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HERE GOES NOTHING*

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ABSTRACT

Subtraction arguments (SAs) support the view that there might have been nothing. The best-developed SA to date, due to David Efird and Tom Stoneham, is claimed by its authors to entail that there are worlds in which there are space-time points but no concrete objects: Efird and Stoneham hold that space-time points are not concrete and that a world made up from them alone contains nothing concrete. In this paper it is argued that whole space-times are concrete and subtractable, so that a subtraction argument commits us to a bolder conclusion: namely, that there are worlds in which there is no space-time (and nothing else concrete). This result has far-reaching consequences: it supports the view that there might have been no time; and constrains accounts of possible worlds. In the course of developing this revised subtraction argument, I counter suggestions (made by Ross Cameron, amongst others) that SAs are question-begging.

Keywords: *subtraction argument, metaphysical nihilism, material objects, concrete objects, space-time, possible worlds, empty world*

Some are inclined to believe that there might have been nothing—at least, that there might have been nothing *concrete*—but one might wonder whether any support can be given for this view beyond brute intuition. Is there anything that might be said to persuade at least some of those undecided or in doubt with regard to whether this is a real possibility? It seems so. In his 1996, Tom Baldwin presented an argument for the claim that there might have been nothing concrete: the subtraction argument. Baldwin's paper generated further discussion and debate, including an impressive sequence of papers by David Efird and Tom Stoneham in which the argument is developed and refined and its wider significance explored (see Efird and Stoneham 2005a, 2005b, 2006, 2009a, 2009b).

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Subtraction arguments are intrinsically interesting, but they also have potential knock-on consequences. For one thing, as Efird and Stoneham make clear, a subtraction argument might set constraints on accounts of the nature of possible worlds: if there is a plausible argument for the claim that there might be nothing concrete, then any account of what possible worlds *are* which ruled out there being nothing concrete would at least incur a cost.[1] For another, subtraction arguments might have more specific consequences in terms of committing us to the existence of possibilities of certain kinds: for instance, a subtraction argument might show that it is possible for there to be no time (that there are timeless worlds). In this paper I won't say much more about these potential consequences; I'll simply to try to gauge the persuasive force of subtraction arguments and give some consideration to the question of what sorts of possibilities they press us to acknowledge.

1. Baldwin's original argument

Baldwin's argument depends upon three claims:

(A1) There might be a world with a finite domain of 'concrete' objects

(A2) These objects are, each of them, things which might not exist

(A3) The nonexistence of any one of these things does not necessitate the existence of any other such things (Baldwin 1996, 232)

The argument then runs roughly as follows. By A1, it could be that there are finitely many concrete objects. By A2, were it to be that there were finitely many concrete objects, then for any one of those objects, it could be that that object not exist. By A3, that would *not* require that something other than those original finitely many exist. And it seems that by repeating these steps we can infer by stages to the possibility of a world containing no concrete objects, establishing metaphysical nihilism (MN).

[1] Here the distinction between accounts of *what possible worlds are* (accounts of the *nature* of possible worlds), on the one hand, and determinations of *what possible worlds there are* (of what possibilities there are), on the other, is crucial. A successful subtraction argument would show that there is a possibility of a certain kind (e.g. that it is possible that there be no concrete things). It would constrain accounts of the nature of worlds by rendering implausible those accounts of the nature of worlds which cannot furnish a world which corresponds to that possibility. For example, if a subtraction argument shows that it is possible for there to be no space-time (and no space and no time) and Lewisian modal realism requires that each possible world is a maximal spatiotemporal sum, then LMR may be undermined because none of its worlds correspond to the crucial possibility. For more on how subtraction arguments might constrain accounts of the nature of possible worlds, see e.g. Efird and Stoneham 2005b, 21–3.

Note that (A1) and (A2) are not strictly separate premisses: what we need is that it is possible that there be only finitely many concrete objects all of which are contingent. Claim (A3) is a plausible thesis about contingent objects.

2. Efird and Stoneham's revision of the argument

Alexander Paseau (2002) objected to the argument as formulated, claiming that the premisses do not entail MN, because (A3) as stated by Baldwin leaves it open to counter-models. (The key point here is that (A3) as stated can be satisfied by models in which (a) each particular object that could exist is contingent, and (b) for any particular object, there is no one object which exists in all possibilities in which that object does not exist, but (c) there is no empty world—e.g. $\{a,b\}$, $\{a,c\}$, $\{b,c\}$, $\{a\}$, $\{b\}$, $\{c\}$.)

