

Non-mereological pluralistic supersubstantivalism: an alternative perspective on the matter/spacetime relationship

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ABSTRACT

In both the historical and contemporary literature on the metaphysics of space (and, more recently, spacetime), a core dispute is that between *relationism* and *substantivalism*. One version of the latter is *supersubstantivalism*, according to which space (or, again, spacetime) is the only kind of substance, such that what we think of as individual material objects (electrons, quarks, etc.) are actually just parts of spacetime which instantiate certain properties. If those parts are ontologically dependent on spacetime as a whole, then we arrive at an ontology with only a single genuinely independent substance, namely the entire spacetime manifold. This is *monist supersubstantivalism*. A view on which the parts of spacetime are ontologically prior to the whole has been called *pluralistic supersubstantivalism*. As currently formulated, supersubstantivalism (in either its monist or pluralistic forms) carries significant advantages and encounters major difficulties. I argue that some of the latter motivate an alternative formulation, *non-mereological pluralistic supersubstantivalism*, according to which spacetime is a real substance, but what we think of as material objects are also real substances, irreducible to and numerically distinct from that larger spacetime manifold and any of its parts. Yet, the underlying nature of those material objects is ultimately the same type as that of spacetime: at bottom, a particle is just a smaller quantity of spacetime embedded in or contained by or co-located with the larger whole that we would normally think of as ‘spacetime,’ capable both of genuine movement within/across the larger spacetime manifold and (at least in principle) independent existence from it.

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1. Introduction

With respect to the ontology of space, relationism (sometimes spelled ‘relationism’) is, roughly, the view that space is reducible to a set of relations between

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physical substances, with no reality over and above them. By contrast, substantivalism is the theory that space is a substance, an independently existent reality. The debate between advocates of relationism and substantivalism is longstanding and ongoing (though since the advent of relativity theory much of the debate has been recast in terms of the ontology of spacetime). A particular version of substantivalism present in some historical figures (e.g. Spinoza), known as *supersubstantivalism*, has become the object of intense interest within the metaphysics of science literature, with favourable treatments found in such authors as Arntzenius (2012), Field (1989), Gilmore (2014), Grant (2013), Lehmkuhl (forthcoming), Lewis (1986), Morganti (2011), Quine (1981), Schaffer (2009), and Sider (2001, 2006). On supersubstantivalism, what we normally think of as fundamental material objects (whether particles, fields, strings, etc.) are understood as *identical with* or *constituted by* or *eliminable in favour of* spatial (or, more commonly, spacetime) points or regions. So what we typically consider to be an individual electron is actually just a part of spacetime (whether a region or a point) possessing certain properties¹ associated with the kind 'electron': negative charge, half-integral spin, etc. Spacetime points or regions are themselves the substrata² in which these properties inhere, such that the only irreducible substances in nature are those points/regions.

That's the basic idea at least; Grant (2013), Lehmkuhl (forthcoming), Morganti (2011), Schaffer (2009) and others point out that multiple formulations of supersubstantivalism are possible, along multiple divisions. For instance, depending on where one stands concerning the atoms vs. gunk vs. extended simples debate regarding composition, one might prefer to speak of the relevant substance as a spacetime *point* or as an ineliminably extended spacetime *region*. Further, and independently of where one falls on *that* debate, one might opt to affirm the reality of material objects while yet reducing them to spacetime regions/points (*reduction as identity*), or one might want to dump material objects from one's ontology altogether in favour of spacetime regions/points (*reduction as elimination*), or one might argue that spacetime regions/points help to *constitute* material objects, but are not strictly identical with them. Further still, one might advocate a version of supersubstantivalism according to which parts of spacetime can instantiate any of the properties typically thought to be possessed by material objects, whether geometrical, qualitative or dispositional (a view Lehmkuhl calls *modest supersubstantivalism*), or instead a version according to which the parts of spacetime can instantiate only geometrical properties (*radical supersubstantivalism*).

It is not always clear which exact formulation of supersubstantivalism is favoured by a certain author, though with respect to the regions vs. points issue Morganti (2011, 192) and Schaffer (2009, 132) are explicitly neutral, while Sider (2006) prefers points; on the latter, tripartite division (identity vs. elimination vs. constitution), Schaffer (2009, 133) for example is in favour of the identity formulation, Grant (2013, 161) prefers constitution³ and Arntzenius (2012, 181–182)

apparently favours an eliminativist interpretation: 'Supersubstantivalism is the claim that the only object that exists is spacetime, or, perhaps better: supersubstantivalism claims that there are no material objects and no fields, just spaces which have properties.'

At any rate, those points/regions are seen as parts of the larger spacetime manifold, 'spacetime taken as a whole.' Given their status as parts, this raises a further question as to the relationship between the parts and the whole. *On the one hand*, if the parts (the regions/points) are existentially independent from the resultant whole, which whole is constructed out of those parts, then on this view, there are many individual substances (as many as there are individual regions/points) and the whole apparently depends for its existence on the parts. I take this to be Sider's (2006, 393) view. It has received (from Lehmkuhl) the label of *pluralistic supersubstantivalism* to bring out the fact that on this view, there are multiple individual substances, though all of the same underlying type. *On the other hand*, one could maintain with Schaffer (2009, 135–137) that the larger spacetime manifold, the whole, has an ontological priority over and against any part of spacetime. This leads to *monist supersubstantivalism*, according to which the only existentially independent substance is spacetime itself, taken as a single whole. Smaller regions or points can properly be said to exist, but they are derivative on the whole.

