Composition as Identity, Leibniz's Law, and Slice-Sensitive Emergent Properties

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1. INTRODUCTION

Composition as identity, I am convinced, expresses a deep truth about the structure of reality. But even among its adherents, there is little agreement as to just what that truth is. In an earlier paper (Bricker 2016), I developed and endorsed a "moderate" version of composition as identity according to which there is a generalized identity relation, "being the same portion of reality," of which composition and numerical identity are distinct species. Composition is a genuine *kind* of identity, I claimed, but it is not numerical identity; for unlike numerical identity, it fails to satisfy Leibniz's Law. *Prima facie* counterexamples to composition satisfying Leibniz's Law abound. For example, a composite whole and its parts differ with respect to their *numerical properties*: the whole is numerically one; the parts (collectively) are numerically many. That a genuine identity relation can fail to satisfy Leibniz's Law is controversial, to be sure. Many philosophers and logicians take Leibniz's Law to be constitutive of identity. There is a risk, then, that disagreements over composition as identity will devolve into terminological disputes. The moderate theorist, therefore, has the burden of saying why composition should be classified with numerical identity as a genuine identity relation, and not with relations that are "identity in a loose and popular sense," such as so-called "qualitative identity." Whether and how that can be done will be one of the topics of this paper.

Strong versions of composition as identity, in contrast, have no truck with kinds of identity that fail to satisfy Leibniz's Law. The strong theorist holds: the whole is identical with the parts that compose it; therefore, the properties of the whole do not differ from the properties

of the parts taken together. The strong theorist has the burden of somehow showing that the offending numerical properties do not provide counterexamples to Leibniz's Law, perhaps because they are relations in disguise. In my earlier paper (Bricker 2016: 276-80), I argued that various strategies for defending the strong theory are incompatible with taking the framework of plural logic to be fundamental.[1] As a second topic of this paper, I consider whether there is a version of strong composition as identity that evades my earlier argument, a version that formulates composition as identity within the framework of plural logic, but claims nonetheless that a composite whole and its parts taken together have all of their genuine properties in common. I believe that there is such a view, and that it is the most formidable version of strong composition as identity. It holds that, *at the fundamental level*, portions of reality have mereological, but not plural, structure. Although there is a fact of the matter as to whether a

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[1] A similar argument was given in Sider (2007). But Sider (2011: 208-15) now rejects the argument because he no longer takes the framework of plural logic to be fundamental. I claim below that there is a crucial ambiguity in what it means to take the framework of plural logic to be "fundamental." In any case, however, I do not see how composition as identity can even be formulated properly without the use of plural logic. Using schematic letters in place of plural variables weakens the theory, and introduces an irrelevant dependence on language. Using quantification over sets (or classes) in place of plural quantification, as was done in early presentations of classical mereology (Tarski 1937) also weakens the theory (since not all pluralities form sets), and introduces an irrelevant dependence on sets, something I find especially problematic. For I prefer the reverse reduction of sets to plural logic over the reduction of plural logic to set theory. See Bricker (forthcoming, chapter 1).

portion of reality is composite or atomic, there is no fact of the matter as to whether it is plural or singular. This will need some explaining.

It turns out that these two topics merge into one. The propped-up moderate theory is just the new version of the strong theory in disguise. But however one characterizes the view, I am inclined to reject it. The main issue, we shall see, has to do with whether *slice-sensitive emergent properties* are possible. I will argue that they are, making use both of specific examples and general principles of modal plenitude. I do not claim that my argument against this version of composition as identity is irresistible. But it cannot be evaded as easily as a related argument against strong composition as identity given by Kris McDaniel (2008). I take a detailed look at McDaniel's argument to pave the way for my own argument.

2. Leibniz's Law

Leibniz's Law is a principle of the logic of identity. As traditionally understood, it applies to individuals: *x* is identical with *y* if and only if *x* and *y* have all of their properties in common. Here 'property' must be understood in an *abundant* sense: for any things, there is at least one property had by all and only those things.[2] Call this identity relation between individuals *singular identity*.

Leibniz's Law can be extended naturally to *plural identity*, where a plurality *xx* is identical with a plurality *yy* if and only if every one of *xx* is one of *yy* and every one of *yy* is one

[2] On abundant vs. sparse conceptions of properties, see Lewis (1986: 59-63).

of *xx*.[3] Here '*xx*' and '*yy*' are plural variables that range indifferently over individuals and pluralities; but to save words, I will count an individual as a plurality of one so that I can just say that plural variables range over pluralities. Properties of pluralities—*plural properties*—apply collectively, not distributively. And again, 'property' must be understood in an abundant sense: for any pluralities of things, there is at least one property had by all and only those pluralities.[4] I can now introduce an important distinction for what follows among plural properties: a plural property is *slice-sensitive* iff it holds of *xx* but not of *yy*, for some *xx* and *yy* that have the same fusion.[5]

Let us say that singular and plural identity are forms of *numerical* identity. Because plural variables range over both individuals and pluralities of individuals, plural identity subsumes singular identity, and Leibniz's Law for plural identity entails Leibniz's Law for singular identity. We could, then, just take Leibniz's Law for plural identity as our basic principle of the logic of identity. We could even eliminate singular variables and quantifiers

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[3] Pronounce '*xx*' as "the *x*'s" if you like. Although 'plurality' is grammatically singular, it is important not to think that, on my usage, a plurality is a single set-like object.

[4] Those who do not accept plurally plural quantification will have to approximate this using quantification over classes (taking properties of pluralities to apply to the corresponding classes): for any class of classes, there is a least one property had by all and only the members of that class of classes.

[5] I use 'slice' broadly: whenever *xx* composes *y, xx* give a way to "slice" *y*, whether or not *xx* overlap. I use 'fusion' and 'compose' to denote the same relation: *y* is the fusion of *xx* iff *xx* compose *y*.

altogether. But it will be more convenient to stick with the standard formulation of plural logic that contains both singular and plural variables, and to formulate Leibniz's Law in a way that allows it to apply to a wider range of purported identity relations. We can do this most easily by using schematic variables **x** and **y** that can be replaced by either singular or plural variables, and letting 'is identical with' take either singular or plural arguments. We can then express Leibniz's Law as a schema:

> **Leibniz's Law**. For any **x** and any **y**, **x** is identical with **y** if and only if **x** and **y** have all of their properties in common.

