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This chapter explores a potential analogy between mereological principles and laws of nature. Against a backdrop of what Marmodoro has termed 'power structuralism' (and a rejection of a Humean worldview), the connection between parthood and modality may be richer than has hitherto been considered. Mereological principles delineate possibilities for parts and wholes, and putting powers at the centre of a discussion about parthood can furnish a novel conception of mereological laws, much as dispositionalism has done so for natural laws; namely, these principles express connections between fundamental dispositional properties. By extending dispositionalism to comprehend mereology in this way, we can help fulfil its promise to provide a foundational, naturalistic metaphysics: foundational mereological debates then begin to mirror those relating to dispositionalist views of laws of nature: we may take *mereological* laws to hold necessarily or contingently, each with associated strategies for dealing with supposed counterexamples to one's preferred set of mereological principles. We can thus bring new life to the debate over whether questions of composition admit of contingent or only necessary answers.

## Powers, parts and locations

Marmodoro (2017) proposes an original and intriguing synthesis of powers/dispositionalist metaphysics with mereology. One of the foundational principles of dispositionalists is the Eleatic stranger's test for reality: the real is that which is, or at least can be, efficacious.

The principle says that what is real is what is powerful. I take what is powerful to be what can act causally on something else or be acted on, as well as what drives activity simpliciter . . . There are two ways one can proceed from here in developing one's ontology further: either assume objects and show them to be powerful or assume powers and show how objects consist of them. Power structuralism follows the second path (Marmodoro 2017: 110).

This chapter largely takes this synthesis, power structuralism, for granted, not because it is obviously correct (it is a metaphysical theory, after all), but in order to help explore its potential, in particular some of the conceptual links which the power mereologist has at her disposal. First, however, this section adds some brief considerations in its favour, based on some claims of another influential powers theorist (not to say power mereologist), George Molnar. Aside from lending some support to the power mereology synthesis, this will help highlight its non-classical-mereological, anti-Humean leanings.

Molnar (2003: Chapter 10), notes that, pre-theoretically, powers are *portable* properties (159). How should we understand this? Molnar claimed that powers' locations are parasitic on their objects. Why should this be the case? One potential answer is that powers are parts of their objects.

Such an answer requires the following principle (which is very difficult to deny).

**Inclusion 1:** If x is a part of y, then the location of x is a subregion of the location of y.

Assuming that powers are parts, together with Inclusion 1, entails Molnar's claim about powers' locations. So the thesis that powers are parts of their objects would explain their occupation of subregions of these objects. The mere assumption that powers are *properties* of objects does not do this - properties of objects need not be included in these objects' locations. Molnar's claim that powers are *intrinsic* properties of their objects might do this, but on what basis can we say that powers are intrinsic properties? Assuming, plausibly, that parts are intrinsic to their wholes, the claim that powers are parts of their objects also entails Molnar's claim that parts are intrinsic.

While Inclusion 1 is very plausible, the argument from explanation (of powers and objects sharing locations) needs further elaboration: we would also need to determine that powers-as-parts is the *best* explanation, not to mention that co-location of powers with their objects is something that needs explaining. Without delving into these details,

perhaps the best we can say here is that the thesis that powers are parts *coheres* with the claims that powers' locations are parasitic on, and are intrinsic to, their objects.

Alternatively, the following principle, Inclusion 2, while intuitive enough, is more debatable but provides for a stronger inference to the thesis that powers are parts:

**Inclusion 2:** If the location of x is a subregion of the location of y, then x is a part of y.

Assuming Molnar's claim that powers' locations are shared with their objects, together with Inclusion 2, *entails* that powers are parts.

Any well-rounded theory of powers should have something to say about powers' locations. To be sure, one needn't accept Molnar's claims that powers are intrinsic and location-parasitic on their objects, but it is worth noting that these claims are in keeping with a naturalistic metaphysics of powers. The thesis that powers are parts of their objects, in turn, generates a simple picture of the connection between the locations of powers and those of their objects.

Now, having cited Molnar's claim about powers' locations, to support a conception of powers as parts, we should also note that Molnar disapproved of such a conception: Molnar suggests that detachability distinguishes parts from properties, the former being detachable from their objects, the latter not (2003:160-1). But in an anti-Humean metaphysic, such as dispositionalism is, separability need not be characteristic of proper parthood: for the anti-Humean, there may be necessary connections between distinct objects, so we need not think of parts as detachable in any way from their wholes. The urge to distinguish parts from properties on the basis of detachability, therefore, is more natural from a Humean stance, which the powers theorist will naturally reject.

