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Humean Scientific Explanation

Elizabeth Miller

In a recent paper (2012), Barry Loewer attempts to defend Humeanism about laws of nature from a charge that Humean laws are not adequately explanatory. Central to his defense is a distinction between *metaphysical* and *scientific* explanation: even if Humeans cannot offer further metaphysical explanations of particular features of their "mosaic," that does not preclude them from offering scientific explanations of such features.

According to Marc Lange (2013), however, Loewer's distinction is of no avail. Defending a *transitivity principle* linking scientific explanantia to their metaphysical grounds, Lange argues that a charge of explanatory inadequacy resurfaces once this intuitive principle is in place.

This paper lays out, on the Humean's behalf, some options for responding to Lange's criticism. After introducing Humeanism (§1) and the disagreement between Loewer and Lange (§2), I survey three strategies for Humeans hoping to reply to Lange's allegation of explanatory inadequacy (§3, §4, and §5). The moral: Lange's criticism does not bolster his anti-Humean convictions with an argument from premises that those not already sharing in his convictions must accept.

This debate between Lange and Loewer brings into focus some questions of general interest. One concerns varieties of explanation: How should we understand the relationship between metaphysical explanation and explanation of other sorts, including scientific explanation? Another concerns the character and commitments of Humeanism: What should Humeans make of talk of "grounding"? That is, what form does Humeanism, typically expressed in terms of supervenience, take in a philosophical context in which grounding is a central notion? Although this paper mostly raises rather than answers such questions, it offers some insight into what hangs on various choices we might make between competing candidate answers.

1 Humeanism about laws

Humeanism, a contemporary philosophical orientation incorporating Hume's fabled squeamishness about "fundamental necessity in nature" (Loewer 2012, p. 116), can be expressed as a conjunction of two supervenience theses (Maudlin 2007, p. 51; cf. Lewis 1994a). One expresses Humeanism about laws: the laws, and all other physical facts, supervene on the complete intrinsic global physical state of the world—the entirety of space-time. There can be no difference in the laws at two worlds without a corresponding difference in their global states.[1]

The other thesis characterizes the world bearing its global state as a "mosaic" of individuals bearing separable local states: the global state of the world supervenes on the distribution of qualities across localized individuals in space-time, plus some relations linking them. The emphasis here on qualities—intrinsic, categorical properties—manifests a characteristic Humean distrust of metaphysical necessity. Roughly, the qualities had by one individual are entirely internal to it, placing no logical or metaphysical constraints on the qualities had by any entirely distinct individual (Loewer 2012, p. 116). That is, the metaphysically possible distributions of qualities across two distinct individuals are just the combinatorial possibilities—there is no threat of cross-individual conflict or constraint.

The conjunction of these theses expresses a view that, roughly put, distinguishes some special individuals, which we can think of as the tiles of the mosaic, and identifies the qualities wholly internal to each tile, plus some privileged relations between them. Once we fix the distribution of relevant qualities and relations across the tiles, we thereby fix all the physical facts in this sense: there cannot be a

[1] As Maudlin points out, and as a referee helpfully reminds me, Humeans need to say something more about what this complete global physical state of the world includes, so as, roughly put, to preclude simply building the laws themselves into the global physical state. Maudlin's proposal: "The intrinsic physical state of the world can be specified without mentioning the laws (or chances, or possibilities) that obtain in that world" (2007, p. 52). Note, too, that the two theses of Humeanism can come apart, which generates some subtleties. For example, one might accept the first thesis, taking the laws to supervene on the global physical state, without endorsing supervenience of this global physical state on separable qualitative states of, and some relevantly privileged relations linking, localized individuals. While my primary concern here is with supervening Humean laws, all the positions I will sketch are open to Humeans endorsing both theses.

difference in these facts without a difference in the distribution of the qualities and relations over these elements of the space-time mosaic.

David Lewis's particular brand of Humeanism places further restrictions on the character of the Humean mosaic (Lewis 1983, 1986; Hall 2012; Lower 2012). Lewis trims down the supervenience base for the laws and other physical facts, restricting the relevant individuals to point-sized ones—either points of space-time or individuals occupying those points—and restricting the relevant relations to purely spatio-temporal or geometrical ones. Note that Lewisians need not say the only facts are facts about the qualities of point-sized individuals and their arrangement. In fact, Lewisians who believe some (perhaps all) collections of space-time points have mereological fusions certainly grant that there are non-pointy individuals. Rather, the key claim is that facts about these other individuals supervene on facts about the qualities and arrangement of point-sized elements of the mosaic: there can be no difference in any facts obtaining at two worlds without some difference in the qualities instantiated at or geometrical relations among space-time points in these worlds.[2] Most importantly for present purposes, there can be no difference in the physical laws without a corresponding difference in the space-time mosaics.

On Lewis's own Humean best system account of laws, the laws supervene on the mosaic because the laws are special systematic generalizations about the mosaic (Lewis 1994a, pp. 478-80; Loewer 2004, p.1118; Loewer 2012). On Lewis's view, some proper subset of all the facts, or true propositions, about the mosaic will stand out insofar as its members jointly pin down the features of things more efficiently than the members of any other subset, optimally balancing simplicity and informativeness.[3] The generalizations within this special subset are the laws.

A contrasting anti-Humean conception treats laws as further facts not fully supervening on facts about the actual features of non-nomic entities. Motivating the anti-Humean's denial of supervenience

[2] If two worlds are isomorphic with respect to space-time structure and the distribution of qualities, then all the same facts hold in those worlds, with one caveat: someone sympathetic to this background picture might want to modify it slightly to allow for haecceitistic differences between the worlds.

[3] I am taking facts to be true propositions, but there are open questions about the metaphysical status of facts (and propositions) in general, as well as disagreement about whether facts so understood can be the relata of grounding relations—contrast Rosen (2010) and Fine (2012) on this point.

may be a background picture on which laws are constraints on, rather than summaries of, actual history: anti-Humean laws "*produce* or *govern* and thereby *explain* the evolution of events" (Loewer 2012, p. 118; his emphasis). A related anti-Humean charge is that the Humean conception of laws fails to provide the Humean with sufficient explanatory resources. Tim Maudlin articulates one version of this criticism:

> If the laws are nothing but generic features of the Humean Mosaic, then there is a sense in which one cannot appeal to those very laws to *explain* the particular features of the Mosaic itself: the laws are what they are in virtue of the Mosaic rather than vice versa. (2007, p. 72; his emphasis; cf. Armstrong 1983, p. 40.)

Instances of laws are among the facts about particular features of the mosaic on which the law themselves, as mere generalizations about the mosaic, supervene. As a result, we might be inclined to say, as Maudlin does, that the laws are what they are partly in virtue of, or because of, these instances—the instances in some sense explain the laws. But then, the worry goes, the laws cannot also help explain their instances, for, allegedly, this would amount to the instances helping to explain themselves, which really would be no explanation at all. The problem, though, is that we do expect laws to help explain their instances. We expect, for example, to explain the fact that some particular white substance burns with a yellow flame by reference to the law that all sodium burns yellow (Lange 2013).