Note that Leibniz's Law, so formulated, includes *four* instances, two of which mix singular and plural variables. That requires that it be meaningful to ask whether one thing is identical with two or more things. But accepting the Leibniz's Law schema does not prejudge whether one thing is ever identical with two.

We can now make good sense of the claim that composition fails to satisfy Leibniz's Law. When we put composition in place of identity, one of the instances is this: for any *xx* and any *y*, *xx* compose *y* if and only if *xx* and *y* have all of their properties in common. Composition fails to satisfy Leibniz's Law if this instance is false. And *prima facie* it *is* false. Consider, for example, a deck of cards. The cards compose the deck, but although the cards are 52 in number, the deck is not 52 in number. But perhaps this "first appearance" is deceiving.

In this paper I will be concerned just with the left-to-right direction of Leibniz's Law, the principle of the *indiscernibility of identicals*. (Indeed, some philosophers take Leibniz's Law to be just the left-to-right direction.) The indiscernibility of identicals needs to be distinguished

from the linguistic principle, the *substitutivity of identicals*, which can fail with respect to a language whose predicates do not express genuine properties, or express different properties in different linguistic contexts. For example, the substitutivity of identicals fails with respect to English. From "Shorty is so-called because of his size" and "Shorty is identical with Frankie," one cannot conclude "Frankie is so-called because of his size." But that failure does not challenge the indiscernibility of identicals: the predicate 'is so-called because of his size' does not express a genuine property, but rather a relation. (Or, if 'express' is understood so that it does express a property, it expresses different properties in different linguistic contexts.) What the genuine properties are, and what exemplifies those properties, is a matter of the structure of reality; it is a matter of metaphysics, not language. Whether an application of Leibniz's Law is legitimate, then, is also a matter of metaphysics, not language. Return to the example of the deck of cards, and the swift argument from an instance of Leibniz's Law to the conclusion that the cards are not identical with the deck. That is only a legitimate application of Leibniz's Law if 'are 52 in number' expresses a genuine property. And to determine whether or not that is so, we must look to the fundamental structure of reality, not the grammatical structure of language.

3. Composition as Identity

According to the doctrine of composition as identity, in some sense, a whole is identical with its parts taken together. But in what sense? Adding that the whole "is nothing over and above" its parts is suggestive, but not much more. Saying that a whole and its parts are "the same portion of

reality,"[6] as I do, just raises the question whether being the same portion of reality entails identity. For in English we can say that things are the same *F*—the same color, the same age—without it following that those things are identical. The problem of how to characterize composition as identity is especially acute given that philosophers who espouse composition as identity often appear to have very different doctrines in mind.

We can get a start on distinguishing different versions of composition as identity by asking two questions: first, is the "identity" in question a genuine identity relation? And, second, if it is a genuine identity relation, does it satisfy Leibniz's Law? We can then formulate strong and weak versions as follows, roughly in accord with how these versions are characterized in the literature. *Strong composition as identity* holds that there is only one identity relation, that it satisfies Leibniz's Law, and that whenever some things *xx* compose a thing *y*, *xx* are identical with *y*. *Weak composition as identity* also holds that there is only one identity relation and that it satisfies Leibniz's Law, but it denies that composition literally is or entails identity. Rather, composition is merely analogous to identity in striking and important ways. The version of

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[6] The expression 'portion of reality', as I use it, is a term of art that, although syntactically singular, is semantically neutral with respect to the plural/singular distinction. Talk of "portions of reality" could be regimented within plural logic using the schematic variables introduced above.

composition as identity I call "moderate" is not much discussed in the literature.[7] As I use the term, *moderate composition as identity* holds that there are multiple *kinds* of identity which can be reduced to two basic kinds: numerical identity, which satisfies Leibniz's Law, and generalized identity—same portion of reality—which does not. Whenever *xx* compose *y*, *xx* are identical with *y* according to this latter kind of identity: *xx* are the same portion of reality as *y*. Composition, then, is literally a kind of identity.[8]

I call the view *moderate* because, without Leibniz's Law, it lacks many of the consequences of the strong version some of which, within a framework of plural logic, are clearly false if not outright contradictory. For example, within the framework of plural logic one can derive from composition as identity and substitutivity of identicals the principle known as *Collapse*:

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[7] But cf. Cotnoir (2013), who can be construed as introducing a general identity relation distinct from numerical identity. It is unclear, however, whether he insists that any identity relation satisfy Leibniz's Law.

[8] I prefer to understand strong and moderate composition as identity broadly so that they include much more than what is stated here: they encompass a full theory of the composite nature of reality, including classical mereology. But the additional content will not be relevant here. See Bricker (2016) for the details.

Collapse. *x* is one of *yy* if and only if *x* is part of the fusion of *yy*.[9]

But, surely, the right-to-left direction of Collapse is false: no molecule that is part of the fusion of the cards—that is, is part of the deck—is one of the cards. This gives powerful reason to prefer moderate over strong composition as identity.

In other ways however, moderate composition as identity is not moderate at all. For one thing, it allows that a genuine identity relation can fail to satisfy Leibniz's Law. In this way, it shares at least some of the "strangeness" of Don Baxter's version of composition as identity.[10] For another thing, it allows that *xx* be the same portion of reality as *yy* even though *xx* are not the same plurality as *yy*. In this way, it shares at least some of the "strangeness" of Peter Geach's relative identity according to which *x* can be the same *F* as *y*, but not the same *G*, even though both *x* and *y* are *G*s.[11] But on closer inspection, the association between Baxter's or Geach's

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[9] For arguments that strong composition as identity leads to Collapse, see Yi (1999) and Sider (2007). For further unacceptable consequences of Collapse, see Sider (2014). Yi (2014) considers a related kind of collapse that results when composition as identity is combined with plural logic: generalized identity collapses into plural identity (if both satisfy substitutivity). It then follows that if *xx* are the same portion of reality as *y*, then *xx* are one. And that trivializes strong composition as identity.

[10] For Baxter's groundbreaking approach to composition as identity, see Baxter (1988a) and (1988b).

