

# Chapter 5

## Underdetermination as a Path to Structural Realism

Katherine Brading and Alexander Skiles

### 5.1 Introduction

Two general arguments for structural realism have dominated the literature. The first is inspired by John Worrall's claim that the view offers the "best of both worlds" when it comes to the issue of radical theory change [28]. The argument has an *epistemic* conclusion, suggesting a retreat from the full range of realist commitments about what we can know about unobservable entities, to a more modest subset of these commitments, specifically the *structural* features of such entities. Insofar as this argument is successful, it leads to epistemic structural realism (ESR). The second argument considerably ups the ante, moving from an epistemological claim to an *ontological* one. Ontic structural realism (OSR), defended most prominently by James Ladyman and Steven French, is the view that realists ought to endorse the more radical claim that in some sense all there *is* are these structural features. The central argument for this position begins from the so-called "problem of metaphysical underdetermination".<sup>1</sup>

The focus of this paper is the second argument. Originally formulated in the context of quantum physics, the argument has also been applied in the context of spacetime theories, and discussions have typically assumed that the argument is generally sound. Those who have criticized the argument seem to concede that the alleged metaphysical underdetermination *would be* problematic were it to hold, but then go on to argue that it disappears on closer scrutiny of the particular theory in question.<sup>2</sup>

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<sup>1</sup> For presentations of this argument, see [9, 11, 13, 21, §1.2].

<sup>2</sup> For example, see [5, pp. 158–160, 7, pp. 30–31, 16, 17]; for criticism of this type of response, see [10]. An exception to the trend is [22].

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In this paper we pursue a different line of inquiry: we examine whether, *even if* the alleged underdetermination is granted, we ought to embrace OSR. After outlining what we take the argument from metaphysical underdetermination for OSR to be (Section 5.2), we offer three criticisms, all of which grant for the sake of discussion that our fundamental physical theories are metaphysically underdetermined in the way the proponent of OSR insists (Sections 5.3, 5.4, and 5.5). Influential as the argument has been, we conclude that it is unsatisfactory as a path to OSR (Sections 5.6).

## 5.2 Stating the Argument

In a well-known passage, Ladyman first stated the argument from metaphysical underdetermination as follows:

Even if we are able to decide on a canonical formulation of our theory, there is a further problem of metaphysical underdetermination [...] In the case of individuality, it has been shown [...] that electrons may be interpreted either as individuals or as non-individuals. We need to recognize the failure of our best theories to determine even the most fundamental ontological characteristic of the purported entities they feature. It is an *ersatz* form of realism that recommends belief in the existence of entities that have such an ambiguous metaphysical status. What is required is a shift to a different ontological basis altogether, one for which questions of individuality simply do not arise. [13, pp. 419–420]

In subsequent literature, presentations of the argument have been similarly informal.

We propose to regiment this line of reasoning as a valid argument that proceeds in two stages. The first attempts to establish a *negative* conclusion targeting what French has called “object-oriented” realism [9, p. 168]: roughly, any of the standard realist views according to which our best fundamental physical theories commit us to objects that are at least as fundamental as the physical structures into which those objects figure.<sup>3</sup> The second stage then attempts to derive the *positive* conclusion that OSR is (all other things equal) preferable to its more traditional counterpart.<sup>4</sup> Here is our re-construction of the argument in more detail:

### The argument from metaphysical underdetermination

(P1) Object-oriented realists are committed to objects (that are ontologically basic) having determinate *individuality profiles*: (i) there is a fact of the mat-

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<sup>3</sup> French takes the view defended by Psillos [18] as representative. Note that by “object-oriented realist” we also have in mind those who take *neither* objects nor the structures within which they are embedded to be ontologically prior; see e.g. [6].

<sup>4</sup> We take no stance on whether this is the *only* way to formulate the argument, nor do we claim that every proponent of OSR would accept each of its premises. Perhaps there is another way to proceed; we doubt, however, that it will diverge much from the argument we will discuss (though see Section 5.5).

- ter about *whether* an object is an individual or not, and (ii) if it *is* an individual, there is a fact of the matter about how, precisely, it is individuated.<sup>5</sup>
- (P2) If (P1) is the case, then adopting object-oriented realism commits us to expecting that our best theories will accurately describe what these individuality profiles are like.
- (P3) But our best theories fail to offer individuality profiles for their purported objects (much less describe precisely what they are): the individuality status of these objects, as given by our best theories, is *metaphysically underdetermined*.
- (C1) So object-oriented realism is (probably) false.
- (P4) If OSR is true, then our best theories are not infected with metaphysical underdetermination.
- (C2) So, all other things equal, OSR is preferable to object-oriented realism.

