Is the Macro Grounded in the Micro?

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Abstract

Let a priority micro pluralist be someone who holds that particles or other microscopic objects are fundamental. Rivals to priority micro pluralism include priority monism (the view that the only fundamental concrete object is the entire cosmos) as well as the Aristotelian view that some ordinary macroscopic objects are fundamental. Although priority micro pluralism is popular, I show that it encounters great difficulty in even the most straightforward cases. For example, this tennis ball is spherical; how is this fact to be grounded in facts about the microscopic realm? I consider a number of possible answers to this question. The most promising proposals attempt to exploit the close connection emphasized by Kripke between objects and their original material constituents. I argue that these proposals fail. I conclude that it is worth seriously considering alternatives to this sort of pluralism.

Keywords

grounding, priority pluralism, origin essentialism, micro-reductionism, composition

Jonathan Schaffer (2010: 31–2) has characterized the doctrine of priority pluralism this way: 'The pluralist holds that the parts are prior to their whole, and thus tends to consider particles fundamental, with metaphysical explanation snaking upward from the many'. My concern here will be with the *priority micro pluralist*, who *does* consider particles or other microscopic objects to be fundamental and who believes there is a metaphysical explanation of our ordinary macroscopic world in terms of them. She holds, in slogan form, that the macro is grounded in the micro.

Pluralism is not without its rivals. Schaffer, for instance, lays claim to a venerable tradition of monism in defending the view that the only fundamental concrete object is the entire cosmos. And Inman (2017) and Bernstein (2021) offer arguments in defence of the Aristotelian view that some ordinary macroscopic objects are fundamental.[1]

Despite these rivals, however, pluralism remains a popular view.[2] But its popularity is something of a mystery, for, as I shall show in this short paper, the view encounters great difficulty when subjected to even the most basic questioning.

The pluralist holds that the macro is grounded in the micro. How strong a commitment is that? Should the pluralist take *all* facts about macroscopic objects to have microscopic grounds? Even modal facts? Facts of self-identity? Facts about essence? About existence? About

[1] Bernstein does not go so far as to endorse the view.

[2] For example, Horgan (1982: 29) tells us that 'many contemporary philosophers believe ... that all the facts about our world are somehow fully determined by the microphysical facts concerning the subatomic "building blocks" of the world'. Ellis (2001: 64) informs us that 'the accepted paradigm of ontological dependence is to be found in the theory of micro-reduction'. And Sider (2003: 140) finds 'attractive' the principle that 'the properties of wholes, in the actual world anyway, are determined by the properties of and relations between their atomic parts (where "atom" means "atom of physics", not "partless simple")'. These and other examples are given in ch. 4 of Inman (2017).

grounding? For present purposes we may allow the pluralist to exempt such potentially troublesome cases. We will assume only that her view requires micro grounds at least in the quotidian case of *shape*—that she must take every fact about what shapes ordinary macroscopic objects have to be grounded in facts involving only microscopic objects. If the pluralist cannot maintain even that commitment, then it is hard to see how she can claim that there is an explanation of the macro world in micro terms.

The problem for the pluralist is that it is not at all clear that this commitment can be borne out. Those who think there might be a way to maintain pluralism without satisfying even this weak commitment are invited to say what that way is.

I.

Take a case that is as straightforward as one could hope for. Consider an ordinary macroscopic object that has existed for a while, say this tennis ball *b*. At the present time *t*, it has a certain shape: it is spherical. For the pluralist, the fact that *b* is spherical at *t* will be grounded in some collection of 'micro facts', facts involving only microscopic objects. But which facts exactly?

The obvious answer will not work. Call *b*'s microscopic constituents at *t*, whatever they are, the *X*s. At *t*, the *X*s stand in a certain relation that we might call *being arranged spherically*. (The precise nature of this relation will not matter.) Could the fact that *b* is spherical at *t* be grounded in the fact that the *X*s are arranged spherically at *t*?