There are significant arguments to be made in favour of supersubstantivalism, both in general and also for the specifically monist version advocated by Schaffer. A quick sampling:

- (a) There is the *argument from parsimony*, which makes the point that an ontology able to get by with only one fundamental type of substance (spacetime) is more economical than an ontology requiring two types of substance (spacetime and matter). And if one follows Schaffer, the gains to economy become even more pronounced, insofar as one reduces not only the *types* of irreducible substance to one, but also the *tokens*: the only irreducible, existentially independent substance is the single, giant whole that is spacetime.
- (b) There is the *argument from harmony*, formulated by Schaffer (2009, 138–140), according to which supersubstantivalism provides a ready explanation as to why the geometrical and mereological properties of a material object always match up perfectly with those of the spacetime region it allegedly 'occupies.' Why should that necessarily be the case, if in fact material substances are genuinely distinct from the substance that is spacetime? By contrast, the truth and necessity of this harmony becomes obvious on supersubstantivalism.
- (c) The *argument from materialization*, formulated by Schaffer (2009, 141), takes as its starting premise the fact that, necessarily, a material object must be found in spacetime. Material objects cannot exist without

occupying some spatiotemporal location; particles, etc. cannot exist, Godlike, extraspatially or atemporally.

The dualist [one who believes that material substances are distinct from spacetime] has no obvious explanation for materialization. Why can't a material object just happen not to stand in the containment relation to any spacetime regions? So it seems the dualist must impose another brute necessary connection on the world (Ibid.)

- (d) The *argument from substratum theory*, formulated by Morganti (2011, 192–195), makes the case that substratum theory, one of the principal competitors in substance ontology (alongside primitive substance theory, bundle theory, and hylomorphism), is only workable if combined with supersubstantivalism. Consequently, if one favours substratum theory, one must accept supersubstantivalism. I cannot get into the details of Morganti's argument here, but the basic idea is that substratum theory faces three serious objections (having to do with apparent incompatibility with metaphysical naturalism, commitment to extreme haecceitism and problematic circular existential dependence), each of which can be readily addressed provided one takes spacetime points/regions as the substrata.
- (e) There are also various *arguments from physics*, from developments in both relativity theory and field theory, that seem to point towards the truth of supersubstantivalism. I will not attempt to summarize the relevant details here, but see Grant (2013, esp. 154–155 and 161–163), Lehmkuhl (forthcoming), and Schaffer (2009, 142–144) for discussion.⁴

That is obviously not an exhaustive summary of the existing arguments for supersubstantivalism. Still, hopefully the preceding provides at least an introduction to the theory and to some of its supports. With that introduction in hand, I can now state my thesis: supersubstantivalism is indeed true, but not in quite the formulations in which it has been presented in the recent literature. It *is* true as a theory about the underlying type-identity between spacetime and material objects. Individual material objects are, at bottom (in their underlying intrinsic natures), the same type of thing as spacetime. However, supersubstantivalism is *not* true as a theory that posits individual material objects as mere parts of spacetime (whether as *identical* with those parts or as *composed of* those parts or as *eliminable in favour of* those parts). What is needed is a version of supersubstantivalism that preserves the type-identity proposal while denying that material objects are identical with or constituted by or eliminable in favour of parts of that one larger spacetime manifold. That can be done by supposing that an individual material object is an instance of spacetime that is embedded in or contained by or co-located with the larger spacetime manifold.

I will refer to this alternative formulation as *non-mereological pluralistic supersubstantivalism*. To state the view a bit more precisely, it can be broken down into six propositions:

Non-Mereological Pluralistic Supersubstantivalism (1) individual material objects are real substances; (2) the larger spacetime manifold is a real substance; (3) individual material objects are not parts of the larger spacetime manifold; (4) individual material objects can (in principle) exist independently of the larger space-time manifold and vice versa;⁵ (5) individual material objects are members of the same underlying natural kind as the larger spacetime manifold, and are thus distinguished from that larger manifold by the possession of one or another sort of accidental (contingent) property;⁶ (6) individual material objects relate to the larger spacetime manifold in at least one of three ways: by embedding, containment, or co-location.

This alternative formulation of supersubstantivalism thus maintains that there is a real distinction between the larger spatial manifold and what we typically think of as physical objects (unlike thinkers such as Arntzenius (2012), who openly advocate the elimination of physical objects), while yet affirming that this distinction is one of token rather than type, since physical objects belong to the same natural kind as that larger manifold. Non-mereological pluralistic supersubstantivalism is thus a version of the identity theory of the relationship between material objects and spacetime (and correspondingly is opposed to the reduction and elimination theories). But the sort of identity advocated is type-identity rather than token-identity. It will be argued below that this alternative version of supersubstantivalism retains core advantages of existing versions while wholly sidestepping some serious objections to which those versions are vulnerable.

The remainder of the study is divided as follows: in the next section, I lay out certain objections facing the recent formulations of supersubstantivalism. Some of these are familiar from the existing literature, others are new. I argue that certain of these objections are serious enough to warrant openness to a new formulation of the theory. Then, in section three, I explain non-mereological pluralistic supersubstantivalism in greater detail (among other things clarifying the meaning and import of the 'embedded in/contained by/co-located with' disjunction employed above) and argue that it sidesteps the objections. Section four concludes with a short recap.⁷

2. Problems facing recent versions of supersubstantivalism

2.1. First objection

The most obvious worry facing recent formulations of supersubstantivalism is the challenge they pose to our common-sense way of conceiving the world, according to which space contains independently existent, irreducible material objects (whether or not space is conceived as a reality on its own accord, and in whatever way 'containment' is cashed out). To suggest that fundamental particles, let alone the macro-level entities composed of them (rocks, chairs, dogs, people, etc.), are really identical with spacetime regions instantiating certain properties (or *constituted* by those regions or even *eliminable* in favour of them)

is counter-intuitive. Sider (2001, 111) alludes to this in an amusing fashion when he writes: "A region of space-time bounded out the door and barked at the mailman" – it sure sounds strange to say! Indeed, it sounds like a "category mistake":

Sider ultimately thinks the worry can be overcome. Likewise, building off that passage of Sider's work, Schaffer (2009, 144) writes: 'I agree that common sense is dualistic.⁸ I just don't think common sense should be taken too serious on this issue. Common sense – what Einstein called "a deposit of prejudices laid down in the mind before you reach eighteen" (Bell 1951, 42) – is a poor guide to the fundamental structure of reality.' His point can be buttressed by drawing attention to the many ways in which contemporary physics seems to depart radically from our common-sense intuitions about how the world is supposed to work.