David Efird and Tom Stoneham deal with this by providing the following replacement for (A3). This replacement, they plausibly claim, captures the spirit of subtraction (Efird and Stoneham 2005a, 309):

(B) $\forall w_1 \, \forall x(E!xw_1 \supset \exists w_2(\neg E!xw_2 \;\&\; \forall y(E!yw_2 \supset E!yw_1)))$

That is, every particular possible world w_1 is such that every particular thing x that exists at that world is such that there is another possible world w_2 which is such that x does not exist at that world (w_2), and everything that exists at that world (w_2) is something which exists at w_1. (Here object variables range unrestrictedly over concrete objects. See E&S 2005a, 306 n. 12.)

Now, it has been suggested that E&S's formulation of SA is question-begging. This is an important issue to which we will return later in the paper, but we can note here that (B) in and of itself is not question-begging: it does not, on its own, entail MN. If there is no world containing only finitely many concrete objects, (B) might be true and yet there be no 'empty' world.

One further concern that might be voiced at this point arises because (B) seems to be a thesis *about worlds* (see Efird and Stoneham 2005a, 320). This might seem to entail that the plausibility of (B) will be dependent upon views about the *nature* of worlds. Efird and Stoneham are concerned about this because they are interested in subtraction arguments acting as a *constraint* on accounts of worlds. I am concerned about it because it threatens to make other conclusions drawn from subtraction arguments (e.g. that there might have been no time) dependent upon particular metaphysical views on the nature of worlds, thus limiting their force, scope, and appeal.

This concern can be addressed by framing a principle which fulfils the role of E&S's (B) within a subtraction argument but which does not refer to or quantify over worlds, making it clear that the notion of subtractability applies to objects. This can be done by using plural quantification, as follows:

> Necessarily, if there are some (contingent) objects (that exist) *X*, such that every object (that exists) *x* is one of those objects *X*, then, for each object (that exists) *y*, it could have been *both* that *y* does not exist *and* that every object (that exists) *z* is one of those objects *X*

(E&S make some use of what are effectively plural logic formulations in their 2005a, but do not bring the formulations to bear on this issue.)

3. Characterizing concreteness: a first try

So, it seems that we can formulate a valid and non-question-begging subtraction argument. But, crucially, in order to secure it as well supported by pre-philosophical intuition, we need to clarify the sense of 'concrete' which applies and ensure that the premisses are intuitively plausible given that reading (see E&S 2005a, 310).

Efird and Stoneham offer this initial characterization of concreteness (2005a, 310):

> An object *x* is concrete iff *x* is spatiotemporally located and *x* has intrinsic qualities

E&S say that this classes space-time points as abstract: they admit that space-time points are spatiotemporally located, but claim that they lack intrinsic properties (2005a, 312). E&S claim that this is an acceptable result

> since a world which contained only spacetime points would contain nothing which had any intrinsic properties, and a world like that would be a world which might as well contain nothing at all from the perspective of the question, 'Why is there something rather than nothing?' (E&S 2005a, 312)

This is dubious. I will present two arguments against the view. Before I do that, however, another issue needs to be addressed.

4. Space-times and space-time points are contingent

I will argue below that whole space-times are concrete things and subtractable. If whole space-times are to be subtractable, they will have to be contingent. Are they?

It seems that, if there is one finite but unbounded space-time, then there might have been a greater number of such space-times. If that is right then at least some space-times are contingent, but there seems no reason to suppose that the first (or any other) should differ from the others in this regard. (This is one point at which views about the nature of possible worlds might seem to threaten to make a difference: it might seem that different results might be returned depending on whether or not Lewisian modal realism obtains with regard to worlds. The worry here would be that Lewisian modal realism rules out there being possibilities containing multiple finite unbounded universes. There is, however, no difference in the final result if LMR is correct. In Lewis's metaphysics, whole space-times—and space-time points—are world-bound individuals: strictly speaking, they exist *at* only one Lewisian possible world and are thus contingent by the lights of Lewis's account of modality.)

It might be suggested in response that, when we speak of 'whole space-times', what we are in fact talking about are just *sets* of space-time points (this suggestion was made in conversation by Tom Stoneham). This threatens the brief argument for contingency sketched above, because, thanks to the fact that there are continuum-many space-time points, two or more finite but unbounded arrangements of space-time points could be made up from the same set of points as might make up one finite but unbounded arrangement. (This observation seems not to undermine the claim of contingency where a Lewisian view of worlds obtains, but it does need to be answered on other views of worlds.) There are four points we can offer by way of response to this 'sets' proposal.

First, surely a whole space-time consists of space-time points *standing in spatiotemporal relations*, but if the 'set' claim were correct then it would seem to follow that a set of space-time points (on this view, a space-time) might form a single unified (spatiotemporal) arrangement in one possibility and exist in another possibility in an utterly fragmented state —i.e. with none of its members standing in spatiotemporal relations to one another. It seems, therefore, that the set of points *cannot* be identical with the original unified space-time.