No. Consider a possible world in which, starting before *t*, we gradually replace the *X*s one by one with qualitative duplicates in the manner of the ship of Theseus, so that by the time *t* rolls around, none of the *X*s overlaps *b* any longer. At *t* we deform *b* while arranging the *X*s spherically elsewhere. Then although the *X*s are arranged spherically at *t*, *b* is not spherical at *t*. Since this is possible, the fact that the *X*s are arranged spherically at *t* does not ground the fact that *b* is spherical at *t*.[3]

Of course, the problem is not confined to this fact about *b*'s shape; it arises for a wide range of facts, such as the fact that *b* is falling, or that it is rotating, or that it is elastic. But since the case of shape is particularly straightforward I will continue to develop my argument in terms of it.

The above argument against what I called the obvious answer assumes the principle of *grounding necessitation*: if the facts $f_1,...,f_n$ ground the fact *g*, then necessarily, if $f_1,...,f_n$ all obtain, so does *g*. If the pluralist rejects this principle, then she can embrace the obvious answer. For she

[3] Skiles (2015) has discussed Theseus-style obstacles to finding grounds for the *existence* of ordinary macroscopic objects (and deRosset (2013) has discussed similar obstacles in the case of the existence of groups of macroscopic objects). But two points should be made. First, no such obstacle will worry the pluralist who accepts necessitism, the view that necessarily everything exists necessarily (Williamson 2013). For such a pluralist, there will be no possible world in which *b* fails to exist, and so no world in which any purported ground for *b*'s existence, no matter what it is, obtains without *b*'s existing. And second, although *some* pluralists may insist upon micro grounds for macro existence facts, others may be quite happy to let such facts go without micro grounds. For they may suggest that existence facts, like essence facts or self-identity facts, are tricky 'metaphysical' cases which lie outside the scope of the core pluralist idea. No such maneuver will work for the quotidian fact that *b* is spherical at *t*.

can concede that it is possible for the *X*s to be arranged spherically at *t* while *b* is non-spherical at *t*, and yet insist that the fact that the *X*s are arranged spherically at *t* grounds the fact that *b* is spherical at *t*. But although some philosophers have indeed wished to reject the principle,[4] most have found it plausible. After all, if it is possible for the *X*s to be arranged spherically at *t* while *b* is *not* spherical at *t*, then that surely shows that the *X*s' arrangement is, in Dasgupta's (2016: 393) phrase, 'not the full story' of what makes *b* spherical. Although there is more to be said on the matter, there is no room to do so here, and so I shall simply assume the principle of necessitation in what follows.

What else might the pluralist take as the 'micro ground' of the fact that *b* is spherical at *t*? One option can be dispensed with straightaway. Suppose the pluralist thinks that *b*'s shape supervenes on the totality of micro facts: duplicate our world at the micro level, and you have a world in which *b* is spherical at *t*. The pluralist might propose on this basis that the fact that *b* is spherical at *t* is grounded in the totality of micro facts—that is, in all of the micro facts taken together. But this cannot be right. A fact's grounds provide a kind of metaphysical explanation (namely, a grounding explanation) of why that fact obtains, and explanations must be relevant to what they explain. But consider the fact that a certain electron near Alpha Centauri has unit negative charge; that fact is part of the totality of micro facts. If anything is irrelevant to the grounding explanation of why *b* is spherical at *t*, that fact is. Suppose someone asks why this ball here is spherical. It would be bizarre to respond, 'Well, there is this electron near Alpha Centauri ...' The charge of this extrasolar electron is just not involved in the grounding explanation of the fact that *b* is spherical at *t*. And so that fact cannot be grounded in the totality of micro facts. Its ground must be more discriminating.[5]

But is the above argument against this totality proposal not suspiciously strong? Could it not be used to establish in one fell swoop the falsity of monism? The monist, after all, holds that the cosmos is the sole fundamental concrete object. It therefore seems inevitable that she will take the fact that *b* is spherical at *t* to be grounded in a fact about the cosmos. But the cosmos contains lots of electrons near Alpha Centauri—and many other things which bear equally little connection to *b*. So mustn't the monist run afoul of the requirement that explanations should be relevant to what they explain?