None of this is decisive, of course, but the mention of Inclusion 2 also serves the purpose of illustrating how the invocation of intuitive principles can quickly lead to revisionary mereology when combined with a consideration of physical phenomena. Since the powers of an electron - spin, charge and mass - being powers of non-extended entities, share each other's location, Inclusion 2 tells us that they are therefore *mutual* parts of each other and that each of these powers also has the *electron* itself as a part (I am indebted to Cotnoir's

[2013](#) discussion of inclusion and mutual parthood here). Moreover, if we assume that these powers – spin, charge, mass – being numerically distinct from each other and the electron, are *proper* parts of an electron (if parts at all – which they are, according to Inclusion 2), then weak supplementation is violated (although strong supplementation is not).<sup>1</sup>

In the next section, we push this consideration of challenges to mereological bulwarks into the realm of meta-mereology, relating to the nature of mereological principles. This helps lay the ground for the parallel I wish to draw between the laws of nature and the laws of mereology.

## The decline of topic neutrality and analyticity

Consider the following principles:

- (1) if  $x$  is a proper part of  $y$ , then  $y$  is not a proper part of  $x$
- (2) if  $x$  is a proper part of  $y$  and  $y$  is a proper part of  $z$ , then  $x$  is a proper part of  $z$
- (3) if  $x$  is a proper part of  $y$ , then there is some proper part  $z$  of  $y$ , that is disjoint from  $x$ .

These are examples of what were at one time considered conceptual truths; however, while it has been claimed that certain principles are constitutive of the *meanings* of mereological terms such as ‘part’ and ‘whole’, one can now find many robust challenges to the analyticity of such principles (e.g. on a minimal conception of proper parts as parts which are not identical to the whole, Inclusion 2, combined with cases of co-located simples, challenges 1 and 3). Such challenges have, in turn, cast doubt on the topic of the neutrality of mereology. In this connection, Varzi and Gruszczyński note:

The part-whole relation may apply to a very broad range of domains, and within most of these domains it may behave in accordance to such principles as [1–3]. But there is a growing consensus that this is the best one can say, and that mereology is best understood as a theory – or a plurality of theories – whose fundamental truths do not reflect the properties of the part-whole relation itself *but the nature of the entities to which it applies*. This is obviously not what Husserl had in mind. Yet precisely here, in the apparent failure of the Husserlian conception of part-whole as a formal ontological relation, lies the richness of much contemporary work in mereology. (2015: 413; italics added)

Varzi's and Gruszczyński's discussion gives rise to several divergent lines of thought.

First, it is perhaps suggestive of two opposed general approaches to metaphysics: Should we start with the contents of the actual world and try to determine which structure – encoded, for example, by mereological and topological principles – best fits with it? Or should we look for a structure – tested against any world imaginable – that would fit with the actual world, *however it might turn out*?<sup>2</sup> Perhaps more precisely, should we grant different mereological principles for different domains, or should we only accept those principles which apply to all (possible) objects? The latter approach adheres to the topic-neutral conception of mereology; the former to mereology as pluralistic, domain-specific. The former also seems more aligned to the spirit of dispositionalism, at least of the power-mereology kind (Marmodoro 2017): properties and features of the actual world – for example, in the present context, whether two things are ever *actually* co-located – take precedence when determining the metaphysics of objects, that is, when answering questions about their identity, possibilities and structures.<sup>3</sup>

A second divergence, which Varzi and Gruszczyński raise more explicitly, relates to the source, so to speak, of what we might term mereological regulation (which we might refer to as the metaphysical ground of mereological principles). Are mereological tendencies, principles and laws due to the nature of the part-whole relation itself, to the nature of objects in general, or to the natures of the objects of a given domain? The first and the second of these agree about the scope of mereological laws (that they apply to all things), but differ on their ground – the first takes this to be the relation, the second takes it to be the objects. The second and third of these options agree on the grounds of mereological laws – the objects – but differ principally in their scope, which relates to what counts as a mereological law: the second only admits laws that apply to *all* things, while the third also permits as mereological laws those principles which apply only to restricted domains.