Secondly, it seems that an arrangement of space-time points is a something; and that, where there are two such arrangements, one is, obviously, distinct from the other, so neither can be identical with the one there might have been.

Thirdly, it seems that space-time *points* are themselves contingent things (on Lewisian GMR *and* on other views of worlds). There are three key observations we can make in support of this view. (I offer these observations in order of increasing force, ending with what seems the most forceful point in favour of the view.) (O1) It seems that the space-time points of the actual world are 3+1 points (they are arrayed, we will assume, in three spatial and one temporal dimension), but it seems that 1+1, 2+1, 4+1, … , worlds are possible (and perhaps even 3+2 and 3+3 worlds). Further, it is plausible, for instance, that 3+1 points are distinct from 4+1 and 3+2 points, so that different points must be involved depending on which possibility is realized. (O2) It seems that there could have been a Newtonian world—a world in which a framework of *spatial* points endured through time—so that there would be, strictly speaking, no *space-time* points (that is, no items which are fundamental components of the spatio-temporal framework of the world and both spatially unextended *and* momentary). (O3) It seems that there could be a world with continuous branching time (so that it can be that, at each moment, time divides into indefinitely many branches), but branching time is not *necessary*. The cardinality of the set of points constituting such a densely branching world would be larger than the cardinality of a set of points needed to constitute a world without such branching. Now, it *could* be maintained that space-time points are necessary existents and the larger set of points exists (even if not all of its points are 'used' to constitute space-time), but we should note some further considerations which count against this move, as follows. (i) The resulting account posits a necessary truth which alternative accounts do not, namely that this very large set of space-time points exists (on this sort of cost associated with metaphysical theories, see E&S 2005b, 25–6). (ii) The proposed account identifies space-time with a set of space-time points, but now we encounter at least one puzzle. In those possibilities where time does not branch, some but not all of the points in the set are arranged to form *something*—a structure in which events do, or at least could, occur—but this something is not, we are to suppose, space-time (because space-time, according to the view under consideration, is the whole set of points, and not all of the members of that set are parts of the structure). One might also ask for an account of the difference, in such a possibility, between those points which are, and those points which are not, included in the structure. It would be very tempting—given the suggestion that the large set of space-time points exists necessarily, *at least as abstract things*—to adopt a Williamson-style view (Williamson 2002) and say that the points included in the structure are (contingently) concrete, whereas the 'unused' points remain abstract. But this, of course, would be to give up on the idea that space-time points are never concrete. (There are yet further potential costs to the view which has the large set of points necessarily existing: for one, it threatens to multiply hugely the range of possibilities, because there will be otherwise indistinguishable but distinct possibilities which vary *only* in terms of *which* points are included in a non-branching structure.)

5. Two arguments against the view that a world comprised only of space-time points effectively contains nothing from the perspective of the question 'Why is there something rather than nothing?'

Recall that Efird and Stoneham said that

> a world which contained only spacetime points would contain nothing which had any intrinsic properties, and a world like that would be a world which might as well contain nothing at all from the perspective of the question, 'Why is there something rather than nothing?' (E&S 2005a, 312)

I want to make two objections to this suggestion. (Both objections are plausibly telling, but the second is the more forceful.)

(1) If space-times and space-time points are alike classed as abstract items, then a puzzle arises concerning their status—and the generation of this puzzle or mystery casts doubt on the classification. Space-times and space-time points are contingent items (as argued above), so they do not number among the *necessary* abstract objects; but neither do they fall into the other class of abstract objects which seem intelligible (and which Efird and Stoneham countenance)—that is, things, like the centre of mass of the earth, which are *parasitic* upon concrete objects and thus exist only where there are concrete things to be parasitic upon. (At least, *whole* space-times do not seem to be parasitic in this way: space-time *points* might be thought to be parasitic—upon whole space-times.)

(2) It seems it is simply not true that 'a world which contained only space-time points would contain nothing which had any intrinsic properties'. Efird and Stoneham speak only about space-time points and simply overlook spatiotemporal *regions* and *whole* space-times. Spatiotemporal regions and whole space-times are spatiotemporally located, and, moreover, they *do* have intrinsic properties—as I'll argue below.

That space-time regions and whole space-times have intrinsic properties is supported by the following observations (the second observation listed is the more telling).

First, in General Relativity, massive objects bring about changes to the geometry of space-time: that is, massive objects produce changes in the *geometrical properties* of space-time. (Space-time can vary in its 'curvature': it can have an elliptical geometry—the sort of geometry exhibited by the relations between points on a sphere; it can have a 'flat' or Euclidean geometry; it can have hyperbolic geometry—such as exhibited by the relations between points on a 'saddle' shape; and, in addition, there can be variations in curvature across space-time.) These properties are not themselves a matter of space-time points standing in relations to massive objects; rather they are properties of space-time itself—properties of space-time regions which plausibly supervene on relations between the space-time points which make up the space-time.