2 Loewer and Lange on self-explanation

Loewer's defense against the foregoing criticism draws on a distinction between metaphysical and scientific explanation.[4] On his view, a metaphysical explanation (of the relevant sort) is one "in which a type of fact—say mental facts—is shown to be grounded in or constituted by some other kind of fact—say neurological fact[s]" (2012, p. 131). The fact that a complex physical system has some mental

[4] Loewer's terminology can be somewhat confusing, as it can seem to suggest that scientists are exclusively interested in "scientific" explanations, even though science may sometimes underwrite what Loewer classifies as "metaphysical" ones. Really, Loewer is gesturing towards a distinction between two answers we might give to a "why?" question, such as, when considering some ice, "Why is this sample of H_2O solid?" One sort of answer, the metaphysical one, explains the fact that the ice is solid by citing more fundamental facts about, for instance, the present structural arrangement and attributes of the molecules in the sample. The other sort of answer, the scientific one, cites facts about the earlier temperature and features of some water sample and the changing environmental conditions, as well as some laws relating these facts to the present state of the sample.

property may be grounded in, may obtain in virtue of, facts about the neurological features of its parts. The fact that the substance in my glass is clear and liquid may be partly grounded in the fact that the substance is H_2O, along with various environmental facts about, among other things, the temperature and pressure in the room.

Loewer's so-called "scientific" explanations are different: "Scientific explanation of a particular event or fact need not show that it is grounded in a more fundamental event or fact but rather, typically, shows why the event occurred in terms of [temporally] prior events and laws" (2012, p. 131). For instance, we may scientifically explain the fact that some rock nears the ground with momentum *p* by citing facts about its mass and about the forces acting on it, plus some laws of nature, but we need not, in offering this scientific explanation, invoke the metaphysical grounds of any explanans—such as facts about the rock's microphysical composition that might help ground facts about its mass.

According to Loewer, once we distinguish these two varieties of explanation, we see that the charge of self-explanation does not pose a genuine threat to Humeanism. For although Humean laws are metaphysically explained by facts about the mosaic, they still may scientifically explain their instances. That is, there is no tension between the following three theses, even when we link instances of laws themselves to the cited facts about the mosaic metaphysically explaining those laws:

> LAWS SCIENTIFICALLY EXPLAIN A law helps *scientifically* explain its instances.
> NO SELF-EXPLANATION No fact helps *scientifically* explain itself.
> MOSAIC GROUNDS A law is *metaphysically* explained by facts about the mosaic.

According to Loewer, the mere appearance of tension arises only when we conflate two notions of explanation that are properly distinct.

As I have stated it here, the thesis of MOSAIC GROUNDS is amenable to two readings, two ways of explicitly linking the law-grounding facts about the mosaic to instances of laws. While it is not entirely clear which Loewer prefers, both readings can set the stage for self-explanation worries along the lines of Lange's reply to Loewer. To distinguish these readings, it will be helpful to appeal to Lange's notion of "local Humean facts," facts about the features of particular individuals in space-time that serve as a supervenience base for the Humean laws (2013, p. 258). Humeans sympathetic to Lewis's particular

conception of the mosaic might restrict these to facts about the distribution of qualities across only point-sized individuals. Lange opts for a more permissive approach on which facts about non-point-sized but localized individuals, such as samples of sodium, also count among the local Humean facts. I will follow suit, as all Lange needs to get his criticism going is the claim that instances of some Humean laws are among the local Humean facts, however conceived—and I will suppose Humeans will grant this, even though they might prefer to take a law concerning point-sized entities, rather than larger samples of sodium, as their paradigmatic example of one whose instances count among the local Humean facts.[5]

The local Humean facts constitute a supervenience base for Humean laws. On the first reading of MOSAIC GROUNDS, moreover, the local Humean facts collectively ground the laws, so each local Humean fact helps ground them. On the alternative reading, the laws are not, or may not be, grounded directly in the local Humean facts but instead are grounded in some mediating global fact or facts, intuitively about the *entire* mosaic. Apparently, this is the reading Lange prefers; he characterizes Humean laws as grounded in "a giant fact capturing the complete Humean mosaic," such as some global conjunctive fact C (2013, p. 258). Lange then takes a further step: C "holds in virtue of various local Humean facts" it conjoins, including instances of the laws. Since Lange does not explicitly affirm the transitivity of grounding or partial grounding (cf. Schaffer 2012), he does not conclude that an instance of a law thus helps ground the law, but those who do so have an even easier route to Lange's self-explanation objection, converging with the first reading of MOSAIC GROUNDS.

We can incorporate the key aspects of both readings of MOSAIC GROUNDS, in a way that sets the stage for Lange's reply, with a replacement:

[5] Alternatively, Humeans may restrict local Humean facts to facts about point-sized individuals and take as their paradigmatic example Lange's law that all sodium burns yellow, even though instances of that law are not, strictly speaking, among the local Humean facts. Then they can say the law and its instances have common grounds in the local Humean facts, using Lange's transitivity principle to generate the conclusion that some local Humean facts both help scientifically explain and ground the law's instances. In order to generate self-explanation, they need some additional principle, such as: whatever helps scientifically explain some fact helps scientifically explain the grounds of that fact, too.

INSTANCES GROUND There are some laws such that an instance of such a law either helps metaphysically explain the law or helps metaphysically explain fact C about the mosaic, which in turn metaphysically explains that law.

Given Loewer's distinction between metaphysical and scientific explanation, there still is no explicit conflict between this new thesis, LAWS SCIENTIFICALLY EXPLAIN, and NO SELF-EXPLANATION. Lange insists, however, that there is a serious tension lurking just beneath the surface. For he takes Loewer's two varieties of explanation to be linked by a transitivity principle:[6]

> If E scientifically explains [or helps to scientifically explain] F and D grounds [or helps ground] E, then D scientifically explains [or helps to scientifically explain] F. (2013, p. 256; bracketed remarks his.)

In rough slogan form: *a metaphysical ground of whatever scientifically explains (or helps scientifically explain) some fact at least helps scientifically explain that fact, too*. So, for instance, according to this principle the grounds of facts about a rock's mass do help scientifically explain the rock's behavior, even if we do not explicitly appeal to those grounding facts in our "scientific" account of the rock's fall to the earth.

Of central importance for Lange, though, are not grounds of facts about particular features of such cases but grounds of general laws to which we might appeal in scientific explanations of them. Take, as Lange's example of the sort of law described by INSTANCES GROUND, the law that all sodium burns yellow. By LAWS SCIENTIFICALLY EXPLAIN, the law that all sodium burns yellow is supposed to help scientifically explain the fact that some particular sample burns yellow. According to Lange, the Humean law is grounded in global fact C and so, by his transitivity principle, C helps scientifically explain the fact that the substance burns yellow. But this very fact, among the conjuncts of C, helps ground C, and so, by another application of Lange's transitivity principle, helps scientifically explain

[6] Lange's transitivity principle links explanations of distinct sorts (scientific and metaphysical explanations); note that it is distinct from any principle affirming the transitivity of a single kind of explanatory relation, such as metaphysical explanation—as I mentioned above, Lange may not affirm the transitivity of (partial) grounding, itself.

whatever C explains. That is, the fact that this substance burns yellow helps scientifically explain the fact that the substance burns yellow.[7]

There is an even more direct route to self-explanation for those who opt for the other disjunct in INSTANCES GROUND, skipping mediating appeal to C. The law that all sodium burns yellow is supposed to help scientifically explain the fact that some particular substance burns yellow. The fact that this particular substance burns yellow, as an instance of the law, helps ground the law, so, by the transitivity principle, it helps scientifically explain the fact that this particular substance burns yellow.

