Reality Making

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Laws and the Completeness of the Fundamental

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Any explanation of one fact in terms of another will appeal to some sort of connection between the two. In a causal explanation, the connection might be a causal mechanism or law. But not all explanations are causal, and neither are all explanatory connections. For example, in explaining the fact that a given barn is red in terms of the fact that it is crimson, we might appeal to a noncausal connection between things being crimson and their being red. Many such connections, like this one, are general rather than particular. I call these general noncausal explanatory connections *laws of metaphysics*.[1] In this chapter I argue that some of these laws are to be found in the world at its most fundamental level, forming a bridge between fundamental reality and everything else. It is only by admitting fundamental laws, I suggest, that we can do justice to the explanatory relationship between what is fundamental and what is not. And once these laws are admitted, we are able to provide a nice resolution of the puzzle of why there are any nonfundamental facts in the first place.

1.1 The Fundamental and the Derivative

I begin with two distinctions: between causal and metaphysical explanation on the one hand, and between fundamental and derivative reality on the other.

First, explanation. Explanation comes in many kinds. One kind is causal: we explain why our barn is red by saying that it was painted. Here, although the painting explains the redness, still the latter consists in something other than the former. But there is another kind of explanation in which there is no such 'distance'.

[1] The notion of a law of metaphysics has also been discussed by Sider (2011, §12.4) and Wilsch (2015).

This is the kind of explanation at work when we explain why the barn is red by saying that it is crimson. Here the redness simply consists in, or is nothing over and above, the crimsonness. Call this second kind of explanation *metaphysical explanation*.[2]

Philosophers have used the term 'ground' in speaking of such explanation, but they have not all used it in the same way. For some, to say that *A* grounds *B* is to say that *A* metaphysically explains *B*, while for others '*A* grounds *B*' states an explanatory connection to which this metaphysical explanation will appeal.[3] And still others do not explicitly say whether they mean the explanations or the connections that appear in them. Since this distinction is important here, I will avoid the term 'ground'.

I turn now to reality. Reality has many aspects: we speak of *economic* reality or *physical* reality or *practical* reality. One aspect, which I will call *fundamental* reality, is the way reality is in itself, with respect to its intrinsic structure. A description of fundamental reality will perspicuously represent this intrinsic structure; it will 'carve reality at the joints'. When we say that a given electron has negative charge, if our best science is on track we describe fundamental reality. Not so when we say that Obama is president. Although in saying this we *do* describe reality, we do not describe fundamental reality.[4]

Fundamental reality bears a special explanatory relationship to nonfundamental or *derivative* reality: the way derivative reality is may be metaphysically explained in terms of the way fundamental reality is. We will express this explanatory relationship by saying that fundamental reality is *complete*.[5] I will argue that it is only by admitting fundamental laws of metaphysics that we are able to see how the thesis of completeness can be true.

In order to make my argument cleanly, I adopt a framework that is both widely used and reasonably neutral, on which reality consists of *facts*. Like others who adopt this framework I believe that it need not carry any ultimate commitment to facts, but I will not defend this here.[6] Against this background

[2] For discussion of metaphysical explanation and of the related notion of ground, see Fine (2001, 2012), Schaffer (2009), Rosen (2010), and Wilson (2014). I should note that the term 'metaphysical explanation' is misleading on two counts. First, metaphysical explanations are often given outside metaphysics: in science, for instance, or in ethics. Second, not all explanations in metaphysics are metaphysical explanations. For one thing, metaphysicians sometimes give causal explanations. For another, it may be that there are noncausal explanations in metaphysics that are not metaphysical explanations: essentialist explanations, for instance.

[3] For the former usage, see Litland (2013) and Dasgupta (2014). For the latter, see Audi (2012a, 2012b).

[4] For discussion of fundamentality see Fine (2001), Schaffer (2010), and Sider (2011).

[5] The term is due to Sider (2011, ch. 7).

[6] These others include Fine (2001), Raven (2012), and Dasgupta (2014).

we can understand the distinction between fundamental and derivative reality as a distinction between fundamental and derivative facts.[7] And we can understand the claim that fundamental reality is complete as the claim that every derivative fact may be metaphysically explained in terms of fundamental facts.

Our topic requires us to make quite fine-grained distinctions, since such distinctions can make a difference to metaphysical explanation. For example, we can explain why the singleton set {Socrates} exists by saying that Socrates exists, but not vice versa. This is so even though the explanandum holds just in case the explanans does. Or again, we can explain why it is not the case that it is not the case that Obama is president by saying that Obama is president, but not vice versa, even though the explanandum and explanans logically entail one another. If we take the explanandum and explanans of a metaphysical explanation to be facts, our conception of facts must allow these distinctions. We will therefore take facts to be structured entities built up from worldly constituents like objects, properties, quantifiers, connectives, and so on. Facts, then, will be isomorphic to structured propositions à la Russell.

To see why fundamental laws are required by the thesis of completeness, we must state it more precisely. In order to do this, we must first say a bit about explanation and its structure.

1.2 The Structure of Explanation

In one sense of the term, an explanation is a communicative act. But most philosophers of explanation have understood this communicative sense in terms of another sense of explanation, on which an explanation comprises facts 'out there in the world'. We may then take an explanation in the communicative sense to be an attempt to communicate these facts.[8] Our concern here will be with explanation in the factual sense.

What is the structure of such explanation? One simple picture is as follows. Within an explanation we may distinguish the *explanandum*, or the fact that is explained, from the facts that are appealed to in explaining the explanandum. And this latter group may be further divided. There is first of all the *explanans*, or what does the explaining. The explanans may be one fact that on its own fully explains the explanandum, or it may be a group of facts that jointly explain it. But the explanans is not all that must be appealed to in explaining the explanandum,

[7] Fine (2001) argues that on some antirealist views—expressivism, for instance—there are facts that are part of neither fundamental nor derivative reality. Set any such facts aside. When I speak of facts, I mean only those facts which are part of reality.

[8] Strevens (2008, §1.21).

for we must also appeal to some fact of *explanatory connection* between explanans and explanandum. In a causal explanation, the connection might be a causal mechanism or law of nature. For example, we might give the following toy explanation of Socrates's death:

Explanans: Socrates drank hemlock.
Connection: It is a law of toxicology that anyone who drinks hemlock dies.
Explanandum: Socrates died.

In giving a metaphysical explanation, we will by contrast appeal to some noncausal connection. We will consider below what such a connection might be.

The distinction between explanans and connection might be thought spurious. Isn't the explanandum explained by both facts taken together rather than only by the explanans? Although this objection is friendly to my argument, I do not wish to rest on it. There surely is a sense in which the explanans and connection jointly explain the explanandum, but I think we can also recognize a difference in their explanatory roles. The explanans is the distinctive source of the explanatory 'oomph'; it is what *makes* the explanandum obtain. It is hard to articulate this difference, but it would be foolish to ignore it for that reason.

Although the toy explanation above has the form required by Hempel's deductive-nomological account of explanation, I do not assume this account.[9] I do not assume that an explanatory connection must be a law or even a general fact, though I will argue below that some connections *are* laws. And I do not assume that the explanandum must be deductively entailed by the explanans together with the connection.