As we said before, our strategy is to simply concede premise (P3) for sake of argument, and focus on the status of (P1), (P2), and (P4). That said, it is important to be clear about what (P3) says. This premise should be read as being amenable to a myriad of views about the metaphysics of physical objects. (P3) does not preclude, for example, the possibility of theories according to which some types of object are individuals while others are not; for all (P3) says, the individuality profile of the object-oriented realist's ontology may be very complex indeed. What (P3) *does* preclude however, on pain of metaphysical underdetermination, is a metaphysics of physical objects on which there is no fact of the matter about whether and how objects are individuated (any theory that fails to specify an individuality profile for its objects is necessarily *incomplete*). This will be important in what follows (Section 5.3).

One final point before moving on. The appeals to metaphysical underdetermination are sometimes presented with a *semantic* gloss that our formulation lacks. For example, French writes:

The imposition of permutation symmetry ensures a kind of *referential inscrutability* which is manifested in both horns of the underdetermination: on the particles-as-individuals view we lose the possibility of specifying which label is associated with which individual; on the alternative, we don't have individuals at all. Only in the former case does some form of causal theory of reference get any purchase, but it's tenuous at best. And given that the physics cannot tell us which case corresponds to how the world is, the question naturally arises: if the realist cannot specify to what it is she is referring—veiled individuals or non-individuals—then to what extent can she claim to be referring to objects at all? [9, pp. 175–176, emphasis added]

In other words, the “underdetermination” prevents the standard realist not only from discerning the individuality profile of her ontology, but even from making out her claim to be referring to objects at all! As far as we know, this version of the

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<sup>5</sup> We leave the restriction to *ontologically basic* objects implicit throughout, for consideration later (Section 5.5).

argument has not been addressed at all in the literature; while not denying its possible importance, we shall not discuss it here.

### 5.3 Object-Oriented Realism and Premise (P1)

According to premise (P1), a commitment of object-oriented realism is that there is a fact of the matter about *whether* objects are individuals or not—and if so, there is a fact of the matter about *how* they are individuated. In this section, we argue that the object-oriented realist has good reason to reject this premise.

#### 5.3.1 Support for (P1)

French and Ladyman support (P1) by appeal to recent history of physics as well as the testimony of physicists themselves. The first claim is that the concept of object inherited from classical physics involves a commitment to those objects *as* individuals. In their [11], they focus on atomism in the late nineteenth and early twentieth centuries, writing:

How was the content of atomism cashed out? Or, equivalently, how was the “nature” of atoms understood? Briefly and bluntly put, atoms were understood as individuals where the metaphysical nature of this individuality was typically explicated in terms of substance or, more usually in the case of physicists at least, in terms of the particles’ spatio-temporal location. Thus, one of the most prominent and ardent defenders of atomism, Boltzmann, incorporated such an understanding of the nature of atoms in terms of their individuality in Axiom I of his mechanics. The content of atomism was thus cashed out explicitly in terms of the metaphysical nature of atoms. [11, pp. 35–36]

The point is that the axioms that underpin classical Maxwell-Boltzmann statistics include individuality in the concept of object, in the sense that a state and its permutation are counted as distinct states.

The second claim they make is that quantum statistics were seen by the physicists of the time as undermining the view that quantum particles are individuals. The development of quantum mechanics included the development of both Fermi-Dirac and Bose-Einstein statistics, in which a state and its permutation are not counted as distinct states. The connections between individuality, permutation invariance, and different statistics can be challenged,<sup>6</sup> but French and Ladyman are making a case based on history, and their point is that, at the time, physicists saw these developments in quantum mechanics as undermining the view that quantum particles are individuals. French and Rickles briefly summarize the history as follows:

We shall call this view—that quantum particles are, in some sense, not individuals—the Received View. It became fixed in place almost immediately after the development of quantum statistics itself [...]. Thus at the famous Solvay Conference of 1927, Langevin

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<sup>6</sup> Such as in the work of Simon Saunders; see especially [25] and [26].

noted that quantum particles could apparently no longer be identified as individuals, and in that same year both Born and Heisenberg insisted that quantum statistics implied that the “individuality of the corpuscle is lost” [...]. Some years later, in 1936, Pauli wrote to Heisenberg that he considered this loss of individuality to be “something much more fundamental than the space-time concept” [...]. [12, p. 221]

The implication French seems to draw from these considerations is that once we are committed to an ontology of particles, we are also committed to providing an individuality profile for those particles (i.e. to discussing whether these particles are individuals or non-individuals). This is the support offered by French and Ladyman for (P1).

