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# TWO CONCEPTIONS OF SPARSE PROPERTIES\*

BY

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**Abstract:** Are the sparse properties drawn from all the levels of nature, or only the fundamental level? I discuss the notion of sparse property found in Armstrong and Lewis, show that there are tensions in the roles they have assigned the sparse properties, and argue that the sparse properties should be drawn from all the levels of nature. The issue has direct bearing on reductionism. If the sparse properties are drawn from all the levels of nature, then macro-scientific properties are just as primary as micro-scientific properties, and do not need to be reduced to them.

## 1. *Two conceptions: scientific and fundamental*

*Background:* It is now standard to distinguish between the *abundant* and *sparse* conceptions of properties, as distinct and equally legitimate conceptions that play distinct and equally legitimate roles. The abundant properties provide the semantic values of meaningful predicates, while the sparse properties carve out the joints of nature on which the causal powers hinge.<sup>1</sup>

It is also now standard to think of nature as *layered*, on which the natural properties are ordered into supervenience families: mental properties, which supervene upon biological properties, which then supervene upon chemical properties, atomic properties, particle properties, quark properties, and perhaps more below. The levels of nature are reflected in the hierarchy of science: psychology, which is above biology, which is then above chemistry, atomic physics, particle physics, quark physics, and perhaps more below.<sup>2</sup>

*Question:* Are the sparse properties drawn from all the levels of nature, or only the fundamental level? On what I label the *scientific* conception of the sparse properties, the sparse properties are drawn from all the levels of nature – they are those invoked in the scientific understanding of the world. On what I label the *fundamental* conception of the sparse properties,

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the sparse properties are drawn from only the fundamental level of nature – they are only those invoked in fundamental physics.<sup>3</sup>

For instance, consider the abundant properties of (i) *being a kazoo*, (ii) *being a quark*, and (iii) *being a proton*. Which of these are sparse properties? *Being a kazoo* is not invoked in the scientific understanding of the world, and is not a plausible candidate for being a sparse property, on either conception. This is a clear negative. *Being a quark* is invoked in fundamental physics (as of now, at least), and so is a plausible candidate for being a sparse property, on either conception. This is a clear positive. *Being a proton* is the controversial case. This is invoked in the scientific understanding of the world, but not in fundamental physics. Should *being a proton* be considered a sparse property?

*Answer:* I argue that *being a proton* should indeed be considered a sparse property, and that in general the right conception of the sparse properties is the scientific conception. The scientific conception not only provides a better occupant of the sparse property role than does the fundamental conception, but the fundamental conception is of dubious legitimacy, since there is no guarantee that there is a fundamental level – nature might be infinitely complex.

The question of whether to conceive the sparse properties scientifically or fundamentally has direct implications for *reductionism*. On the scientific conception, the properties invoked by *total science* are ontologically on par. All carve out joints of nature. Muons, molecules, minds, and mountains are in every sense equally basic.

## 2. *The role of the sparse properties: similarity, causality, and minimality*

David Lewis distinguishes the sparse properties from the abundant properties, by the following characteristics:

Sharing of [the sparse properties] makes for qualitative similarity, [the sparse properties] carve at the joints, they are intrinsic, they are highly specific, the sets of their instances are *ipso facto* not entirely miscellaneous, and there are only just enough of them to characterize things completely and without redundancy.<sup>4</sup>

From this list of characteristics, one can distinguish those characteristics that identify whether a given candidate is suited to play the role of a sparse property, from those characteristics that the property acquires in virtue of occupying the role. In short, one can distinguish the *qualifications for*, versus the *responsibilities of*, the office of sparse property.

Here I suggest that there are three main qualifications for being a sparse property:

- (1) *Similarity*: sparse properties ground objective similarities;
- (2) *Causality*: sparse properties carve out causal powers; and
- (3) *Minimality*: sparse properties serve as a minimal ontological base.