Either way, then, Lange's transitivity principle extracts an explicit contradiction from a suspected tension between the bottom-up metaphysical explanation of Humean laws and top-down scientific explanations of their instances:

> LAWS SCIENTIFICALLY EXPLAIN A law helps scientifically explain its instances.
> NO SELF-EXPLANATION No fact helps scientifically explain itself.
> INSTANCES GROUND There are some laws such that any instance of such a law either helps metaphysically explain the law or helps metaphysically explain fact C about the mosaic, which in turn metaphysically explains that law.
> TRANSITIVITY Whatever metaphysically explains or helps metaphysically explain some fact [a law, or global fact C] helps scientifically explain whatever the fact helps scientifically explain.

There are three strategies available to Humeans wishing to maintain that laws can be scientifically explanatory (LAWS SCIENTIFICALLY EXPLAIN) in the face of Lange's challenge. These correspond to three ways of thinking about the grounding relations linking Humean laws and their instances, all of which are consistent with the theses of Humean supervenience—to my knowledge, these have not been explicitly distinguished in the literature. *Groundless* Humeans reject INSTANCES GROUND because they deny there are any relevant relations of metaphysical dependence linking laws and their instances (§3). *Bottom-up* Humeans retain INSTANCES GROUND but challenge one or both of TRANSITIVITY and NO SELF-EXPLANATION (§4). *Contrarian* Humeans, like their groundless counterparts, reject INSTANCES GROUND

[7] To clarify: the focus here is on circularity arising when laws themselves feature among our scientific explanantia. As I discuss in §5, related concerns can arise with explanatory appeals to metanomological facts, such as the fact that L is a law, as well.

but for a different reason: they claim that either the laws themselves or some other global facts grounding the laws help ground their instances (§5).

3 Groundless Humeanism

Before plunging headlong into the dispute between Loewer and Lange, Humeans should note an early choice point: Will they even countenance a relevant notion of grounding, granting that instances of laws or other facts about the Humean mosaic help ground, in this sense, Humean laws? Lewisians, for instance, and others with a general distrust of fine-grained modal or hyperintensional notions, may wish to part ways with Lange *and* Loewer early on. These groundless Humeans can grant there is some weak sense in which Humean laws are "fixed by" the mosaic, but they will balk at any suggestion that laws are grounded in the mosaic in the sense of being what they are *because* of or *in virtue of* prior facts about the mosaic—and so will reject INSTANCES GROUND.

Why do Loewer and Lange both seem to take for granted the premise that Humean laws are grounded in facts about the mosaic? Perhaps one reason is the asymmetric supervenience between Humean laws and facts about the mosaic, including C and the local Humean facts subsumed therein. Any difference in the laws indicates some difference in the distribution of relevant qualities and relations across elements of the mosaic, but the opposite is not true: two worlds differing at least somewhat with respect to their across-mosaic distributions nonetheless may share the very same general laws. It may be a law in multiple worlds that all sodium burns yellow, for instance, even though the worlds differ with respect to how much sodium they contain.

But those—anti-Humeans and Humeans alike—who take Lange's transitivity principle to *generate* problematic self-explanation for Humeans must have something more than this asymmetry in mind. For if asymmetric supervenience really were the only thing at issue, then some cases in which one fact's obtaining is a necessary precondition for but does not ensure the obtaining of another would already generate trouble apart from any considerations about the character of laws. Consider a world consisting of some yellow particles in empty space. According to the laws for this world, each particle is yellow

until it collides with another, at which point it becomes (and remains) excited and acquires a chance, greater than zero and less than one, of turning red after some post-collision interval of time. Suppose particle *a* collides with its neighbor, becomes excited, and subsequently turns red at *t*. The fact that particle *a* was involved in a collision prior to *t* supervenes on the facts that *a* is excited at *t* and that *a* turns red at *t* (plus the laws): if *a* had not been involved in an earlier collision, it would not have been both excited and red at *t* (unless the laws were also different). The opposite is not true: *a* could have failed to turn red despite the fact that it was involved in an earlier collision. Since a particle just gains some post-collision chance of turning red, two worlds that agree that *a* (or *a*'s counterpart) was involved in a collision prior to *t* still may disagree with respect to some facts about *a*'s excitement state and color at *t*.

If asymmetric supervenience established grounding of the sort at issue, then the facts about *a*'s excitement state and color at *t* would help ground the fact that particle *a* was involved in a collision prior to *t*—or, alternatively, would help ground a conjunctive fact in turn grounding the fact that particle *a* was involved in a collision prior to *t*. But, plausibly, the fact that particle *a* was involved in a collision prior to *t* also should help scientifically explain, in Loewer's sense, the facts that *a* is excited at *t* and that *a* turns red at *t*. By Lange's transitivity principle, then, these facts about *a*'s excitement and color at *t* should help scientifically explain themselves. That is, if grounding were just a matter of asymmetric supervenience, then this would already be a case of partial scientific self-explanation, regardless of what we say about laws.

One upshot is that those who take seriously Lange's principle and related worries about scientific self-explanation must be operating with a more robust notion of grounding. Like Loewer, they are not concerned with mere covariation between facts but with the idea that one fact ultimately is "constituted by" or holds in virtue of some metaphysically prior fact (2012, p. 131; cf. Rosen 2010 and Fine 2012). The laws must count as somehow metaphysically secondary to prior facts about the mosaic in which they are, allegedly, grounded. A second upshot is that Humeans wary of grounding in this sense can, in fact, skirt much of the Loewer-Lange kerfuffle, since without a sufficiently robust notion of grounding, Lange's self-explanation criticism is a non-starter. Such groundless Humeans simply deny that the local

Humean facts themselves or the conjunction C subsuming them grounds or helps ground the laws.[8] These Humeans insist that their commitments to patterns of covariation between the local Humean facts and laws bring no commitment to the thesis that other facts about the mosaic are metaphysically prior to the laws.