Nevertheless, disconnect with common intuition might yet plausibly be seen as a cost (even if a small one) borne by supersubstantivalism. This issue is of course bound up with much larger debates concerning the epistemology of metaphysical inquiry, debates I cannot delve into here. I will simply note that Sider, even while favouring supersubstantivalism, gives 'ordinary' ontology a greater *prima facie* weight in such considerations than does Schaffer, acknowledging that a theory must provide strong justification for making us depart from deeply held common-sense beliefs, given that such beliefs are the starting point of theoretical inquiry (though of course not necessarily the end point). Sider (2001, xv–xvi) writes:

One approaches metaphysical inquiry with a number of beliefs. Many of these will not trace back to empirical beliefs, at least not in any direct way. These beliefs may be particular, as for example the belief that I was once a young boy, or they may be more general and theoretical, for example the belief that identity is transitive. One then develops a theory preserving as many of these ordinary beliefs as possible, while remaining consistent with science. There is a familiar give and take: one must be prepared to sacrifice some beliefs one initially held in order to develop a satisfying theoretical account. But at theoretical account should take ordinary belief as a whole seriously, for only ordinary beliefs tie down the inquiry.

With that broad understanding of metaphysical method in place, there is motivation to try and see just how much supersubstantivalism can accommodate of ordinary, common-sense belief. Perhaps it can accommodate very little, and the theoretical benefits of that disconnect remain so great that this is not a major concern; on the other hand, perhaps alternative formulations of supersubstantivalism (formulations that maintain its core theoretical advantages) could be found that retain more of the content of ordinary belief. Certainly on Sider's view, it is worthwhile to keep on the lookout for such alternative formulations.

2.2. *Second objection*

Related to the worry over conflict with common sense (and perhaps just a specific version of it) is the concern that supersubstantivalism does away with local motion in the way it is usually conceived. We normally think of the motion of an

electron (for instance) as involving a single, unified material object progressing through or across a background spatial manifold. On supersubstantivalism, what we have instead is a collection of properties (negative charge, half-integral spin, etc.) being possessed by one spacetime region or point followed by another followed by another, etc., such that the set of properties is successively possessed by an ordered series of regions/points. Local motion is, on this account, reconceived as something more akin to the 'motion' seen on a computer screen: one pixel is lighted followed by an adjacent pixel followed by an adjacent pixel, etc., such that it *looks* like there is a unified character moving across the screen, whereas in fact, there is just a set of stationary pixels successively receiving an image. That is, arguably, deeply counter-intuitive.^{9,10}

2.3. Third objection

A further problem has to do with the production of *unified* property-sets over time and during 'motion' (however exactly 'motion' is cashed out). Normally, substratum theory seems to provide a decent explanation for the unification of a collection of otherwise diverse and inherently separable properties; that is, the intrinsic properties associated with the kind 'electron' (precise rest mass, negative charge, half-integral spin, etc.) come together and remain together because they inhere in one and the same substratum, despite the fact that this specific rest mass is in principle capable of instantiation separately from negative charge and vice versa.¹¹ Thus there is no need to posit the existence of primitive compresence relations or whatnot, as do many proponents of bundle theory;¹² nor is there any need to posit the existence of ontologically robust natural kinds/substantial forms ('electronhood') that are explanatorily prior to their associated properties, as on primitive substance theory and hylomorphism.¹³ However, while substrata might still account for synchronic property-unification on standard supersubstantivalism, it is not clear that it can help at all with diachronic property-unification involving motion. The reality of the substratum might explain how all these diverse properties hold together at *x* at time *t*₁ (namely they hold together by being jointly instantiated at/possessed by *x*), but it is not clear why just that same set of properties (whether thought of as universals or tropes) should then appear together at *y* at time *t*₂. Why just that set? Remember, for the substratum theorist, the only thing unifying the otherwise diverse members of the set is the substratum, and now at time *t*₂, we're dealing with a different substratum, *y*, so what explains the consistency and unity of the property-set?

2.4. Fourth objection

Another well-known worry for supersubstantivalism has to do with modality. *Prima facie*, it seems as if any material object could, in theory, have been at a

different place at time t_n than it actually is. That is, in principle, I could have been sitting a half-inch to the left of where I am in fact sitting at time t_n . But as currently formulated, supersubstantivalism does not allow for this; on substratum theory, the identity of an object is necessarily tied up with the specific substratum its properties are instantiated in, such that if those properties were in a different substratum, then the object itself would be a numerically different object. But substrata are spacetime regions/points, on supersubstantivalism. So change of place entails change of identity. I literally would not have been me had I been sitting an inch to the left (nor would any of my constituent subatomic particles have been the same subatomic particles, etc.). This again is counter-intuitive. There are different ways of trying to address this objection; Schaffer (2009, 145) deals with it by adopting a counterpart theory of *de re* modal properties (i.e. it's true that it would not have been *me* sitting a half inch to the left at time t_n , but in some adjacent possible world, I have a near-identical counterpart there at that time and that suffices to capture the relevant modal intuitions). By contrast, Skow (2005, 65, cited in Grant (2013, 164)) argues it can be addressed by claiming that the precise location of spacetime regions can vary from one possible world to the next – that is, he denies that the precise geometrical relations between regions of spacetime are essential to them, such that the overall structure of the whole spacetime manifold could in principle have been different. Naturally, there are worries about both sorts of reply: those who oppose counterpart accounts of modality will resist Schaffer's reply, and those who incline towards essentialism about the internal structure of spacetime will resist Skow's reply.¹⁴ Of course those are not decisive points against either reply, just costs to be borne by them, depending on one's background ontology.