Of course, my aim here is to argue against pluralism, not in favour of monism. And so it is no objection to my argument if it reveals a difficulty, not just for pluralism, but for monism too. Still, I do not think the latter can be refuted so easily. The purported difficulty for monism appears to rely on the following principle: if the fact *f* is grounded in the fact *g*, and if *g* involves an object *x*, then all of the parts of *x* (or facts about those parts) will be relevant to the explanation of *f*. And this principle is doubtful. Suppose, for example, that the fact that this windbreaker is blue is grounded in the fact that it is this particular cerulean shade. And suppose further that the windbreaker has a fleece inner lining. Although this lining is part of the windbreaker, it seems irrelevant to explaining why the windbreaker is blue. The nature of the lining simply makes no difference to the windbreaker's colour.

I do not wish to argue that there is no difficulty for monism anywhere in the vicinity of my objection to the totality proposal. But if there is, it will require further machinery to develop. We need not worry that the objection on its own is somehow suspiciously strong.

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[4] Among them are Leuenberger (2014) and Skiles (2015); see also Skiles (2020).

[5] Dasgupta (2014: 9) makes a similar point.

Let us therefore leave aside the totality proposal. What else might the pluralist take as the micro ground of the fact that *b* is spherical at *t*?

She might protest that we were too hasty in abandoning the obvious answer, despite its falsity. For she may suspect that it is on the right track and that it simply requires an additional component. The micro ground of the fact that *b* is spherical at *t*, the pluralist might suggest, must be taken to consist of not only the fact that the *X*s are arranged spherically at *t* but also the fact that the *X*s *compose b* at *t*.

This proposal will not work as it stands. For the fact that the *X*s compose *b* at *t* involves *b* and is therefore not a micro fact. But if the pluralist can find a micro ground of the composition fact, then she can plausibly take that ground, together with the *X*s' spherical arrangement at *t*, to be the micro ground of *b*'s sphericality at *t*.[6] The search for a micro ground of the composition fact will occupy us for the remainder of the paper.

II.

What could it be about micro reality that makes the *X*s compose *b* at *t*? Is it perhaps that the *X*s are in contact at *t*? That they are stuck together? That they are 'arranged tennis-ball-wise'? No such answer can be correct. For we have already seen that there is a possible world in which *b* is composed of objects wholly distinct from the *X*s. In a world like that, the *X*s can be any way you like at *t*; be they in contact or stuck together or whatever, they still do not compose *b*. The pluralist, it seems, must reach beyond facts about how the *X*s are at *t* if she is to find the micro ground of their composing *b* at *t*.

The most promising pluralist strategy appeals to facts connected with the material origins of *b*. At least since Kripke (1980) it has been recognized that ordinary objects are intimately connected with their original constituents. One might think, for instance, that if *b* was originally made from certain bits of rubber, then necessarily anything originally made from these bits is *b*.[7] One might think also that the original constituents of *b* bear some important and general relation to each other at the time of *b*'s origin; call this the *origin relation*. Intuitively, some things stand in the origin relation at a time just in case they compose something that comes into existence at that time. And one might think *b*'s original constituents bear some important and general relation to its present constituents; call this the *unity relation*. Intuitively, some things stand in the unity relation just in case they compose the same persisting object. So perhaps, letting the *Y*s be the original microscopic constituents of *b*, the pluralist can take the micro ground of the fact that the *X*s compose *b* at *t* to be

> (1) There is a time such that (a) the *Y*s at that time stand in the origin relation to one another and (b) the *Y*s at that time stand in the unity relation to the *X*s at *t*.[8]

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[6] This is an application of the Cut rule in deRosset's (2014) logic of strict ground. This rule, as deRosset notes, is derivable in Fine's (2012) pure logic of ground.

[7] This is an example of what McKay (1986) calls a constitutional sufficiency principle. The argument below is informed by discussions of such principles in Salmon (1981), Forbes (1994), Robertson (1998), Hawthorne and Gendler (2000) and Hawthorne (2006).