The properties that qualify thereby acquire a real unity, suiting them to perform the remaining responsibilities of intrinsicness,<sup>5</sup> specificity, and non-miscellaneity. This understanding of sparseness is in accord with the way Lewis explains the notion when discussing David Armstrong's theory of universals: "There are the universals that there must be to ground the objective resemblances and causal powers of things, and there is no reason to believe in any more."<sup>6</sup>

Why think, though, that all three qualifications of similarity, causality, and minimality converge on one sort of entity?

### 3. *The rift within the sparse properties: similarity and causality versus minimality*

The rift between the scientific and fundamental conceptions of the sparse properties occurs because the qualifications of similarity, causality, and minimality diverge. The scientific properties are perfectly suited to play the similarity and causality roles, but imperfectly suited to play the minimality role. The fundamental properties are perfectly suited to play the minimality role, but unsuited to play the similarity and causality roles.

*Similarity*: Consider two creatures, both of whom believe that *p*. Surely there is an objective similarity between these creatures. Or consider two neurons, or two atoms of oxygen, or two protons. Surely each pair exhibits objective similarities.

The scientific properties are perfectly suited to ground the objective similarities within the above pairs. These objective similarities are grounded in shared scientific properties: psychological, neurobiological, chemical, and subatomic properties, respectively.

The fundamental properties, however, are unsuited to ground the similarities within the above pairs. As the discussion of multiple realizability has shown, the pair members may be utterly dissimilar at the fundamental level. For instance, one of the *p*-believers might be a human being, the other a silicon-based robot.<sup>7</sup>

*Causality*: Consider a process in which a creature who desires that *p* acts to achieve *p*. Surely desires have such causal powers. As Jerry Fodor quips: "If it isn't literally true that my wanting is causally responsible for my reaching . . . then practically everything I believe about anything is false and it's the end of the world."<sup>8</sup> Or consider the process in which two connected neurons fire in sequence, or in which hydrogen and oxygen are converted into H<sub>2</sub>O, or in which a nucleus undergoes  $\alpha$ -decay. Surely

being a neuron, being oxygen, and being a nucleus involve the possession of such causal powers.

There is an ongoing debate about how to reconcile macro-causation with certain physicalist doctrines. But macro-causation is not to be denied – the real question is *how* it should be understood. Even Jaegwon Kim, who has done more than anyone to problematize the relation between macro-causation and physicalism, maintains, “there seems to be no particular problem about biological causation or chemical causation . . .”<sup>9</sup> Kim in fact is at pains to agree that macro-scientific properties generally do possess causal powers: “Having a mass of 1 kilogram has causal powers that no smaller masses have, and water molecules, or the property of being water, have causal powers not had by individual hydrogen or oxygen atoms.”<sup>10</sup>

The scientific properties are perfectly suited to carve out the causal powers of macro-properties. The causal powers of desires, neurons, oxygen, and nuclei are due to scientific properties. The properties figure in scientific laws, which codify their particular powers.

The fundamental properties, however, are unsuited to carve out the causal powers of macro-properties. Being a synapse, for instance, involves possessing the power to transmit a pulse from one neuron to another. No fundamental property has this power (this is essentially the point Kim makes above, in saying that water molecules have powers that individual hydrogen and oxygen atoms do not).

*Minimality:* The project of providing a minimal ontological base is part of the project of providing an ontological assay.<sup>11</sup> The goal of an ontological assay is to characterize the contingent basis for all contingent truths.

Suppose that there are fundamental properties on which the macro-properties supervene. Then these fundamental properties are perfectly suited to serve as a minimal ontological base. Specify which fundamental properties are where, and the arrangement of the macro-properties is thereby fixed. The scientific properties can also do the job of providing an ontological base, but imperfectly, since the macro-scientific properties they include are redundant. This redundancy is still a far cry from the uncountable redundancies of the uncountable horde of abundant properties, which really would be unsuited to provide an ontological base. But the fundamental properties still serve better here.