2.5. Fifth objection

A final complaint against existing formulations of supersubstantivalism arises out of the very idea that spacetime, as understood in contemporary physics, could fulfil the same explanatory roles as that played by substrata in substance ontology. The ability to fulfil these functions is key for Morganti's (2011) positive argument for supersubstantivalism, and I take it to be important for Sider (2006) as well. The same can be said for Schaffer (2009, 137–138): 'I take it that the primary role that material objects are supposed to play is the role of *substrata*. Material objects are supposed to provide the pincushions for properties....Substantival spacetime regions bear properties. So they do what objects should do. Thus, there is no need for a second sort of substance to do what has already been done. Spacetime is pincushion enough to support a propertied world! [Emphasis in original] Now, the idea that the key role for substrata is to function as property bearer is not wholly uncontroversial among substratum theorists; Moreland (1998) for instance explicitly restricts the explanatory role of substrata to that of individuating universals. However, that substrata play a role

as property bearers would be granted by many substratum theorists, and this explanatory role is key for such thinkers as Martin (1980), for whom substrata function principally as truthmakers for the truth that substances are intrinsically property bearers. (As a nominalist who takes properties to be tropes rather than universals, Martin is not concerned about the need to individuate universals.) So granting that substrata are supposed to be property bearers, can spacetime regions/points be substrata? Here is one issue on which the points vs. regions distinction takes on some significance.

Let's look at the points option first. Sider (2006) identifies substrata as either spacetime points or numbers (basically, individual mathematical abstracta, if indeed such exist). His willingness to countenance the latter is significant; it indicates that on his view, the internal nature of substrata is so thoroughly bare that it is not clear whether one is dealing with concrete individuals or abstract individuals. By contrast with Sider's commitment to substrata being space-time-points-if-concrete, Morganti (2011) wants to leave open whether substrata are spacetime regions or spacetime points, while Schaffer (2009) seems to prefer their being extended regions (with the further assumption that a region is an extended simple, irreducible to a collection of spatial points). One advantage of taking substrata as identical with extended spacetime regions is that such a view avoids stock Aristotelian complaints about atomism: there is no way that extended objects could be constructed out of unextended objects, because that would involve getting something from nothing (or rather, something from what is *in the relevant respect* nothing, namely getting extension from non-extension). Add one unextended object to another (or millions for that matter) and the result is *not* an extended object. The same thing could perhaps be said for the attempt to construct space out of spatial points. (And by 'construct' I mean literal, physical composition, not mathematical modelling, which of course can posit a consistent spacetime built up out of geometrical points.) Such traditional worries, long ignored, have re-emerged in the literature on fundamental material composition.¹⁵ Sider (2006, 393) rejects them and takes it that spacetime points could indeed serve to construct the overall spatiotemporal manifold by standing in spatiotemporal relations to one another, writing that 'a natural and economic theory of points of space-time is that each one is a partless, truly bare particular that stands in a network of spatiotemporal relations.' But that in turn seems to involve a problematic symmetric existential dependence relation (or, to use a more technical label, a *chicken-and-egg worry*): how can the spatiotemporal manifold as a whole be constructed out of spatiotemporal relations between spacetime points, if those spacetime points can constitute no spatiotemporal regions (since they are unextended) and hence cannot ground any such relations? Unless one is committed to a strong version of ontic structural realism in which relations are ontologically prior to substances, this will seem objectionable.

Alternatively, let's say one sides with Schaffer and supposes that substrata are best identified with extended spacetime regions. This carries with it a potential complication of its own: because a spacetime region is essentially extended (being extended is part of its intrinsic identity as a spacetime *region*), it is essentially propertied. Thus, it is not a substratum as substratum theorists traditionally conceive of it: it is not an *inherently propertyless* bearer-of-properties,¹⁶ because it is already inherently propertied, possessing extension and a set of other properties entailed by extension (shape, size, divisibility, etc.). Spacetime begins to look even less like the substratum of traditional substratum theory when one adds in all the properties attributed to it by recent physics, including not only geometrical/structural properties but also assorted dispositions: powers to be warped in various ways, powers of expansion and (possibly) contraction, etc. Arguably this same point may hold with respect to the claim that substrata are spacetime points; however, it is not as immediately obvious that a spacetime point is of itself already a property bearer.

The supersubstantialist might retort at this point: who cares? Sure, grant that spacetime regions are not substrata in quite the sense understood by traditional substratum theorists. So just pair supersubstantialism with a more amenable substance ontology, like primitive substance theory. Advocates of this theory, such as Ellis (2001, 2002), Hoffman and Rosenkrantz (1997), Loux (1974, 1978, 2002), Lowe (1989, 1994, 1998, 2000, 2006, 2012), and Macdonald (2005), among others, contend that substances, rather than being internally complex entities composed out of more basic ontological constituents (like substratum + attributes, as on substratum theory, or prime matter + substantial form, as on hylomorphism), are *sui generis*, basic elements in ontology. According to the primitive substance theorist, an individual substance is just the instantiation of its associated substance-universal/natural kind, and thus possesses all the properties entailed by membership in that kind, and *that's it* – there's not much more to be said re: its basic ontology.¹⁷ By plugging supersubstantialism into *this* substance ontology, one can affirm that spacetime is itself a natural kind of object with its own intrinsic, defining properties. Such an object can of course be a bearer of further properties; but it is not a substratum in the way that substratum theorists usually think of it in the substance ontology literature: that is, it is not an *inherently propertyless* bearer-of-properties, but rather an *inherently propertied* entity capable of bearing further, accidental properties.¹⁸

That is certainly a possible reply, and for those already sympathetic to primitive substance theory, it will be an unproblematic reply; in fact in my own discussion of pluralistic supersubstantialism below, I will remain neutral between substratum theory and primitive substance theory. It is nevertheless worth pointing out the possible need to shift from substratum theory to primitive substance theory, insofar as such a need would come into conflict with Morganti's (2011) argument for supersubstantialism, namely the argument that substratum theory implies supersubstantialism. (One might think this important loss

to supersubstantivalism would be mitigated by the potential gain that, since the above-stated objections from ‘common-sense ontology’, from motion and from modal facts were stated in terms of substratum theory, perhaps those objections would no longer be applicable if supersubstantivalism were reformulated in terms of primitive substance theory instead. Unfortunately, that reformulation will not help with those objections. I will not here go through the details to show why.)