[8] It is perhaps most natural to understand locutions like 'the *X*s at *t*' in terms of temporal parts: 'the *X*s at *t*' refers to the plurality whose members are the *t*-parts of each of the *X*s. But the existence of temporal parts is controversial and so it is worth noting that there is a way for the

The pluralist can then take the micro ground of the fact that *b* is spherical at *t* to consist of (1), together with the fact that the *X*s are arranged spherically at *t*.

One can be forgiven for wondering whether this grounding proposal is really compatible with pluralism. The pluralist, after all, supposedly champions the slogan that the macro is grounded in the micro. But the proposed micro ground of the macro fact that *b* is spherical at *t* involves the origin relation and the unity relation, and the instantiation of these relations may seem not to be a wholly microscopic matter.

Strictly speaking, the proposal does not run afoul of the pluralist commitment that has been our focus thus far, which is that every fact about what shapes ordinary macroscopic objects have is grounded in facts involving only microscopic objects. For the origin relation and the unity relation are not non-microscopic objects: in the relevant sense, they are not objects at all. All the same, the proposal might be thought to violate a more general commitment of pluralism, one which we have so far not attempted to articulate. That commitment is something like this: every fact about what shapes ordinary macroscopic objects have is grounded in a fact about how things are microscopically. Grant that the only *objects* involved in (1) are microscopic; still it might be thought that (1) is not a fact about how things are microscopically.

It is not easy to properly assess this objection to the proposal. To have any confidence in our assessment we would need to explicate in more detail the origin and unity relations as well as the notion of how things are microscopically. This is no small task. Nor is it clear that, once that task is done, the grounding proposal will be judged incompatible with pluralism. After all, the pluralist might try to offer analyses of the origin and unity relations in microscopic terms. (If a non-disjunctive analysis seems hopeless, the analysis might proceed by cases. The pluralist might take the *X*s to stand in the origin relation at *t*, for instance, iff at *t* they become stuck together, or at *t* their activity begins to constitute a certain 'life-y' kind of self-maintaining event (à la van Inwagen 1990), and so on.) Alternatively, she might take these relations as primitive, and simply insist that facts involving them, including (1), count as facts about how things are microscopically. If these ways of developing the pluralist position are in certain respects theoretically unlovely, that does not show they are incompatible with pluralism. And the pluralist may insist that any theoretical vices are offset by the huge gain in overall parsimony that comes with grounding the macroscopic world in the microscopic one.[9]

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pluralist to avoid any reference to them. In addition to the origin relation, she can recognize a 'termination' relation; intuitively, some things stand in the termination relation at a time just in case they compose something that goes out of existence at that time. And instead of the unity relation, she can recognize a certain kind of event: the 'succession' of the Z_1s by the Z_2s. Intuitively, the Z_1s are succeeded by the Z_2s when some persisting object changes from being composed of the Z_1s to being composed of the Z_2s. The pluralist can then take the micro ground of the fact that the *X*s compose *b* at *t* to be the fact that there are times $t_0,...,t_n$ and pluralities the Y_0s,...,Y_ns such that: at t_0 the Y_0s stand in the origin relation to one another, at no time between t_0 and t_1 is it the case that the Y_0s stand in the termination relation to one another or are succeeded by some other plurality, at t_1 the Y_0s are succeeded by the Y_1s, at no time between t_1 and t_2 is it the case that the Y_1s stand in the termination relation to one another or are succeeded by some other plurality, at t_2 the Y_1s are succeeded by the Y_2s, ..., and at *t* the Y_ns are succeeded by the *X*s. Similar remarks apply to the other grounding proposals considered below.

[9] On the relationship between parsimony and ground see Schaffer (2015).

Fortunately, we need not pursue the difficult task of assessing this objection's ultimate force. We can grant, if only for the sake of argument, that the proposal is compatible with pluralism. There is a further objection it cannot overcome.