A key issue here is how a mereology deals with apparent exceptions to its principles. This chapter aims to sketch a novel map of the options for dealing with such exceptions, by bringing dispositionalist accounts of laws of mereology into line with those of laws of nature. The next section lays some groundwork for making such an alignment; the last section then maps the options.

## Merging mereology with a theory of powers

Theories of composition can be divided into three groups, according to how they answer the question: Under what conditions does composition occur? We can categorise answers to this into three types: never (nihilism), always (universalism), sometimes (restricted composition).

For the project of synthesising mereology with a powers metaphysic, the answer *never* - mereological nihilism - is of little interest. Conceiving of powers as parts is of interest because it provides a novel way in which the Eleatic principle might be borne out: "assume powers and show how objects *consist* of them" (Marmodoro, 2017: 110; italics added). Mereological nihilism also precludes a conception of effects as compositions of powers (Mumford and Anjum, 2011: Chapter 4).

The answer of universalists, *always*, has marginally greater potential to fit with power mereology (than *never* does) - but it would be a relatively awkward fit. Mereology would not be informative regarding compositions of powers that result in interesting manifestations of the sort with which science concerns itself, because if universalism were true, everything would fuse with everything. Mumford and Anjum (2011: Chapter 4) offer a model of causation according to which powers can come together, which is to say that they *compose*, to produce an effect that neither could produce alone. If composition has any such role to play in a theory of causation, then there must be something special about the composition of powers; whereas if composition occurs between *any* and *all* things, talk of composition of powers adds nothing to the discussion. For the universalist, the mere existence of some things is enough for them to compose - composition is an "ontological free lunch" (Armstrong 1997: 12-13) - and powers would compose whether they jointly produce an effect or not. What makes the difference between the compositions of powers that do result in novel effects and those that do not? For the universalist, the difference cannot be that the former compose, while the latter don't, for the simple reason that all *must* compose provided only that they exist. Moreover, universalism has ties to extensional mereology - indeed, it has been argued that the former entails the latter (Varzi 2009). Another aspect of causation that Mumford and Anjum discuss is the potential for powers to combine to produce genuine cases of *emergence*, where the effect is a whole that is more than the sum of its component causes. Thus, extensional mereology would rule out this understanding of emergent effects as compositions of causes.

It remains to consider restricted composition (*sometimes*). On this view, the composition of parts into wholes is something that depends on the satisfaction of certain conditions which may not always obtain: the organisation of simple objects in such a way as to constitute a

life, for example, or in such a way that constitutes 'ordinary' objects such as tables and chairs, but not extraordinary objects such as the fusion of the number three and the Eifel Tower.

It is perhaps a restricted view that coheres best with the project of merging mereology with a theory of powers. Mereological composition, on such a view, can be considered event-like - it is something that happens, an entity coming into existence (over and above the parts - coherent with the anti-Humean worldview), not as a matter of course (i.e. guaranteed by the mere existence of its parts) but, rather, as dependent on what the state of the world is. This is not to say that the object itself is an event (that is, we do not need to deny the event-object distinction), but its coming into existence is.

Returning now to the topic of how to deal with apparent exceptions to mereological principles, let's consider Cartwright's arguments concerning laws of nature, which can be seen as arguments in favour of conceiving of such laws not as exceptionless regularities, but rather statements that describe powers. Cartwright (1980) points out that laws of nature must trade off between description and explanation. For example, Newton's law of gravitation  $F = Gmm'/r^2$  is explanatory to the extent that it abstracts from actual events, for objects are affected not only by their mass and the distance from other objects but also by, for example, their charge. Hence, simply stated,  $F = Gmm'/r^2$  is not an exceptionless regularity - it fails to describe what happens. A natural suggestion, then, is to admit exceptions into the statement of the principle, saying that it applies in the absence of such interferences as charge - but in that case, it loses its explanatory force, applying only to idealised circumstances that do not obtain in the actual world. To the extent that laws of nature are explanatory, then, they are not true; they can be made true, by the addition of *ceteris paribus* clauses, but this renders them unable to explain actual events. Cartwright's solution is to say that laws of nature are in fact statements about powers. Laws can then be seen, not as exceptionless regularities but as tendencies, the product of powers of objects; the existence of exceptions is accommodated by this conception while nonetheless recognising the value of laws qua generalisations.