Someone sympathetic to the basic self-explanation worry might object that this is all a bit too quick, for even if there is not grounding per se linking Humean laws to their instances, surely there is some intimate relation between generalization and instance that might generate problematic circularity when we attempt to explain an instance in terms of a general law, a part in terms of a whole. But for groundless Humeans who deny there are robust relations of metaphysical dependence linking laws to their instances, there is nothing antecedently more problematic about explaining particular facts about some part of the mosaic in terms of generalizations about the whole than explaining the generalizations about the whole in terms of particular facts about its parts. Now, lurking in the background at this point might be a different sort of worry: maybe *none* of this is explanatory. Maybe groundless Humeans, with a metaphysics entirely lacking in grounding relations, cannot offer any genuine explanations linking laws and instances. At the end of the next section (§4), I offer some general comments about the character of

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[8] Lewis describes natural properties and relations as "fundamental," and he also sometimes uses the language of "reduction," which may seem to suggest that he is committed to, or at least motivated by, a background picture on which some local Humean facts are prior grounds of other facts, even if official statements of his Humean doctrine (cf. 1986, 1994a) merely invoke supervenience. Ned Hall directs me to the following passage, however:

> Imagine a grid of a million tiny spots—pixels—each of which can be made light or dark. When some are light and some are dark, they form a picture, replete with interesting intrinsic gestalt properties. The case evokes reductionist comments. Yes, the picture really does exist. Yes, it really does have those gestalt properties. However, the picture and the properties reduce to the arrangement of light and dark pixels. They are nothing over and above the pixels. They make nothing true that is not made true already by the pixels. They could go unmentioned in an inventory of what there is without thereby rendering that inventory incomplete. And so on.
>
> Such comments seem to me obviously right. The picture reduces to the pixels. And that is because the picture supervenes on the pixels: there could be no difference in the picture and its properties without some difference in the arrangement of light and dark pixels. Further, the supervenience is asymmetric: not just any difference in the pixels would matter to the gestalt properties of the picture. And it is supervenience of the large upon the small and many. In such a case, say I, supervenience is reduction (Lewis 1994b, p. 294).

Here, Lewis clearly states that reduction, in his sense, just *is* asymmetric supervenience of the sort familiar from his doctrine of Humean supervenience—he, at least, means nothing stronger.

Humean explanation relevant to this concern. For now, though, notice that this is not a worry about self-explanation in particular, but an expression of a more general conviction about the nature of explanation.[9]

4 Bottom-up Humeanism

If we take its defining characteristic to be a suspicion of "necessary connections between distinct existences," then commitment to Humeanism does not preclude engagement with a robust notion of grounding (Loewer 2012, p. 116 fn. 2). For the Humean, laws and local Humean facts or their conjunction need not be relevantly distinct in the sense that Humean laws are, roughly speaking, generalizations over the local Humean facts. If they wish, then, Humeans may consistently endorse INSTANCES GROUND, joining Loewer in describing laws as derivative on facts about the mosaic—and so taking laws, as generalizations about the whole mosaic, either to be grounded in the local Humean facts directly or to be grounded in a mediating global fact C, itself grounded in the local Humean facts.

Now, strictly speaking, bottom-up Humeans who endorse INSTANCES GROUND and who wish to claim laws are fully grounded in the totality of local Humean facts or in C also will need to include among or subsume within their preferred full grounds the fact that everything is part of the global space-time mosaic. This sort of totality fact is needed to rule out a case in which an indistinguishable counterpart of the actual mosaic is a proper part of what exists in some other world and so furnishes only partial grounds of the laws in that world—laws that may differ from the laws in the actual world because they summarize not only facts about the counterpart of the actual mosaic but some additional local Humean facts. The worry is that this possibility is incompatible with the actual local Humean facts or their conjunction fully grounding the laws, since there is some world in which these facts hold but the laws differ. In order to rule out this possibility while retaining the theses of Humean supervenience and

[9] For the sake of completeness, it is worth noting that Humeans somewhat sympathetic to groundless Humeanism could, at least in theory, deny INSTANCES GROUND and evade Lange's criticism while still retaining some of the grounding relations described by that thesis: they could grant that C grounds the laws but reject relations of grounding between the local Humean facts and C, or they instead could allow that the local Humean facts help ground C but reject relations of grounding between C and the laws. The key would be to motivate the move from supervenience commitments to grounding claims in one case but not the other.

affirming INSTANCES GROUND, Humeans can expand their inventory of privileged relations borne by elements of the mosaic.

By endorsing INSTANCES GROUND, bottom-up Humeans open themselves up to Lange's objection, but they may have the resources to resist his criticism. In slogan form, Lange's transitivity principle says a metaphysical ground of whatever scientifically explains (or helps scientifically explain) some fact at least helps scientifically explain that fact, too. Note that this principle rules out the possibility of even an anti-Humean law being partially grounded in facts about the mosaic—along with, perhaps, some "further facts" conferring on relevant generalizations some privileged nomological status. It also conflicts with certain background metaphysical pictures divorced from direct concern with the character of laws. For one, it rules out any view on which even the partial metaphysical grounds of scientifically explicable physical facts are facts about something—God, say—that cannot figure in any scientific explanation. In addition, it rules out a metaphysics of robust "levels" of reality on which a lower-level entity is not the right sort of thing to figure in a scientific explanation of a higher-level phenomenon, perhaps because higher-level facts fail to supervene on—and thus are robustly "over and above," even if they may be partially grounded in—lower-level ones. Granted, such metaphysical stories are not going to appeal to Humeans who go in for the idea that all facts supervene on facts about a single level of physical individuals, but these examples illustrate that Lange's principle is not only problematic for Humeans.

There also are some cases wholly compatible with Humean commitments that arguably make trouble for the transitivity principle. These are somewhat similar to cases invoking robust levels of reality, but Humeans appealing to them will reject commitment to metaphysical irreducibility incompatible with the supervenience of all physical facts on the Humean mosaic. Instead, Humeans will take the relevant examples to be ones in which we cite what are in some sense higher-level or general scientific explanantia, even though these cited facts are wholly metaphysically grounded in other facts about the mosaic. Importantly, these are cases in which, arguably, particular grounding facts about the mosaic are incidental to what is being explained.

For example, suppose that the fact that James the snail is in biological state B at t_1 helps scientifically explain the fact that particle q in James's brain is in an excited state at t_2. But now also suppose biological facts are distinct from but wholly grounded in facts concerning the instantiation of properties described by fundamental physics. More specifically, the fact that James the snail is in biological state B at t_1 is grounded in facts about the arrangement of some relevant particles, and so perhaps, to follow Lange's preferred structure, a conjunctive fact specifying the locations of these particles at t_1. So now either the fact that p is at l itself helps ground the fact that James the snail is in state B, or the conjunctive fact, which in turn is partly grounded in the fact that particle p is in location l, does. Either way, it follows from Lange's transitivity principle that the fact that particle p is in location l at t_1 helps scientifically explain the fact that particle q in James's brain is in an excited state at t_2.

But suppose the fact that p is in location l at t_1 is compatible with any number of biological states obtaining at t_1—since p could very well stay in the same location while other particles were rearranged. In addition, the fact that James the snail is in biological state B at t_1 is compatible with p's failing to be in location l at t_1—for James could be in the same biological state if another particle were at l instead. Then even though the fact that James is in B at t_1 helps scientifically explain the fact that q is excited at t_1, we might doubt the conclusion, licensed by the transitivity principle, that the fact that p is in location l at t_1 helps scientifically explain the fact that q is excited at t_2. After all, the fact that p is in location l is compatible with any number of facts about James's biological state at t_1, and the fact that James is in biological state B at t_1 likewise is compatible with any number of facts about the location of p at t_1.