Secondly, taking General Relativity to describe at least some ways things could be with regard to space-time, it is also notable that there are infinitely many 'vacuum' solutions to the equations of GR—solutions which don't involve there being matter. In these different solutions there are variations in the geometrical properties of space-time (the 'curvature' of the space-time involved) *in the complete absence of massive objects*. It seems, then, that space-time might differ in its properties without anything else existing which is concrete: the relevant properties are ones which whole space-times can have when they are 'lonely'. Interesting vacuum solutions include the Minkowski, de Sitter, and Anti de Sitter spacetimes (see e.g. Choquet-Bruhat 2009, 118–21).[2] Einstein himself saw the existence of the de Sitter solution as highly significant. Einstein was for a long time attached to 'Mach's principle'—the claim that all gravitational fields can be attributed to material sources—and as a result felt that '[i]t would be unsatisfactory … if a world without matter were possible … it should be the case that the $g_{\mu\nu}$-field is fully determined by matter and cannot exist without the latter' (Einstein 1917, quoted in Janssen 2014, 202), but, in the wake of his exchange with Willem de Sitter and Felix Klein, Einstein abandoned this view and admitted the de Sitter world as a genuine possibility— 'there … is a singularity-free solution to the gravitational equations without matter' (Einstein 1918, quoted in Janssen 2014, p. 207). Reflecting on this stage in the development of his views, Einstein later said

> one should no longer speak of Mach's principle at all. It dates back to the time in which one thought that the 'ponderable bodies' are the only physically real entities and that all elements of the theory which are not completely determined by them should be avoided. (I am well aware of the fact that I myself was long influenced by this *idée fixe*.) (Einstein to Felix Pirani, February 2, 1954; quoted in Janssen 2014, 207)

For there to be one matter-free solution to the equations of GR would be significant in itself: since the de Sitter space-time has curvature properties, its existence shows that space-times can have these characteristics while 'lonely', making the characteristics intrinsic. That there are *multiple* vacuum solutions, varying in curvature properties, presses the point.[3]

Worries might be raised here with regard to the role of the notion of an intrinsic property in the argument. The first worry concerns the difficulty

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[2] The Minkowski, de Sitter, and anti-de Sitter space-times differ in the values assigned to the cosmological constant, but even with a fixed value for the cosmological constant there are still infinitely many vacuum solutions by choice of Cauchy data obeying the constraint equations.

[3] Thanks to Chris Fewster for helpful explanations of the physics here, particularly in relation to vacuum solutions. For more detail on the significance of the de Sitter solution, see Janssen 2014, 167–70 and 198–208, esp. 207.

of providing an *analysis* of intrinsicality. Here it is worth noting what Efird and Stoneham say on the matter. They remark that, in the literature discussing how to analyse 'intrinsic', there is 'general agreement over which properties are intrinsic' and add that this 'should give us confidence that the concept of intrinsicality is in good order and that it can be put to philosophically useful purposes, even if we struggle to explicate it' (E&S 2005a, 311 n. 21). I agree with the thrust of this remark, but a second and related worry should be considered. It might be suggested that the claim that a whole space-time is a concrete item relies on a contentious case of alleged intrinsicality (curvature properties) and that it will, therefore, need to call on an analysis of intrinsicality for support.

The status of curvature properties as intrinsic can be defended without appeal to a full-dress *analysis* of intrinsicality. The key point is simple: curvature properties are analogous to clear cases of intrinsic properties in material objects, such as (rest) mass. One might add that the fact that they are properties that a space-time might have in circumstances in which there are no objects that are both wholly distinct from it and concrete can be taken as indicative of their status as intrinsic, given that they plausibly do not fall into any of the types which make trouble for attempted full-blown analyses of intrinsicality. (They are not trivially apt to be had by something lonely—as is the property of being lonely; nor are they disjunctive—as is *being a lonely cube or an accompanied non-cube*.)[4]

Against these observations it might be suggested that consideration of the way in which curvature properties are defined raises significant concerns about their status. Let us grant for the sake of argument that we are obliged to pick out curvature properties in terms of subjunctive conditionals, along the following lines:

> A space-time region *r* has curvature property C iff were a light signal to be generated *thus-and-so* in *r* then it would propagate *so-and-thus*

It might be suggested that this undermines the claim of intrinsicality, by making curvature somehow relational. But this line is not at all convincing. First, the claim about definition at worst makes curvature properties analogous to dispositional properties like being water-soluble; but being dispositional does not entail being relational. Water-solubility is an *intrinsic* property: on plausible understandings of dispositional properties, a thing might be water-soluble even though there were no