#### ***4. Disruptions along the rift: tensions in Armstrong and Lewis***

Armstrong and Lewis both deserve credit for distinguishing the abundant and sparse conceptions. But *which* sparse conception does each have?

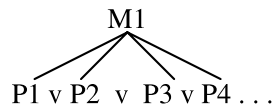
Armstrong identifies the sparse properties with his immanent universals. So the question for Armstrong is whether he accepts macro-scientific

universals. In describing the *a posteriori* aspect of his view, he says: “What properties and relations there are in the world is to be decided by total science, that is, by the sum total of all enquiries into the nature of things.”<sup>12</sup> This is the scientific conception, on which there are macro-scientific universals. But in connecting his view to physicalism, he says, “. . . I look for the genuine universals, the genuine properties and relations, in the fundamental notions of physics.”<sup>13</sup> This is the fundamental conception.

This tension is somewhat veiled by Armstrong’s acceptance of *complex* (conjunctive and structural) universals. Armstrong allows that, if P and Q are monadic universals and R is a relational universal, then (i) P&Q may also be a universal: a conjunctive universal; and (ii) R<P, Q> may also be a universal: a structural universal.<sup>14</sup> The reason why he allows these complex universals is that (i) the conjunctions and structures may have causal powers beyond what their components have individually (synergy), and (ii) in infinitely complex worlds, only conjunctive and structural universals are available.

So it might seem that Armstrong has a way of incorporating both the scientific and fundamental conceptions into his ontology. His universals (including the complex ones) are the scientific properties, and his simple universals (if there are such) are the fundamental properties (if there are such). Indeed, he sometimes seems to adopt this very view: “Macroscopic particulars do not fail to exist if it turns out that they are assemblages of fundamental particulars! In the same way, complex universals exist even if they turn out to be assemblages of fundamental universals.”<sup>15</sup> Immediately thereafter, Armstrong characterizes the chemical property of *being methane* as perhaps a structural universal, involving four hydrogens and one carbon in certain bonding relations.

*But the conjunctive/structural model is the wrong way to understand the macro-scientific properties.* Consider the property of being a desire. It is *not* a conjunction of, or structure of, fundamental properties – it is a *disjunction* of such conjunctions/structures (likewise for methane). Or at least, in the respect in which two creatures with desires can thereby enjoy an objective similarity, and in the respect in which being a desire contributes causal powers as codified in psychological laws, it is as a disjunction of conjunctive/structural bases:



So there is a tension in Armstrong between (i) his acknowledgment of the existence of macro-scientific properties which figure in macro-scientific laws, (ii) his reductive physicalism on which, “[A]ll fundamental universals . . . are those studied by physics, and all other first-order universals are

structures involving nothing but these fundamental universals,"<sup>16</sup> and (iii) his disavowal of disjunctive universals.<sup>17</sup> The tension is that the macro-properties acknowledged in (i) are only structures of the kind countenanced in (ii) in the disjunctive sense rejected in (iii).<sup>18</sup>

Armstrong has replied, in personal communication, that sparseness might come in degrees: "With this in mind, *being methane* is a pretty sparse property, and is a conjunctive/structural property having as constituents the perhaps slightly sparser properties *being carbon* and *being hydrogen* and *being bonded*." But this reply is in tension with taking the sparse properties to be the immanent universals. Whether or not a universal exists cannot be a matter of degree: existence is all-or-nothing.

As to Lewis, he identifies the sparse properties with both the fundamental and the natural properties. Immediately after introducing the sparse conception, Lewis speaks of microphysics as engaged in the project of identifying the *fundamental* properties: "What physics has undertaken, . . . is an inventory of the *sparse* properties of this-worldly things."<sup>19</sup> And in defending reductionism about the mental, he asserts: "I hold, as an *a priori* principle, that every contingent truth must be made true, somehow, by the pattern of coinstantiation of fundamental properties and relations."<sup>20</sup> This is the fundamental conception.