Other arguments—from metaphysics and from logic—might be invoked by someone wishing to maintain (P1), and we will discuss these considerations in Section 3.3 below.<sup>7</sup> Our focus here is on the argument for OSR that has dominated the literature, where the support for (P1) is the historical evidence. How convinced should we be of (P1) on this basis? Well, it is not clear that this support for (P1) works, even on its own terms, because it is not clear that French and Ladyman’s story is the right way to read the historical evidence.

It is worth saying a few more words about this. We do not dispute that the belief that quantum mechanical particles are not individuals was held to represent an important difference between classical physics and quantum physics, by many of the leading physicists of the time. However, French’s own work has shown that quantum mechanics can in fact support an interpretation of its particles as individuals: crucially for the argument from underdetermination, the question of whether quantum particles are individuals or non-individuals is underdetermined by the physics. The physicists that French cites, as believing that quantum mechanics leads to the “loss of individuality” of corpuscles, believed this because they believed that the particles that are the subject-matter of quantum mechanics are described by quantum mechanics in such a way that they are determinately non-individuals. What then, might these same physicists have believed about the status of quantum particles, if they had come to believe that quantum mechanics does not determine whether such particles are individuals or non-individuals? Might they not have concluded that the shift implied by quantum mechanics is not from individuals to non-individuals, but from individuals to particles for whom the categories of individual and non-individual do not apply?

Well, so much for speculative history. Regardless of what they would have said, we think that the latter answer—that there can be objects that are not determinately individuals or non-individuals—is a viable response, and one that should be on the table. (We will come to metaphysical and logical reasons why this might be problematic in a minute, but we will develop this a bit further first.) Consistent with this response is an approach to the objects of physics that we term “law-constitutive”.

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<sup>7</sup> Indeed, French’s continued endorsement of (P1) is related to his logical investigations (see [8]).

### 5.3.2 A Law-Constitutive Approach to Objects

We suggest that a law-constitutive approach to the objects that are the subject-matter of a physical theory is viable, and allows for ontologically basic objects that may be individuals, non-individuals, or not determinately either. This last option asserts that ontologically basic objects may lack an individuality profile, contra (P1). Moreover, such objects need not be such that they can be “structurally reconceived”.<sup>8</sup> If we are right, then the rejection of (P1) is consistent with object-oriented realism when combined with a law-constitutive approach to the objects of physics.

It is worthwhile, then, saying a little about the “law-constitutive” approach to the objects that are the subject-matter of a physical theory. That is to say, a necessary (and sufficient, in the strong version) condition of something to *be* a physical object is that it satisfy the laws of that physical theory. The view says something stronger than that to be a certain *kind* of object is to satisfy a certain system of laws. That claim is perhaps uncontroversial. The view we are offering makes the far more radical claim that what it is to *be* a physical object *at all* is to satisfy a certain system of physical laws: there is no concept of physical object that can be given prior to the specification of the laws. This is *not* to say that objects ontologically depend upon our *theories* about what those laws are, or even upon the laws themselves. The proposal is simply that physical theory exhausts all there is to say about what it is to be a physical object: no prior, or theory-independent, conditions of objecthood are to be had.<sup>9</sup>

This gives us a sense in which the physical notion of object has some autonomy from (and can be considered apart from) the metaphysical and logical notions (of which more below). It opens up a third notion of object. Brading [1] has recently argued that the historical roots of the law-constitutive approach go back at least to Newton. Since the support for (P1) offered by French and Ladyman appealed to the authority of historical figures, this history is not irrelevant. Newton is explicit in his writings on natural philosophy that he is offering an account of body suitable for—and restricted to—the purposes he has in mind (his mathematical natural philosophy), and that for something to *be* such a body (a physical body) it must move in accordance with the laws.<sup>10</sup> The claim is that Newton proposed a weak version of

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<sup>8</sup> And even if they can, further argument is required to establish (C2), as we discuss below.

<sup>9</sup> There is no guarantee that when we work out the details with respect to the specific laws that we find in this, the actual world, we will arrive at an account of physical object that can indeed serve as their subject-matter. Furthermore, there is no guarantee that this strategy will generate one unified kind of physical body: perhaps the bodies that serve as the subject matter of the laws when gravitation is included will turn out not to be identical to those that serve as the subject matter of the laws when electrical phenomena are at issue. Thirdly, there is no guarantee that the law-constitutive approach to physical bodies will deliver individuals. But these issues are all to be distinguished from the philosophical viability of the law-constitutive approach as a possible account of what it is to be a physical body. We say something more about the issue of philosophical viability below.

<sup>10</sup> For further discussion, see [1].

the law-constitutive view, according to which a necessary condition for something to be a physical body is that it satisfy the laws of motion (but other conditions are also required).

For our purposes, the crucial point is this: if we adopt this approach to physical objects then, unless dictated by the laws, the individuality profile required for physical objects by premise (P1) need not, after all, obtain. We have a viable notion of object of which the object-oriented realist may avail herself, thereby rejecting (P1) as giving necessary conditions on objecthood.