[11] For Geach's defense of relative identity, see Geach (1967). For discussion and critique, see Perry (1970).

views on identity and moderate composition as identity turns out to be superficial. The moderate theory must be evaluated on its own terms.

4. A Defense of Moderate Composition as Identity

Moderate composition as identity faces the following challenge: *how in the absence of Leibniz's Law can one characterize what counts as a genuine kind of identity?* Unless this challenge can be met, one might wonder whether moderate composition as identity just collapses into weak composition as identity. In my earlier paper, I argued that moderate composition as identity *is* a distinct view, with the power to shape and inform our metaphysical conception of reality; but I despaired of providing an elucidation of the generalized notion of identity that would be of any assistance to someone who claimed not to understand it. In that paper, I bypassed an obvious strategy: perhaps, although generalized identity fails to satisfy Leibniz's Law, it satisfies a *restricted version* of Leibniz's Law; and it is in virtue of satisfying the restricted version that it is appropriately called a genuine identity relation. But what is the right restriction? It won't do just to say that a genuine identity relation satisfies Leibniz's Law restricted to properties that are not *slice-sensitive*; for plural properties are called "slice-sensitive" in virtue of failing to satisfy Leibniz's Law, and we would be going in a circle. But perhaps there is a more informative way to capture the restriction, and thus to characterize what relations are genuine kinds of identity.

To see what I have in mind, consider how David Lewis describes the failure of Leibniz's Law. He writes:

> Even though the many and the one are the same portion of Reality, and the character of that portion is given once and for all whether we take it as many or take it as one, still we do not really have a generalized principle of the indiscernibility of identicals. *It does matter how you slice it—not to the character of what's described, of course, but to the form of the description.* (Lewis 1991, p. 87, my italics)

The italicized sentence suggests two things. First, it suggests that the sought-after restricted version of Leibniz's Law quantifies only over properties that ascribe "character." I take it that the character of a portion of reality supervenes on the fundamental properties and relations had by that portion of reality and its parts, taken singly or plurally. In particular, then, we have the following consequence. Suppose that *xx* and *yy* are the same portion of reality, but that they slice that portion of reality differently. Then: *no fundamental property applies to xx but not to yy*. For if it did, then the character of a portion of reality would depend on how you slice it.

The second thing suggested by the passage from Lewis is this: failures of Leibniz's Law are due to differences in our ways of describing or representing reality, not to differences in reality itself. In my earlier paper, I argued against strong composition as identity on the grounds that the framework of plural logic is fundamental, and so failures of Leibniz's Law that result from logical properties definable from the fundamental relation of plural logic, 'is one of', show that Leibniz's Law fails at the fundamental level. Numerical properties taking plural arguments illustrate this failure. But I now think there are two different notions of "fundamental" at play that my argument conflates. We need to distinguish between what is fundamental *at the level of*

our representations of reality from what is fundamental to reality itself, *at the level of being*.[12] Properties and relations that are fundamental at the level of our representations are *ideologically* basic, but need not be *ontologically* basic. This distinction will have broad application, but it applies first and foremost to logical notions. For example, our representations of reality involve content with Boolean and quantificational structure; and that structure is fundamental at the level of our representations. But, as I see it, there is no Boolean or quantificational structure at the level of being. At the level of being, there is only a pattern of instantiation of fundamental properties and relations. Boolean and quantificational propositions are made true by that pattern. To think that one must posit fundamental Boolean or quantificational structure in reality itself is to hold to a naive picture account of representation.[13]

The passage from Lewis suggests that something similar should be said about the distinction between plural and singular that is fundamental to plural logic. Even if we grant that the framework of plural logic is fundamental at the level of our representations, we need not grant that there is plural structure at the level of being. Propositions that we formulate within a framework of plural logic are made true, somehow, by what is fundamental at the level of being; but the plural structure inherent in those propositions is not mirrored by any corresponding plural structure in reality. Portions of reality, the fundamental existents, are either composite or atomic, but they are not in themselves either singular or plural.

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[12] Compare Jenann Ismael (2015) where this distinction is made in in connection with Humean accounts of laws and chance.

[13] See Bricker (2006) for how this plays out with respect to general propositions.

Let me illustrate the proposed view a bit further. Among the apparatus that we use to represent reality are *structured propositions.* Say that two structured propositions have *the same content* just in case they are true of the same portions of reality. (This notion of "same content" presupposes a plenitudinous reality such as a modal realist accepts; propositions that have the same content are "necessarily equivalent" according to some metaphysical modality.) Since the framework of plural logic is fundamental to our representations of reality, structured propositions can differ in that one involves plural predication, the other singular predication. Consider some (composite) portion of reality; and let *F* be the full intrinsic character of that portion. Then, on the view being considered, the structured proposition that some *x* exemplifies *F* and the structured proposition that some *yy* exemplify *F* are distinct structured propositions that have the same content. The propositions, we might say, differ at the level of representation but not at the level of being. Now, suppose the portion of reality in question is composed of seventeen atoms. Let '*aa*' denote the plurality of atoms: each one of the atoms is one of *aa*. Then it is true to say: *aa* is seventeen in number. Let the fusion of *aa* be *b*. Then it is true to say: *b* is one in number. But there is simply no fact of the matter whether the portion of reality is seventeen in number or one in number. These numerical properties do not supervene on the intrinsic character of that portion of reality.

If we accept this view that plural logic is not fundamental at the level of being, then we have a neat way of characterizing a moderate version of composition of identity that is clearly distinct from weak composition as identity. For we now have a way of saying when a relation is a genuine kind of identity and not just a relation analogous to identity. We have the following analysis:

> **Identity**. A relation taking plural or singular arguments is a *kind of identity* just in case it satisfies Leibniz's Law restricted to properties that supervene on properties and relations that are fundamental at the level of being.

We can still say that the composition relation fails to satisfy unrestricted Leibniz's law: the numerical properties are still around to serve as counterexamples. But because the numerical properties do not supervene on properties and relations that are fundamental at the level of being, they are no threat to composition being a kind of identity. If all slice-sensitive properties similarly fail to supervene and so do not contribute to character, then composition is a kind of identity and moderate composition as identity is vindicated.

