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ORIGINAL RESEARCH

Priority monism and the emergence of spacetime

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Abstract
There has been a recent surge of interest in the idea that spacetime is not fundamental. Much of this interest has focused on the implications for physics. There has been less work investigating the implications of spacetime emergence for existing theories in metaphysics. This paper aims to fill this gap by considering the impact of spacetime emergence on priority monism. We argue that one prominent version of priority monism is incompatible with spacetime emergence. We go on to present a solution to this problem, which involves rethinking the nature of concreteness. This leads to a new version of priority monism that is compatible with emergent spacetime.

Keywords Mereology · Spacetime emergence · Location · Priority monism

1 Introduction

Lately philosophers have been exploring the idea that spacetime is emergent. Such a view has become prominent in recent discussions of quantum gravity, where attempts to reconcile quantum mechanics with general relativity lead to the apparent loss of spacetime at the fundamental level (Butterfield & Isham, 2009; Lam & Esfeld, 2013; Huggett & Wüthrich, 2013; Wüthrich, 2018). Despite the loss of spacetime, it is expected that spacetime will nonetheless emerge at certain energy scales, or certain

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levels of description, namely those currently probed by general relativity and quantum mechanics.

So far, efforts have been focused on developing metaphysical accounts that explain how spacetime emerges from entities in quantum gravity (Baron & Le Bihan, 2024, 2022; Lam & Wüthrich, 2018, 2020; Crowther, Linnemann, and Wüthrich, 2020; Baron, 2021; Le Bihan, 2021; Knox, 2018). Less attention has been paid to the implications that spacetime emergence has for existing debates in metaphysics, though there has been some important work in this direction (see, for instance, Lam and Wüthrich 2023; Le Bihan 2017; 2018; McKenzie 2017; Wüthrich 2020).

Here, we deal with the implications of spacetime emergence for priority monism. Priority monism is the view according to which there is exactly one fundamental entity. All derivative concrete entities then metaphysically depend on the fundamental one. According to one prominent form of priority monism, the one fundamental entity is the cosmos. This form of monism has been developed by Schaffer across a series of papers (2010a, 2010b; 2009; 2013). In this paper we'll argue that priority monism of this kind conflicts with the idea that spacetime is not a fundamental feature of reality, that it is emergent. We focus on Schaffer's priority monism because it is supported by a number of powerful arguments.[1]

Having identified the conflict between priority monism and spacetime emergence, we then propose a way of redeveloping priority monism so that it avoids this conflict. The solution is to reject a core assumption of Schaffer's monism, namely that what it is to be a concrete entity is to be a part of the cosmos. Instead, we propose a new definition of concreteness that invokes a distinction between the cosmos and the world. Here we argue that concreteness should be interpreted as *worldly parthood*. Using this alternative definition of what it is to be concrete, we propose a new form of priority monism, one that is compatible with the idea that spacetime is an emergent entity.

In some ways this new version of monism is a significant departure from Schaffer's view. Schaffer takes all dependence relations between the cosmos and derivative concrete entities to be mediated by mereological relations; on our view dependence is mediated by a mixture of mereological and non-mereological relations. In this way, the view we develop is similar to versions of priority monism discussed by Calosi (2023). However, it is also an advance on existing versions of monism, since it is compatible with the possibility of spacetime emergence.

The rest of the paper is structured as follows. We start by providing a sharper statement of priority monism, and outline a range of notions that will be useful in the paper. After that, we present an argument against priority monism based on spacetime emergence (Sect. 3). In Sect. 4, we provide a solution to the argument, and develop a new form of priority monism. In Sect. 5, we consider a range of alternative solutions to the argument outlined in Sect. 3, and argue that our solution is superior. Section 6 sums up.

[1] This is not the only version of monism to consider. For other versions of priority monism see Calosi (2023, 2018, 2020, 2014), Morganti (2009), Ney (2020, 2021). These versions are not clearly identical to Schaffer's view, and so it remains open as to whether the arguments developed here apply to these other versions of monism. For further discussion of monism see Baron and Tallant (2016), Kovacs (2020).