For French and Ladyman, a realism that commits us to physical objects, but fails to determine the individuality or otherwise of those objects, is so strange that they reject it in favor of a commitment to “pure structure” as ontologically basic. Our view is that individuality is distinct from object-hood, and that the “metaphysical underdetermination worry” over individuality can be avoided in a less dramatic-sounding manner. By appealing to the law-constitutive account of physical objects, we can pull apart objecthood and individuality in a very natural way: if a theory makes no commitments concerning whether or not the objects it purports to be about are individuals, then we need not conjoin a metaphysics of individuals versus non-individuals to that theory in order to have a physical notion of object for our theory to be about. In such a case, requiring that we discuss these objects in terms of individuality (and perhaps even commit ourselves one way or another on the matter) demands that we go beyond the content of the theory: we have to add an interpretational layer not warranted by what the theory itself says. Expressed in this way, the alleged “strangeness” of a commitment to objects that is not accompanied by a metaphysics of individuality doesn’t sound strange at all—at least not to us.

These grounds for the rejection of (P1) would be cold comfort to the object-oriented realist if the law-constitutive approach necessarily led to structuralism via a different route. French and Ladyman suggest the possibility of a law-constitutive view when writing about Cassirer’s structuralism:

Charge, like the other intrinsic properties, features in the relevant laws of physics and according to Cassirer, what we have here is a reversal of the classical relationship between the concepts of object and law (Cassirer [2], 131-2): instead of beginning with a “definitely determined entity” which possesses certain properties and which then enters into definite relations with other entities, where these relations are expressed as laws of nature, what we now begin with are the laws which express the relations in terms of which the “entities” are constituted. From the structuralist perspective, the entity “constitutes no longer the self-evident starting point but the final goal and end of the considerations [...]”. [11, p. 39]

This is a law-constitutive view of the entities that serve as the subject-matter of physics, in a structuralist version, since laws express *solely relations* and objects are *wholly constituted* by these relations.

But notice: whether the structuralist outcome follows from the law-constitutive approach depends on the nature of physical laws, including whether those laws attribute intrinsic properties to objects. In itself, the law-constitutive approach to physical objects is neutral with respect to structuralism: adopting the approach is consistent with, but does not entail, a structuralist reading of the objects that are the subject-matter of those laws.

In sum, the suggestion is that we have a viable concept of physical object that does not entail a substantive further issue about whether those objects are individuals or not. This is a concept of physical objecthood that is consistent with the alleged underdetermination, but which does not necessarily conceptualize objects structurally, and certainly does not eliminate them in favor of structure. It is not our aim here to explicate and defend the law-constitutive approach.<sup>11</sup> Our purpose here is simply to draw attention to this alternative realist position, and to highlight how it can be used to dissolve worries about “metaphysical underdetermination”.

### *5.3.3 Objects as Individuals: Requirements from Logic and Metaphysics*

The law-constitutive view of objects concerns the concept of physical object, but we have also to address concerns from metaphysics and logic. The questions about what conditions an object has to satisfy have long been given a double-sided treatment, having both a metaphysical and a logical face (think of Aristotle’s treatment of individuals). On the metaphysical side, an object must be countable. On the logical side it must be capable of serving as an object of predication.<sup>12</sup>

Do the metaphysical and logical notions require that an object be determinately individual or non-individual, and if so, how does this affect (P1)? The issue of individuality concerns whether an object can be named such that it may be uniquely re-identified at later times and across possible worlds. Our question is therefore whether being countable and/or serving as objects of predication presuppose a fact of the matter about whether the objects in question are individuals.

Consider first the metaphysical requirement that objects must be countable. Traditionally, this rests on the prior condition that objects can be named. However, quantum mechanics casts doubt on this condition. One way to interpret the countability requirement is that there be a determinate answer to the question “how many?”. There are numerous examples from quantum theory in which the most natural description of the objects involves numerical distinctness without commitment to naming the objects. Paul Teller [27, p. 128] has a discussion of this issue where he argues for the superiority, in certain contexts, of the Fock space representation of atomic electrons: we model the electrons in a particular atom using occupation numbers, which are numbers describing how many times each property is instantiated, with no regard to “which” particle has which of the properties. In other words, we get the kinds of electron, plus the number of electrons instantiating each kind,

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<sup>11</sup> That is a much bigger project, to be carried out elsewhere. Among the issues to be addressed are constitution (what precisely is being constituted in any give case (objects, properties, etc.)) and instantiation (the relationship between a theory and its subject-matter, more generally).