The connection in a given explanation should be distinguished from the fact that the explanans explains the explanandum. Although the two facts are closely related, the explanation appeals only to the former. Indeed, a natural suggestion, though one I do not assume, is that the former will explain the latter, at least in part.[10] For example, the fact that Socrates's drinking hemlock explains his death will itself be explained—partly explained, anyway—by the 'law of toxicology'.

The classification of a given fact as explanandum, explanans, or connection is relative to which explanation it is taken to be part of. In our toy explanation, for example, Socrates's drinking hemlock serves as explanans: it is what explains Socrates's death. But we might give a separate explanation of why Socrates drank

[9] Hempel and Oppenheim (1948).

[10] See Bennett (2011), deRosset (2013), and Dasgupta (2014) for discussion of this issue as it pertains to metaphysical explanation.

hemlock, and in this new explanation Socrates's drinking hemlock will serve as explanandum.

Call any explanation that satisfies the above simple picture of explanation an *atomic explanation*. Although this simple picture has its attractions, it is *too* simple. For an explanation can also comprise multiple atomic explanations that have been 'concatenated'. We may, for instance, give the following explanation of the fact that our barn is coloured in terms of the fact that it is crimson. We first explain why the barn is coloured by saying that it is red, and we then explain why it is red by saying that it is crimson. Although a corresponding atomic explanation is also available, the 'compound' explanation is surely in order as it stands.[11]

In general, a compound explanation can be regarded as having a treelike structure. For example, we may plausibly give the following explanation of the fact that a certain figure *S* is a square. First we explain why *S* is a square by saying that it is equilateral and it is a rectangle. We then explain why it is equilateral by saying that its sides are of equal length, and we explain why it is a rectangle by saying that it has four sides that meet at right angles. In this example the first atomic explanation, at the root of the tree, branches into two further atomic explanations corresponding to the two facts that constitute its explanans.

This is an example of a compound explanation in which the *explanans* of one atomic explanation is given a further explanation—in which the explanans of one atomic explanation does double duty as the explanandum of another such explanation. But explanatory connections too may be further explained. We might extend our explanation of *S*'s being a square, for instance, by concatenating it with an atomic explanation whose explanandum is the connection between *S*'s having equal sides and its being equilateral.

In general, then, we may represent an explanation by means of a *tree*, Figure 1.1, with the *target* of the explanation at the root of the tree. The target's children will be the explanans and explanatory connection of the target's atomic explanation. Both explanans and connection, as we have seen, may be further explained; that is, they may be the explananda of further atomic explanations. If either *is* further explained, then it will have children: the explanans and connection of this further atomic explanation. These last facts may in turn be explananda of yet further atomic explanations, and so on.

Such explanatory trees will be quite useful to us. But there is one structural feature of explanations that is so far not represented by them and that we must not neglect. These trees as we have defined them ignore the distinction between an explanans and an explanatory connection: both are simply children of their

[11] I take this 'chemical' terminology from Strevens (2008).

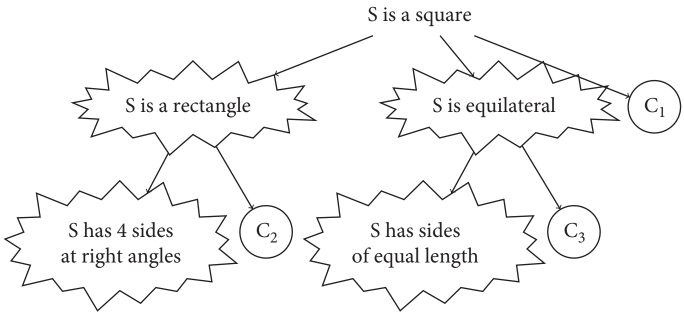

Figure 1.1 Explanation of the fact that *S* is a square.

explanandum. We may mark this distinction graphically by enclosing explanantia with starbursts (to depict the explanatory 'oomph' they provide) and connections with circles. We will always draw the explanatory connection as the rightmost child. Our explanation of *S*'s being a square, then, may be represented as in Figure 1.1.

1.3 The Thesis of Completeness

I turn now to the proper statement of the thesis of completeness. How should we understand the claim that fundamental reality is complete?

We might take it to require that every derivative fact have a metaphysical explanation in which every fact save the target is fundamental. But this would be too strong. One might think, for instance, that in order to explain in terms of fundamental facts why Philadelphia is the most populous city in Pennsylvania, we must appeal to derivative facts in the following way. First, we explain this derivative fact about Philadelphia's population by appeal to further derivative facts about human beings. Second, we explain these facts about human beings by appeal solely to fundamental facts. Despite the appeal to the derivative, this explanatory situation is compatible with the thesis of completeness. For we are still able to show how fundamental reality accounts for Philadelphia's population.

One might wonder how we could possibly be *forced* to appeal to derivative facts to explain Philadelphia's population. Consider the fundamental facts appealed to in the above explanation. Couldn't we simply give an explanation of this fact about Philadelphia by appeal to these fundamental facts alone? Not necessarily. For one might think that none of them could serve as an explanatory connection between other fundamental facts and the fact about Philadelphia. Indeed, one might think that *no* fundamental fact could serve as such a connection. Philadelphia is, so to speak, too far above the fundamental.

We must, then, understand the thesis of completeness in a different way. We might take it to require that every derivative fact have a metaphysical explanation in which no derivative fact is left unexplained; that is, one in which every derivative fact has children. But this would be too weak. The requirement is satisfied, for instance, by an explanation in which every fact is derivative but explained in terms of other derivative facts, which are themselves explained in terms of further derivative facts, and so on without end. Here although every derivative fact in the explanation *is* explained, it is explained only in terms of other derivative facts. Since the explanation never appeals to any fundamental fact, it does nothing to show how its target is accounted for by fundamental reality. And so if there is a derivative fact that can only be explained in this infinitary way, completeness is false.

Instead, we should allow explanations of derivative facts to appeal to the derivative, but require that these appeals be 'discharged': if we appeal to a derivative fact, we must show how that fact is accounted for by fundamental reality. We will assume that if, in discharging one appeal, we make a further appeal to the derivative, then the first appeal is not discharged unless this further appeal is. For otherwise we will not have shown how the first fact is accounted for by fundamental reality.

We can state this requirement precisely in terms of our notion of an explanatory tree. We will require that every maximal path that begins at the target and proceeds down the tree contain a fundamental fact.[12] Let *Strong Completeness* be the thesis that every derivative fact has an explanation that satisfies this discharging requirement. That is:

> **Strong Completeness** Every derivative fact has an explanation whose tree is such that every maximal path that begins at the target and proceeds down the tree contains a fundamental fact.

Call an explanation of the sort guaranteed by this thesis a *strongly fundamental explanation*.

[12] This formulation of the requirement is informed by Rosen's (2010) formulation of metaphysical naturalism. One might think we should instead adopt the stronger formulation that every maximal path beginning at the target must have a point beyond which every fact is fundamental. (This formulation is more analogous to Rosen's.) But it is very plausible that no fundamental fact can be explained by appeal to any derivative fact (if indeed fundamental facts can be explained at all). Given this assumption the two formulations are equivalent.