[4] Indeed, if being apt to be possessed in circumstances in which nothing distinct from the object exists is taken to be a mark of intrinsicality, the status of curvature properties as intrinsic is *more* secure than many intuitively intrinsic properties of material objects: the existence of vacuum solutions to the equations of General Relativity makes a strong case for the possession of curvature properties by lonely space-times, whereas support for the claim that it might be that Lincoln exist and have, say, mass *m* and nothing else (concrete) exist and yet Lincoln possess mass is far weaker.

water in existence. Secondly, it is plausible that dispositional properties have categorical bases—if, for example, item *b* is water-soluble, then it has some *categorical* property G in virtue of which it is such that, were it immersed in water, then it would dissolve. It might be suggested at this point that there is a significant distinction between the case of water-solubility and the case of curvature, because in the case of water-solubility the counterfactual has to be hedged (with ‘under standard circumstances’ or somesuch), indicating that there is a categorical property which ‘has a life independent of the counterfactual’; whereas, in the case of curvature, no such hedging is required. But this suggestion would be mistaken: the pattern of propagation of light signals within a space-time region will be sensitive to a whole range of potentially interfering factors (e.g. the presence of dense transparent media).

6. Consequences of space-times being concrete

If space-times are concrete items, what consequences might follow for subtraction arguments?

It might be that the argument fails. It might be that (B) is intuitively compelling when the range of the quantifiers is restricted to exclude spatio-temporal regions and whole space-times, but fails to be compelling without this restriction. If this is how things turn out then we can perhaps subtract down to empty space-time but not get down to zero concrete items—though it would be a delicate question whether there were a viable version of the argument establishing that there can be empty space-time, or whether doubts over the truth of (B) given the sense of ‘concrete’ we have made out would undermine even that restricted conclusion.

Alternatively, it might be that space-times are subtractable (and that we can make an intuitive case for this). If this is how things turn out, we get additional interesting consequences from subtraction arguments. One consequence would be that there might have been no space-time. Some additional plausible premisses concerning space and time would then yield the conclusions that there could have been no space (at all) and that there could have been no time (at all)—that is, no space as an aspect of space-time and no space of any other form either, and likewise for time.

It might be thought that if whole space-times were to turn out to be concrete items (by the lights of our best shot at a rational reconstruction of the notion of concreteness) then that would undermine the intuitive case for (B). Surely we balk at the subtraction of space-time? This is a nice question, and one that we will return to below, but I suspect that resistance here is based on a residual conviction that space and time comprise an immutable background for existence, radically different from the run of the material world—a conviction which is (a) independent of the intuitions which drive the subtraction argument and (b) undermined to at least some extent by the deliverances of empirical investigation (undermined, that is, by discoveries about the nature of space and time in the actual world). The revisions in our views brought about by Relativity should lead us to recognize that space-times are at least *less* different from things we intuitively class as concrete than seemed to be the case prior to Einstein, so that our conviction that concrete objects are subtractable should carry over to whole space-times, if our best shot at giving a general characterization of concreteness includes them.

In the remainder of the paper I will argue that the revised SA should lead us to conclude that there could have been nothing—really nothing: no concrete objects, and no space-time. I first address a challenge to the account of concreteness to which we have appealed up to this point. This challenge threatens the status of whole space-times as concrete items. I will then turn, in the final section, to consider a further challenge to our revised SA and defend the subtractability of space-times.

7. A problem for the subtraction argument, and a revised account of concreteness

Efird and Stoneham's subtraction argument faces a challenge which may impact on the status of whole space-times.

The initial characterization of concreteness leads to a problem for (A1)—the claim that there might be a world with a finite domain of 'concrete' objects. If space is continuous, then each extended concrete object will have infinitely many concrete proper parts. (This objection is raised by Gonzalo Rodriguez-Pereyra; see his 1997, 163.)

Efird and Stoneham respond to the challenge by proposing a revised account of what it is to be concrete (2005a, 314–15):

> An object *x* is concrete iff *x* is spatiotemporally located and *x* has intrinsic qualities and *x* has a natural boundary

This revised account seems to secure (A1). To see this, consider a block of gold sitting on a wooden shelf. This is an extended object. It is concrete. It (the block of gold) is ST located, has intrinsic properties, and it has a natural boundary (its boundary with the air around it and the wooden shelf that supports it). The items in the proper subregions of the region it occupies are not, however, concrete, by the revised account, because they lack (complete) natural boundaries. (For more on natural boundaries, see Sider 2001.)

It seems this revised account of concreteness would rule out whole space-times as concrete items: both finite but unbounded space-times and infinite space-times also lack boundaries of any kind.