Consider a world in which *b* originates from the *Y*s in just the way it does in the actual world, but in which, beginning shortly after *b*'s creation, we gradually replace the *Y*s over time with qualitative duplicates. After this replacement process finishes, we collect the discarded *Y*s and with them fashion a new ball *c* that is qualitatively just like *b*. The *Y*s have been 'recycled' to originate *c*.[10] Is *c* identical to *b*? It can't be, for *b* still exists, and it is not in two places at once. But recall that in the actual world, *b* was originally composed of the *Y*s, and eventually came to be composed of the *X*s (presumably by, over time, sloughing off some of the *Y*s and picking up some of the *X*s). Since, in this merely possible world, *c* was originally composed of the *Y*s, and *c* was qualitatively just like *b* was in the actual world, nothing prevents our supposing that *c* suffers a similar fate: it comes to be composed of the *X*s at *t*. So in this world, (1) obtains. Yet the *X*s do not compose *b* at *t*; they compose *c*. Thus (1) does not ground the fact that the *X*s compose *b* at *t*.

The pluralist's proposal for micro-grounding the fact that *b* is spherical at *t* therefore fails. For (1) could obtain, and the *X*s could be arranged spherically at *t*, without *b*'s being spherical at *t*; and so the first two facts do not ground the third.

To avoid such recycling difficulties, the pluralist might modify (1) to include *b*'s 'order of origin'.

> (2) There is a time such that (a) the *Y*s at that time stand in the origin relation to one another and (b) that is the first time they are so related and (c) the *Y*s at that time stand in the unity relation to the *X*s at *t*.

On this proposal, the fact that *b* is spherical at *t* is grounded in (2) together with the fact that the *X*s are arranged spherically at *t*. The earlier recycling world is no threat to this proposal. After all, in that world (2) fails to obtain, since there *c* is the *second* thing made from the *Y*s.

Still, there are reasons to think no (2)-style proposal can be adequate. One involves considerations of explanatory relevance. Since on this proposal (2) is part of what grounds the fact that *b* is spherical at *t*, (2) must be relevant to why *b* is spherical at *t*. Yet it seems irrelevant to why *this* ball is spherical whether there has ever been anything *else* that was originally composed of the *Y*s. But then the grounds of the fact that *b* is spherical at *t* cannot include (2).[11]

Even setting aside considerations of relevance, however, there is reason to reject the (2)-style proposal, since there are cases it cannot accommodate. Suppose that in 1800 an oak tree originates from a certain collection of microscopic constituents, the *A*s. As it grows, the tree

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[10] See Salmon (1981), Forbes (1994), Robertson (1998), and Hawthorne and Gendler (2000) for further discussion of recycling.

[11] This point illustrates the way in which the earlier debate over constitutional sufficiency principles is transformed when viewed in the context of the debate over pluralism. In the earlier debate, considerations of relevance were largely beside the point: the participants were simply concerned to uncover modally sufficient conditions for being this or that object, and modal notions are insensitive to the distinction between what is and is not relevant (Fine 2017). In the present context, by contrast, we are concerned with *explanation* and so considerations of relevance are central.

gradually exchanges its constituents with its environment, until by 1900 none of the *A*s are part of the tree anymore. In that year, another oak tree τ sprouts. As it happens, τ also originates from the *A*s, and as it reaches maturity it becomes qualitatively very similar to the older tree. Suppose we ask the pluralist for the micro ground of the fact that τ is tree-shaped in 2022. Letting the *B*s be the microscopic constituents of τ in 2022, on the (2)-style proposal this ground will consist of the fact that the *B*s are arranged in a tree shape in 2022 together with the micro ground of the *B*s' composing τ in 2022, which according to the proposal is

> (2′) There is a time such that (a) the *A*s at that time stand in the origin relation to one another and (b) that is the *second* time they are so related and (c) the *A*s at that time stand in the unity relation to the *B*s in 2022.

But (2′) fails to ground the fact that the *B*s compose τ in 2022. To see this, consider a counterfactual scenario in which there are not two oak trees but three: a third, earlier tree originates in the year 500 from the *A*s and grows until its death in 1000. The following counterfactual is clearly false: had an earlier tree grown in this way, τ would have sprouted a century earlier. The mere existence of an earlier tree, one wants to say, cannot transport *this* tree into the past. So although τ is presumably qualitatively very similar to the counterfactual tree that sprouts in 1800, they are nonetheless distinct. Call this counterfactual tree σ. We may suppose that, by gradual exchange of its constituents with the environment, σ comes to be composed of the *B*s in 2022. Thus in this possible world (2′) obtains, and yet the *B*s do not compose τ in 2022. They compose σ. And so the pluralist's revised grounding proposal cannot accommodate this case, since (2′) could obtain, and the *B*s could be arranged in a tree shape in 2022, without τ's being tree-shaped in 2022.