5. From Moderate Composition as Identity to Strong Composition as Identity

With a slight change in perspective, however, the moderate theory just presented looks like a version of strong composition as identity in disguise. Let me explain. We are now supposing there is a clear distinction between those features that are fundamental at the level of being, the features that give rise to character, and those features that arise from our representations of reality, including features that depend on our slicing reality in different ways. To get at fundamental ontology, the existents that are fundamental to reality, we need to "factor out" the slice-sensitive features and posit that the fundamental existents have only the features that give rise to character. Considering only these fundamental existents and their properties and relations, it seems that *unrestricted* Leibniz's Law holds after all, at the level of being. For at the level of

being the properties that are putative counterexamples to Leibniz's Law simply do not exist, or at any rate, can be deemed not genuine in the relevant sense. So, on the view being considered, strong composition as identity holds with respect to fundamental reality. Although at the level of representation, there are multiple kinds of identity, at the level of being there is just the one relation of identity that every portion of reality bears to itself. What I called numerical identity turns out to itself belong to our representational apparatus, and so can be deemed non-genuine. This change in perspective turns the usual way of thinking about identity on its head: generalized identity, not numerical identity, is the genuine identity relation.

I asked in the introduction: *is there a version of strong composition as identity that is compatible with taking plural logic to be fundamental?* We now see that that question is ambiguous, and that it is enough if the version of the strong theory is compatible with taking plural logic to be fundamental at the level of representation, fundamental to our *theorizing* about reality. That is all that is needed for strong composition as identity to be properly formulated. It may at first seem odd that strong composition as identity cannot be stated purely in terms that are fundamental to reality, without the aid of plural logic. Composition as identity, then, is a truth that can only be expressed using a representational apparatus that does not accurately mirror reality at the fundamental level. But if I am right that Boolean and quantificational structure are no more mirrored by reality than is plural structure, then all of our theorizing about reality will be in the same boat. If we had to write our theories in terms that are fundamental at the level of being, they would be reduced to infinite lists of particular facts. That's no way to gain insight into the nature of reality.

Call this moderate-cum-strong version of composition as identity ***Mods***. For those sympathetic to the intuitions behind composition as identity, there is a lot to like about **Mods**. It

seems to be a reasonable interpretation of Lewis's remarks, even though Lewis is often taken, wrongly I think, to accept only weak composition as identity.[14] Moreover, it seems to be a natural development of the view of strong composition as identity theorists, such as Einar Bohn, who want to attribute all violations of Leibniz's Law to our ways of representing reality, and not to reality itself. But on the proposed version, unlike Bohn (2014), there is no attempt to avoid violations of Leibniz's Law by introducing an explicit relativization to concepts. That cannot succeed. For one thing, it inevitably mangles plural logic because the fundamental notion of plural logic, is-one-of, is itself slice-sensitive, and would have to be relativized to concepts. For another thing, it raises uncomfortable questions as to what these concepts are, and how they fit into reality. Rather than struggling to avoid violations of Leibniz's Law, **Mods** accepts them, but relegates them to the realm of representation.

Most importantly, **Mods** is not committed to Collapse or any of its nasty consequences because the principle of substitutivity that leads to Collapse does not hold in the plural framework within which the theory is expressed. Granted, in some sense there is a collapse at the level of being. Singular identity, plural identity, and generalized identity all collapse into one. Whenever *xx* and *yy* are the same portion of reality, the proposition that *xx* is plurally identical with *yy* and the proposition that *xx* is the same portion of reality as *yy* have the same content. But there is no collapse at the level of representation. So there is no need to endorse claims formulated in plural logic that are obviously false. Ordinary truths couched within plural logic come out as literally true on the proposed version of strong composition as identity. It's just that

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[14] See Bricker (2016: 280-3) for more discussion of Lewis's view. See also Bohn (2011), who similarly thinks Lewis has been wrongly understood.

differences in these truths sometimes reflect, not differences in fundamental reality, but differences in the representational apparatus we use to describe that reality.

In spite of its many attractions, I reject **Mods**, whether it is taken to be a version of moderate or a version of strong composition as identity. It does not jibe with my conception of reality. The deflationary notion of composition that I accept is essentially intertwined with the notion of plurality. To hold that reality is composite at the fundamental level in the way that I do is just to hold that reality has plural structure through and through. That is not an argument, of course, and need have no force against a proponent of **Mods** who rejects my deflationary notion of composition.

Can I do better? To see how one might formulate an argument against **Mods**, note that **Mods** has implications for emergent properties. Say that a property is *emergent* if and only if it is fundamental (at the level of being) and whether or not it holds of a portion of reality does not supervene on the fundamental properties and relations of that portion's proper parts, taken singly or plurally.[15] According to **Mods**, portions of reality are not plural or singular in themselves. Thus, according to **Mods**, emergent properties of portions of reality are not plural or singular in themselves, but only in how we designate them. An emergent property applies indifferently to a plurality or to the fusion of that plurality. But, then, no emergent property applies to only one of two different pluralities with the same fusion; there are no slice-sensitive emergent properties. This suggests that the best—and perhaps the only—way to argue against **Mods** is to argue that

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[15] Note that this is *strong* emergence, requiring the failure of *logical* supervenience. On strong vs. weak emergence, see Chalmers (2006).

slice-sensitive emergent properties are possible. And that is something, I hope, that even those attracted to **Mods** will feel pressure to accept on independent grounds.

6. McDaniel's Argument Against Strong Composition as Identity

Before turning to my argument against **Mods**, I want to consider a related argument against strong composition as identity in McDaniel (2008). Like me, McDaniel thinks that the possibility of emergent properties can make trouble for strong composition as identity. But McDaniel does not consider—or even allow for—emergent properties that take plural arguments. And for that reason, his argument cannot succeed.[16]

McDaniel begins with some standard terminology. Say that *w* and *z* are *duplicates* iff there is a one-one correspondence between the parts of *w* and the parts of *z* that preserves all perfectly natural properties and relations.[17] (One must add that it preserves the part-whole relation, if that relation is not perfectly natural.) This notion of duplicate can be extended to apply to pluralities in a natural way: *xx* and *yy* are *plural duplicates* iff there is a one-one correspondence between *xx* and *yy* that preserves all perfectly natural properties and relations, and such that corresponding

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[16] Sider (2014) has argued, on different grounds, that McDaniel's argument does not succeed against versions of strong composition as identity that accept Collapse. But Sider's argument does not apply to a version such as **Mods**, which rejects Collapse.