But Lewis also identifies the sparse properties with the natural properties, and allows that naturalness can come in degrees. Moreover he acknowledges the possibility that the world might be infinitely complex in such a way that there are no perfectly natural properties, but only properties that are natural to an ever-greater degree.<sup>21</sup> This suggests the scientific conception.

This tension in Lewis is most striking when comparing his views on infinite complexity with his reductionism about mentality. If natural-enough is good enough for sparseness in an infinitely complex world, why isn't it good enough for mental properties in the actual world? Alternatively, if mental properties aren't good enough for sparseness because they aren't perfectly natural, how could anything be good enough in an infinitely complex world? This tension manifests itself in an inconsistent treatment of worlds with and without a bottom level. In worlds with a bottom level, Lewis refuses sparse macro-properties; while in worlds without a bottom level, Lewis allows sparse macro-properties (infinitely many, recruited from all of the infinitely many levels below the "good enough" cut-off).

Lewis has replied, in personal communication, that he prefers the fundamental conception, and considers infinite complexity too far-fetched to take too seriously: "If an otherwise good approach to sparse properties must treat that far-fetched possibility as an exception, so be it." I would question the claim that infinite complexity is far-fetched,<sup>22</sup> but in any case the tension remains. If an alternative conception of sparse properties may treat infinite complexity by the rule, then I would say that it is thereby a better conception.

### 5. *Mending the rift: scientific, fundamental, or both?*

One might contemplate three main ways to mend the rift between the scientific and the fundamental conceptions of the sparse properties. One might accept the scientific conception only, accept the fundamental conception only, or accept both as distinct and equally legitimate conceptions. It might *seem* at this point that the choice is obvious. The scientific conception is suited to play all three of the roles of similarity, causality, and minimality (albeit imperfectly for minimality), while the fundamental conception is only suited to play the role of minimality.

Yet one might imagine advocates of each position speaking as follows:

*Scientific Only:* We have two conceptions and one role. The question is, which conception better satisfies the role? Here the scientific conception is the runaway winner. It meets all three qualifications of similarity, causality, and minimality (albeit imperfectly for minimality), while the fundamental conception meets only the one qualification of minimality.

*Fundamental Only:* Indeed the question is which conception better satisfies the role. But it should not be assumed that each qualification is of equal weight. Rather, the weightiest qualification is minimality, which deserves first weight to such an extent that a small advantage in meeting minimality outweighs even an utter advantage in meeting similarity and causality. [Some dithyramb on minimality would presumably follow . . .]

*Coexistence:* Both of you two mistakenly assume that there is only one role to be played. This is a mistake analogous to the mistake of thinking that the abundant and sparse conceptions are in competition for playing the property role. In both cases the solution is to see both conceptions as distinct and equally legitimate conceptions that play distinct and equally legitimate roles. Just as Lewis showed that the abundant and sparse conceptions should coexist, so the foregoing considerations show that the abundant, scientific, and fundamental conceptions should all coexist. The abundant properties provide the semantic values of meaningful predicates, the scientific properties carve out the joints of nature on which similarities and causal powers hinge, and the fundamental properties constitute the minimal ontological base for an assay.

If the debate were to end here, I suppose the advocate of coexistence would win (it would then be a very interesting question as to what would follow for reductionism.) But notice to what degree both the fundamental-only and coexistence positions depend on the minimality qualification. Thus the advocate of scientific-only might continue:

*Scientific Only*: Both of you two mistakenly assume that the minimality qualification is legitimate. If not then (i) it cannot be given any weight, much less sufficient weight to trump similarity and causality as the fundamentality-only position maintains; and (ii) a conception that accords with it cannot thereby play a genuine role as the coexistence position requires.

## 6. *Re-conceiving the role: from minimality to primacy*

It seems possible that the world might be infinitely complex, in the sense that properties might be endlessly supervenient upon lower-level properties.<sup>23</sup> Suppose that there is infinite complexity, and that, for each level L, the arrangement of the characteristic properties of L supervenes on the arrangement of the characteristic properties of L-1 (the level below), but not *vice versa*.