Second, consider a case from statistical mechanics. Suppose we cite the fact that the air in the room is at temperature T at t_1 as part of the scientific explanation of the condensation on my glass, and thus the fact that a droplet slides down the side of the glass with velocity v at t_2. The fact that the air in the room is at temperature T at t_1 is grounded in a conjunctive fact characterizing the state of each of the particles in the room, describing them as together instantiating one of the various microstates compatible with the air in the room being at T. That fact, in turn, is partly grounded in the fact that particle r has a particular kinetic energy K at t_1. But the fact that the air in the room is at temperature T is consistent with

any number of microstate facts and so any number of facts about *r*'s specific kinetic energy. In addition, *r*'s having kinetic energy *K* is likewise compatible with many different macrostate facts, since the temperature in the room depends on the kinetic energies of many other particles as well. In this case we might doubt, despite the dictates of Lange's transitivity principle, that the fact that *r* has kinetic energy *K* at t_1 helps scientifically explain the fact that the droplet slides down the side of the glass with velocity *v* at t_2.

These examples share three features. (i) First, they are cases offering what are, in some sense, general or higher-level scientific explanations, insofar as the cited explanantia are, it seems, distinct from but grounded in more specific or lower-level facts. For example, we cite the fact that James is in biological state *B* at t_1 as part of the scientific explanation of the fact that *q* is excited at t_2, even though this explanans is either grounded, in part, by the fact that *p* is at *l*, or is grounded in a conjunctive fact concerning the arrangement of fundamental particles in James, which in turn is partly grounded in the fact that *p* is at *l*. (ii) Second, they are cases in which cited explanatory general facts are multiply realizable and so compatible with the failure of some actually obtaining lower-level facts (Putnam 1967; Fodor 1974). For example, James could still be in biological state *B* at t_1 if not particle *p*, but some other particle, were in location *l*. (iii) Third, they are cases in which some particular cited lower-level facts are consistent with multiple incompatible higher-level facts. For instance, *p* could still be in location *l* if James were in a different biological state altogether at t_1—other particles would just have to be in different locations.[10]

Now for the key move: for bottom-up Humeans, many cases of scientific explanation citing best system laws to account for particular instances of those laws share these features. (i): Bottom-up Humeans take Humean laws cited in such explanations either to be grounded in the local Humean facts or to be grounded in a conjunctive fact C, which is in turn grounded in the local Humean facts. (ii): The

[10] While those convinced of the futility of attempts at interlevel or intertheoretic reduction—I have in mind views discussed by Fodor (1974), Nagel (1998), and Batterman (2002), among others—may be more open to these sorts of examples, the force of such cases is not tied to such non-reductive metaphysical convictions.

laws underdetermine the features of the mosaic, insofar as the laws are generalizations over instances—we could have the very same laws, the same generalizations, even if the space-time mosaic were somewhat different. (iii): Single local Humean facts underdetermine those laws, in the sense that the laws require the truth of generalizations over the whole mosaic, rather than just the truth of some particular instances.

What should Humeans take to be the bearing of these cases? Humeans can pursue a two-pronged strategy here: It is not clear exactly what Loewer and, by association, Lange have in mind when they deem some fact "scientifically" explanatory, but we can distinguish more restrictive accounts and more permissive accounts of what it takes for some fact to be scientifically explanatory in the relevant sense. On a more restrictive account, the transitivity principle is suspect. On a more permissive account, the prohibition on partial self-explanation is suspect. Either way, then, the conjunction of TRANSITIVITY and NO SELF-EXPLANATION—on which Lange's argument rests—is suspect.

The first possibility is that these cases demonstrate failures of the transitivity principle and so the falsehood of TRANSITIVITY in Lange's inconsistent tetrad. Behind this line of thought is an intuition that sometimes higher-level or general facts about or features of systems are explanatorily relevant in ways their lower-level or specific counterparts are not, and, moreover, that the counterparts in such cases may not even help with the relevant explanations. Someone sympathetic to this idea would say, for instance, that it is that fact that James is in state B, but not a fact about the particular location of particle p, which scientifically explains the later state of q. Or, for another example, it is the fact that this salt exhibits some general structural character common to water-soluble compounds, and not the fact that it has some very particular microphysical character, which explains its dissolution in water.

Bottom-up Humeans who want to make this move may admit that a higher-level or structural property can be realized in multiple ways, and they may grant that it is convenient to characterize, for instance, the structural property M of solubility disjunctively, as that of having microphysical character m_1, or having microphysical character m_2, or . . . . A fan of grounding and of the transitivity principle will want to move from this disjunctive characterization to the conclusion that one disjunct—that expressing

the actually instantiated microphysical properties of our salt sample—helps scientifically explain the dissolution: *What it is* for this particular salt to have structural feature *M* is for it to be in microphysical state m_1, so how could the microphysical state *not* be explanatory?

At least arguably, though, the salt's microphysical features count as irrelevant to its solubility once we take into account facts about the salt's structural character. Perhaps, then, the fact that the salt is in state m_1 does not even help scientifically explain, in the relevant sense, its dissolution (cf. Yablo 1992 and Strevens 2004). Similarly, bottom-up Humeans who want to reject the transitivity principle in order to answer Lange's charge should say that the general law that all sodium burns yellow may help scientifically explain some instance of that law, even though any particular instance of that law—including the very one to be explained—is similarly explanatorily irrelevant to the explanandum.

To be fair, there is an added complication in making this sort of move in the case of laws. Maybe it is plausible that particular facts about *p*'s location at t_1–which help ground facts about James's state *B*—are explanatorily irrelevant to the state of *q* at t_2, since the facts about *p*'s location at t_1 could be the same even if the facts about *q*'s state at t_2 were different, and the facts about *q*'s state at t_2 could be the same even if the facts about *p*'s location at t_1 were different. But something parallel cannot be said when explaining an instance in terms of a Humean law: it is not the case that the facts about this sample of sodium's color upon burning, which help ground the law that all sodium burns yellow, could stay the same even if facts about this very sample's color upon burning were different. So even if Lange's principle is not valid in general, perhaps it still holds in cases that matter for the Humean.

To disagree, Humeans must resist the suggestion that this sort of counterfactual covariation is a sure-fire indication of explanatory relevance. Here is one thought along these lines: when we offer a law as part of the scientific explanation for some instance, we are focusing on certain general or generalizable features in order to subsume it under some larger organizational structure—akin to focusing on the salt's macrostructure rather than its microstructure. That it is this particular flame and this particular sodium at this particular point in space-time are irrelevant to the explanation the general law provides in the case. Thus any particular instance of a law, even the very instance to be explained, does not contribute to the

law's general explanation of the instance, just as facts about the microstructure of some salt sample do not contribute to an explanation of its behavior offered partly in macroscopic terms. To fail to appreciate this point is to fail to recognize the general character of laws. Of course, we also seek to explain particular features of cases, but perhaps we manage to do this work in our explanations by counting facts about other particular features of the mosaic among our additional explanantia. That this particular salt burns yellow at this particular point in space-time has something to do with what just happened at some other particular points in space-time—the striking of a match at some moment, its interaction with some earlier temporal stage of the sodium sample, and so on. But there is no threat of *self*-explanation here.