[17] Following McDaniel and Lewisian tradition, I use 'perfectly natural' in phrasing these definitions, instead of 'fundamental'. But note that only properties and relations fundamental at the level of being should count as perfectly natural, and factor into the definition of duplicate.

elements are duplicates of one another. (If the *xx* and *yy* are atomic, the second clause can be dropped.) Now, before going any further I want to flag an important assumption that McDaniel appears to be implicitly making, an assumption that will be crucial in applying the above definitions. It is this: perfectly natural properties are exemplified by individual objects, not by pluralities of objects; perfectly natural relations hold between individual objects, not between pluralities of objects. That, of course, is an assumption I will be at pains to argue against below. The assumption plays a role in judgments as to whether *xx* and *yy* are plural duplicates. Suppose, contrary to the assumption, that there is a perfectly natural property *F* that is exemplified (collectively) by *xx* but is not exemplified by *yy*. Then no one-one correspondence between *xx* and *yy* preserves all perfectly natural properties: *xx* and *yy* are not plural duplicates. And that is as it should be for the strong theorist, since the portion of reality referred to by *xx* does not have the same qualitative character as the portion of reality referred to by *yy*.

After introducing these definitions, McDaniel claims, as the first premise in his argument against strong composition as identity, that the strong theorist will be committed to what he calls the *Plural Duplication Principle:*

> (PDP) If the *xx* compose *w*, the *yy* compose *z*, and the *xx* are plural duplicates of the *yy*, then *w* is a duplicate of *z*.[18]

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[18] This formulation is from Sider (2014). It is more intuitive than McDaniel's formulation, and does not differ in any way relevant to the argument.

McDaniel's argument that the strong theorist is committed to (PDP) invokes Leibniz's Law, and is roughly this. Since, for the strong theorist, *xx* is identical with *w* and *xx* and *yy* are plural duplicates, *w* is a duplicate of any individual identical with *yy*, and so *w* and *z* are duplicates. It is important to note two things about this argument. First, the argument is only a legitimate application of Leibniz's Law if the relation of duplication between individuals and the relation of duplication between pluralities is one and the same relation. But that is something the strong theorist is committed to. For the qualitative character of a portion of reality does not depend on whether it is represented as a single object, or as a plurality of objects; and so the relation, *having the same qualitative character*, should apply either way. The argument invoking Leibniz's Law switches the *form* of the duplication relation, but it does not illegitimately switch the relation being said to hold. From now on, I will simply speak of the duplication relation, allowing it to take either singular or plural arguments.[19] Second, the argument assumes that the duplication relation in question is not slice-sensitive. For if it were slice-sensitive, the application of Leibniz's Law would not be legitimate. This second assumption is also not problematic for the strong theory under discussion; it also follows from the idea that the qualitative character of a portion of reality is the same, no matter how you slice it. Now, granting these two assumptions, the argument that the strong theorist is committed to (PDP) is unassailable. Indeed, (PDP) just expresses the strong theorist's view that once we give the qualitative character of the *xx*, we have thereby given

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[19] McDaniel does not explicitly make this "one-relation" assumption. He is content to leave the argument at an informal level, one that does not invoke any specific formulation of Leibniz's Law.

the qualitative character of *w*, the fusion of the *xx*. In Lewis's words (quoted by McDaniel): "Describe Magpie and Possum fully—the character of each and also their interrelation—and thereby you fully describe their fusion." (Lewis 1991: 85)

The second premise of McDaniel's argument against strong composition as identity is the claim that (PDP) is incompatible with the possibility of emergent properties. His definition of emergent property is a bit different than the one I gave above, but not in any way that will matter. It is as follows (omitting the qualifier 'strongly' before 'emergent'):

> A property *F* is *emergent* iff (i) *F* is perfectly natural, (ii) *F* can be exemplified by a composite material object, and (iii) *F* does not locally supervene on the perfectly natural properties and relations exemplified by only atomic material objects. (p. 131)

The argument for the second premise is this. (I quantify over possible objects, but the argument could instead be given using modal operators.) Suppose that emergent properties are possible. Let *F* be an emergent property that holds of some composite object *w*, and let *xx* be the atomic parts of *w*.[20] Then, by clause (iii), there will be some other object *z* that does not exemplify *F* whose atomic parts, *yy*, are plural duplicates of *xx*. It follows that *w* and *z* are not duplicates, contradicting (PDP). I will return to this argument shortly.

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[20] As McDaniel notes, the mereological atomism presupposed by this argument is not essential. I am happy to go along with it.

The third and final premise is that emergent properties are indeed possible. He mentions two sorts of example: quantum properties of entangled systems and phenomenal properties of conscious subjects. McDaniel's third premise is weaker than what I will be arguing for below, namely, that *slice-sensitive* emergent properties are possible. In any case, I do not contest the third premise.

Putting this all together, we have the following argument against strong composition as identity.

(1) Strong composition as identity entails (PDP).

(2) (PDP) is incompatible with the possibility of emergent properties.

(3) Emergent properties are possible.

Therefore, strong composition as identity is false.[21]

I do not think that this argument succeeds. The strong theorist can and should reject the second premise. McDaniel's argument for that premise depended on his implicit assumption that perfectly natural properties and relations never take plural arguments. That assumption is needed to go from the failure of local supervenience to there being duplicate pluralities whose fusions are not duplicates. To see this, consider again the case of an emergent *F* exemplified by *w* with atomic parts *xx*. By clause (iii) of the definition of

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[21] Actually, what McDaniel asserts for the first premise is that "any reasonable formulation of [strong] composition as identity" will entail (PDP); but I take it that **Mods** would count as a "reasonable formulation," and so McDaniel's argument should apply to it.