In such an infinite descent there could not be a minimal base. Suppose (for *reductio*) that there were a minimal base B. Consider any property P in B. P belongs to some level L. Now either some P-subvening property(s) from a level below L is in B, or not. If so then B fails to be minimal, since the inclusion of the P-subvener renders P redundant. If not then B fails to be a base, since it excludes the nonsupervening facts below.

Indeed, in such an infinite descent there could not be any fundamental properties. All properties would be macro-properties.

But *all* the roles that the sparse properties play still need to be played in such infinitely complex worlds – the ideas of carving nature at the joints, and providing an ontological assay, are not invalidated by infinite complexity.<sup>24</sup> An infinitely complex world could still enjoy objective similarities and causal powers. An infinitely complex world could still be assayed, in the sense that there might still be a robust distinction to be drawn between the relatively sparse contingent truths at each level, and the uncountable horde of abundant contingent truths.

Indeed, why can't nature contain redundancies, whether infinitely complex or not? Surely it is metaphysically possible that nature itself could be nonminimal. And a redundant world could still enjoy objective similarities and causal powers, and could still be assayed.

Since the project of ontological assay is still feasible in infinitely complex and in ontologically redundant worlds where minimality fails, it follows that minimality is not essential. One must reconceive what is required for an ontological assay in non-minimality-requiring terms.

What is needed for the project of ontological assay is a principled distinction between what is *primarily* real, and what is merely *derivative*. This is not to suppose that reality comes in degrees, or that “derivatively real” is code for “unreal”. Rather the idea is to distinguish the ontological structure of reality (the primary) versus the linguistic truths which are “made



true” by the existence of such an ontological structure (the derivative).<sup>25</sup> To speak metaphorically, “all God had to do” was to create the primarily real. So what is needed is a principled distinction between ontological and linguistic structure. What is not needed for the project of ontological assay, and what the possibilities of infinite complexity and ontological redundancy refute, is that this ontological structure be minimal.

The minimality qualification, then, should be superseded by a *primacy* qualification:

(3') Primacy: sparse properties serve as the ontological basis for linguistic truths.

Both minimality and primacy are ways of characterizing the notion of *the ontological base*. The difference is that the minimality qualification requires that the base not contain any redundant elements, while the primacy qualification only requires that the base is capable of participating in the *truth-making* relation.<sup>26</sup> This is why only primacy allows for infinitely complex and ontologically redundant worlds.

### ***7. Re-mending the rift: the triumph of the scientific conception***

Once minimality is superseded by primacy, the scientific conception triumphs. The scientific properties are perfectly suited to serve the primacy role, since they provide an articulation of ontological structure regardless of the complexity or redundancy of nature. The fundamental properties, however, are unsuited to serve the primacy role, since they require the contingent presupposition of a finitely complex, non-redundant world.

Indeed, isn't it plausible *independent of concerns about complexity and redundancy* that macro-properties (such as being a belief, a neuron, an oxygen atom, or a proton) are on the ontological side of the distinction between the ontological and the linguistic? Molecules aren't merely manners of speaking.

And so it emerges that the scientific properties are perfectly suited to play *every* role that the sparse properties should play (similarity, causality, and primacy). The fundamental properties turn out to be unsuited for *any* legitimate role. Thus one should accept the scientific conception of the sparse properties only.

The triumph of the scientific conception brings with it the viewpoint of *the primacy of total science*. The properties of minds and mountains do not need to be reduced to anything else. They are primarily real from the start.

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## NOTES

\* Thanks to David Armstrong, Phil Bricker, David Lewis, Ted Sider, and Chris Swoyer.