The various objections against supersubstantivalism considered in the present section are none of them decisive (nor decisive when taken collectively). And the last point might be seen less as an objection and more as an argument for changing the dominant background substance ontology that supersubstantivalists have heretofore been working with. Nevertheless, what has been presented in this section may yet serve to motivate the examination of an alternate formulation of supersubstantivalism, one that is able to sidestep some of these worries (and one whose compatibility with primitives substance theory is openly acknowledged). Let’s turn then to consider that alternative.

3. Non-mereological pluralistic supersubstantivalism

The basic idea of this theory has already been stated: material objects and spacetime belong to the same fundamental natural kind, i.e. they are fundamentally the same *type* of thing, but the former are in no way parts of the larger spacetime manifold.¹⁹ They are not proper parts of that manifold, whether independent proper parts or dependent proper parts (where the latter is a commitment of monist supersubstantivalism). Material objects are not identical to those regions/points of the larger manifold (i.e. the manifold’s proper parts), nor constituted out of them, nor eliminable in favour of them. Rather, a material object is itself a spacetime region or point, but one that is separate and distinct from the larger spacetime manifold and its parts and able (at least in principle) to exist independently. Where there is an ultimate type-identity posited between what we think of as matter and what we think of as spacetime, the idea that instances of the former could exist independently of the latter should not seem counter intuitive, or at least no more counter intuitive than the idea that one region or point of spacetime might in principle exist independently of another.

What then is the precise relationship between material objects and that larger spacetime manifold? Here, I believe there is room for disagreement: perhaps it is a form of containment, or embedding, or simply co-location (to name three potentially workable options – there may be others). Let’s flesh these options out a bit further:

- (1) By ‘containment’ I mean the idea that material objects are literally located *within* the larger spacetime manifold; if one pictures that manifold as a giant balloon, this view would in turn picture material objects as smaller balloons floating within the larger balloon. Again, material objects are

the same fundamental kind of thing as spacetime, but smaller, and of course typically possessed of very different contingent properties. Many material objects possess negative charge (for instance), whereas the spacetime manifold does not. To carry the balloon analogy a bit further, the smaller balloons floating within the larger balloon may be very different in colour from that larger balloon (and from each other), may contain different quantities of helium, may even have some properties simply lacked by the larger balloon (e.g. maybe some of the smaller balloons are marked with fingerprints, whereas the larger is not). Still, just as the smaller balloons are still balloons, still the same underlying type of object as the object containing them, so material objects remain at bottom the same sort of substance as the spacetime manifold, they remain instances of *spacetime*.

- (2) By 'embedding' I mean the idea that a material object is related to the larger spacetime manifold as a fish is related to the water in which it swims. The fish is never literally co-located with any quantity of water, and in its motion through the water, it both affects the motion of that water and is affected by it reciprocally. The fish and the water can be seen as in competition for location, as it were, with the fish pushing aside the water to be where-the-water-was, and the water then re-filling the space previously occupied by the fish after the latter has moved.²⁰ To bring the analogy a bit closer to non-mereological pluralistic super-substantivalism, it might be better to think of a block of ice floating through a body of water. The same relationship between the movement of the ice and the correlative movement of the water obtains, but with the addition that the ice and the water are, at bottom, the same kind of entity, namely H₂O.
- (3) By 'co-location' I mean that material objects are smaller hunks of spacetime that simply overlap the larger spacetime manifold. This will of course be a controversial idea, insofar as the possibility of co-located substances (and especially co-located substances belonging to the same natural kind) is extremely controversial. But for those who hold to the possibility of such co-location (and there are good arguments in its favour), it can be seen as an option for the explication of pluralist supersubstantivalism.

In what follows I will not try to defend one of those three views over and against the others. I also cannot develop them in any great detail here – however, as there are large existing literatures on the metaphysics of co-location and containment,²¹ and at least some historical literature on the embedding option (see again Bennett (1999)), readers can refer to these for some additional options with regard to fleshing out these alternatives. (One considerable advantage of *not* trying to flesh out these alternatives here: I needn't commit myself to any

one of the existing, competing accounts of co-location, etc., and can leave it open to the reader to plug in her favoured account.)

Nevertheless, while remaining neutral concerning which of the three (or more) versions should be adopted, it would be useful to lay out briefly at least some of their possible pros and cons.²² So, with respect to the containment idea, it can be noted that the notion of certain circumscribed portions of spacetime (physical objects) being contained within a larger such portion (the overarching spacetime manifold) has the twin advantages of (a) easy translation into comprehensible visual models, and (b) unambiguously distinguishing the *tokens* of spacetime while preserving identity in *type* – think again of the smaller-balloon-inside-a-larger-balloon analogy. A disadvantage would be that it is not immediately clear how the containment version of the theory can remain truly distinct from the embedding and co-location versions of the theory. Arguably, this is a spot where the balloon analogy breaks down: the image of a smaller balloon contained in a larger, and moving inside that larger balloon, is of course an image of something moving *through space*; but taking supersubstantivalism on board, doesn't that mean that the smaller object would have to be either co-located with the substance that is space or instead displacing it? And wouldn't that in turn reduce the containment option either to embedding or co-location? (This worry might perhaps be addressed depending on how one develops the background ontology of containment, but I cannot take that up here.)

