds of explanations we accept in other fields'. More troubling is Dawes' own argument against the rational acceptability of divine explanations, an argument which relies on an 'optimality condition' (*ibid*., 85): 'On the assumption that [God] is a rational agent we can assume whatever he wills, he would choose the best possible means of achieving it.' If that's right, then 'the *explanandum* must be the best way in which this intention could have been achieved. If it is not, then positing this intention simply fails to explain, for the *explanandum* is not what the theistic hypothesis would predict' (*ibid*., 86). But I think so-called 'hard choices' (cf. Chang, 2017) make trouble for this idea. On plausible accounts of hard choices, there is no best option available. And this may be true even of God. But we clearly accept explanations of our own choices in cases like this, in terms of the good. So I see no problem with applying the same to God, especially given the range of creative options available to him – the ultimate 'hard choice'. Alternatively, perhaps God *did* create the best possible world, but it may be that 'There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy.' I have in mind theistic multiverse theories (see for example Kray, 2010), on which our universe is but one small corner of an infinite multiverse, which contains literally every universe worth having: the best possible world. On this view, Dawes' optimality condition could be met. Creating in just this way would be the optimal way for God to achieve his will.

41. True, on a broadly Platonic version of Teleological Foundationalism, these necessary moral truths rationalize (and thereby explain) the actions of an *agent*, a divine craftsman, God. I am grateful to an audience member at the

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University of California, Santa Barbara, for pointing out that this agent figures crucially into the explanation of the fundamental laws of nature, and therefore into scientific explanations more generally. So, to avoid running afoul of premise 2 in the main argument, this agent had better not call out for explanation but lack one. Many reasons and arguments have been offered in favour of a necessary being, especially in the Christian philosophical tradition, but it's important not to confuse *justifications* with explanations. (You may receive justifications for Platonism about numbers, for example, reasons to believe that view about numbers is true. But on that view numbers themselves are necessary, and do not stand in need of explanation.) To reconcile this variety of Teleological Foundationalism with premise 2, I believe it is sufficient to say this: the arguments of this article show that scientific explanation can be successful only if, at bottom, reality is teleological, intentional. Insofar as this requires an agent, the arguments of this article give us reason – justification – to posit such an agent, to adopt a view of the world that includes such an agent, whose existence does not call out for explanation. And whereas Swinburne (2004, 79), for example, believes that the structure of explanation requires that God be contingent, the arguments of this article point in the opposite direction: the success of scientific explanation gives the Christian theist reason to suppose that God is necessary, needing no further explanation.

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