Now, Humeans who wish to reject the transitivity principle in order to answer Lange's charge will want to further motivate the claim that the transitivity principle fails in cases in which we cite laws to explain their instances, since they need not say (i)-(iii) describe sufficient conditions for a failure of transitivity. The suggestion, though, is that once they appreciate the fact that at least some cases with features (i)-(iii) are problematic for Lange's principle, and once they appreciate the fact that explanatory appeals to laws with which Lange is concerned share features (i)-(iii), these Humeans may be able to make a principled case for resisting deliverances of the transitivity principle that serve as the basis for Lange's criticism.

Note also that the strategy of opposing the transitivity principle should not only be attractive to bottom-up Humeans who share Lange's uneasiness about scientific self-explanation, since Lange's principle poses trouble for Humeanism going beyond worries about self-explanation in particular. If the transitivity principle holds in general, then the fact that this substance burns yellow should be partly scientifically explained by any other instance of the general law that all sodium burns yellow—for example, the fact that the flame in some fire in a salt mine five hundred years ago burned yellow. In fact, any local Humean fact that helps ground the law or C should help explain this instance. Many bottom-up Humeans will not want to bite this bullet, and so will have reason to mount a quite general attack on the transitivity principle.

Alternatively, or in addition to challenging Lange's transitivity principle, bottom-up Humeans can allow that scientific explanatoriness of Loewer's sort does sometimes transfer to the metaphysical grounds of explanantia, perhaps even in cases exhibiting features (i)-(iii). Maybe the fact that *p* is in location *l* at t_1 does help scientifically explain, if only in some rather attenuated sense, the fact that *q* is in an excited state at t_2—this option may look especially appealing to those operating with a more permissive background picture of what it takes for a fact to be scientifically explanatory. Humeans who are willing to grant this will also need to maintain, in reply to Lange, that a fact can help scientifically explain, in a parallel sense, itself—denying NO SELF-EXPLANATION.

Consider a universe consisting of thirteen particles and fluctuating between two states, S_1, in which exactly seven of those particles are blue, and S_2, in which exactly seven are green. Suppose that, in both cases, every particle is either blue or green, but there are no further facts about which individual particles will be blue or green, except for this: whenever the universe is in state S_1, then at least one of *a* and *b* is among the seven blue particles. It seems we might offer a scientific explanation of the fact that *a* is blue in part by citing the fact that the universe is in state S_1.[11] But, plausibly, the fact that *a* is blue still could help ground the fact that the universe is in state S_1; what it is for the universe to be in state S_1 in this instance is for it to contain exactly seven blue particles, with *a* among them. So perhaps, as the transitivity principle dictates, the fact that *a* is blue helps scientifically explain itself.

A more general but related worry concerns cases in which we want to at least help explain the fact that a particular individual has some feature by citing the fact that all individuals of a relevant sort have this feature: this particular atom has mass *m* because all hydrogen atoms have mass *m*, for instance. It seems we might be interested in including this sort of claim in a larger explanatory story regardless of

[11] Since Loewer characterizes scientific explanations as "typically" explaining the fact that some event occurred at a time by citing a fact about the state of the world at a *different* time (2012, p. 131), someone might resist the suggestion that this example counts as a case—or at least a typical case—of scientific explanation in Loewer's sense. The more crucial point, though, is that this seems to be an example of *some* sort of top-down *non*-grounding explanation compatible with a bottom-up direction of grounding. (Note also that Lange's favored example of scientific explanation—explaining the color of a flame by citing a law plus the fact that the burning substance is sodium—does not involve appeal to any earlier states of the world, either.)

our view about the nature of laws, but Lange's prohibition on self-explanation rules this out, at least given the assumption that the fact that this atom has mass *m* can *help* ground the fact that all atoms of the relevant sort have mass *m*, plus his transitivity principle.[12]

Now maybe what a defender of Lange should say in reply is that these and earlier cases, all of which allegedly make trouble for one or both of Lange's prohibition on partial scientific self-explanation and his transitivity principle, really appear problematic only because they rely on *anti*-Humean intuitions or smuggle in some metaphysical baggage inconsistent with Humeans' or at least bottom-up Humeans' antecedent commitments. In other words, perhaps Humeans in general, or at least bottom-up Humeans in particular, are wedded to the conjunction of TRANSITIVITY and NO SELF-EXPLANATION. Maybe the fact that James is in state *B*, the fact that the universe is in state S_1, and the fact that all hydrogen atoms have mass *m* can play some privileged explanatory roles only if these facts fail to be relevantly fixed by—supervenient on or grounded in—corresponding particular facts allegedly underlying them. Likewise, perhaps appeals to general laws can provide special explanatory insight that outstrips whatever insight might be provided by their more particular counterparts—their individual instances, or conjunctions of these instances—only if the laws fail to supervene on, or at least fail to be grounded in, the local Humean facts or their conjunction.

This objection can sound quite compelling against a certain background conception of scientific explanation: one on which offering an explanation for some fact involves showing why that fact had to obtain given some facts about, and perhaps further constraints on, the metaphysical structure of reality. This naturally suggests that if the laws provide some explanatory insight outstripping that provided by their individual instances, or a conjunction of these instances, then the laws have to possess some metaphysically robust features underwriting this explanatory insight that are not fixed by features of their

[12] As Bernhard Nickel and Alex Silk have emphasized to me, however, this sort of consideration will not be universally compelling, for one might insist that a general fact, such as the fact that all hydrogen atoms have mass *m*, can be genuinely explanatory only if it is not even partly grounded in its particular instances.

more particular instances—so there is a clear link between a law's privileged role in scientific explanation and its metaphysical priority.

However, an alternative conception of scientific explanation, friendlier to Humeanism, allows that explanation is sometimes a matter of uncovering mere patterns or regularities in reality, and then classifying particular facts as instances of these patterns. If we adopt this sort of picture, we still can grant that there is a sense in which Humean laws—and even patterns more generally—have some explanatory force that outstrips the explanatory force attaching to even a conjunction of their instances. Laws gain a special explanatory status in virtue of their privileged standing in a systematization of the local Humean facts. They offer a special sort of top-down insight, explaining their instances by highlighting general structural features of the global mosaic and then classifying instances within that structure (cf. Kitcher 1989).[13]

But this sort of top-down explanatory insight at least seems to be compatible with standard Humean supervenience claims and even with bottom-up Humeans' grounding claims. Compare: we might offer an explanation of some element in a mathematical series by revealing a general pattern linking its component terms without thereby being committed to the view that the pattern fails to supervene on these particular elements—that any alteration of the whole pattern must correspond to a change in some particular term in the series—or even to the view that facts about the whole series cannot be grounded in relevantly prior facts about its particular elements. Likewise, Humeans can argue that there is nothing particularly metaphysically worrying about laws, as elements of an organizational structure, possessing explanatory power that outstrips the power attaching to the disparate facts they unify, and bottom-up Humeans, in particular, can go on to challenge Lange's dual commitment to the transitivity principle and the principle that no fact can help scientifically explain itself, even while maintaining that Humean laws are grounded in local Humean facts or in their conjunction.

[13] Loewer, for instance, claims that Humean laws "explain by unifying" (1996, p. 113). Thanks to Ned Hall for many helpful discussions of related points.