With respect to the embedding option, an obvious advantage would be the avoidance of the reduction worry facing the containment model (just noted), and likewise avoidance of the widespread scepticism regarding the possibility of co-location. Potential disadvantages include: (a) the relative underdevelopment of this notion in contemporary metaphysics, since despite its historical importance, it is an option scarcely discussed in the recent literature; (b) the arguably counter-intuitive implication that any instance of motion necessarily entails some expansion of the larger spatial manifold (since any instance of movement within that manifold entails that some portion of it gets displaced outward). Granted, that implication may not seem so counter-intuitive in the context of contemporary physics, where the expansion of spacetime is already generally affirmed; still, it may seem odd to some that this scientific conclusion can be arrived at a priori by work on the metaphysics of material objects and spacetime.²³

With respect to the co-location idea, an obvious advantage would be the avoidance of the various worries noted above facing containment and embedding. Potential disadvantages: (a) many philosophers are deeply sceptical of the idea that any two physical objects could be co-located (though the idea does of course have many defenders, particularly in the literature on constitution – recall the alleged co-location of a statue and the stuff out of which it is made); (b) it may be less parsimonious than the other options, insofar as it entails that wherever there is a physical object there is *ipso facto* a second such object (the

larger spatial manifold) co-located with it; and (c) it arguably does not address the harmony issue that is supposed to be an advantage of supersubstantivalism generally – i.e. supersubstantivalism is supposed to be able to explain why the geometrical and mereological properties of a material object always match up perfectly with those of the spacetime region it allegedly ‘occupies.’ (See again the Introduction.) On the co-location option, this again seems like a primitive fact. For those who take the harmony argument as a particularly crucial component of the positive case for some sort of supersubstantivalism, that last downside might seem decisive against co-location.²⁴

Obviously, much more could be said with respect to containment vs. embedding vs. co-location, and I hope to take that debate up in greater detail in future work. But this study is concerned chiefly with introducing non-mereological pluralistic supersubstantivalism and displaying some of its philosophical motivations, rather than defending one or another particular formulation of the theory. As such I’ll refrain from further inquiry into those options and turn briefly to some of its advantages.

So in terms of the explanatory virtues of non-mereological pluralistic supersubstantivalism, it should be noted that it retains the same type-parsimony of other versions of supersubstantivalism, including monist supersubstantivalism. It holds, with them, that there is only one fundamental type of physical substance. It is less economical than monist supersubstantivalism, insofar as it maintains that there are many fundamental, numerically distinct, independently existent tokens of the type ‘physical substance.’ However, that relative loss of economy (a loss shared with existing versions of pluralistic supersubstantivalism) is adequately compensated for in other ways.

First, non-mereological pluralistic supersubstantivalism is compatible with each of the four major competing substance ontologies: substratum theory, bundle theory, primitive substance theory and hylomorphism. One can maintain that the larger spacetime manifold and the independent smaller spacetime hunks related to it (i.e. what we normally think of as material objects) are all, at bottom, bare substrata contingently instantiating assorted properties both dispositional and geometrical/structural; or, one can maintain that the larger manifold and the individual material objects are all, at bottom, property-bundles, containing some common types of properties and some different, but fundamentally the same basic type of entity; or, one can maintain that the larger manifold and the individual material objects are all, at bottom, primitive substances of the same fundamental type, i.e. instances of the same fundamental natural kind, consequently sharing certain essential types of properties (e.g. perhaps certain causal powers + spatial extension, etc.). They could share these essential properties even if possessed of some different types of *accidental* properties, such as their vastly different sizes or the presence or absence of mass. Finally, one could also maintain that both the larger manifold and the individual material objects are all compounds of substantial form and prime matter,

sharing the same basic type of substantial form and consequently some of the same types of properties (again, perhaps certain causal powers, spatial extension, etc.) even if possessed of some different types of accidental properties (like vastly different sizes). This generous ecumenism re: substance ontology seems to me a point in favour of the theory; of course, it may be that the other recent formulations of supersubstantialism are also capable of being formulated in accordance with these other substance ontologies. I have already suggested that Schaffer's version might admit (if not demand) reformulation in terms of primitive substance theory, and Grant (2013, 158–159) mentions the possibility of crafting a bundle theoretic version. So this neutrality may not be a *special* advantage of non-mereological pluralistic supersubstantialism.

Second, and more importantly, the theory avoids all of the objections canvassed in the previous section. Affirming as it does the real, irreducible existence of material objects capable of independent existence and genuine motion through a background spatial manifold, it accords much better with our common-sense ontology of the physical world and sidesteps the assorted difficulties surrounding motion. Since material objects are real and really distinct from the background spatial manifold (even though both belong to the same ultimate natural kind), the common-sense understanding of motion, as contrasted with the pixelated understanding noted above, is restored. Motion need not be thought of as the transference of properties from one spacetime region to another, as on existing recent formulations of supersubstantialism, but rather as the continuous transition of an object from one position to another across a distinct background entity (the larger object that is the spatial manifold). It further allows for whatever story about property-unification one favours, both at a time and over time, in accordance with the explanations offered by any of the four substance ontologies: inherence in one and the same substratum over time and across time/motion, as on substratum theory; or compresence relations between members of a bundle that obtain at a time and across time/motion, as on bundle theory; or unification by an ontologically prior kind/substantial form at a time and across time/motion, as on primitive substance theory and hylo-morphism. It allows for the relevant common-sense ideas about modality (i.e. that a material object could genuinely have been located at a different place at a given time, different from where it actually was), since material objects are real and really distinct from the larger spatial manifold through which/across which they move. Finally, non-mereological pluralistic supersubstantialism avoids all the complications arising from the attempt to make the larger, background spatial manifold (and the smaller regions that are its parts) the substratum for all properties.