However, one might think that *Strong Completeness* is *too* strong. It requires us not only to discharge appeals to derivative facts as explanantia, but also to discharge appeals to derivative facts as explanatory connections. And although the former requirement is plausible enough, one might question the latter. After all, explanantia and connections differ in their explanatory roles. One might even think that connections are somehow peripheral to explanation: they lack the 'oomph' that explanantia provide. Let us therefore consider weakening *Strong Completeness* so that we require only that appeals to derivative facts as explanantia be discharged. On this proposal, we obtain the thesis:

> **Weak Completeness** Every derivative fact has an explanation whose tree is such that every maximal path *containing only explanantia* that begins at the target and proceeds down the tree contains a fundamental fact.

Call an explanation of the sort guaranteed by this thesis a *weakly fundamental explanation*.

One might think to reject *Weak Completeness* on the grounds that it simply ignores the need to account for derivative facts appealed to as explanatory connections. *Weak Completeness*, it might seem, is compatible with there being a derivative fact that can be explained only by appeals to derivative connections which cannot themselves be discharged. But connections are indispensable to explanation; one cannot explain anything without appeal to them. So if there *is* such a derivative fact, then there is an important sense in which this fact cannot be accounted for by fundamental reality. And so one might worry that *Weak Completeness* is compatible with there being a derivative fact that cannot be accounted for by fundamental reality.

But *Weak Completeness* should not be rejected on this basis. To be sure, *Weak Completeness* is compatible with there being a derivative fact that is explained by appeals to derivative connections that are not themselves discharged *within that very explanation*. But it guarantees that those appeals will at least be discharged in separate 'standalone' explanations. After all, derivative connections are derivative facts. Since *Weak Completeness* guarantees a weakly fundamental explanation for every derivative fact, it guarantees weakly fundamental explanations for these connections. And thus these appeals to derivative connections *will* be discharged.[13]

However, one still has the sense that *Weak Completeness* is wrong about the 'sources' of completeness, or of failures of completeness. Consider the following explanatory scenario. A derivative fact *A* can be explained only by appeal to

[13] Thanks to Cian Dorr, Kit Fine, and Daniel Waxman for discussion of this issue.

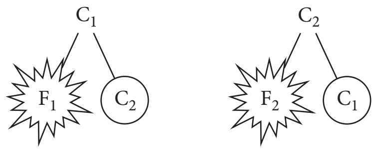

Figure 1.2 A problem for *Weak Completeness*.

a derivative connection C. Although A may be given a weakly fundamental explanation, C has no such explanation. Indeed, we might suppose there is simply no way to show how fundamental reality accounts for C in any sense. C just 'floats free' of the fundamental. One has the sense that completeness fails in this scenario, not just because of C, but because of A too. Since A can be explained only by appeal to C, and there is no way to account for C, there is no way to account for A. *Strong Completeness* respects this sense: A and C will both lack strongly fundamental explanations. But as far as *Weak Completeness* goes, there is no trouble at all with A. It satisfies the only requirement *Weak Completeness* imposes.

This shortcoming of *Weak Completeness* can be parlayed into a serious objection. Suppose there are two derivative facts C_1 and C_2 that figure in each other's explanations as depicted in Figure 1.2. The sole atomic explanation of C_1 has fundamental explanans F_1 and connection C_2, and the sole atomic explanation of C_2 has fundamental explanans F_2 and connection C_1. Of course, these will not be the only explanations of C_1 and C_2. We may obtain a compound explanation of C_1, for instance, by concatenating the atomic explanation of C_1 with the atomic explanation of C_2. And we may extend this compound explanation by concatenating it with the atomic explanation of C_1. And so on. But we may suppose that the only compound explanations of C_1 and C_2 result from repeated concatenations of these atomic explanations.

Clearly, this explanatory scenario is not compatible with the thesis of completeness. There is no way to show how either C_1 or C_2 is accounted for by fundamental reality: any attempt results in our going around in a circle. But the scenario is perfectly compatible with *Weak Completeness*. The only explanantia, after all, are fundamental, and so any explanation of C_1 or C_2 will be weakly fundamental.

Weak Completeness misjudges this scenario because it does not allow an appeal to a derivative explanatory connection to be the 'source' of a failure of completeness. In many cases this shortcoming is concealed, since the troublesome connection will itself lack a weakly fundamental explanation and so *Weak Completeness* will fail anyway. But the present scenario lays the shortcoming bare: an appeal to C_1 or C_2 is a 'source' of completeness failure, yet both have weakly fundamental explanations.

Strong Completeness, by contrast, prohibits this scenario. Given any explanation of C_1 there will be a maximal path running down the 'right-hand side' of the explanatory tree that includes only repeated instances of the derivative facts C_1 and C_2. And similarly for C_2. The scenario is thus incompatible with *Strong Completeness*.

To be sure, the scenario exhibits a kind of explanatory circularity. And although some philosophers have wished to leave open the possibility of circular explanation,[14] many have taken it to be impossible. But this is beside the point. If one thinks the fundamental is complete, then one need not even take a stand on whether the scenario exhibits an impossible kind of circularity in order to conclude that it does not obtain. For we have a clear judgment that one can on grounds of completeness alone reject the scenario. *Strong Completeness* accords with this judgment; *Weak Completeness* does not.

We should not be tempted to add an anticircularity condition to *Weak Completeness* in order to rule out the scenario. For completeness is compatible with circularity. The thesis of completeness could be satisfied, for instance, if C_1 and C_2 had other atomic explanations in addition to those depicted in Figure 1.2. I conclude that *Weak Completeness* is irredeemably flawed as a statement of the thesis of completeness.

Strong Completeness, then, is the right way to understand the thesis. Insofar as we have reason to believe that the fundamental is complete, we have reason to believe *Strong Completeness*.

1.4 An Objection to *Strong Completeness*

But *Strong Completeness* places serious explanatory demands on us, and one might well worry that these demands cannot be met. The force of this worry is best brought out by means of the following objection. I will argue that it is only by admitting fundamental laws of metaphysics that we are able to see how the worry may be addressed.

The objection is this: there appears to be no way to give strongly fundamental explanations—explanations of the sort guaranteed by *Strong Completeness*—of a large class of derivative facts. The class is best characterized by means of a new notion of derivativeness, one that applies to things rather than facts. Intuitively, a *derivative thing* is a thing (broadly understood) that is not among 'the basic furniture of the world'. There are countless such things: think of Stonehenge, or of the *Odyssey*, or even of the property of being a city. The class of

[14] Such as Nozick (1981, 116–21) and Jenkins (2011).

derivative *facts* I have in mind are simply those that involve derivative *things*. Such facts surely *are* derivative. For if they were fundamental, then the things they involve would figure in the fullest description of fundamental reality. And this would seem sufficient to render these things part of the basic furniture of the world.

But what is it for a fact to involve a given thing *a*? Our conception of facts as structured entities gives us two ways this may occur. First, the fact may contain *a* as a constituent; the fact that Obama is president involves Obama in this way. Second, the fact may contain a complex whose value is *a*; the fact that $3 + 2$ is prime involves 5 in this way.