2 Preliminaries

Let's begin with a brief overview of Schaffer's priority monism. Priority monism, for Schaffer, is stated as follows:

$$\exists!x(Bx \wedge Bu)$$

This statement of monism says that there is exactly one entity that is metaphysically basic (*Bx*), which is the cosmos (*u*). Following Schaffer, we take the cosmos to be the fusion of all of the basic entities (*covering*) where the basic entities are constrained to not share any parts (*no overlap*).[2] For Schaffer these two conditions constitute the *tiling constraint*, the idea that the "basic actual concrete objects collectively cover the cosmos without overlapping" (Schaffer 2009, p. 38). The tiling constraint, for Schaffer, is motivated by the notion of completeness: the idea that the basic entities constitute a complete 'blueprint' for reality, insofar as they fix all other derivative entities.

Note that the completeness requirement is developed alongside a particular picture of how everything depends upon the basic entities. In this picture, mereological relations mediate all dependence relations. The resulting picture is thus one in which the basic entities generate derivative entities via parthood relations. This is an important aspect of Schaffer's view and one that we will return to later on.

Next, for Schaffer, the notion of being basic is further defined as follows:

$$Bx =_{df} Cx \wedge \neg\exists y(Cy \wedge Dxy)$$

Where this says that something is basic just when it is concrete and there is no concrete entity upon which it depends. This definition invokes two central notions: *concreteness* (*Cx*) and *dependence* (*Dxy*). The notion of concreteness is, for Schaffer (2010b, p. 38), further specified via a notion of parthood (*Pxy*):

$$Cx =_{df} Pxu$$

Where to be concrete is to be part of the cosmos. Following Schaffer (2010a, p. 347), we leave dependence as a primitive notion.

Note that the notion of concreteness here is important: it is one of only two moving parts in Schaffer's definition of priority monism. The other, of course, being the notion of basicness. Note also that parthood is central to Schaffer's definition of concreteness. This, in turn, makes it central to his version of priority monism, by virtue

[2] Schaffer states these two conditions as follows:

Covering Sum: $x(Bx) = u$

No Overlap $(\forall x)(\forall y)((Bx \wedge By \wedge x \neq y) \supset \neg(\exists z)(Pzx \wedge Pzy))$

Where Sum: $x(\phi)$ refers to the fusion of all entities that satisfy description ϕ. In this paper we use different notation to that used by Schaffer to specify fusions, and so we don't use Schaffer's formal definition of Covering in what follows. We do, however, adopt the definition of No Overlap as stated (where $\supset$ is just $\rightarrow$).

of the central role that concreteness plays in precisely specifying the view. It thus pays to say a bit more about how we are thinking of parthood in this paper.[3]

Let P be a primitive two-place relation of parthood. Let's assume that P is a partial order, and thus is reflexive, transitive, and antisymmetric. Then add standard mereological definitions of overlap and fusion (see below). Note that we'll need a notion of fusion to account for Schaffer's specification of the cosmos as the mereological sum of everything that is basic. Here, we choose a notion of fusion defined in terms of parthood and overlap; but there are other options.

$$Oxy =_{df} \exists z(Pzx \wedge Pzy) \text{(Overlap)}$$

$$F_{\varphi}z =_{df} \forall x(\varphi x \rightarrow Pxz) \wedge (\forall y(Pyz \rightarrow \exists x(\varphi x) \wedge Oxy) \text{ (Fusion)}^4$$

We'll also assume that P obeys one decomposition axiom and the axiom schema for unrestricted composition:

$$\neg Pxy \rightarrow \exists z(Pzy \wedge \neg Ozx) \text{ (Strong Supplementation)}$$

$$\exists x\varphi x \rightarrow \exists z F\varphi z \text{ (Unrestricted Fusion)}$$

This gives us General Extension Mereology (GEM), which we assume throughout. In addition to GEM we also assume principles of *inheritance*.[5] One such principle is the inheritance of location. Sider (2007, p. 70) states this principle as follows:

Inheritance of Location: If x is part of y, then y is located wherever x is located.