One final note about the commitments of bottom-up Humeanism. Strictly speaking, bottom-up Humeans who wish to maintain INSTANCES GROUND while answering Lange need only challenge the conjunction of TRANSITIVITY and NO SELF-EXPLANATION, and so, if they wish, may still maintain one or the other conjunct individually. Retaining Lange's transitivity principle, in particular, might not be a viable option, however, if doing so required bottom-up Humeans to grant not only that a fact can help scientifically explain itself but also that a fact can fully scientifically explain itself. And so it may seem as though Lange misses an opportunity by focusing on explanations of individual instances, and so partial grounds, of laws, instead of considering a consequence of the transitivity principle concerning full grounds: since, according to bottom-up Humeans, C fully grounds the laws, if the laws together also fully scientifically explain C, then it should follow from Lange's principle that C fully scientifically explains itself.

Humeans, however, will not agree that the laws fully scientifically explain C if doing so amounts to granting that these laws can pin down all features of the space-time mosaic—after all, Humeans allow that different mosaics can share the same laws. A modified version of the challenge loosens the requirement that the laws scientifically explain all the particular features of the mosaic, insisting instead that they explain just some select general features common to any mosaic sharing these laws. But now the explananda may be too general rather than too specific: for Humeans may not wish to grant that laws do fully scientifically explain such general facts. For one thing, at least some of the facts at issue will be the very laws themselves. For another, if Humean laws count as explaining in virtue of bringing to bear some systematization of global features on particular parts of the mosaic, this sort of systematizing explanation may not be available when it comes to accounting for very general features of the mosaic: the laws will not subsume global patterns themselves under global patterns. One upshot is that if Humeans are right about what laws are, laws themselves may help scientifically explain their individual instances, and perhaps even conjunctions of those instances, without fully explaining some generalizations about the

global mosaic—Humeans may take this to be a feature rather than a bug of their explanatory picture, however.[14]

5 Contrarian Humeanism

So far I have described two ways in which Humeans may conceive of relations of grounding linking laws and their instances. Groundless Humeans say there are no such relations, denying INSTANCES GROUND. Bottom-up Humeans agree with Lange that instances of Humean laws help ground either those laws or global fact C, which in turn grounds the laws, but they suggest that metaphysical and scientific explanations may nonetheless "run in different directions," despite Lange's protestations to the contrary, by casting doubt on one or both of TRANSITIVITY and NO SELF-EXPLANATION (2013, p. 258). There is also a third option: some Humeans may deny INSTANCES GROUND not because of groundless Humeans' squeamishness about grounding but because of a *contrarian* attitude towards some of the relations of grounding posited by INSTANCES GROUND. These contrarian Humeans may say, for example, the laws actually help ground their instances, rather than those instances, or some conjunctive fact subsuming them, grounding the laws.

This contrarian suggestion may seem to be a total non-starter thanks to a now familiar asymmetry captured by the Humean supervenience theses: If there can be a difference in the local Humean facts without any difference in the laws, how can the laws help ground the local Humean facts? The key insight is that Humeans can distinguish between the local Humean facts and a distinct set of global facts, and then explain the patterns of supervenience between the laws and the local Humean facts in terms of the relations of both of these to the global facts.

Humeans have a choice when it comes to characterizing global facts and their relations to the laws. On the first option, the global facts include conjunctions of local Humean facts, including our familiar fact C, as well as generalizations about the entire mosaic—such as the fact that everything *F* is *G*.

[14] A referee suggests that even these Humeans might still want to insist that metanomological facts, such as the fact that it is a law that all sodium burns yellow, can scientifically explain such generalizations, including the laws themselves—I touch on this issue in §5.

So the laws, on this picture, are members of a privileged proper subset of these global facts. We then can express Humean commitments in terms of supervenience or necessary covariation between facts of these various sorts. More specifically, Lewis (1986) takes all the global facts, including the laws, to supervene on the local Humean facts. He also takes the local Humean facts to fail to supervene on the laws—the laws are limited generalizations of the local Humean facts and so under-specify them. Presumably, though, he does take the local Humean facts to supervene on the global facts. Any difference in the global facts will have to correspond to some difference in the local Humean facts, and any difference in the local Humean facts will have to correspond to some difference in the global facts.

Since there is symmetrical supervenience between global facts and local Humean facts, we can go on to ask which of these ground the others. Humeanism is sometimes characterized as a reductive metaphysical view. There is one weak way of understanding this in terms of supervenience, which even groundless Humeans can endorse: Humean laws supervene on local Humean facts, but not vice versa. A somewhat stronger way, in terms of bottom-up Humeans' notion of grounding, says the laws themselves, or at least some global facts grounding the laws, are grounded in the local Humean facts.

Contrarian Humeans, though, can retain standard Humean supervenience claims while reversing the direction of grounding between local Humean facts and global facts—taking the global facts to ground the local Humean ones. These contrarians thus deny that either C or the laws are grounded in even all the local Humean facts taken together. Instead, the local Humean facts are grounded in a larger collection of global facts, including both C and the laws (or, if they prefer, a conjunctive fact subsuming these other global facts).

Such contrarian Humeans can explain the one-directional supervenience of the laws on the local Humean facts by citing the metaphysical dependence of local Humean facts on the larger set of global facts. So just as a bottom-up Humean does not expect that, in general, a proper subset of the local Humean facts, rather than all of them together or their conjunction, will alone ground the laws, the contrarian Humean does not expect that some proper subset of the global facts—namely, the laws—will alone ground all local Humean facts. The mistake, according to the contrarian, is the slide from the

observation that the laws by themselves fail to constitute a supervenience base for the local Humean facts to the conclusion that the laws therefore cannot *help* ground those facts.

Adoptees of a slightly weaker form of contrarianism do not insist that the laws themselves help ground their instances but instead reject INSTANCES GROUND with the thought that laws and local Humean facts share common grounds. One option along these lines is to take both the laws and the local Humean facts to be wholly grounded in global fact C. Another option—also open to those uncomfortable with conjunctive facts (cf. Audi 2012)—begins with a conception of global facts not as conjunctions of or generalizations over local Humean facts but as facts citing the instantiation by the entire mosaic of global properties, such as, roughly, the fact that *the mosaic* has the property of having *F*-ness instantiated at (x_1, t_1), *G*-ness instantiated at (x_2, t_2), . . . , and also the fact that the whole mosaic has the property of being such that all its *F*-instantiated elements are also *G*-instantiated ones (Schaffer 2010, p. 59). Note that many such facts should be unproblematic for Lewisians who take the mosaic to be a feature-bearing mereological sum of space-time points. Note also, however, that the global facts so conceived will need to include the fact that the whole mosaic has the property of being such that everything is a part of it—contrarians opting for this conception of global facts will need to modify their supervenience base accordingly, just as those opting for the earlier conception must, along with bottom-up Humeans, accommodate their own sort of totality fact (§4).