Take a fact that involves, in either of these ways, a derivative thing—say, that Stonehenge is in England. How can we give a strongly fundamental explanation of it? We might try first to offer an atomic explanation. To fix ideas, let its explanans be the fact that there are particles 'arranged φly'. Although (we may suppose) this explanans is fundamental, it might be thought that the same cannot be true of the explanatory connection. The connection will apparently be something like:

> That there are particles arranged φly makes it the case that Stonehenge is in England.[15]

This fact will not be fundamental, since it involves Stonehenge.[16] So our atomic explanation is not strongly fundamental.[17]

Of course, we can offer more complex explanations, but these will face the same difficulty. Consider an arbitrary explanation *E* of the fact that Stonehenge is in England. Call this fact *A*. It appears we will always be able to construct a maximal path down the 'right-hand side' of *E*'s explanatory tree that never reaches the fundamental, thus showing that *E* is not a strongly fundamental explanation. Let

[15] Perhaps 'makes it the case' should be replaced by something like 'determines' or even 'grounds'. But I will use 'makes it the case' as a generic placeholder.

[16] Sider (2011, 143–4) makes a similar point. Such connections, it should be acknowledged, give rise to a significant puzzle. For if the connections are derivative, then they must themselves be explained by fundamental facts, and it is not at all clear what these facts might be. (The puzzle has been discussed by Bennett (2011), deRosset (2013), and Dasgupta (2014).) But the objection I develop here is independent of this puzzle: it would remain even if we could find fundamental facts that could plausibly be taken to explain these connections.

[17] We might attempt to avoid this conclusion by taking the connection to involve only facts. That is, we might take it to be of the form *fRg*, where *f* is the fact that there are particles arranged φly, *g* is the fact that Stonehenge is in England, and *R* is some 'making it the case' relation. If the connection is of this form, it will not itself involve Stonehenge. But this move is ultimately to no avail, for the connection will still involve the derivative fact *g*. And surely any derivative fact is itself a derivative thing. The fact that Stonehenge is in England is no more a part of the world's basic furniture than Stonehenge itself. Since the proposed connection involves a derivative thing, it is not itself fundamental. Similar remarks apply below.

the first fact in the path be A, the (derivative) fact that Stonehenge is in England. E will contain an atomic explanation of A with explanans B_1 and explanatory connection C_1. Let the second fact in the path be C_1. As before, this connection will apparently be something like:

> B_1 makes it the case that Stonehenge is in England.

And if that is so, then C_1 is not fundamental since it involves Stonehenge. So if E does not contain a further explanation of C_1, we have the desired path. If on the other hand E does contain such an explanation, then it will contain an atomic explanation of C_1 with explanans B_2 and explanatory connection C_2. Let the third fact in the path be C_2. C_2 will apparently be something like:

> B_2 makes it the case that B_1 makes it the case that Stonehenge is in England.

And so C_2 also involves Stonehenge and thus will not be fundamental. So if E does not contain a further explanation of C_2 then we again have the desired path, while if E does contain such an explanation we can continue as before. So either the desired path is some path of the form $A, C_1, C_2, \ldots, C_n$, or it is the infinite path $A, C_1, C_2, \ldots$.[18] Either way, E is not a strongly fundamental explanation.

In the face of this objection, one might think we should abandon *Strong Completeness*. For whatever the attractions of the view, if it cannot accommodate facts involving derivative things it must be given up. But in fact this drastic step is not necessary.

The objection depends on the following assumption: in an atomic explanation whose explanandum is A and whose explanans is B, the explanatory connection will be something like:

> B makes it the case that A.

If the connection is of this form, then it will involve the things that are involved in A and B. So if A involves Stonehenge, for instance, the connection will too. The connection will thus be barred from the fundamental.

But once this assumption is examined it is clear that it should be rejected. Consider again our crimson barn. To be sure, we might take its crimsonness to explain its redness by means of a connection of the above form, perhaps:

> That the barn is crimson makes it the case that it is red.

[18] It is perhaps possible that there is an even longer infinite path through E of which this last path is a proper subpath. But we should not rest our defense of *Strong Completeness* on dubious claims about what facts might lie 'after' these infinitely many facts.

But in addition to this barn-involving connection, there seems to be a more general connection between an arbitrary thing's being crimson and its being red. And so we might instead give an explanation by appeal to this general connection. This second explanation would seem to be a perfectly good one, certainly no worse than the first. And although we will examine such general connections in detail below, it is clear even now that this connection will not be something like:

That the barn is crimson makes it the case that it is red.

For surely the general connection does not involve this particular barn.

If this notion of a general metaphysical-explanatory connection can be made out, we might be able to meet the demands of *Strong Completeness* after all. In particular, we might be able to use such connections to give strongly fundamental explanations of facts involving derivative things. In the next section I sketch an account of these general connections, which I call *laws of metaphysics*. I then apply this account in a few simple cases to give strongly fundamental explanations of facts involving derivative objects and properties. I suggest that in light of the account's success, we are able to see how *Strong Completeness* can be true after all.

It is worth noting that the notion of a law of metaphysics has interest apart from the issue of completeness. Just as many causal explanations appeal to general causal-explanatory connections—laws of toxicology, perhaps—so it is plausible that many metaphysical explanations will appeal to such general explanatory connections. Examples are not hard to come by; the connection between crimson and red provides an especially clear case. And so even those who reject *Strong Completeness*—indeed, even those who reject any completeness requirement—may find something of value in the account below.

1.5 Laws of Metaphysics

Let *Crimson* be the general connection mentioned in §1.4 between an arbitrary thing's being crimson and its being red. It seems we may give the following perfectly good atomic explanation of the fact that the barn is red:

Explanans: The barn is crimson.
Connection: *Crimson*.
Explanandum: The barn is red.

But what is the logical form of the fact *Crimson*?

A natural thought is that this fact is just a universal generalization, something like:

For all x, if x is crimson, then that x is crimson makes it the case that x is red.

It may be that *Crimson* is materially equivalent to some such universal generalization. But even if this is so, there is reason to think the two are distinct facts. Consider some other crimson object, perhaps a crimson planet in a distant galaxy. Since universal generalizations are explained, at least in part, by their instances, if *Crimson* is a universal generalization it will be partly explained by facts about this planet. So if we were to explain the redness of the barn and then explain in turn all the facts in our explanation, we would have to appeal to facts about this planet. But it is very plausible that such facts play no role whatsoever in explaining the redness of our barn. They are just irrelevant! At the very least we do not want our understanding of *Crimson* to commit us to taking the barn's redness to be explanatorily dependent on some extragalactic planet.[19]

What if we hold a unificationist view, on which explaining something is a matter of fitting it into a larger pattern?[20] Isn't the redness of the barn then explanatorily dependent on the distant planet, since the planet is part of the larger pattern? No. Unificationism is a view about what makes something count as an explanation, not about the content of explanations. The unificationist will say that part of what makes our explanation count as an explanation is that it is an instance of a larger pattern of similar explanations, one of which concerns this planet. This distant planet, then, does play a role in what makes our explanation count as an explanation. But the unificationist is under no pressure to take the planet to appear in the explanation itself nor in the explanation of any of the facts in this explanation.

The argument that *Crimson* is not a universal generalization depends on the claim that universal generalizations are partly explained by their instances. It might be proposed that some universal generalizations—those that are 'nonaccidental'—can be explained in terms of the essences of things, or in terms of some sort of laws.[21] But this proposal is quite compatible with our explanatory claim. For example, one might think that nonaccidental universal generalizations are jointly explained by their instances together with essences or laws. Or one might think that such generalizations admit of two independent explanations, one given partly in terms of their instances and one given in terms of essences or laws. Or, what strikes me as most likely, one might think that these generalizations are partly explained by their instances, which are themselves partly explained by essences or laws. And still other options are available. So this proposal gives

[19] Thanks to Zee Perry for discussion on this point.
[20] Kitcher (1981) develops an influential unificationist account of explanation.
[21] Rosen (2010, 118–21) considers these proposals.

us no reason to deny that universal generalizations are partly explained by their instances.