<sup>1</sup> The abundant/sparse distinction comes from David Lewis (1986) *On the Plurality of Worlds*, Oxford: Basil Blackwell. See also David Armstrong (1979) *A Theory of Universals*, Cambridge: Cambridge University Press, George Bealer (1982) *Quality and Concept*, Oxford: Oxford University Press, and Chris Swoyer (1996) “Theories of Properties: From Plenitude to Paucity”, *Philosophical Perspectives* 10, pp. 243–264. For a useful overview see D. H. Mellor and Alex Oliver (1997) “Introduction”, in *Properties*, Oxford: Oxford University Press, pp. 1–33.

<sup>2</sup> The layered view of nature traces back at least to Isaac Newton [1704] (1952) *Opticks: Or a Treatise on the Reflections, Refractions, Inflections, and Colours of Light*, New York: Dover. Important contemporary discussions include Paul Oppenheim and Hilary Putnam [1958] (1991) “Unity of Science as a Working Hypothesis”, reprinted in *The Philosophy of Science*, eds. Richard Boyd, Philip Gasper, and J. D. Trout, London: MIT Press, pp. 405–27; Jerry Fodor [1974] (1991) “Special Sciences, or the Disunity of Science as a Working Hypothesis”, reprinted in *The Philosophy of Science*, pp. 429–42; and Jaegwon Kim (1993) “The Nonreductivist’s Troubles with Mental Causation”, in *Mental Causation*, eds. John Heil and Al Mele, Oxford: Oxford University Press, pp. 189–210.

<sup>3</sup> There certainly is logical room for even more conceptions of sparse properties (!), though I consider the scientific and fundamental conceptions to be the primary contenders.

<sup>4</sup> Lewis 1986 (*op. cit.*) Other glosses in the literature accord with this focus, such as Armstrong, “Properties” (orig. 1992), reprinted in *Properties (op. cit.)*, pp. 160–72). Ted Sider (1995) “Sparseness, Immanence, and Naturalness”, *Nous* 29, pp. 360–77 focuses on the similarity role, and Swoyer 1996 (*op. cit.*) focuses on the causal role.

<sup>5</sup> As to intrinsicness, some independent grasp of that notion may be provided by the idea of that which is shared among duplicates. As such the notion of intrinsicness extends farther than the notion of sparseness, since the intrinsic properties are closed under the Boolean operations, while the sparse properties are not (I owe this point to Sider, personal communication; and also Sider’s unpublished manuscript “Two Conceptions of Primitive Naturalness”). Perhaps the sparse properties, however, can be taken to constitute the *basic intrinsics*, and the intrinsic properties can be defined as the class of basic intrinsics closed under the Boolean operations. This is similar to the idea of Lewis [1983] (1999) in “New Work for a Theory of Universals”, reprinted in *Papers in Metaphysics and Epistemology*, Cambridge: Cambridge University Press, pp. 8–55, pp. 27–8. See also Rae Langton and David Lewis [1998] “Defining ‘Intrinsic’”, reprinted in *Papers in Metaphysics and Epistemology, op. cit.*, p. 116–32.

<sup>6</sup> Lewis 1983 (*op. cit.*) p. 12.

<sup>7</sup> Here I am drawing on Hilary Putnam [1967] (1991) “The Nature of Mental States”, reprinted in *The Nature of Mind*, ed. David Rosenthal, Oxford: Oxford University Press, pp. 197–203.

<sup>8</sup> Jerry Fodor (1990) “Making Mind Matter More”, in *A Theory of Content*, Massachusetts: M. I. T. Press, pp. 137–60, p. 156.

<sup>9</sup> Jaegwon Kim (1998) *Mind in a Physical World*, Massachusetts: M. I. T. Press, p. 106.

<sup>10</sup> Kim (1998) *op. cit.* p. 108. Kim maintains that the problems of mental causation derive from the functionalization of the mental, and do not generalize to other macrophenomena. In the main text I assume that mental phenomena can be treated on par with chemical and biological phenomena, but this is a separate issue.

<sup>11</sup> Here I am drawing on Gustav Bergmann (1967) *Realism*, Wisconsin: University of Wisconsin Press.