Is there an analogous line of argument for the existence of dispositions to compose - for the claim that mereological principles are descriptions of powers? If powers give rise to mereological facts, as per the proposed coherence of power mereology with restricted composition, we can say the following: powers determine all that happens in the world; it happens that parts come together to make wholes; therefore, powers determine when composition occurs. This much can be said without any meta-mereological consideration

of how to deal with apparent exceptions to classical mereological principles. However, it doesn't quite hit the mark: it gets us as far as the claim that powers determine when the conditions for composition are met, but not as far as the claim that mereological laws are statements about powers.

To take the analogy between laws of nature and mereological laws further, we need to consider how a powers ontology ought to conceive of laws concerning material beings, and I suggest that we take dispositionalist accounts of physical laws as a guide. While mereological laws state the conditions under which composition occurs, a powers ontology, according to which powers explain all that happens in the world, says that powers determine when those conditions are met, which is to say that every case of composition occurs because of powers. However, there are different ways to conceive of laws, and we can frame this in terms of Euthyphro-style questions: Do things happen in the ways they do because of laws, or are the laws what they are because things happen as they do? Do laws supervene on local matters of fact (Humeanism), or are matters of fact constrained by laws? A powers view reframes things: laws emerge from – or rather, are none other than the *products of* – dispositional properties of things.

Dispositionalism is an “explanatory ontology” (Mumford 1998): it is meant to provide a *fundamental explanation* of what happens in the world; all events, then, are the product of dispositions, and any case in which some things come together in such a way as to compose something is, on the restricted-composition picture, an event – one in which something new is brought into existence, as a result of the activities of its parts. If, however, mereological laws are conceived as constraining what composites come into existence, they would amount to governing laws over dispositions, ensuring that powers don't bring anything into existence that would violate them.<sup>4</sup> According to dispositionalism, powers are the basis of what happens in the world and give rise to laws of nature; assuming that powers are, at the same time, subject to laws of *composition* seems to challenge the scope and sufficiency of powers to explain the dynamic world: on such a picture, powers would not be restricted by physical laws in what they give rise to (the former would be taken as the basis of the latter, after all) but would be so restricted by mereological laws. Of course, the mereological universalist may note that their principle of composition imposes no such restriction, since it admits all combinations as composites. However, in the spirit of the Eleatic stranger, we should perhaps also exclude principles which inform of such free-lunch entities: if such entities are not in themselves efficacious, and can no more act or be acted upon than their parts taken separately, they fail the stranger's test for reality.

I thus propose that powers give rise to mereological laws, which is to say that mereological laws are effectively statements about dispositions in two senses: dispositions are the substance of mereology, not only in the sense that they are themselves parts (as per Marmodoro 2017) but also in the sense that they wholly determine when the part-whole relation obtains, without interference, restriction or ontological additions from powers-independent metaphysical laws. This is one way of fleshing out the claim that the fundamental truths of mereology “do not reflect the properties of the part-whole relation itself *but the nature of the entities to which it applies*” (Varzi and Gruszczyński 2015, 413; italics added). We also now have the resources to make sense, should we need to, of different mereological laws applying to different objects: if there is such diversity, it is a result of differences in mereologically relevant powers.

This proposed parallel between natural and mereological laws is somewhat complicated, however, by the fact that, in the context of mereological debates, there are roughly two types of exception to otherwise intuitive mereological generalisations: actual exceptions and merely possible/imagined exceptions.<sup>5</sup> The same might be said for discussions about physical law, of course, but for mereologists, counterexamples may be sourced from far-flung – metaphysically possible but perhaps physically impossible – worlds. In the following section, I take the question of how much of modal space mereological laws need to cover to count as such, and recast it in terms of the proposal that powers are the basis of mereological law in the same way that they are the basis of physical laws, mapping the options in terms of an existing disagreement between dispositionalists: those who claim that the laws of nature are metaphysically contingent and those who hold them to be necessary.

## Contingentism and necessitism for laws, natural and mereological

As noted earlier, the traditional view is that certain claims about composition are constitutive of the meaning of mereological terms; it is perhaps no coincidence, then, that mereological debates have been traditionally assumed to be matters of necessity.