emergent property, there will be *yy* that are "just like" *xx* with respect to the perfectly natural properties and relations that are exemplified by atoms, but such that the fusion of *yy*, *z*, doesn't exemplify *F*. Can we conclude that *xx* and *yy* are plural duplicates, so as to contradict (PDP)? No, for if we allow that there may be natural properties exemplified by some of the *xx* plurally, then the *xx* can be "just like" *yy* in the sense relevant to the failure of local supervenience even though *xx* are not plural duplicates of *yy*. For, unless *F* is slice-sensitive, the strong theorist can and should say that *F* is exemplified not only by *w* but also by *xx*. After all, *w* is identical with *xx*! For the strong theorist, there is just the one portion of reality that can be represented either singularly or plurally, and however we represent it, it exemplifies *F*. So the assumption that natural properties are exemplified by objects, and never by pluralities, should be rejected by the strong theorist. Now since *z* doesn't exemplify *F*, neither does *yy*, and *xx* and *yy* are not plural duplicates after all. There is a natural property, *F*, that is not preserved by any one-one correspondence between *xx* and *yy*. And so emergent properties do not pose a challenge to (PDP).[22]

To get a sound argument against strong composition as identity, we need to replace the third premise with the stronger "*slice-sensitive* emergent properties are possible," and accordingly replace the second premise with the weaker "(PDP) is incompatible with the possibility of slice-sensitive emergent properties." That is an argument I can accept. But

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[22] See Bohn (2012) for a similar response to McDaniel's argument.

there is no need to give the details.[23] When arguing against **Mods**, there is no need to take a detour through (PDP) at all. The possibility of slice-sensitive emergent properties is directly incompatible with **Mods**.

7. Slice-Sensitive Emergent Properties: Three Illustrations

I turn now to consider three sorts of case that support, in somewhat different ways, the possibility of slice-sensitive emergent properties. In each case, I think, there is pressure to say, if emergent properties are possible at all, then so are slice-sensitive emergent properties. I hope that the scenario described in each case will seem intuitively possible on its face. But, for me, the judgments of possibility are supported by general principles of modal plenitude. In this section, I present the three cases; in the next section, I consider the general principles that support them.

First case: infinite series. Perhaps the clearest cases of slice-sensitive emergent properties arise from considering infinite series. When infinite series have both positive and negative terms,

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[23] The argument for the revised second premise is roughly this. Suppose slice-sensitive emergent properties are possible. Suppose *xx* and *yy* are plural duplicates, where *xx* compose *w* and *yy* compose *z*, with *w* and *z* composite. Because *xx* and *yy* are plural duplicates, *w* and *z* have the same emergent properties on one way of slicing. But on other ways of slicing *w* and *z* need not have the same emergent properties. One way of slicing *w* and *z* is the trivial one-membered slicing given by *w* and *z* themselves. With an appeal to plenitude, we can suppose that *w* and *z* do not have the same emergent properties on this trivial slicing. But that is just to say that *w* and *z* are not duplicates, contradicting (PDP).

the sum may depend on how the terms are grouped or ordered. That provides a model for how a possible world could have emergent properties of the whole world that depend in part on how the world's atoms are sliced. Here is a very simple illustration. Consider a world with denumerably many atoms, a_1, a_2, a_3, …., each of which has positive or negative unit charge. Suppose the distribution of charge is as follow: +1 to a_1, –1 to a_2, +1 to a_3, and so on. Suppose there are two fundamental properties, C_1 and C_2, that each assign a "net charge" to the world as a whole. (We can concoct scenarios in which these properties figure in the world's fundamental laws.) C_1 is the net charge relative to the slicing given by the plurality a_1+a_2, a_3+a_4, … . (I use '+' for both mereological sum and arithmetic sum; context decides.) C_1 has the value $(1 – 1) + (1 – 1) + … = 0$. C_2 is the net charge relative to the slicing given by the plurality a_1, a_2+a_3, a_4+a_5, … . C_2 has the value $1 + (–1 + 1) + (–1 + 1) + … = 1$. C_1 and C_2 are slice-sensitive emergent properties.[24]

I expect the following objection: the net charge properties are not emergent properties, for they supervene on the charges of the individual atoms *together with fundamental relations that give the groupings*. In other words, there are fundamental relations among the atoms, R_1 and

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[24] One could question whether the values of C_1 and C_2 are legitimately "sums" of the infinite series, since these series do not converge; but I don't think that matters to the force of the example. In any case, one could easily construct fancier examples involving conditional convergence. An infinite series is *conditionally convergent* iff it converges, but the series of absolute values of the terms diverges. The sum of a conditionally convergent series depends on the *ordering* of its terms; and different orderings corresponds to different slicings in the world where the infinite series is exemplified. For example, the sequence of atoms $<a_1, a_2, a_3, …>$ corresponds to the slicing given by the plurality: a_1, a_1+a_2, a_1+a_2+a_3, … .

R_2, where $a_1R_1a_2$, $a_3R_1a_4$, … and where $a_2R_2a_3$, $a_4R_2a_5$, … . (Maybe R_1 and R_2 can be thought of as fundamental relations of bonding between atoms.) If the world is correctly described by taking the relations R_1 and R_2 to be fundamental, not the properties C_1 and C_2, then the case for slice-sensitive emergent properties evaporates.

But why claim that the world envisaged must have fundamental relations that group the atoms, rather than allowing that there are worlds of both sorts, some with fundamental relations, others with fundamental emergent properties? The objection only has force if it derives from a general strategy for eliminating all emergence, for redescribing any purported case of an emergent property by adding fundamental relations to the supervenience base. I reject the general strategy. Indeed, even if we allow that there is no fundamental plural structure, worlds with fundamental properties and with fundamental relations have distinct structures, and so are distinct worlds. But in any case, to apply the strategy only in cases of purported slice-sensitive emergent properties would be *ad hoc* at best. I conclude, then: if emergent properties are possible at all, then slice-sensitive emergent properties are possible as well. That is the lesson of the world with emergent properties of net charge.