The revised account is, however, open to objection. Consider a finite but unbounded world which is entirely filled by uniform matter. Intuitively this matter comprises a single concrete item, but the revised account rules that this is not a concrete object. (This objection is raised in Cameron 2007, 275–6.) We can add further support to this objection by considering a case in which we consider first a world in which the matter *almost* fills the space-time. Here the revised account rules that there is a concrete object, but rules otherwise in the intuitively very similar case in which the matter does fill the space-time.

A related objection concerns the fields of modern physics. Fields are plausibly concrete things:[5] they are spatiotemporally located, they have intrinsic properties, and they are contingent (and they can produce effects in intuitively concrete things); and yet at least some fields do not have natural boundaries. Some fields do not come to an end; rather, they extend indefinitely and merely attenuate (the electric field surrounding a charge distribution of non-zero net charge extends to infinity, attenuating but never exactly zero, by Gauss's law, even if the charge density vanishes outside a bounded region; a similar situation arises with Einstein's field equations for the metric, under the standard assumption that this is to be a Lorentzian signature).[6]

Efird and Stoneham respond to Cameron's objection by amending the boundary condition as follows (Efird and Stoneham 2009a, 134):

> *x* is such that, if it has a boundary, it has a natural boundary

In order to avoid complications about parts of the total boundary of a thing, we might use the following formulation:

> *x* is such that it has no non-natural boundaries (or boundary-sections)

With this further revision of the account of concreteness, whole space-times are again counted as concrete.

Note, in addition, that space-time *regions* (in the sense of extended proper parts of space-time) are *not* counted as concrete: they have boundaries, but it seems that these are not natural boundaries. This has the consequence that a possibility comprising only an empty space-time

[5] Efird and Stoneham endorse the view that fields are spatiotemporally located and have intrinsic properties. They say that 'the [initial account] classifies electric fields as concrete and that is correct' (Efird and Stoneham 2005, 311). In the associated footnote (n. 25) they endorse the view that a world containing only fields and no matter would contain something relevant to the question 'Why is there something rather than nothing?'

[6] Thanks to Chris Fewster for his helpful advice on the physics here.

contains only one concrete object—namely, the whole space-time.[7]

So, this revised version of the account of concreteness classes whole space-times as concrete items, and rules that non-maximal space-time regions are not concrete, so that a world containing one whole space-time and no material objects contains only one concrete item. We are returned to the situation noted above: either whole space-times are subtractable—and the subtraction argument commits us to the possibility of there being no space-time—or (B) fails when the range of its object quantifiers is taken to include whole space-times, and the subtraction argument fails as a consequence.

8. Subtraction, basic components, and space-times

Can anything be said to support the subtractability of whole space times?

In this section I will mount a limited defence of the subtractability of whole spacetimes by pursuing the following strategy. I will consider the nature of our intuitive acceptance of (A1) and (B) and show that the stories we could tell on which (A1) and (B) are plausibly true do not provide any basis for drawing a distinction between intuitively central cases of concrete objects (medium-sized dry goods) and whole spacetimes with regard to subtractability.

I want to consider what's going on when we judge that (A1) and (B) are plausible. How do these judgements relate to thinking which, as far as

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[7] In his 2007, Cameron argues that (B) is false if the no-non-natural-boundary account of concreteness is correct (see page 276)—or, at least, that if concreteness is understood in terms of the no-non-natural-boundary account, then the intuitive motivation for belief in (B) is undermined (see page 274). The argument involves a people—the Qube—who believe: (i) that there is an object with a natural boundary which is a god and which contains infinitely many further gods; (ii) that each god has an essential size, so that eroding the object destroys gods whose boundaries are encroached; and (iii) that, due to the powers of the gods, the object is proof against complete erosion. The Qube can share our intuition that the destruction of one object cannot magically entail the existence of another, but they deny (B) understood in terms of a no-non-natural-boundary account of concreteness: eroding the object will destroy a concrete (no-non-natural-boundary) thing, but result in some other thing coming to have a natural boundary and thereby coming to be concrete on the account given; and there's no way to grind away all of the object. Cameron claims that the views of this people do not involve the denial of any fundamental metaphysical intuition (see page 278). The argument is ingenious, but it fails. As E&S note (2009, 135), the Qube should admit, surely, that it could have been that none of the gods existed. And if they deny this, then their resistance is simply a matter of their peculiar theology, and their refusal to accept (B) is based on denial of a deep metaphysical intuition that we hold—namely, that it is not necessary that an object composed of gods of this strange kind exists. (One might further object that the 'contained' gods in Cameron's example *do* have natural boundaries: surely, a boundary which is such that encroaching upon it leads to the destruction of an object is natural. Note that mere containment inside a coating of some material of similar density does not prevent a boundary existing: e.g. a sphere of gold might be contained within a cube of platinum—see E&S 2005a, 314.)

possible, avoids commitment to particular metaphysical theories?