But analyticity is not the only source of this assumption. Here’s Sider:

What are [the] synthetic necessary truths? Many would cite mathematical examples. I would cite also the laws of mereology, whatever those are. There are some conditions, *C*, such that it is necessarily true that whenever objects satisfy conditions *C*, there exists an object that is composed of those objects. (2003: 202–3)

Thus, challenges to the analyticity of principles like answers to the special composition question, or principles 1–3 given earlier, are not necessarily challenges to the necessitarian assumption about mereological laws, for the latter might be taken to be expressions of *synthetic* necessary truth.

One direct challenge to the necessitarian orthodoxy is Ross Cameron's "Contingency of Composition" (2007).<sup>6</sup> Cameron's strategy is to survey the reasons that might be given in favour of necessitarianism, and show how each fails. As such, it is a largely negative case, but something of a positive case falls out of this as a matter of course: in the absence of reasons in favour of the necessary truth of mereological principles, we should not make the assumption that they are necessary, for the stronger claim is more in need of substantiation; instead, arguments in favour of particular mereological principles should favour their contingent truth, by default.

I am generally sympathetic to Cameron's position, but what I want to suggest is that this question – concerning the contingency or necessity of composition principles – should be subordinated to another, namely, concerning the modal status of laws that arise from powers. Dispositionalism is a global metaphysic, a foundational worldview. I have suggested that a dispositionalist should understand composition as arising from powers, and as such, mereological principles should be considered applicable to objects *in virtue of* objects' powers. Much as laws of nature may be considered general codifications of powers, so should laws of mereology.<sup>7</sup>

Now, among dispositionalists, there are those who argue for the metaphysical necessity of laws of nature (Shoemaker 1998; Ellis 2001; Bird 2007) and those who argue for their metaphysical contingency (Mumford 1998).

Mumford endorses the Contingency Thesis:

CT: the laws of nature are logically (metaphysically) contingent. (1998: 236)

Mumford reasoned that, while the possession of certain dispositions determines the classification of a particular as of one kind or another, any given particular, nonetheless, “could have had different dispositions to the ones it actually has” (ibid.). Assuming that powers determine facts and principles of composition, Mumford’s contingentist reasoning would similarly apply to mereological laws: it is metaphysically possible for particulars to be in possession of different dispositions, and such possibilities are not constrained by the type of entity an object is. As such, there could be dispositions that give rise to different laws of composition than those which actually obtain. In this connection, if we conceive of powers as parts, the contingency in question can be thought of in terms of the possibility for a given particular to have different power-parts than it actually has, such that actual laws – physical or compositional – would be violated.

Should we admit only those mereological principles that are adequate to absolutely all worlds? That is an option, but it goes against the stance towards metaphysical theorising mentioned earlier, according to which we should favour principles that adhere, so to speak, to actual goings on – “to adopt the framework that is best for the specific world we find ourselves in” (Newton-Smith 1980: 229 – see note 2). *Other things being equal*, a world that features entangled particles is a better place for mereological principles that admit of distinct co-located objects than one which doesn’t feature such physical phenomena; in general, then, mereological principles may be more or less adequate depending on the phenomena of the world we find ourselves in. Much like the trade-off found in Cartwright’s argument mentioned earlier, the more general our mereology (in terms of possible phenomena accommodated), the less applicable it is to actual goings on.

Alternatively, one might favour a dispositional essentialist account according to which the laws of nature are metaphysically necessary. As part of this picture, the laws of nature are guaranteed in all accessible worlds by the dispositional essences of objects or their properties. What about our ability to imagine worlds in which the actual laws of nature are violated? As part of this picture, much as Kripke dealt with supposed imaginings of water composed of XYZ ( $\neq$  H<sub>2</sub>O), we can consider these worlds as containing objects *superficially* similar but *essentially* different from anything in the actual world. Such imagined worlds therefore do not represent genuine possibilities relative to the actual world (or relative to the object/natural kind in question), and the properties that give rise to alien laws of nature are themselves alien. Analogously, then, the view that composition is the product of

powers would tell a similar story about our ability to imagine worlds in which the actual laws of mereology are violated. With the distrust of imagination, debates about mereological laws would need to be recast: a principle of composition can better withstand the description of far-flung worlds at which that principle is apparently violated, for the priority should be how to best describe the *actual* world; imaginings that violate the laws of nature – being metaphysically impossible – would be irrelevant in that regard.