The pluralist might instead try to avoid recycling difficulties in a different way, by incorporating the ball *b*'s exact time of origin t_0. She might take the fact that the *X*s compose *b* at *t* to be grounded in

> (3) The *Y*s at t_0 stand in the origin relation to one another, and the *Y*s at t_0 stand in the unity relation to the *X*s at *t*.

The pluralist can then take the micro ground of the fact that *b* is spherical at *t* to consist of this fact, together with the fact that the *X*s are arranged spherically at *t*.

But surely *b* could have been made a bit earlier than it actually was—that is, a bit earlier than t_0. Consider a possible world in which that's so, and suppose that shortly after *b*'s creation the *Y*s are recycled to originate a new ball at t_0. Since *b* still exists, this younger ball is distinct from *b*. And yet, we may suppose, the younger ball comes to be composed of the *X*s at *t*. (3) thus obtains in this possible world even though the *X*s do not compose *b* at *t*, and so this grounding proposal fails.

So including order of origin is unsuccessful, as is including time of origin. But might both together do the trick?

> (4) The *Y*s at t_0 stand in the origin relation to one another, and t_0 is the first time they were so related, and the *Y*s at t_0 stand in the unity relation to the *X*s at *t*.

But like the (2)-style proposal, the (4)-style proposal appeals to factors that are seemingly irrelevant to why *b* is spherical at *t*. And even apart from such considerations there is reason to

reject it. Note again that *b* might have been made a bit earlier than t_0; the factory conveyor belt might perhaps have run a touch faster. Had this happened, it's likely, or at least possible, that rather than being made from the *Y*s, *b* would have been made from a slightly different collection of microscopic constituents, the *Y*′s. (Perhaps a few paint molecules would have wafted, or would have failed to waft, away from the applicator.)[12] The *Y*′s, we may suppose, overlap the *Y*s almost completely. Suppose further that in this counterfactual scenario, the original constituents of *b*, the *Y*′s, are gradually removed from *b* and replaced with qualitative duplicates. The *Y*s (not the *Y*′s) are then collected and assembled to compose a new ball at t_0 that is qualitatively just like *b*. The *Y*′s, we may say, are 'almost-recycled' to create this new ball.[13] Again, since *b* still exists, this younger ball cannot be identical to *b*. And yet, we may suppose, the younger ball comes to be composed of the *X*s at *t*. (4) thus obtains in this counterfactual scenario even though the *X*s do not compose *b* at *t*, and so this grounding proposal is no more successful than the earlier ones. In a similar way, we should reject grounding proposals that combine order and location of origin, or order and time and location of origin.

The final material origins grounding proposal I'll consider is this. Faced with the above difficulty for the (4)-style proposal, the shrewd pluralist will note that in our counterfactual scenario, although the younger ball is the first object originally made from the *Y*s, it is not the first object originally made from what we might call a *Y-variant*.[14] Let's say that a *Y*-variant is any collection of microscopic objects, the *Y**s, such that an object originally made from the *Y*s could have been originally made from the *Y**s.[15] The pluralist might offer a grounding proposal based on the fact

> (5) The *Y*s at t_0 stand in the origin relation to one another, and t_0 is the first time any *Y*-variant was so related, and the *Y*s at t_0 stand in the unity relation to the *X*s at *t*.

But the situation here is much the same as with the (2)-style proposal. Although the (5)-style proposal avoids the difficulties faced by the (4)-style proposal, it is still inadequate. For it seems

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[12] Slight variation in material origins is widely thought possible: see, for example, Chandler (1976: 106), Lewis (1986: 244), and Salmon (1986: 75). Robertson (1998: 732n) says that 'I know of no one writing on this topic who wants to deny' this possibility. She further notes that 'even Kripke's (1980: 113) original formulations of origin essentialism are cautious: he says that the wooden table in the Princeton lecture room could not have been made from a "*completely* different block of wood"; similarly, he says that Queen Elizabeth could not have originated from a "*totally* different sperm and egg"'.