As a first pass, we can sharpen this principle using a generic location relation Lxy (x is located at y):

$$\forall x \forall y \forall z((Pxy \wedge Lxz) \rightarrow Lyz)$$

This principle can be refined further by specifying the operative notion of location in a bit more detail. There are several candidate notions of location that could be used: exact, weak, entire and pervasive location. For present purposes, we will focus just on exact and weak location. It is standard to take one of these notions to be primi-

[3] For this, we follow the formalization offered by Cotnoir and Varzi (2021).

[4] We take this notation from Cotnoir and Varzi (2021, p. 162). Three things to note about the notation. First, φ means any well formed formula in an appropriate language. For simplicity, we assume the language is just classical first-order predicate logic with identity. Second, φx indicates that x is a free variable in φ. Third, φ in the expression $F_{\varphi}z$ seems to refer to the set of items that satisfy the formula φ.

[5] See also Cameron (2014); Markosian (2014); Sider (2007).

tive, using it to define the rest. We'll do the same. We thus take, as primitive, *exact location*.

Following Parsons (2007), we take something's exact location to be its shadow in substantival spacetime.[6] If we let *Lxy* mean that *x* is exactly spatiotemporally located at *y* (Casati & Varzi, 1999), then with Parsons (2007), we define *weak location* in terms of exact location and mereology:

$$WLxy =_{df} \exists z(Lxz \wedge Ozy) \text{ (Weak Location)}^{7}$$

Intuitively, we can think of an object as being weakly located at a region if that region is not completely free of the object.

Using exact and weak location, we can now specify the inheritance of location more precisely:

$$\forall x \forall y \forall z((Pxy \wedge Lxz) \rightarrow WLyz) \text{ (Inheritance of Location)}$$

If this principle is true, wholes cannot occupy exact locations that are mereologically disjoint from any of their parts.[8] [9]

Why accept the inheritance principle? We will have more to say about this later on. For now, we follow Sider, who takes the inheritance of location to be one of the conceptually significant features of parthood. As he puts it:

> The locations of a thing's parts are automatically reflected in the thing's location—more evidence of the intimate nature of the part-whole connection. Parthood is alone in this respect; my location is not tied to the locations of my relatives, things I own, things I am near, and so on... Everyone accepts the inheritance principles. If they are true, then the part-whole connection is a uniquely intimate one. (Sider 2007, p. 75)

[6] Think of the exact location of an object as a region that has the same size and shape, and stands in all of the same relations to other things as the object (Gilmore, 2018).

[7] Note that this definition of weak location makes exactness an analytic truth:

$\forall x \exists y(WLxy \rightarrow \exists z Lxz)$ (Exactness)

Exactness is potentially problematic in a quantum context, where entities may have a weak location but no exact location (see, for example, Pashby (2016); Calosi (2022, 2021)). Note that it is also potentially useful for us (see Sect. 5). As a referee points out, Exactness provides a powerful argument in support of ruling out our fifth alternative option since it rules out that P4 and P8 can both be true. While we lack the space to explore other definitions of weak location here, we note that this is a potentially interesting avenue to explore with regard to the argument we present below.

[8] The standard definition of mereological disjointness is taken to be: $Dxy =_{df} \neg Oxy$.

[9] Why not use exact location throughout? Such a principle is far too strong: wholes are not exactly located where each of their parts are exactly located. Note that there is a weaker principle that uses weak location throughout:

$\forall x \forall y \forall z((Pxy \wedge WLxz) \rightarrow WLyz)$ (Inheritance of Location)

If the principle used above is too strong, this weaker principle could be used instead. So far as we can see, this makes no difference to the arguments that follow.