<sup>12</sup> If we restrict this to being an object of *sortal* predication the link between the metaphysical and logical aspects, as two sides of the same coin, becomes evident since (on many views) sortal predicates provide conditions for counting.

but no labels enabling us to refer to any one electron in particular—we don't name the electrons. Thus, in quantum mechanics there can be a determinate answer to the question "how many?" independently of whether we name the objects in question.

From this example we see that the metaphysical requirement that objects be countable can be met without appeal to individuality. Thus, the issue of countability is independent of whether the objects concerned are individuals or not. More than that, the requirement of countability does not depend on whether or not the objects are determinately individuals or not.

In order to talk about objects we require a logical notion of object: we must be able to apply predicates. One point in the debate seems to be the claim that the possibility of logical predication depends on appeal to metaphysically robust objects—objects that can be named and then re-identified across possible worlds, and over time. However, Simon Saunders [23, 24] has shown that the logical notion of object, as object of predication, is a weaker notion, requiring only numerical distinctness.

Saunders has argued for a version of Leibniz's Principle of the Identity of Indiscernibles on the basis of which the above example of Fock space poses no problem for the logical notion of object because it admits two-place relations that cope with numerical distinctness for otherwise identical objects: " $x$  is one meter away from  $y$ " (for example) gives numerical distinctness by failing to be true when  $x = y$  and being true when  $x \neq y$ . Saunders writes:

Consider the spherically symmetric singlet state of two indistinguishable fermions. Each has exactly the same mass, charge, and other intrinsic properties, and exactly the same reduced density matrix. Since the spatial part of the state has perfect spherical symmetry, each has exactly the same spatiotemporal properties and relations as well, both in themselves and with respect to everything else. But an irreflexive relation holds between them, so they cannot be identified (namely "... has opposite component of spin to ..."). [24, p. 294]

In Saunders' terminology (following [20]), fermions are "weakly" discernible. Weak discernibility is indeed weak: we cannot refer to one of the two objects in preference to the other. Nevertheless, we can state of the pair that there are two objects, and we can make assertions concerning the properties of those objects. Thus, these objects serve as objects of predication, in the weakened sense given by Saunders' analysis, enabling Saunders to draw the following conclusion:

I think they [French and Ladyman] are mistaken in their view that failing transcendental individuality, the very notion of object-hood is undermined by particle indistinguishability in quantum mechanics [...] It is true that from exact permutation symmetry it follows that such particles [...] may in certain circumstances not be uniquely identifiable, in the sense that it may not be possible to refer to one member of the collective rather than another. But it does not follow, from logical principles, that such particles cannot be objects of predication. Indeed they can [...]. [23, p. 131]

The logical notion of object does not require that there is a fact of the matter about whether objects are individuals or not. Logic *is* sensitive to individuality and lack thereof: if we enrich our language by adding names to our objects, this will be relevant logically in certain contexts. However, this sensitivity is not relevant to the

point that we wish to make here: serving as an object of predication does not depend on prior determination of the status of the object with respect to individuality.

In sum, metaphysics and logic appear to require countability as a condition of objecthood, but not individuality.<sup>13</sup>

The conclusion Ladyman draws from this is that structurally reconceived objects are admissible, but that the scientific realist's objects (since they must satisfy the individuality criteria of (P1)) are not. We claim that this inference is not justified, given the availability of the law-constitutive alternative. We shall say more about this in Section 5.5.

### 5.3.4 Numerical Diversity as a Criterion of Objecthood

Pooley [17] also argues that the realist should focus on *numerical diversity*. For Pooley, however, numerical diversity is sufficient for individuality. Thus, he rejects our characterization of individuality as concerning whether an object can be named such that it may be uniquely re-identified at later times and across possible worlds. Instead, he distinguishes between “haecceitistic individuality” (for which we reserve the term “individuality”) and “non-haecceitistic individuality” (for particulars which satisfy the numerical diversity condition, but neither of the further conditions of having transworld and over-time identity conditions.) We think that he is right to focus attention on numerical diversity, but that his association of individuality with numerical diversity is potentially misleading, and that our taxonomy is preferable, for the following reasons.

Adopting Pooley's terminology, metaphysical underdetermination becomes, in the context of spacetime theory, underdetermination between haecceitistic and non-haecceitistic interpretations of the individuals that are the spacetime points of spacetime theory. This, Pooley suggests, is not a troubling form of underdetermination: the non-haecceitistic interpretation is the “core” realist position, which the realist may or may not supplement with haecceities. He writes: “If this is the only choice to be made, it hardly constitutes an interesting threat to the realist's belief in the existence of spacetime points” [17, p. 10].