As Cameron notes, the choice between necessitarianism and contingentism about mereological laws has consequences for how debates about composition play out. Consider, for example, van Inwagen's claim that composition occurs when simples behave in such a way as to constitute a life. This view assumes that there are fundamentally two kinds of objects: simple and complex. Sider (1993) objected to van Inwagen's organicism by invoking the metaphysical possibility of gunk, that is, worlds in which there are no simples, but every object has proper parts; assuming that organicism is necessarily true if true at all means it is made false by the mere possibility of gunk. Cameron (2007) points out that van Inwagen can admit the possibility of gunk provided he drops the necessitarian construal of organicism and provided we have no reason to think that the actual world is gunky.<sup>8</sup> The view of mereological laws as allied with Mumford's brand of dispositionalism casts this as follows: organicism is a *contingent* metaphysical law; objects *could* have been possessed – or composed – of mereological powers such that every part has a proper part, in which case, organicism would have been false.

Against a background of the *necessitarian* picture as assimilated to a theory of powers, according to which both the mereological and natural laws are metaphysically necessary, the organicist can address Sider's objection from the possibility of gunk by claiming that gunky objects are, in fact, *impossible* but in such a way that the conceivability of gunky worlds is accommodated: worlds of gunk can be admitted, just not in worlds accessible from the actual world; rather, they would be worlds of alien dispositional properties and, hence, of alien parthood.

In this way, dispositionalism strengthens its status as a foundational worldview. Powers are the source not only of natural laws but also of mereological laws, and the division between contingentist and necessitarian dispositionalists can be seen as underlying that between contingentist and necessitarian mereologies. This goes some way towards the promise of naturalised metaphysics: the result of dispositionalist discussions about natural law provides a guide to other putatively foundational metaphysical debates concerning material beings.

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<sup>1</sup> Weak Supplementation (WSP): If  $x$  is a proper part of  $y$ , then there's some  $z$  that's part of  $y$  but disjoint from  $x$ . Strong Supplementation (SSP): If  $y$  is not part of  $x$ , then there's some  $z$  that's part of  $y$  but disjoint from  $x$ .

<sup>2</sup> The author's attention was first drawn to this foundational/methodological question by Newton-Smith's (1980) discussion of the metaphysics of time, which considers the suggestion that we should assume a structure that maximally encompasses others, such that the view that time is continuous is favoured over the view that it is dense, and the view that it is dense is favoured over the view that it is discrete. Against this, he adopts the attitude that, "rather than adopt a framework that is more or less adequate to any possible world, we want to adopt the framework that is best for the specific world we find ourselves in" (Newton-Smith 1980: 229).

<sup>3</sup> But in that case, imagined exceptions of far-flung worlds, to otherwise actually adequate mereological principles, might be discounted, as being irrelevant to actual objects - this aligns with the necessitarian view of the final section below, which takes such exceptions to be alien objects, with alien mereological powers and principles.

<sup>4</sup> One might be tempted to argue that principles such the inclusion principles discussed earlier or principles 1-3 concerning proper parts are not about answering the special composition question (When do some  $x$ 's compose?). However, interest in these is often due to their (often surprising) implications for this very question.

<sup>5</sup> Each of these may be more or less direct: quantum phenomena may directly challenge the principle of impenetrability, for example, and in doing so pose problems by implication for mereological systems that are committed to it.

<sup>6</sup> Parsons (2013) also provides a very interesting discussion.

<sup>7</sup> Where would such a project, making powers the basis of laws natural and metaphysical, stop? Why not posit dispositions as logical lawmakers, too? One answer might be that logic, concerning the rule of reasoning, remains essentially topic neutral, whereas mereology, concerning material beings, is not. However, the topic neutrality of logic may be challenged (Varzi 2014) - and if the challenge is successful, this question may have more bite (or promise, as the case may be).

<sup>8</sup> To be a truly naturalised mereology, the view needs to posit mereological principles that are reflective of actual, empirically discoverable dispositions. We can posit a disposition to arbitrarily decompose, for example, but what empirical worth does this have? Should mereology be limited by possibilities of physical discovery? Should we reject infinite parts because of physical limits to division? (Braddon-Mitchell and Miller 2006 provide an interesting discussion).