On this second variety of contrarianism, general laws are not, or at least need not be, members of a strict subset of the global facts, but instead can count as distinct from but grounded in such facts. Contrarian Humeans who opt for this route can deem the asymmetric supervenience between the laws and the local Humean facts a result of their common grounding in these global facts. Since the laws are grounded in the global facts, but the global facts are not grounded in local Humean facts, laws can help scientifically explain their instances without generating partial scientific self-explanation. It does follow on this view that laws may not be able to scientifically explain the grounding global facts themselves, but, again, this may not be a great loss from the point of view of Humeans who see laws as explaining their instances by fitting them into global patterns (§4).

Relatedly, contrarian Humeans of both stripes should give some thought to the explanatory role of *meta*nomological facts. What fact do I cite when I appeal to a law in the course of a scientific explanation of some yellow flame? It might just be the law itself, the fact that all sodium burns yellow. But I might also invoke, in addition, the metanomological fact that *it is a law that* all sodium burns yellow. The second option can seem to pose a special challenge for contrarians: if the metanomological facts are themselves distinct from but partly grounded in the laws or some other global facts, then the fact that it is a law that all sodium burns yellow arguably cannot help explain the law that all sodium burns yellow—assuming, that is, that both the transitivity principle and the principle that no fact can help explain itself hold. So one could, at least in theory, choose to explain each instance of law L by reference to the fact that L is a law, but not explain L itself by reference to that fact, on pain of generating partial meta-self-explanation.

This concern about metanomological facts is closely connected to the earlier concern that Humean laws fail to explain many global generalizations (including themselves), even though they explain instances of those generalizations (§4). But just as in the earlier case, at least some Humeans may deny there is a deep problem here, for it is far from clear that, for Humeans, the fact that L is a law should have any further explanatory force beyond that already attached to L. Note that this issue is distinct from the issue of whether laws have explanatory force beyond that of accidental generalizations. Humeans think that laws, unlike other true generalizations, have special explanatory force in virtue of their privileged role in the best system. But Humeans may already marshal this systematizing explanatory force when bringing a law itself to bear in some case; the fact that it is a law may report or reiterate this force without adding to it.[15]

By making the contrarian move, Humeans abandon suppositions about grounding that might otherwise seem attractive. For example, they deny that all conjunctions are grounded in their conjuncts

[15] But contrarian Humeans who have reservations about this consequence (cf. Lange 2009, p. 301) should join their more traditional counterparts in reevaluating the transitivity principle and the principle that no fact can help explain itself—and, as already noted, Humeans have other reasons to be wary of these principles.

and that all generalizations are grounded in their instances—in fact, they take grounding to run the other way in some important cases. However, the contrarian move has benefits as well as costs. For one, it offers a way of making sense of the intuition that a universal generalization is more than a mere conjunction of claims, each of which describes a single instance (Russell 1919, p. 200). It also gives robust metaphysical expression to what I suggested is the top-down explanatory character of the Humean best system account (§4). Now, I also suggested that Humeans can reap benefits of this explanatory character, casting doubt on Lange's argument, without taking up a contrarian metaphysical stance. So the top-down explanatory character of Humean best system laws does not in any way require a revisionary, top-down account of metaphysical explanation. The contrarian move is not a necessary component of every satisfactory response to Lange; it is, rather, a central component of one possible interesting response.

Contrarian Humeanism is also of broader interest, regardless of what we think of Lange's argument. For the debate about the metaphysical character of laws has traditionally been one about supervenience: Humeans think all physical facts, including nomological facts, supervene on the local Humean facts, while anti-Humeans allow that there may be non-supervening nomological facts. But there are also some interesting, more complex distinctions to explore between anti-Humeanism and what appear to be *varieties* of Humeanism, with Humeans united on questions of supervenience but divided on questions of grounding.[16]

References

Armstrong, D. (1983) *What is a Law of Nature?* Cambridge: Cambridge University Press.
Audi, P. (2012). Grounding: Toward a theory of the *in-virtue-of* relation. *Journal of Philosophy*. 109(12), 685-711.

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Batterman, R. (2002). *The devil in the details: Asymptotic reasoning in explanation, reduction, and emergence*. Oxford: Oxford University Press.
Fine, K. (2012). Guide to ground. In F. Correia and B. Schneider (Eds.) *Metaphysical grounding: Understanding the structure of reality* (pp. 37-80). Cambridge: Cambridge University Press.
Fodor, J. (1974). Special sciences (Or: The disunity of science as a working hypothesis). *Synthese* 28(2), 97-115.
Hall, N. (2012). David Lewis's metaphysics. In E. Zalta (Ed.) *The Stanford Encyclopedia of Philosophy* (Fall 2012 Edition) <http://plato.stanford.edu/archives/fall2012/entries/lewis-metaphysics/>.
Kitcher, P. (1989). Explanatory unification and the causal structure of the world. In P. Kitcher and W. Salmon (Eds.) *Scientific explanation* (pp. 410-505). Minneapolis: University of Minnesota Press.
Lange, M. (2009). Why do the laws explain why? In T. Handfield (Ed.) *Dispositions and causes* (pp. 286-321). Oxford: Oxford University Press.
Lange, M. (2013). Grounding, scientific explanation, and Humean laws. *Philosophical Studies* 164, 255-261.
Lewis, D. (1983). New work for a theory of universals. *Australasian Journal of Philosophy* 61(4), 343-377.
Lewis, D. (1986). *Philosophical papers:Volume II*. Oxford: Oxford University Press.
Lewis, D. (1994a). Humean supervenience debugged. *Mind* 103(412), 473-490.
Lewis, D. (1994b). Reduction of mind. Reprinted in D. Lewis (1999) *Papers in metaphysics and epistemology: Volume II* (pp. 291-324). Cambridge: Cambridge University Press.
Loewer, B. (1996). Humean supervenience. *Philosophical Topics* 24(1): 101-127.
Loewer, B. (2004). David Lewis's Humean theory of objective chance. *Philosophy of Science* 71(5), 1115-1125.
Loewer, B. (2012). Two accounts of laws and time. *Philosophical Studies* 160, 115-137.
Maudlin, T. (2007). *The metaphysics within physics*. Oxford: Oxford University Press.
Nagel, T. (1998). Reductionism and antireductionism. In G. Bock and J. Goode (Eds.) *The limits of reductionism in biology* (pp. 3-13). Chichester, NY: Wiley.
Putnam, H. (1967). Psychological predicates. In W. Captain and D. Merrill (Eds.) *Art, mind, and religion* (pp. 37-48). Pittsburgh: University of Pittsburgh Press.
Rosen, G. (2010). Metaphysical dependence: grounding and reduction. In B. Hale and A. Hoffman (Eds.) *Modality: Metaphysics, logic, and epistemology* (pp. 109-136). Oxford: Oxford University Press.
Russell, B. (1919). The philosophy of logical atomism. *The Monist* 29(2): 190-222.
Schaffer, J. (2010). Monism: The priority of the whole. *Philosophical Review* 119(1), 31-76.
Schaffer, J. (2012). Grounding, transitivity, and contrastivity. In F. Correia and B. Schneider (Eds.) *Metaphysical grounding: Understanding the structure of reality* (pp. 122-138). Cambridge: Cambridge University Press.
Strevens, M. (2004). The causal and unification approaches to explanation unified—causally. *Noûs* 38(1), 154-176.
Yablo, S. (1992). Cause and essence. *Synthese* 93, 403-449.