[13] See Robertson (1998) and Hawthorne and Gendler (2000) for further discussion of almost-recycling.

[14] The term is due to Hawthorne and Gendler (2000: 290).

[15] This definition is ambiguous between an existential and a universal reading, and it's not clear on either reading that it succeeds in picking out the collections of constituents from which *b* could have been originally made. If we read 'an object' existentially, we may worry that the definition is too permissive, since there might be some object originally made from the *Y*s that could have been originally made from a very different collection. If instead we read 'an object' universally, we may worry that the definition is too restrictive, since there might be some object originally made from the *Y*s that could not have been originally made from any other collection. But let's grant the pluralist the success of the definition.

irrelevant to why *this* ball is spherical at t whether there has ever been anything *else* that was originally composed of a Y-variant. And in any event, the proposal cannot accommodate cases like the following.

Let t_0, t_1, t_2 and t be four times in chronological order not too far apart from one another. Let the Y_1s and the Y_2s be two collections of microscopic objects such that the Y_1s are a Y_2-variant and the Y_2s are a Y_1-variant. Now let the Y_3s be a Y_1-variant that is not a Y_2-variant.[16] Suppose there are two balls, b_1 and b_2, such that b_1 is made from the Y_1s at t_1 and is then almost-recycled to originate b_2 from the Y_2s at t_2. Let the Xs be the microscopic constituents of b_2 at t. If we now ask the pluralist for the micro ground of the fact that b_2 is spherical at t, she will say that it consists of the fact that the Xs are arranged spherically at t together with

> (5′) The Y_2s at t_2 stand in the origin relation to one another, and t_2 is the *second* time any Y_2-variant was so related, and the Y_2s at t_2 stand in the unity relation to the Xs at t.

But consider a counterfactual scenario in which both balls are made a bit earlier: b_1 at t_0 and b_2 at t_1. Suppose further that in this counterfactual scenario b_1 is made from the Y_3s instead of the Y_1s. The Y_3s are then almost-recycled to originate b_2 from the Y_2s. Finally, the Y_2s are recycled to originate a new ball at t_2, also from the Y_2s. Of course, since both b_1 and b_2 still exist, this youngest ball is identical to neither. And yet, we may suppose, this youngest ball comes to be composed of the Xs at t. In this counterfactual scenario, then, (5′) obtains, but the Xs do not compose b_2 at t. And so we should reject the pluralist's proposed ground for the fact that b_2 is spherical at t. In a similar way we may reject proposals that combine 'variant order' with location of origin, or with time and location of origin.

The prospects for the material origins strategy do not look good. Even if, by means of a still more baroque grounding proposal, we could accommodate this last case, the accommodation would come at the cost of explanatory irrelevance. In my view the (5)-style proposal already contains much that is irrelevant to why b is spherical at t, and thus cannot be correct. Any repair that could accommodate the last case would surely introduce still more irrelevance.

I therefore believe that no version of the material origins strategy is likely to serve the pluralist's aim of coming up with a plausible micro ground of the fact that b is spherical at t. But nor do I know of any other strategy that can supply such a ground. Given the difficulty the pluralist faces in accommodating what is among the most straightforward cases of macro fact, it is worth taking another look at the alternatives to her view. The macro may not be grounded in the micro after all.[17]

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[16] In general, there will be such a Y_1-variant. For suppose not. Then every variant of a Y_2-variant will itself be a Y_2-variant. But it's plausible that if two large collections of microscopic objects have all but one object in common, then they will be variants of each other. So by exhibiting a long chain of such overlapping collections, one can show that absolutely any collection is a Y_2-variant. And this is surely not correct. If the Y_2s are the original microscopic constituents of a certain tennis ball, then surely this ball could not have been made from, say, water taken from the Thames.

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