I must of course reject the strong proposal that nonaccidental universal generalizations are explained by essences or laws to the exclusion of their instances. But this proposal is implausible. For one thing, it is natural to think of universal quantification as a generalized version of conjunction. To say that everything is F is to say that a is F and b is F and so on, for each thing there is. Since conjunctive facts are explained by their conjuncts, it is plausible that universal generalizations are at least partly explained by their instances. For another, we have a clear intuitive judgment that the instances are explanatorily relevant to the generalization. Consider the claim that all quantities of H_2O are also quantities of water. It is not *irrelevant* to the explanation of this that this particular gallon of H_2O is also a gallon of water. So why adopt the strong proposal, especially given that more plausible options are available?

I see no good reason, and so I will assume that *Crimson* is not a universal generalization. But those who think it is a generalization may still accept the larger argument of this chapter, provided they are willing to admit some generalizations as fundamental facts.

If *Crimson* is not a universal generalization, then what is its logical form? It clearly has a sort of generality, but it is a general fact that is not explained by its instances. Since this sort of generality is not achieved through quantification, it must instead be achieved through another variable-binding operator.

I propose therefore that we recognize a new operator $\ll$. We should allow the operator to bind any number of variables, since our intuitive understanding of a general metaphysical-explanatory connection does not support any relevant limit. And because a fact may be metaphysically explained by any number of other facts, the operator should also be variably polyadic 'on the left'.[22] A statement of a general connection will therefore be of the form

$$\varphi_1, \ldots, \varphi_n \ll_{\alpha_1 \ldots \alpha_m} \psi$$

where $\varphi_1, \ldots, \varphi_n, \psi$ are sentences and $\alpha_1, \ldots, \alpha_m$ are variables.[23]

We may now state the fact *Crimson* as

Crimson x is crimson $\ll_x$ x is red.

[22] Cf. Fine's (2012) variably polyadic operator for making statements of ground.

[23] Fine (2015) discusses generic statements of metaphysical explanation in the context of identity criteria and employs a similar notation. Also related are Dorr's (MS) discussion of statements of the form 'to be F is to be G' and Rayo's (2013) discussion of 'just is' statements.

Crimson states the general metaphysical-explanatory connection that holds between an arbitrary thing's being crimson and its being red. We may put this in another way by speaking of facts: *Crimson* states the general connection that holds between facts of the form 'x is crimson' and facts of the form 'x is red'.

Once we have the notion of this general connection in view, we can plausibly see particular connections as a special case. In just the way that, in general, something's being crimson makes it the case that it is red, so in particular does the barn's being crimson make it the case that the barn is red. We may formally achieve this theoretical unification by allowing the $\ll$ operator to bind not just any positive number of variables, but zero variables as well:

The barn is crimson $\ll$ the barn is red.

Where the $\ll$ operator binds one or more variables, we will call the resulting statement a *law of metaphysics*.

There seem to be constraints on which laws (or indeed which metaphysical-explanatory connections) can figure in which explanations. For example, we cannot appeal to *Crimson* in giving an atomic explanation of the fact that Stonehenge is in England. But we *can* appeal to it in giving such an explanation of the redness of any crimson thing. It seems likely that these constraints may be given a partly formal characterization. As a partial and speculative step in this direction, let me propose the following two *principles of fit*.

1. If A has an atomic explanation with explanans $B_1, \ldots, B_n$ and connection $\varphi_1, \ldots, \varphi_n \ll_{\alpha_1 \ldots \alpha_m} \psi$, then $B_1, \ldots, B_n, A$ are obtainable from $\varphi_1, \ldots, \varphi_n, \psi$ respectively by substitution on $\alpha_1, \ldots, \alpha_m$.
2. If $B_1, \ldots, B_n, A$ and $\varphi_1, \ldots, \varphi_n \ll_{\alpha_1 \ldots \alpha_m} \psi$ are facts, and if $B_1, \ldots, B_n, A$ are obtainable from $\varphi_1, \ldots, \varphi_n, \psi$ respectively by substitution on $\alpha_1, \ldots, \alpha_m$, then A has an atomic explanation with explanans $B_1, \ldots, B_n$ and connection $\varphi_1, \ldots, \varphi_n \ll_{\alpha_1 \ldots \alpha_m} \psi$.

The first principle says that the form of a metaphysical-explanatory connection must fit the form of the explanans and explanandum it connects. The second principle says that if a connection obtains, then whenever some facts fit its form, the connection will figure in an atomic explanation with these facts as explanans and explanandum.

1.6 Explaining the Derivative

With the account of §1.5 we are now in a position to substantiate our tentative response to §1.4's objection to *Strong Completeness*. We will show in a few simple cases how laws of metaphysics might make possible strongly fundamental explanations of facts involving derivative things. This section develops the details of these explanations; §1.7 defends the claim that they are strongly fundamental.

For the sake of concreteness, let us suppose the following metaphysical picture. Electrons and regions of space are among the basic furniture of the world, and facts about the locations of electrons are fundamental. Mereological fusions of electrons, by contrast, are not among this basic furniture, and facts about the locations of these fusions are not fundamental. If a and b are two electrons located at points A and B, then the fact that the fusion of a and b is located at $A \cup B$ involves a derivative thing: the fusion of a and b. Given our metaphysical picture, it is plausible that this fact is explained by facts about the locations of a and b. But how will we sharpen this thought into a strongly fundamental explanation?

In order to develop such an explanation, we must first specify its explanandum more precisely. After all, the sentence

The fusion of a and b is located at $A \cup B$

admits of more than one reading. On a 'Russellian' reading, the sentence has the logical form

$$\exists x\, (x \text{ fuses } a \text{ and } b \wedge \forall z(z \text{ fuses } a \text{ and } b \rightarrow z = x) \wedge x\, @A \cup B).$$

It is not clear which fundamental facts explain the Russellian fact. Certainly it is not explained just by the locations of a and b. For surely the locations of two electrons do not explain why there is something that fuses them. And so how could they explain the Russellian fact?[24]

In order for the example to have some plausibility, then, we will give the explanandum sentence a 'functional' reading. We will take it to have the logical form

$$\mathrm{Fu}(a, b)@A \cup B$$

where Fu is the function that maps any two objects to their mereological fusion.[25]

It is not just a and b whose locations explain the location of their fusion. There seems to be a general explanatory connection—a law of metaphysics—linking the

[24] Which fundamental facts *do* explain the Russellian fact? This is a difficult question and one I do not know how to answer. But this is not only a difficulty for *Strong Completeness* but for any completeness thesis whatsoever. I will therefore set the question aside.

[25] One might think that this stipulation still fails to render the example plausible, on the grounds that the functional fact is explained by the Russellian fact. If that is so, then since the locations of a and b do not explain the latter, they cannot explain the former either. I see no reason to think this explanatory situation holds, but those who are worried may give the explanandum sentence a 'referential' reading, on which it has the logical form '$c@A \cup B$'. They may then give it a strongly fundamental explanation as detailed in n. 27.

location of any two things to that of their fusion. Harnessing the account of §1.5, we may state this law as:

Fusion $x@R, y@S \ll_{xyRS} \mathrm{Fu}(x, y)@R \cup S.$

We may now offer the following explanation of the location of the fusion of *a* and *b*:

Explanans: (1) *a* is located at *A*; (2) *b* is located at *B*.
Connection: *Fusion.*
Explanandum: The fusion of *a* and *b* is located at $A \cup B$.