When we probe this issue we find something that may look somewhat dubious at first blush, *but*, when we get a clearer view of how the subtraction argument is supported by intuition we will see that *if* we are happy to endorse subtraction as it applies to paradigm concrete objects (dogs, planets, tables, etc.) then we should be happy to endorse the subtraction of whole space-times.

When we ask ourselves whether there might be finitely many concrete objects it is natural to think something like ‘Well, there could be just three metal cubes’. That is, we base our judgement on thoughts about ‘middle-sized dry goods’.

When it comes to subtraction, it is intuitively plausible that the sorts of things we think about in relation to the issue of finite domains might have failed to exist without their non-existence entailing the existence of something ‘new’ (something not in the ‘starting domain’). But here we should recognize that these sorts of things can fail to exist in ways that do not require the non-existence of all their parts and stuff. A metal cube might fail to exist, though its parts and stuff exist, with those parts and that stuff scattered. Here it might be suggested that the mere intuition that one of those paradigm objects might not have existed does not ensure that the size of the domain of concrete objects could be reduced thereby.[8] This suggestion is, of course, in one way superficial: we can take parts of (paradigm) extended objects to figure in the counts of conceived finite domains of concrete objects. This will require that larger extended objects are made up from finitely many smaller parts with natural boundaries, but that seems to be possible: there are natural boundaries between bones, ligaments, muscles, and so on within human bodies, for instance. Reflection on this issue reveals, however, that thinking about finiteness of domain and subtractability depends on intuitions about how things might be at smaller scales—scales smaller than those at which we find paradigm extended concrete objects, scales at which our intuitions might seem less secure.

Now, one way to try to deal with concern about this ‘drive to the very small/to the level of constitution’ would be to say that we have an intuition which supports what might be called *parts-and-all subtraction* of medium-sized dry goods: that we have a basic intuition that any item of medium-sized dry goods *and all of its constituent parts and stuff* might have failed to exist without that entailing the existence of anything else. The problem with this, however, is that the required principle seems too

[8] It seems that there are ways that things might be at the small scale which would put a limit to subtraction, thus conceived. If mid-sized dry goods were disturbances in some fundamental fields, then ‘removing’ the mid-sized dry goods by stages while the fields remain in place would not be guaranteed to yield a situation in which there was nothing concrete. I’ll return to this case shortly.

close to the desired conclusion, as Cameron points out (2007, 275): ‘if we can get rid of any concrete object and thereby get rid of all its parts, then why not simply, in one step, get rid of that object which is the mereological sum of all the concrete objects?’ It is worth saying that the argument is not rendered *straightforwardly* question-begging by the move —an additional premiss would be required, to the effect that there is a concrete object which is the mereological sum of all the (other) concrete objects, in order to take us to the conclusion—but it does seem to weaken the force of the argument all the same.

There is, however, an alternative response. Our conviction that there can be finitely many concrete things and our conviction that concrete things are subtractable are, I suggest, reliant on the thought that there are ways things could be at the smaller scale/with regard to the constitution of medium-sized dry goods which would allow for finite domains and subtractability. Let’s look at the various different ways things might be with regard to the constitution of material objects and consider (a) whether they allow for a finite domain and subtractibility and (b) what the individual cases have to tell us—if anything—about the status of space-times and their subtractability. It is worth noting in advance, and bearing in mind throughout the discussion, that all that is needed for the success of the SA is that there is *one* way that things might be which would allow for a finite domain of subtractable items. This already has a high degree of plausibility, but let’s consider the cases.

There seem to be four ways that things could be with regard to the constitution of middle-sized material objects that we should consider:[9]

(I) Everyday material objects are made up from finitely many point particles (extensionless atoms)

(II) Everyday material objects are made up from finitely many extended atoms

[9] It might be suggested that there is a tension between the approach adopted here and the approach found earlier in the paper. In arguing for the status of whole space-times as concrete objects appeal was made to what modern physics tells us about space and time, but now appeals are being made to possibilities which may not be consistent with that physics. Views similar to those found in Callendar 2011 and Ladyman and Ross 2007 might prompt someone to say that, though the earlier invocation of actual physics was laudable, this later wandering into areas that might not be consistent with the actual laws of physics is disreputable. The approaches adopted in this paper are, however, consistent. Physics was appealed to earlier to reveal the actual nature of space and time in a way that would lead some at least to *expand* their view of what is possible, but that is entirely consistent with appeals to possibilities which may lie beyond that region of logical space in which the actual laws of physics apply. Surely, in thinking about possibilities, our default position should be that ‘something is possible until proven guilty’. If something is consistent with the laws of physics, that may give us a *stronger* reason to think it possible, but only considering worlds with our physics seems shortsighted. (It’s worth noting, in addition, that possibility IV here may be one which is actually realized.) Thanks to an anonymous referee for this journal for pressing me to address this issue.