Second case: spatial and temporal continua. It is sometimes thought that even if time and space are both continua composed of dimensionless atoms, the instants of time are unified in a way that the points of space are not. Using Bergsonian terminology, we might say that the instants of time form a *qualitative multiplicity*, the points of space a mere *quantitative multiplicity*.[25] The instants of time are not merely juxtaposed, but somehow permeate one

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[25] See Bergson (1910). But I use Bergson merely as a foil; he would not accept the assumption that a continuum is composed of dimensionless points.

another; the points of space, in contrast, are separate and several. It won't much matter for the example whether this makes much sense; it is enough if one grants that it is possible that there be an emergent property of instants of time, call it "*Q*", that does not apply to points of space. Now, consider a four-dimensional Bergsonian world. I will suppose that its metrical structure is Newtonian; any two points of spacetime have an absolute temporal and an absolute spatial separation. But that leaves out the additional structure it has in virtue of the emergent property *Q*. Consider a four-dimensional block, either the whole world or a portion of the world, and ask whether that block has *Q*. It seems that the answer depends on how we slice it. If we slice it into stationary world lines, then it doesn't have *Q*: the different world lines, each parallel to one another, form a quantitative multiplicity, like the points of space. If we slice it into simultaneity "planes," then it does have *Q*: the planes, added together, form a temporal continuum, a qualitative multiplicity. On its face, then, *Q* is a slice-sensitive emergent property.

We could object as before that the slicings are given by fundamental relations; and we can give the same reply. But now there is a more telling objection. If we take *Q* to be an emergent property of one-dimensional world lines, rather than four-dimensional blocks, we no longer have to allow that *Q* is slice-sensitive. The extension of *Q* to four-dimensional blocks will supervene on fundamental properties and relations of proper parts of the block, and there is no need to posit slice-sensitive emergence. This objection is easily countered, however, if we allow that gunky spacetime is possible.[26] For in that case every proper part of a four-dimensional block

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[26] Spacetime is *gunky* iff there are no atoms: every part of spacetime has a proper part. Actually, I am doubtful that gunk is possible. But since most philosophers seem to think otherwise, the example has dialectical force.

of spacetime is itself four-dimensional. The slice-sensitive emergence of *Q* applies all the way down, to smaller and smaller regions of spacetime. It cannot be eliminated.

Third case: directional properties. Some properties of objects are directional: they do not hold absolutely, but only relative to a chosen direction. Consider, for example, the three-dimensional block letters, made famous by the book *Gödel, Escher, Bach*, that present as three different letters when viewed from three different directions. For example, the letter on the cover of the book is a 'G', an 'E', or a 'B' depending on the direction from which it is viewed. A direction naturally corresponds to a slicing of the object, where slices are perpendicular to the direction. The block letter is a portion of reality, then, that can be said to have three different properties depending on how that portion is sliced: one slicing makes it a 'G', one an 'E', and one a 'B'. For another example, consider the phenomenon of iridescence. The color of an iridescent object varies with the direction from which the object is viewed. Again, we can take the color to be relative to a slicing. Of course, there is no reason to think that these physical properties of objects are emergent at the actual world. Presumably, the directional shape properties can be reduced to fundamental geometric relations between the points that compose the block; the directional color properties can be reduced to non-directional fundamental properties and relations that hold at the microscopic level. But it seems to me to be possible that shape or color properties of extended objects be emergent. A world at which shape or color properties are emergent might have directional shape or color properties, and those directional shape or color properties would be emergent as well. If emergent directional properties are slice-sensitive, as I have claimed, it follows that slice-sensitive emergent properties are possible.

The arguments for the possibility of slice-sensitive emergent properties embodied in these three cases rest heavily on modal intuition. That makes them vulnerable to an opponent

who simply claims not to share the relevant intuition. Arguments from modal intuition are weak unless the modal intuitions are backed by general principles. I turn, then, to consider how general principles of modal plenitude might provide support for the possibility of slice-sensitive emergent properties.

8. Slice-Sensitive Emergent Properties: Principles of Modal Plenitude

In other work (Bricker 1991; forthcoming, chapter 9), I have argued that principles of modal plenitude fall naturally into three sorts. First, there is a principle of recombination (narrowly construed). Roughly, for any way of arranging elements taken from sundry possible worlds, there is a possible world that arranges (duplicates of) those elements in that way. Second, there is a principle of plenitude of world contents. Roughly, for any possible world, any element of that world can be replaced by an element *alien* to the world. And third, there is a principle of plenitude for world structures. Roughly, any structure compatible with the framework is instantiated within some possible world (or, at any rate, some portion of reality, whether or not it is properly called a "world"). How might these principles be used to generate possible worlds with slice-sensitive emergent properties? I do not see how a principle of recombination on its own will be of much help. Recombining the fundamental properties from worlds without emergence will not lead to worlds with emergence. But perhaps the latter two sorts of principle of plenitude can do the job.

Start with the plenitude of world contents, and take the fundamental elements of a world to include its fundamental properties. Say that a fundamental property is *alien* to a world if it is

not instantiated at the world, or, more simply, it is not among the world's elements.[27] It is alien *simpliciter* if it is alien to the actual world. A world with alien properties is an *alien world*. It is widely accepted that alien worlds with alien fundamental properties are possible. If the laws of physics had been different, then the fundamental physical properties might have been different as well. What grounds this belief? Not, I think, some belief about the poverty of the actual world. I hold that for *any* possible world, there is a world alien to it. (See Bricker, forthcoming, chapter 9, for discussion.) Moreover, this belief in the possibility of alien worlds is independent of any beliefs about the possible structures of worlds: for any world, there is a world alien to, *but having the same structure as*, that world. We can switch out content, as it were, without changing structure. This leads me to accept the following as a fundamental principle of plenitude:

> **Plenitude of Alien Fundamental Properties.** For any world *w* and any fundamental property *P* instantiated at *w*, there is a world just like *w* except that *P* has been replaced by a fundamental property *Q* alien to *w*.

Other than having *Q* in the place that was occupied by *P*, the worlds are exactly alike.

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[27] I am supposing that conjunctive and structural properties are not fundamental. Also, I take determinables rather than determinates to be fundamental; see Bricker (2017). If determinates are fundamental, one would want to add a clause saying that no determinate of the property's determinable is instantiated at the world.