This explanans is fundamental. And so if *Fusion* is fundamental as well, the explanation is a strongly fundamental one.

We will defend the fundamentality of the fact *Fusion* in §1.7, but first let us consider a few more examples. Take a case involving, not a derivative object, but a derivative property. Let it be the conjunctive property of being charged-and-massive—that is, $\lambda x(Cx \wedge Mx)$. We will suppose that given an electron, the fact that it is charged and the fact that it is massive are fundamental facts.

We can now give an explanation of the fact that this electron *e* is charged-and-massive. It is plausible that this fact is explained by the fact that *e* is charged and the fact that *e* is massive. And there is surely a general explanatory connection between conjunctive properties and their conjuncts, which we may state as:

Conjunction $Fx, Gx \ll_{xFG} (\lambda y(Fy \wedge Gy))x.$

Our explanation will then be as follows:

Explanans: (1) *e* is charged; (2) *e* is massive.
Connection: *Conjunction.*
Explanandum: *e* is charged-and-massive.

Since the explanans is fundamental, if the fact *Conjunction* is fundamental as well then the explanation is strongly fundamental.

It will not have escaped notice that in both of these examples our explananda involve derivative things in the same way: they contain a complex whose value is a derivative thing. For example, the fact that the mereological fusion of *a* and *b* is located at $A \cup B$ contains the complex $\mathrm{Fu}(a, b)$. But a fact may also involve a derivative thing by having that thing as a constituent. For example, let *c* be the fusion of *a* and *b*, and consider the fact that *c* is located at $A \cup B$. We will ultimately need to give strongly fundamental explanations of facts like this too. Although there may be more than one way to do this, let me propose one explanatory strategy that I take to be particularly simple and attractive.

Of course, some will not think there is a further explanatory task here. They will not admit the distinction between two ways of involving, presumably because they do not see facts as structured entities. They will see no distinction between the fact that $\mathrm{Fu}(a, b)$ is located at $A \cup B$ and the fact that c is located at $A \cup B$. From this perspective, to give a strongly fundamental explanation of the former is to give a strongly fundamental explanation of the latter. But I am not so easily appeased. In my view these facts are distinct—one has c as a constituent, while the other has only the fusion function—and demand distinct explanations.

What then explains why c is located at $A \cup B$? I suggest that this question can be answered by properly appreciating what c is. Let us work up to this by first considering a more everyday mereological fusion: this quart of milk. It stands in an intimate relationship to the two pints of milk that compose it. For one thing, the quart is identical to the fusion of the pints. But the relationship goes beyond that, for it also seems that what it is to be the quart is just to be the fusion of the pints.[26] In light of this 'definitional' connection, it is not implausible to think that the fact that the quart is located at a certain region is explained by the fact that the fusion of the pints is located at that region.

Although c is far removed from everyday life, it is plausible that as a fellow mereological fusion it too bears a definitional connection to its parts: what it is to be c is just to be the fusion of a and b. And so it is not implausible to think that the fact that c is located at $A \cup B$ is explained by the fact that the fusion of a and b is so located.

We may therefore propose that there is a general explanatory connection here, one that holds both between the quart and the fusion of the pints and between c and the fusion of a and b. The connection is, we want to say, something like this:

> That the fusion of two things is located at a region makes it the case that z is located at that region, where z is the fusion.

We may propose that by appeal to some law along these lines—call it *Fusion**—we can give an explanation of c's location as follows:

Explanans: The fusion of a and b is located at $A \cup B$.
Connection: *Fusion**.
Explanandum: c is located at $A \cup B$.

But what precisely is the law? We might take it to be

$$\mathrm{Fu}(x, y)@R \cup S \ll_{xyRS} \mathrm{Fu}(x, y)@R \cup S.$$

[26] I take this example from Fine (2010).

But if we take this to be the law, we must abandon our first principle of fit. After all, our explanandum $c@A \cup B$ is not obtainable from $\mathrm{Fu}(x, y)@R \cup S$ by appropriate substitution. To be sure, the principles of fit are not beyond question. But it seems likely that there are *some* formal constraints on which laws can figure in which explanations. What would these constraints be, if these principles are not among them?

Let us therefore seek a law whose 'right-hand side' is of the appropriate form. We wish to state a general explanatory connection between a fact of the form '$\mathrm{Fu}(x, y)@R \cup S$' and a fact of the form '$z@R \cup S$', where $z = \mathrm{Fu}(x, y)$. We might take the law to be:

$$\mathrm{Fu}(x, y)@R \cup S \ll_{xyzRS} z@R \cup S.$$

But this does not capture the relationship between z on the one hand and x and y on the other, since here z varies independently of x and y. Indeed, by the second principle of fit we would be forced to say that the fusion's location explains, not just c's location, but the location of anything that occupies $A \cup B$.

One might think, of course, that c is the only such thing. But this response will not in general be available. For we might wish to explain c's mass in terms of the mass of the fusion by appeal to a law much like *Fusion**. The law will be something like this:

> That the fusion of two things has a given mass makes it the case that z has that mass, where z is the fusion.

If we state this law in the above manner as

$$\mathrm{Fu}(x, y) \text{ has mass } m \ll_{mxyz} z \text{ has mass } m,$$

then the second principle of fit will entail that the mass of the fusion explains the mass of anything else with that mass, which is obviously false.

We must instead state *Fusion** in a way that captures the relationship between x, y and z. To achieve this, we will jointly restrict the ranges of the variables bound by the $\ll$ operator: x, y and z (and R and S) will take only those values for which $z = \mathrm{Fu}(x, y)$. We thus obtain

Fusion* $\quad \mathrm{Fu}(x, y)@R \cup S \ll_{xyzRS\,:\; z=\mathrm{Fu}(x,y)} z@R \cup S.$

By appeal to this law, we may explain the fact that c is located at $A \cup B$ in terms of the fact that the fusion of a and b is so located. But we have already explained the latter above, and we have argued that this explanation is strongly fundamental provided that *Fusion* is a fundamental fact. So if *Fusion** is also a fundamental fact, we may concatenate the present explanation with our earlier explanation to obtain a strongly fundamental explanation of *c*'s location.[27]

Finally, let us note that our strategy for explaining *c*'s location seems applicable also to facts that have derivative properties as constituents. Say that something is 'charsive' if it is charged-and-massive—that is, if it has the conjunctive property *being charged-and-massive*. We earlier distinguished the fact that $\mathrm{Fu}(a, b)$ is located at $A \cup B$ from the fact that c is so located. Letting R be the property of being charsive, we may in the same way distinguish the fact that a given electron e is charged-and-massive ($(\lambda x(Cx \wedge Mx))e$) from the fact that it is charsive (Re).[28] The former has *being charged* and *being massive* as constituents, while the latter has only *being charsive*.