(III)Everyday material objects are made up from finitely many discrete portions of homogenous stuff ('drops' or 'blobs' of matter)

(IV)Everyday material objects are realized by fields

(I) It is at least somewhat plausible that constitution by finitely many point particles is possible. Cameron suggests that our intuitions concerning point particles being a genuine possibility are not very much more secure than our (pre-argument) intuition that there might be nothing (Cameron 2007, 274–5). This seems to be at least something of an overstatement, but let us grant that there is *some* room for doubt as to whether point particles are genuinely possible, so that we should not rely *entirely* on this option in attempting to ground our SA. (We will return to this point about relying on particular potential forms of material constitution shortly.) With regard to space-times, the issue of the subtractability of point particles does not seem to bear one way or the other on the issue of whether space-time regions or whole space-times are subtractable.

(II) It is plausible that constitution by extended atoms is possible. But similar (limited) doubts might be raised here as were raised under (I), so again we should not rest *all* of the weight of our argument on this option. With regard to the issue of space-times and space-time regions, it is worth noting that there are some key similarities between extended atoms and whole space-times, in the terms we've been considering: they are alike in being spatiotemporally extended, contingent, and homogenous. Given these similarities it is unclear what would be supposed to ground a distinction between the two in terms of subtractability.

(III) A further putative possibility to consider is that of portions of homeomerous stuff. A discrete portion of such stuff could be spatially extended and have a natural boundary. Such a portion differs from an atom in that it is not required that its existence be all-or-nothing: a proper part of a portion might exist without the whole portion existing. And yet it seems legitimate to subtract a whole portion. Why? Well, it seems that an additional plausible principle is in play here: necessarily, if there exist some quantities of stuffs which *exhaust* the quantities of stuff (in the sense that there is no quantity of stuff which is neither one of them nor comprised of sub-quantities of one or more of them) and there exists a quantity of some particular stuff, then it's possible for that quantity of that particular stuff not to exist and every quantity of stuff that exists be one of those quantities or comprised by sub-quantities of one or more of those quantities. Briefly: quantities of uniform stuff are subtractable (in this extended sense). Again it would seem that the similarities between quantities of stuffs and space-times are such that it is not clear what would ground a distinction between the two in terms of subtractability—indeed, in this case it is natural to suppose that the similarities are such that if one takes portions of stuff to be subtractable then one should conclude that space-times are subtractable also.

(IV) Constitution by a finite number of fields seems possible. (And, it seems, constitution by fields may be *actual*, which would seem to lend this option some additional weight.) At least some fields seem to be contingent items, so, in the absence of contrary argument, it would seem that constitution by a finite number of contingent fields seems possible. So it seems that there could be a finite domain of contingent material objects and fields. And again, it would seem that the similarities between fields and space-times are such that it is not clear what would ground a distinction between the two in terms of subtractability.

In summary, there seem to be four putative ways for things to be with regard to the constitution of material things which would allow for a finite domain and subtractability. In each case there is *some* room for doubt over whether it is genuinely possible for things to be that way—though in each case there is little ground for that doubt and the doubt is correspondingly weak. That there are four such ways is significant: as noted already, all that is needed for the success of the SA is that there is *one* way that things might be which would allow for a finite domain of subtractable items.

It is worth noting in addition, that in three of the four cases, similarities (or at least, a lack of disanalogies) between the characters of the constituting items and whole space-times suggest that we should not hold a differential attitude towards the subtractability of space-times in comparison to other concrete objects—and the remaining case seems to be neutral on this issue. If one believes that a world of material objects can comprise a finite domain of concrete things, then one should believe that whole space-times are subtractable.

9. Conclusion

We have seen that careful consideration of the account of concreteness developed by Efird and Stoneham strongly suggests that whole space-times should be classed as concrete items. Given this result we are faced with three main options: (i) reject Efird-Stoneham-style accounts of concreteness and search for an alternative account which rules whole space-times non-concrete; (ii) conclude that (B) is false, on the grounds that whole space-times are concrete but not subtractable; (iii) conclude that, even in the face of our observations about whole space-times, the subtraction argument remains intuitively plausible and, on that basis, we have reason to believe that there could have been no material objects *and no space-time either*. I have argued for (iii): space-time as we find it in actuality is a concrete object, it is contingent, and there is no obvious reason to think it any less subtractable than items of middle-sized dry goods, so, at the very least, if one found the subtraction argument persuasive prior to the recognition of the status of whole space-times as concrete items, then one should continue to find the argument persuasive in the wake of such recognition. In short, the revised subtraction argument presented here should lead us to conclude that there could have been nothing, and 'less' nothing than we thought previously—not only no material objects, but no smaller-than-universe-sized concrete items of any type, and no whole space-times either.[10]

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