A mere re-labelling of both options as concerning “individuals” rather than “individuals” versus “non-individuals” does not make a legitimate underdetermination go away, of course. If such underdetermination exists, then the realist faces a systematic underdetermination of the identity conditions of its basic constituents (the spacetime points); if this seemed troubling on Ladyman's “individuals versus non-individuals” formulation, then it remains troubling on Pooley's “haecceitistic versus non-haecceitistic individuals” formulation. We should make it clear that Pooley never implies that the re-labelling removes the problem; for him, the re-labelling

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<sup>13</sup> Bosons, in contrast to fermions, do not satisfy this countability requirement.

is a preliminary step towards denying the alleged metaphysical underdetermination for the theories he considers.<sup>14</sup>

The advantage of our approach, and our terminology, is that we use the term “object” as neutral between (a) haecceitistic individuals, (b) non-haecceitistic individuals, and (c) particulars for whom there is no determinate fact of the matter as to whether they are haecceitistic or non-haecceitistic individuals. This is important because it includes the possibility of objects with no determinate individuality profile. As a result, it allows for the possibility that we do not have to decide between (a) and (b): that we lack the resources to do so does not indicate a metaphysical underdetermination; rather, it indicates that (c) is the appropriate category for the objects of the theory in question.

Pulling together what we have learned so far, the conclusion is that the object-oriented realist has available a route for rejecting (P1), should she so choose. The considerations of this section, including the work of Saunders and Pooley, show that *countability* is the crucial criterion for objecthood. This, and not individuality, is the test for objecthood that can be brought to bear on candidate “objects” arising from the law-constitutive approach to physical objects.

## 5.4 ESR, Object-Oriented Realism, and (P2)

The conclusion (C1) of the argument from metaphysical underdetermination is the rejection of object-oriented realism. There are two targets here. The explicit target is the standard scientific realist, with her full range of beliefs concerning unobservable objects. However, if the step from (C1) to (C2) is to succeed, the epistemic structural realist option must also be ruled out by the rejection of object-oriented realism. In our opinion, the advocate of ESR can—and should—reject (P2).

First, (P2) is nothing more than the *denial* of ESR, which Ladyman himself casts as a form of object-oriented realism, accepting a world consisting of “intrinsically individuated objects with intrinsic natures” [14, p. 28]. What (P2) says, recall, is that being an object-oriented realist entails that not only that each object has a determinate individuality profile, but also that this profile can be uncovered by the physical theories which describe and refer to them. Yet according to proponents of ESR, this is precisely what the pessimistic meta-induction shows us we cannot have (Section 5.1): according to them, we *cannot know* what the objects these theories refer to and describe are intrinsically like.

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<sup>14</sup> Pooley argues persuasively that his non-haecceitistic version of substantivalism is clearly the better interpretation of current spacetime theory than the haecceitistic one, and therefore that there is no genuine metaphysical underdetermination facing the realist when it comes to the status of spacetime points. Pooley also rejects the alleged underdetermination with respect to quantum particles. He is among those who reject French and Ladyman’s claim that a (haecceitistic) individuals interpretation is a genuine option, arguing that quantum particles satisfy numerical diversity but fail both transworld and over-time identity.

But now the problem with the argument's inclusion of (P2) should be clear. On one hand, proponents of ESR deny that we can—much less *should*—expect our best theories to assign an individuality profile to each (type of) object, since part of what the objects of our best theories are intrinsically like is how they are “intrinsically individuated”, in Ladyman’s phrase. But on the other hand, (P2) just takes for granted that our best theories can provide us with epistemic access to facts about these objects are intrinsically like: in short, the premise just states that ESR is false. For it denies the characteristic epistemological claim of this view, by claiming that we should expect our best theories to describe the intrinsic nature of physical objects. In the absence of considerations supporting (P2), which have yet to be offered, we have a stand-off between ESR and OSR. Insofar as the argument from metaphysical underdetermination is intended to push us beyond ESR, and to OSR, it cannot be the *argument* that is doing the work: (P2) suffices.

Note that this route for rejecting (P2) is open not just to advocates of ESR, but also to *any* object-oriented realist who claims that we have limited epistemic access to the individuality profiles of the objects of physics. Even object-oriented realists who are realist with respect to the intrinsic qualitative properties attributed to objects by our best scientific theories may reject (P2). For instance, consider the form of realism offered by Psillos [19].<sup>15</sup> On this view, though we do have epistemic access to more than the structural content of our theories, we do not have enough to secure knowledge of the world’s underlying individuality profile. The dispute is then over whether this epistemic cautiousness amounts to an “*ersatz* form of realism”, as Ladyman [13, p. 420] alleges, or to a discovery about our epistemic situation in the world (be that in principle, or contingent on this particular point of our scientific development). In short, the dispute is no longer over whether metaphysical underdetermination poses a difficulty to object-oriented realists. Rather, at issue is whether forms of object-oriented realism that are epistemically humble enough to reject principles like (P2)—by far the most popular strain in the recent literature—are “realist” enough. If there is a genuine dispute to be had here, it has little to do with metaphysical underdetermination.<sup>16</sup>

In sum, the advocate of ESR should most certainly reject (P2), and the standard object-oriented realist should not concede (P2) without a further fight.