How shall we explain the fact that e is charsive? We may proceed in much the same way that we did in the case of *c*'s location. We will explain the fact that e is charsive in terms of the fact that it is charged-and-massive by appeal to the law:

Conjunction* $\quad (\lambda y(Fy \wedge Gy))x \ll_{xFGH\,:\,H=\lambda y(Fy \wedge Gy)} Hx.$

But we have already explained why e is charged-and-massive, and our explanation is strongly fundamental provided *Conjunction* is a fundamental fact. So if *Conjunction** is fundamental as well, we may concatenate the present explanation with our earlier explanation to obtain a strongly fundamental explanation of the fact that e is charsive.

1.7 Laws as Fundamental

We have now proposed explanations of four facts involving derivative things. If the laws to which these explanations appeal are fundamental facts, then the explanations will be strongly fundamental. And so we will be able to see how it is possible that *Strong Completeness* is true.

But can these laws really be fundamental? To be sure, they do not bear the most obvious mark of the derivative: they involve no derivative things. Stonehenge and the like are nowhere to be found in them. But might there be more subtle reasons to think them derivative?[29]

[27] One might by appeal to a similar law give a strongly fundamental atomic explanation of the fact that c is located at $A \cup B$. Explanans: (1) a is located at A; (2) b is located at B. Connection: $x@R, y@S \ll_{xyzRS\,:\,z=\mathrm{Fu}(x,y)} z@R \cup S$.

[28] Rosen (2010, 125) discusses a similar distinction.

[29] If such laws are fundamental facts, do they bring with them fundamental ontological commitments? Although I cannot settle the matter here, my own view is that they need not do so. Suppose by analogy that one takes it to be a fundamental fact that God does not exist. In my view one need not thereby countenance a certain 'negative entity', the lack of God, that sits alongside electrons and

First of all, one might take these general connections to be themselves explained by still more general connections. *Fusion*, to take one example, states a general connection between a pair of things and their mereological fusion. It might be argued that *Fusion* is itself explained by a more general connection between an *arbitrary* number of things and their fusion, and that it is only this more general connection that is fundamental. But although this may well be true, to properly formulate these more general connections would take us far afield. It would moreover leave intact our ultimate conclusion in favor of metaphysical-explanatory connections that are both fundamental and general. I propose, therefore, that we set such considerations aside. The objections considered below threaten these more general connections as well as the simple laws of §1.6, and our discussion will proceed more clearly if we confine ourselves to simpler cases.

A second reason to doubt the fundamentality of §1.6's laws is best put in terms of a new notion of fundamentality, one that applies to the *constituents* of facts rather than to the facts themselves. Just as we may distinguish fundamental and derivative facts, so we might distinguish fundamental fact-constituents and derivative fact-constituents. A fundamental constituent corresponds to a structural division in fundamental reality. If a description of fundamental reality 'carves reality at the joints', then the fundamental constituents are what correspond to the joints. For example, if the property of being charged is a fundamental constituent, then there is a fundamental distinction between being charged and not being charged. By contrast, there is presumably no fundamental distinction between Barack Obama and everything else, reflecting Obama's status as a derivative constituent.[30]

Let us admit the notion of constituent-fundamentality, if only for the sake of argument. It might be objected that our laws must be derivative facts on the grounds that they involve derivative constituents. *Fusion*, for instance, involves the fusion function, which maps objects to their mereological fusions. Given the background metaphysical picture we assumed, we must surely take *c*—the result of applying the fusion function to *a* and *b*—to be a derivative constituent. But then mustn't we take the fusion function itself to be derivative?

No. Although *c* is a derivative constituent, nothing forces us to say the same of the fusion function. That function is fundamental. From the perspective of the

regions of space in the world's fundamental ontology. Instead, one need hold only that in order to fully describe fundamental reality one must say that God does not exist. In just the same way, one may admit fundamental laws without thereby countenancing 'nomic entities' in the fundamental ontology. One need hold only that in order to fully describe fundamental reality one must make statements of law. (On this issue see Sider (2011, ch. 6).) I thank an anonymous referee for drawing my attention to this matter.

[30] Sider (2011), building on Lewis (1983), develops a notion similar to our notion of a fundamental constituent.

friend of constituent-fundamentality, our position is this: although there is no fundamental distinction between c and everything else, there *is* a fundamental distinction between fusing some objects and performing some other operation on them, or no operation at all.

There may however appear to be an argument showing that the fusion function must be derivative. For if the function were fundamental, the derivative fact

$$\mathrm{Fu}(a, b)@A \cup B$$

would contain (we may suppose) only fundamental constituents. And isn't this absurd?

This argument depends on the following principle:

> If all of the constituents of a fact are fundamental, then the fact is fundamental.

This principle may seem to have some plausibility. For if a fact is built up from constituents that all correspond to reality's joints, how could it fail to be fundamental?

But the principle is suspect on methodological grounds, since it rules out a view that seems coherent and even somewhat plausible.[31] One might think that no fact of the form $\neg\neg\neg A$ is fundamental, on the grounds that such facts are metaphysically explained by facts of the form $\neg A$. At the same time, one might be impressed by the difficulty of giving explanations of certain facts of the form $\neg A$—the fact that a given electron is not located at a given region, for example—and thus be led to take these facts to be fundamental. Even though this view is not obviously correct, it is not without its attractions. Our very theory of fundamentality should not rule it out. But the view is incompatible with this principle. For if $\neg A$ is a fundamental fact, then surely its constituents are fundamental as well; otherwise it could not 'carve reality at the joints'. And since $\neg\neg\neg A$ is built up from those same constituents, the principle requires that $\neg\neg\neg A$ must also be a fundamental fact, which is just what the view denies.

I therefore do not think these considerations of constituent-fundamentality give us reason to doubt the fundamentality of our laws. But the laws might be thought derivative all the same, on the grounds that they involve operators whose variables range over derivative things. Take *Fusion*, for example. At least on the natural way of understanding the general connection between location and fusion, its scope is not in any way restricted. The locations of the parts explain the location of the whole, whether those parts are electrons or elephants.

[31] The following example is due to Fine (2013), who also gives a second example with the same structure. See Sider (2013) in reply.

To be sure, we are not forced by our explanation in §1.6 to take the $\ll$ operator in *Fusion* to range over derivative things. We might restrict its range to electrons and to regions of space, for instance, and still give much the same strongly fundamental explanation of the location of the mereological fusion of *a* and *b*. But such a restriction would be pointless and, at any rate, is not available in all cases. It is pointless because *Fusion* involves the fusion function, which maps objects to their fusions, and so in stating *Fusion* we must make general reference to electron-fusions anyway. And it is not available in all cases because we *must* take the $\ll$ operator in *Fusion** to range over some electron-fusions: the fusion of *a* and *b*, for instance. Our strongly fundamental explanation of *c*'s location requires this.

Our view, then, requires general reference to derivative things at the fundamental level. Is this objectionable?

First of all, the admission of §1.6's laws as fundamental need not commit us to the fundamentality of just any law that makes general reference to derivative things. For example, we need not admit as fundamental the unsightly law

$$Fx \ll_{xF} (Fx \wedge Fx) \vee \neg(Fx \vee Fx).$$

It is perfectly open to us to take this law to be derivative as long as we offer a strongly fundamental explanation of it. Admittedly, I have no general way of judging whether a fact, be it a law or some other kind of fact, is fundamental, but in this I am hardly alone. We have no choice but to adjudicate fundamentality case by case.