But this principle of plenitude does no better than a principle of recombination in generating possible worlds with emergent properties. Starting from a world where all fundamental properties are instantiated by atoms, one gets a world with different fundamental properties instantiated by atoms. One doesn't get a world with fundamental properties instantiated by composites, a world with emergence. To see what more we need, consider the modal intuition behind the third case involving directional properties. The idea there was that, wherever a *structural property* is instantiated, there could be an emergent property instantiated in that place. Given a world like ours where the color properties of a composite object (let us suppose) are structural properties of the object's constituent atoms and molecules, there is an alien world where the color properties of that object are emergent. (Perhaps this alien world is something like how an especially "naïve realist" takes the actual world to be.) The structural properties are still there alongside the new emergent properties; but the latter are now properly called the "color properties" for they are the more eligible semantic values. That suggests that we consider the following extension of our principle of plenitude:

> **Plenitude of Alien Emergent Properties.** For any world *w* and any structural property *P* instantiated at *w*, there is a world just like *w* except that *P* is co-instantiated with a fundamental property *Q* alien to *w*.

But note that this principle not only supports the possibility of emergent properties, it supports the possibility of *slice-sensitive* emergent properties as well. For the directional properties considered in the third case are also structural properties, where the different directions correspond to different properties. For a block letter to be a "G' is for it to be composed of slices

with certain shapes; for it be an "E is for it to be composed of other slices with other shapes. Applying the principle will give different emergent properties for the different directional properties, emergent properties that are slice-sensitive. Do we have, then, a more general and principled argument for the possibility of slice-sensitive emergent properties?

There is a problem. The principle of plenitude of alien *emergent* properties is not a pure principle of world contents. It rests in part on the plenitude of world structures. If we could say that the entire structure of a world is given by its spatiotemporal structure, then we could say that the alien world with emergence has the same structure as the world without emergence. But that conception of a world's structure fails to take into account the pattern of instantiation of fundamental properties and relations, which is also a part of the world's structure. The emergence world does not have the same pattern of instantiation, for it has an *additional* fundamental property co-instantiated with structural properties; and that changes the structure. Indeed, it changes the structure in a radical way, from a pattern of instantiation that does not exhibit emergence to a pattern of instantiation that does. It seems, then, that any attempt to support the possibility of emergence will need to look to principles of plenitude for world structures.

I accept an extremely liberal principle of plenitude for structures:

> **Plenitude of Structures.** Any structure compatible with the framework is instantiated in some portion of reality.

Some comments are in order. First, this principle needs further elaboration if we are concerned only with the structures instantiated in *possible worlds*. A portion of reality is only properly

called a "possible world" if it is unified and isolated from the rest of reality; and perhaps it must be unified in some special way to be a possible world, by spatiotemporal relations, or relations analogous to spatiotemporal relations.[28] But we can set that issue aside here. Second, to fully interpret the principle, we need to answer questions about what the structures are, and how they are individuated. Are we nominalist or realist about the instantiation of structure? If realist, are structures *ante rem* or *in rebus*? But those questions can also be set aside here. What is relevant to present concerns is what the framework is taken to be, and what it is for a structure to be compatible with the framework.

I assume that the framework includes standard first-order logic with identity. Structures that are compatible with first-order logic can be represented, in the usual way, by set-theoretic models. Such a model consists of a domain together with a set of designated properties and relations over that domain, where a property is represented as a subset of the domain and an *n*-ary relation as a subset of *n*-tuples of elements of the domain. The designated properties and relations will correspond to the fundamental properties and relations in a world that instantiates the structure. It will be convenient to separate out the *relational structure* at a world, the structure determined by the relations alone, and the *property structure*, the pattern of instantiation of the properties over the relational structure. Let me illustrate what I have in mind. Consider a Newtonian world consisting of points of spacetime; and suppose it has fundamental properties of mass and charge instantiated directly by those spacetime points. The relational structure of the world, we may suppose, is determined by the fundamental spatiotemporal relations between the points. The property structure of the world is determined by the

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[28] As Lewis (1986: 69-80) held. See Bricker (1996) for discussion.

distribution of mass and charge over the points. A Newtonian world with different fundamental properties—say schmass and scharge—has the same property structure, the same pattern of instantiation of fundamental properties, if its distribution of schmass and scharge is isomorphic to the distribution of mass and charge in the first world.

Thus far, there is nothing to support the possibility of emergent properties. But, in addition to first-order logic with identity, I hold that the framework includes classical mereology; indeed, I take mereology to be a part of logic, broadly construed. It follows that every structure compatible with the framework has mereological structure: the part-whole relation applies to elements of the domain no less than does the identity relation; and the domain of every structure is closed under the taking of fusions. Now, among the structures compatible with the framework will be structures whose designated properties are instantiated by composite elements of the domain, properties that are not definable in terms of other designated properties and relations. Worlds that instantiate such structures will be worlds with emergent properties. So the principle of plenitude for structures will demand that there be worlds with emergence.

But not yet *slice-sensitive* emergence. For the principle of plenitude for structures to demand that slice-sensitive emergent properties be possible, we need the framework to include plural logic. In structures compatible with plural logic, the designated properties and relations may be plural, that is, they may have pluralities of elements of the domain as their arguments; and there will be structures whose designated properties apply to pluralities in every which way. Indeed, there will be structures with a designated property that applies to one but not the other of two pluralities that have the same fusion, but which property is not definable in terms of other designated properties and relations. A world that instantiated that structure would be a world with slice-sensitive emergent properties. Thus, if we include plural logic as part of the

framework, the principle of plenitude for structures will demand that there be a world with slice-sensitive emergence.

But there is a problem. **Mods** takes plural logic to be fundamental at the level of our representations, not fundamental at the level of being. A proponent of **Mods** would be within her rights to say that the structures that are used to interpret plural languages are not "compatible with the framework" in the relevant sense; they are not compatible with the framework that is fundamental at the level of being. According to **Mods**, a structure with a designated slice-sensitive property would represent a world where a fundamental property both is instantiated and is not instantiated by a single portion of reality. That structure can be rejected as impossible with impunity.

I must, then, be guarded in stating my conclusions. I believe that slice-sensitive emergent properties are possible, and therefore that **Mods** should be rejected. I hope that the three illustrative cases I presented have some force to persuade others of this. But I have to concede that whoever rejects the modal intuitions embodied in those cases will have no problem rejecting the principle of plenitude that, for me, grounds the intuitions. For that principle and those modal intuitions are inseparable from the belief that the distinction between singular and plural is fundamental at the level of being. If the framework of plural logic is taken to be fundamental at the level of our representations, but not at the level of being, then some of the structures I take to be possible will not be possible in the relevant sense: they will not be instantiated at the level of being. A stalemate ensues.

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