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<sup>15</sup> Psillos offers a version of scientific realism, but explicitly denies that the scientific realist should be committed to the claim that “two” worlds related by the shuffling of bare particulars are in fact two distinct worlds [19, pp. S19–20].

<sup>16</sup> Notice that a scientific realist who endorses the law-constitutive view of objects will insist that these laws fully determine whether there is a determinate fact of the matter as to the individuality or non-individuality of the objects that are the subject matter of the theory in question; thus, in rejecting (P1), she by-passes the force of (P2).

## 5.5 Reductive vs. Eliminative OSR and (P4)

Our final criticism of the argument from underdetermination starts off with the observation that there are *two* varieties of OSR available—both of which are reflected in French and Ladyman’s presentations of the view.

When articulating OSR, French and Ladyman at times appear to argue for the *elimination* of objects in favor of structure. In early presentations, the metaphysical conundrums that OSR attempts to avoid require “a shift to a different ontological basis altogether” [13, p. 420], one in which objects play nothing more than “a heuristic role allowing for the introduction of the structures which then carry the ontological weight” [7, p. 204]. Once they have played this heuristic role, “the objects can be dispensed with” [11, p. 42].

In other presentations, however, there is a shift in terminology towards “reconceptualization” of objects in structural terms, coupled to the suggestion that structures are *ontologically prior* to objects.<sup>17</sup> The reconceptualization of objects in structural terms is the claim that objects are nothing over and above the “nodes” in a web of relations. As such, it weights the objects and relations equally, and does not give ontological priority to either. One role for the argument from metaphysical underdetermination is, we take it, to get us from this “mere reconceptualization” of objects to a claim of ontological priority for structures (that is, to the rejection of object-oriented realism and the adoption of OSR).

Viewed in this role, the argument proceeds as follows: (i) premise (P1) remains as before: objects must have an associated individuality profile if they are ontologically basic; (ii) yet if, however, objects are ontologically derivative upon structures, no such individuality profile is required; (iii) the objects of physics do not satisfy the individuality conditions; therefore (iv) the ontological priority of structure over objects is established.

Before we get to the main objection, note that this subtle shift (from taking the argument from metaphysical underdetermination to support *eliminative* OSR, to instead taking it to support *reductive* OSR) invites further questions when seen in light of the tenability of the law-constitutive view of objects (Section 5.3). In the absence of an argument from “reconceptualization” of objects in terms of structures to the ontological priority of the latter to the former, the option of remaining an object-oriented realist while giving up the requirement that objects must have a determinate individuality profile appears to remain on the table. However, in their recent treatment of the argument from underdetermination, Ladyman and Ross [15, p. 138] retreat from (P1), endorse reconceptualization, and then comment that this is a “thoroughly structuralist” position. This seems to imply that were the object-oriented realist to concede reconceptualization, she would thereby have conceded the debate to OSR. The option of remaining an object-oriented realist while giving up the requirement that objects must have a determinate individuality profile is, on this account, a delusion.

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<sup>17</sup> For just one example, see [11, p. 37].

There are two ways to think about this, so far as we can see. On the one hand, if reconceptualization yields ontological parity of relations and relata, then further arguments are required to show that either object-oriented language or relations-oriented language more appropriately “reflects basic ontology”, and the object-oriented realist need not concede yet.<sup>18</sup> On the other hand, the advocate of OSR could be claiming that the lesson of reconceptualization is that structure is *ontologically prior* to its decomposition into relations and relata, thereby resisting the push towards the relations versus relata debate. This requires that we distinguish *structuralism* from a commitment to the ontological priority of *relations*, something that has not been the case (at least not clearly so) in the structural realism debate to date.

But set these issues aside: a worse problem with the shift from eliminating objects to “reconceptualizing” them is that it reveals how OSR is a victim of its own argument. Premise (P4), recall, says that OSR is not affected by the metaphysical underdetermination that would (allegedly) infect our best theories if object-oriented realism were true; if it *were*, then adopting OSR would be medicine as lethal as the disease. Now, we have distinguished between proponents of OSR who *eliminate* physical objects from those who merely accord them a *less fundamental* status. But this potential disagreement among proponents of OSR is clearly *no less metaphysical* than the dispute between object-oriented realists about whether objects are individuals or not. For the dispute between eliminative and reductive OSR is a dispute about *what exists*, and these are of course paradigmatically metaphysical disputes, no more settled by the details of the relevant physics than for the object-oriented realists.