But though nothing forces us to take all laws to be fundamental, one might still object to the fundamentality of even the laws of §1.6. For if these laws are fundamental, then in order to describe fundamental reality one must, in some sense at least, talk about derivative things like battles, elephants, and novels. And one might think the fundamental facts simply cannot make reference of any kind to the derivative.

It is clear that some kinds of reference to the derivative are objectionable. We should certainly reject any view on which the fundamental facts make *singular* reference to a derivative thing like Stonehenge. And some kinds of *general* reference to the derivative are also objectionable. Suppose it is a fundamental fact, for example, that absolutely everything, Stonehenge included, is self-identical. As we saw in §1.5, there is reason to take this universal generalization to be metaphysically explained, at least in part, by a fact involving Stonehenge. Since this latter fact is derivative, we must take a fundamental fact to be explained by a derivative one. But that is surely impossible. This generalization, then, cannot be fundamental after all.

But laws of metaphysics are a different kind of general fact. We saw in §1.5 that they are not explained by facts about what they make general reference to. In stating *Crimson*, for instance, we must make general reference to the many crimson things in the world. But *Crimson* is not explained, even in part, by facts about these individual crimson things. So although our laws do make general reference to derivative things, there is no danger that by accepting them as fundamental we will render the fundamental explanatorily dependent on the derivative. In my view, once this aspect of laws is appreciated the apparent objection to their fundamentality dissolves.[32]

Although there is more to be said on this issue, I cannot discuss it fully here. I will simply conclude by suggesting that, far from being a liability, the laws' reference to the derivative turns out to be a great strength.

It stands in need of explanation why there are any derivative facts at all. Why aren't there just the fundamental facts? Why are there battles, elephants, and novels, rather than just atoms and void? We often explain the notion of fundamental reality in intuitive terms by saying that all God had to do in order to create the world was fix the fundamental facts. It is in order to ask: if that's all God did, why are there any further facts? There ought to be an answer.[33]

If there are fundamental laws of metaphysics of the sort we have described, then an answer can easily be given. For it is plausible that it will lie in the nature of any explanatory connection that if the connection and a suitable explanans obtain, then a suitable explanandum will obtain. It is in the nature of the 'law of toxicology', for instance, that if the law obtains and someone drinks hemlock, then that person will die. So too will it lie in the nature of *Fusion* that if *Fusion* obtains, and facts about some objects' locations obtain, then so will a fact about their mereological fusion's location. And this, it seems, can only be due to the way in which *Fusion*'s $\ll$ operator links objects and their fusions.

Since among the fundamental facts are *Fusion*, *a*'s location and *b*'s location, the fundamental facts will by their nature require that the fusion of *a* and *b* have a certain location—a fact which is not among the fundamental facts. The fundamental facts will therefore by their nature require that a further fact obtain.

[32] Do we face a further objection to the fundamentality of a law whose $\ll$ operator binds a variable that ranges *exclusively* over derivative things? If one took all fusions to be derivative, *Fusion** would be such a law. Would this law then involve a derivative thing, *viz.*, a certain *class* or *set* of fusions? I do not think so. It certainly would not involve such a thing in our sense of 'involve'. Nor does there appear to be any other sense in which it would involve such a thing. For one might take the law to obtain and yet refuse to countenance classes or sets in one's ontology. And so it is hard to see how there could be a sense in which the law would involve any such thing. I thank an anonymous referee for drawing my attention to this matter.

[33] I am indebted to Jonathan Schaffer here.

But this further fact is required only as a result of *Fusion*'s general reference to derivative things.

One might, of course, have hoped to maintain a certain austere vision of fundamental reality as entirely 'self-contained'. But it seems such austerity must be given up if we are to explain why there are any derivative facts at all. There must be something within the fundamental facts themselves that requires the existence of further facts. And this is just what our laws of metaphysics provide.

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References

Audi, P. (2012a). 'A clarification and defense of the notion of grounding'. In F. Correia and B. Schnieder (eds.), Metaphysical Grounding: Understanding the Structure of Reality, pp. 101–21. Cambridge: Cambridge University Press.

Audi, P. (2012b). 'Grounding: Toward a theory of the in-virtue-of relation'. Journal of Philosophy **109**(12): 685–711.

Bennett, K. (2011). 'By our bootstraps'. Philosophical Perspectives **25**: 27–41.

Dasgupta, S. (2014). 'The possibility of physicalism'. Journal of Philosophy **111**(9): 557–92.

deRosset, L. (2013). 'Grounding explanations'. Philosophers' Imprint **13**(7): 1–26.

Dorr, C. (MS). To be F is to be G.

Fine, K. (2001). 'The question of realism'. Philosophers' Imprint **1**(1): 1–30.

Fine, K. (2010). 'Towards a theory of part'. Journal of Philosophy **107**(11): 559–89.

Fine, K. (2012). 'Guide to ground'. In F. Correia and B. Schnieder (eds.), Metaphysical Grounding: Understanding the Structure of Reality, pp. 37–80. Cambridge: Cambridge University Press.

Fine, K. (2013). 'Fundamental truth and fundamental terms'. Philosophy and Phenomenological Research **88**(3): 725–32.

Fine, K. (2015). 'Identity criteria and ground'. Philosophical Studies.

Hempel, C. G. and Oppenheim, P. (1948). Studies in the logic of explanation. Philosophy of Science **15**(2): 135–75.

Jenkins, C. (2011). Is metaphysical dependence irreflexive? Monist **94**(2): 267–76.

Kitcher, P. (1981). 'Explanatory unification'. Philosophy of Science **48**(4): 507–31.

Lewis, D. (1983). New work for a theory of universals. Australasian Journal of Philosophy **61**(4): 343–77.

Litland, J. E. (2013). ‘On some counterexamples to the transitivity of grounding’. Essays in Philosophy **14**(1): 19–32.
Nozick, R. (1981). *Philosophical Explanations*. Cambridge,MA:Harvard University Press.
Raven, M. J. (2012). ‘In defence of ground’. Australasian Journal of Philosophy **90**(4): 687–701.
Rayo, A. (2013). *The Construction of Logical Space*. Oxford: Oxford University Press.
Rosen, G. (2010). ‘Metaphysical dependence: Grounding and reduction’. In B. Hale and A. Hoffmann (eds.), *Modality: Metaphysics, Logic, and Epistemology*, pp. 109–35. Oxford: Oxford University Press.
Schaffer, J. (2009). ‘On what grounds what’. In D. J. Chalmers, D. Manley, and R. Wasserman (eds.), *Metametaphysics: New Essays on the Foundations of Ontology*, pp. 347–83. Oxford: Oxford University Press.
Schaffer, J. (2010). ‘Monism: The priority of the whole’. *Philosophical Review* **119**(1): 31–76.
Sider, T. (2011). *Writing the Book of the World*. Oxford: Oxford University Press.
Sider, T. (2013). ‘Reply to Kit Fine’. *Philosophy and Phenomenological Research* **88**(3): 738–46.
Strevens, M. (2008). *Depth: An Account of Scientific Explanation*. Cambridge, MA: Harvard University Press.
Wilsch, T. (2015). ‘The nomological account of ground’.
Wilson, J. (2014). ‘No work for a theory of grounding’. Inquiry **57**(5–6): 535–79.