One problem that might be raised against pluralist supersubstantialism is its non-specificity. That is, I have claimed that it is compatible with multiple conceptions of the relationship between the spacetime we think of as 'matter' and the larger spacetime manifold (or, equivalently, the material objects we think of

as material objects and the material object we refer to as the 'larger spacetime manifold'), namely containment, embedding and co-location – I wouldn't want to assert that these three options exhaust the possibilities. I have further claimed it is compatible with all four of the major competing substance ontologies. I have said nothing by way of trying to specify what the really fundamental, essential properties of this basic natural kind (matter/spacetime) are, whether dispositional, geometrical/structural, qualitative or some combination thereof, or even if it *has* essential properties, or is really more akin to a genuine substratum or to the hylomorphist's prime matter, admitting any and all properties/substantial forms. I have also remained neutral on the associated ontology of fundamental composition (i.e., the atoms vs. gunk vs. extended simples debate). In other words, I have left a great deal undone. However, only so much can be accomplished in a single article. Certainly, the need to provide answers to these questions points towards directions for future work. But though that work is important, and though I do in fact have views about the issues just raised,²⁵ I also think these are questions to be settled within non-mereological pluralistic supersubstantivalism and that the theory can properly accommodate divergent answers to each. Insofar as my aim here has been to introduce the theory and to provide some indication of its plausibility, these unanswered questions should not I think be taken as a mark against it.

4. Conclusion

To sum up, I began by laying out the basic idea of supersubstantivalism as formulated in the recent metaphysics of science literature and then summarized briefly some sample arguments in its favour. In section two, I examined some objections facing the theory (some drawn from the existing literature, some new) and then in section three, suggested an alternative version, *non-mereological pluralistic supersubstantivalism* and argued that it provides a way of sidestepping those objections while still preserving some of the core advantages of supersubstantivalism. A good deal remains to be done; the theory requires further defence, and, as noted, assorted areas that the theory remains neutral on (e.g. the associated substance ontology) are nonetheless important and deserving of further attention. Moreover, specifying commitments in some of these areas would serve to connect the debate on supersubstantivalism to other important debates in the metaphysics of science (esp. that concerning the dispositionalist ontology of laws). I hope to pursue some of these avenues in future work.

Notes

1. Unless otherwise noted, I'll take 'properties' (and synonyms such as 'characteristics,' 'modes' and 'attributes,') as neutral between universals and tropes. Also, here and throughout I assume without argument a constituent rather than relational ontology of substance, according to which property universals and/or tropes are

genuine constituents of particular objects (however exactly that is to be cashed out), in contrast to thinkers like van Inwagen (2011), who defend the notion that universals are only ever extrinsically related to individual objects, and who further maintain that tropes and property instances do not exist.

2. Grant (2013, 158–161) rightly points out that bundle theorists will want to formulate supersubstantivalism differently from those whose sympathies in substance ontology lie with substratum theory (as is the case with Schaffer (2009) and Sider (2006)). Note that while my own formulation of supersubstantivalism will be explicitly neutral between the four main competing substance ontologies (substratum theory, bundle theory, primitive substance theory and hylomorphism), to the extent that the recent literature on supersubstantivalism brings it into relation with those four theories, it usually does so in terms of substratum theory. As such, despite my own desire ultimately to remain neutral here, substratum theory will seem particularly prominent in the first two sections of this article. My thanks to a referee drawing my attention to the apparent imbalance here.
3. And see Gilmore (2014) for discussion of further sub-divisions within the constitution view.
4. Note that Lehmkuhl is critical of Schaffer's discussion here, but thinks that other developments in theoretical physics may support supersubstantivalism (or rather certain versions of supersubstantivalism).
5. I say 'in principle' because I don't wish to discount the possibility that some contingent laws of nature in fact rule this out in our world.
6. Examples of such distinguishing characteristics might include electric charge, mass, spin, or other properties associated with fundamental particles but not space. (Of course, for purposes of the particle taxonomies employed by physicists, such properties are often taken as definitive of a certain sort of particle – e.g. negative charge is regarded as an essential property of an electron *qua* electron. However, on the present suggestion that negative charge remains but an accidental property of the *underlying* natural kind, the natural kind commonly instantiated both by those objects we regard as particles and by those objects we would label as spacetime regions.)
7. While I have heretofore formulated non-mereological pluralistic supersubstantivalism in terms of spacetime, and will continue to do so throughout, I have reservations about this. I realize that the current supersubstantivalist literature is formulated almost entirely in terms of spacetime rather than in terms of space alone, and I am cognizant of the powerful arguments in favour of such a link between space and time (especially those arising from standard interpretations of relativity). Nevertheless, part of me is inclined to cling to a presentist ontology of time with a 'from my cold dead hands!' stubbornness. For those who share this inclination, and hence are further inclined towards a decoupling of substantivalist space from time (a view Gilmore (2014, 6) calls 'separatist substantivalism'), I believe that my theory could be re-written as a theory about the ontology of space rather than spacetime without further major revisions being required. Unfortunately, I cannot pursue this here; I will, however, take the opportunity to highlight the robust defence of presentism recently proffered by prominent theoretical physicist Lee Smolin (2013). I will also note that non-mereological pluralistic supersubstantivalism as developed in what follows is liable to be permissible to endurantists if read as a theory of the relationship between matter and space. However, endurantists probably cannot be on board with it when read as a theory of the relationship between matter and

spacetime. And precisely the opposite result will obtain for perdurantists, who will reject it when read as a theory of the relationship between matter and space, but can be on board when read as a theory of the relationship between matter and spacetime. (My thanks to a referee for emphasizing the need to clarify how the theory relates to the endurantism/perdurantism debate.)