Thus by trading in object-oriented realism for OSR, we have traded one pair of metaphysically underdetermined interpretations for another. In short, the claim that OSR does not infect our fundamental physical theories with metaphysical underdetermination—i.e., premise (P4)—is false. Moreover, we can also run the argument from metaphysical underdetermination against (OSR) as follows:

- (P5) If OSR is true, then there is a fact of the matter about whether objects exist or not.
- (P6) If (P5) is true, then we should expect our best theories to say whether objects exist or not.
- (P7) But our best theories fail to say whether objects exist; whether they do or not is underdetermined by the interpretations offered by eliminative and reductive OSR.
- (C3) So OSR is (probably) false.

Juha Saatsi [22] has also recently suggested that OSR is a victim of its own argument. He claims that “the structuralist proposal only makes matters worse, for

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<sup>18</sup> See the further arguments in [15] for the structuralist position, and the arguments of Chakravartty [5] in favor of object-oriented realism.

with such an alternative structuralist ontology available there would be three instead of two to choose from!” [p. 12]. If this is the case, then premise (P4) must be rejected, and the argument fails to progress to the positive conclusion (C2). Such an outcome might be resisted, as Saatsi notes, if it can be argued that the ability of OSR to accommodate the “common core” of the competing interpretations breaks the impasse. However, we think that the escape from underdetermination does not last long. We reject (P4) because of the metaphysical underdetermination *internal* to the radical structuralist program itself, not simply between it and the object-oriented options. Our best fundamental theories underdetermine the correct metaphysics of structure (elimination versus reduction), whether it can accommodate the interpretations offered by traditional realists or not.

Another response to our objection is that there is considerable dialectical pressure to keep objects around, and this mitigates the ontic structural realist’s problem with metaphysical underdetermination. For example, its proponents need a response to this notorious objection: structures are sets of relations, and relations require objects in order to be instantiated; so their ontology, consisting of nothing but relations, is either Platonic or incoherent. However, this objection is no problem for proponents of non-eliminative OSR, for they can claim that structural relations *do* have relata while their eliminative rivals cannot. The slogan “no relations without relata” requires only that there *be* nodes in the structure (which the non-eliminativist accepts), not that the nodes be ontologically independent of the structure (which she denies).<sup>19</sup> Similarly, French reintroduces non-structural, non-fundamental elements into the ontology of OSR in order to deal with various other challenges [9, pp. 178–184]. But again, these considerations for preferring reductive OSR to its more extreme counterpart is certainly not constrained by physics anymore than principles and arguments about the metaphysics of individuality are for object-oriented realists. Why are proponents of OSR allowed to break the metaphysical underdetermination by doing metaphysics, but not realists who are friendly to objects?

In this paper we have taken no stance on whether it *would* be problematic if our fundamental physical theories were metaphysically underdetermined. However, what we have shown in this section is that if it *is*, then OSR offers no escape from it.

## 5.6 Conclusion

Let us recap. We have presented the argument from metaphysical underdetermination as consisting of three premises (P1–3), a negative conclusion that rejects object-oriented realism (C1), a further premise (P4), and a positive conclusion that asserts OSR (C4). We have argued that the object-oriented realist should reject (P1), and that there is available an account of objects—what we have called the law-constitutive approach—that allows her to do so. We have argued that the epistemic

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<sup>19</sup> Chakravartty’s own response on behalf of eliminative (OSR) is to claim that rejecting the slogan as conceptually incoherent is “question begging” [3, p. 872].

structural realist should certainly reject (P2), even if she does not reject (P1), and that object-oriented realists of any stripe have reasons to question (P2). Thus, insofar as the argument is intended to remove the competitors of OSR (standard scientific realism and ESR) from the game, it fails. Furthermore, we have also argued that the further premise (P4) needed to move to the positive conclusion, asserting OSR, cannot be maintained.

So what path should the proponent of OSR take from here? One option is to modify our reconstruction of the argument; but the onus is on her to offer an explicit and valid argument in support of her desired conclusions, and to show that her premises do not face the same challenges as we have presented here. We think that the prospects are not promising.

In the face of this negative evaluation, it is important not to throw the baby out with the bath water, and to retain the important insights gained from the OSR program. With this conclusion in mind, it is worth noting that much of Ladyman et al.'s [15] recent structuralist manifesto is independent of the success (or failure) of the argument from metaphysical underdetermination. Nevertheless, this argument *is* the central argument by which OSR was introduced, it continues to play a central role in the discussion, and thus deserves independent scrutiny. Our conclusion is that we should look elsewhere than the argument from metaphysical underdetermination when seeking reasons to adopt OSR.

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