<sup>12</sup> Armstrong (1979) *op. cit.* p. 8.

<sup>13</sup> Armstrong (1988) "Can a Naturalist Believe in Universals?", in *Science in Reflection*, ed. Edna Ullman-Margalit, Dordrecht: Kluwer Academic Publishers, pp. 105–6. See also Armstrong's (1989) *Universals: An Opinionated Introduction*, Colorado: Westview Press, p. 87.

<sup>14</sup> Armstrong (1997) *A World of States of Affairs*, Cambridge: Cambridge University Press, pp. 31–8. See also Armstrong (1979) *op. cit.* pp. 30–6, and Armstrong (1989) *op. cit.* p. 84.

<sup>15</sup> Armstrong (1997) *op. cit.* p. 33.

<sup>16</sup> Armstrong (1997) *op. cit.* p. 6.

<sup>17</sup> Armstrong (1979) *op. cit.* pp. 19–23; Armstrong (1989) *op. cit.* pp. 82–3; Armstrong (1997) *op. cit.* pp. 26–8.

<sup>18</sup> In distinguishing *physicalism* from *naturalism*, Armstrong (1998) *op. cit.* mentions that, "[O]ne might think that there are irreducible biological or psychological laws, which is to deny Physicalism, and yet be a Naturalist." (p. 106) But the macro-laws are irreducible in the relevant sense, unless one countenances disjunctive universals: see Jerry Fodor (1974) *op. cit.*

<sup>19</sup> Lewis (1986) *op. cit.* p. 60.

<sup>20</sup> Lewis [1994] "Reduction of Mind", reprinted in *Papers in Metaphysics and Epistemology*, *op. cit.*, pp. 291–324, p. 292; see also Lewis's [1994] "Humean Supervenience Debugged", reprinted in *Papers in Metaphysics and Epistemology*, *op. cit.*, pp. 224–47.

<sup>21</sup> Lewis [1980] "Against Structural Universals", reprinted in *Papers in Metaphysics and Epistemology*, *op. cit.*, pp. 78–107. Sider (1995) *op. cit.* uses infinite complexity to argue that Lewis cannot identify naturalness with sparseness, on grounds that: "What should be the case [in infinite complexity] is that these [Lewis-style properties] come in an infinite sequence of increasing naturalness" (p. 363).

<sup>22</sup> Schaffer (2003) "Is There a Fundamental Level?", *Nous* 37, pp. 498–517. I argue that there is no scientific evidence that the actual world has a fundamental level.

<sup>23</sup> For further discussion and defense of the possibility of infinite complexity, see Alex Oliver (1992) "Could There be Conjunctive Universals?", *Analysis* 52, pp. 88–97, Sider (1995) *op. cit.* pp. 363–4; Armstrong (1997) *op. cit.* p. 33; and Schaffer (2003) *op. cit.*

<sup>24</sup> Likewise, the responsibilities of the office of sparse property-hood (intrinsicness, specificity, and non-miscellaneousness), could obviously still be in force in infinitely complex worlds.

<sup>25</sup> This idea accords with the way Keith Campbell (1990) *Abstract Particulars*, Oxford: Basil Blackwell, understands sparseness, as concerning "the ontic constitution of the cosmos", as opposed to the linguistic facts of predication (pp. 24–5).

<sup>26</sup> For more on the truth-making relation, see Armstrong (1997) *op. cit.* pp. 13–4; Lewis [1998] "A World of Truthmakers?", reprinted in *Papers in Metaphysics and Epistemology*, *op. cit.*, pp. 215–20; and George Molnar (2000) "Truthmakers for Negative Truths", *Australasian Journal of Philosophy* 78, pp. 72–85. Note that the primacy qualification is neutral with respect to such controversial questions as to how localized truth-making is (on the least localized conception, the truth-maker of every truth is: the world), and whether the truth-making relation is contingent or necessary.