8. 'Dualistic' here in the sense of taking matter to be distinct from space.
9. Note that I am assuming here an endurantist account of change; it is of course debatable whether such an account is compatible with supersubstantivalism, especially where that theory is formulated in terms of spacetime rather than space; moreover, most supersubstantivalists today are B-theorists with respect to the philosophy of time, and correspondingly perdurantists with respect to change. As such, many will likely be unconcerned by the present objection, or the attempted upgrades below. However, for those intrepid few who attempt to combine some form of endurantism with spacetime supersubstantivalism (or for those who, like me, are actually invested specifically in supersubstantivalism about space), they will retain some interest.
10. A referee makes the important point that this objection might be defused if formulated supersubstantivalism on an alternative background substance ontology: specifically, if one formulated it in terms of bundle theory instead of substratum theory. For on bundle theory, the movement of negative charge (for instance) from one spacetime region to another would *ipso facto* be the movement of an independently existent entity (in this case, an independent trope), such that the motion would be genuine rather than 'pixelated'.
11. That separability is evident from the reality of particles that possess the same rest mass as an electron but an opposite charge (positrons), and still others that have the same negative charge but a different rest mass (tau leptons).
12. A referee points out here that Simons (1994) and other advocates of so-called nuclear bundle theory (according to which there is no distinct compresence relation and properties are connected by necessary internal ties) would supply comparable or even superior ontological economy. I agree that nuclear bundle theory is more parsimonious than those bundle theories referencing distinct, primitive compresence relations (not to mention substratum theory); however, the gain in parsimony is arguably counterbalanced by a corresponding loss in explanatory power, insofar as nuclear bundle theory cannot explain the links between *fundamental* properties not internally tied together. For more on the complications posed in substance ontology by that specific sort of property linkage, consult Oderberg (2007, 2011) and Dumsday (2010).
13. Indeed, Armstrong (1997, 65–68) takes the opportunity for reduction of ontologically robust natural kinds (kinds conceived as having a reality over and above a set of properties) to be a significant advantage of substratum theory. On his view, with substratum theory in place, there is no need for robust natural-kind essentialism of the sort entertained by Aristotle and the mediaeval Scholastics, and more recently by thinkers like Lowe (2006) and Oderberg (2007).
14. On that note, it is worth observing that Schaffer (2009, 136) argues explicitly in favour of that form of essentialism, which is no doubt part of his motivation for adopting an alternative response to the modality worry. It is also worth observing that this is yet another area in which one's background substance ontology could impact the debate over supersubstantivalism. Schaffer formulates the theory in terms of substratum theory (more on this momentarily, in the discussion of the fifth objection), and substratum theory is compatible with various theories regarding the metaphysics of modality. However, arguably other prominent

substance ontologies are *not* thus compatible – at least, historically some others have been formulated in ways that seem to conflict with counterpart theory. Hylomorphism is the clearest example, but the same could be said for many advocates of primitive substance theory, which is often linked to a traditional sort of natural-kind essentialism. (My thanks to a referee for prompting me to add a discussion of this.)

15. I discuss this in Dumsday (2015a).
16. A referee rightly points out that for most substratum theorists, there is a sense in which substrata are not *wholly* devoid of inherent properties; indeed, in order to avoid incoherence, one must be able to predicate an assortment of formal properties of substrata (e.g. self-identity). However, substratum theorists are committed to the idea that substrata are inherently devoid of paradigmatic contentful properties (e.g. qualitative, structural and dispositional properties).
17. To illustrate: ignoring for a moment the debate over supersubstantialism and assuming that an individual electron is an irreducible substance, the primitive substance theorist would say that the individual electron is just the instantiation of the substance-universal/natural kind 'electron' and that in consequence of being an instance of that kind, it also possesses all the property universals entailed by membership in that kind (negative charge, etc.). Note too, with respect to the constituent vs. relational distinction drawn earlier in footnote #1, that primitive substance theory is nearly always formulated as a constituent ontology, insofar as the substance-universal is viewed as being really instantiated as a particular, rather than existing in a merely extrinsic relation to particulars. (Though Lowe (2012) makes an interesting argument to the effect that primitive substance theory, properly conceived, is neither constituent nor relational.).
18. In fact, Schaffer at least is arguably *already* working within primitive substance theory. That this is not explicitly noted by him may be due to the unusually broad understanding of 'substratum' that he is working with (unusual at least in the context of the substance ontology literature); for Schaffer, a substratum seems to be understood as simply any bearer-of-properties. Thus, an already-propertyed entity can still be a bearer-of-properties in the sense of being capable-of-bearing-*further*-properties. Traditional substratum theorists would say instead that a substratum is an *inherently propertyless* bearer-of-properties. At any rate, on Schaffer's understanding of the term 'substrata,' the affirmation of their reality appears compatible with primitive substance theory.
19. Note that for present purposes, I will take this language of 'type' and 'kind' to be neutral between substratum theory and primitive substance theory (and indeed the other major substance ontologies – more on this below); on the former substance ontology, to say that material objects and spacetime belong to the same type or kind is simply to say that they are both bare substrata. On the latter substance ontology, to say that material objects and spacetime belong to the same type or kind is to affirm that they are both members of some real, ontologically robust natural kind grounding its own set of defining, contentful properties.
20. I borrow this analogy from Bennett's (1999) explication of Descartes' theory concerning the relationship between matter and space.
21. See for instance Kleinschmidt (2014) for a valuable recent anthology of relevant work.
22. My thanks to a referee for emphasizing the need to add some discussion of this.
23. Though for the record, it doesn't seem odd to the author – the line between science and the metaphysics of science is in my view a porous one.

24. My thanks to a referee for objections (b) and (c).
25. For instance, I think spacetime/matter should be conceived in accordance with a certain version of hylomorphism, where the shared fundamental natural kind is to be characterized by certain essential properties, *all of which are necessarily dispositional*. . . . In fact my commitment to dispositionalism is one reason I would wish to oppose Lehmkuhl's radical supersubstantialism, insofar as the latter involves a commitment to categoricism. With regard to the debate over fundamental composition, I have argued elsewhere (in Dumsday 2015b) that there is a way to use dispositionalism to reconcile atomism and the theory of extended simples. I intend to show in a future project that this theory of composition can be combined with non-mereological pluralistic supersubstantialism to provide a novel dispositionalist ontology of space, one that sidesteps the problems facing the one suggested by Bird (2007).

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