One final piece of set up: the emergence of spacetime. To say that spacetime is emergent is to say (at least) that spacetime is not fundamental. We take it to also imply that something in the ontology of a more fundamental theory—such as a theory of quantum gravity—gives rise to a structure that is approximately isomorphic to generally relativistic spacetime (Lam & Wüthrich, 2020). Spacetime thus depends on this more fundamental structure. Exactly what this notion of dependence might be remains controversial. For now, we will simply take the emergence of spacetime to be an instance of a general notion of dependence that can be sharpened in various ways. Emergence in this sense is compatible with a range of more specific relations, including functional realisation, ontological dependence, parthood, material constitution and so on.[10]

3 The argument

We turn now to the argument against priority monism from spacetime emergence. The argument is based on the idea that the fundamental entities described by a theory of quantum gravity are not spatiotemporal. This key feature of the argument will allow us to derive a contradiction, thereby making trouble for priority monism via the connection between concreteness and parthood, on the one hand, and the interaction between parthood and location, on the other. Here's the argument:

P1 There are concrete spatiotemporally located entities (Assumption).
P2 All concrete entities are parts of the cosmos (from $Cx =_{df} Pxu$).
P3 There are concrete spatiotemporally located entities that are parts of the cosmos (from P1, P2).
P4 The cosmos is located wherever its parts are located (from the inheritance of location).
P5 The cosmos is spatiotemporally located (from P4, P3).
P6 The cosmos is the one fundamental entity (from Monism).
P7 Fundamental entities are not spatiotemporally located (from quantum gravity).
P8 The cosmos is not spatiotemporally located (from P7, P6).
Therefore,
C1 The cosmos both is and is not spatiotemporally located (from P8, P5).

Shortly, we will address ways to respond to this argument. First, let's unpack the premises. P1 is the plausible assumption that there exist at least some concrete entities located in spacetime. P2 is central to Schaffer's monism. As noted in Sect. 2, concrete entities are defined as being parts of the cosmos. Since concrete spatiotemporally located entities are concrete entities, it follows that they are parts of the cosmos, which delivers P3. P4 then follows from the inheritance of location: the exact location of the cosmos cannot be disjoint from its spatiotemporally located parts.

[10] Here we take this to mean that spacetime depends on there being *some entities or other* in quantum gravity that give rise to a structure that is approximately isomorphic to generally relativistic spacetime. This is roughly what Lowe (1994) calls 'generic ontological dependence'.

From this it follows that the cosmos itself is spatiotemporally located (P5). P6 is then just a statement of priority monism.

This brings us to P7. P7 follows from the idea that spacetime is emergent. For if spacetime is emergent, then whatever is fundamental cannot be spatiotemporally located. P8 then follows from P6 and P7: if the fundamental entities are not spatiotemporally located and the cosmos is fundamental, then the cosmos is not spatiotemporally located either. Finally, P8 contradicts P5, giving us C1.

There are two things to note about the argument. First, an analogous argument does not work against priority pluralism. According to priority pluralism, there are multiple fundamental entities, not one. The cosmos is not fundamental; rather, it depends on its parts. Schaffer (2010b, p.43) states this view as follows:

$$(\exists x)(\exists y)((Bx \wedge By \wedge x \neq y) \wedge \neg Bu)$$

Where this says that there exists at least two basic entities, and the cosmos is not basic. Here's what a parallel argument against priority pluralism would look like:

P1* There are concrete spatiotemporally located entities (Assumption).

P2* All concrete entities are parts of the cosmos (from $Cx =_{df} Pxu$).

P3* There are concrete spatiotemporally located entities that are parts of the cosmos (from P1*, P2*).

P4* The cosmos is located wherever its parts are located (from the inheritance of location).

P5* The cosmos is spatiotemporally located (from P4*, P3*).

P6* There are multiple concrete entities-the 'plurality'-that are fundamental (from Pluralism).

P7* Fundamental entities are not spatiotemporally located (from quantum gravity).

P8* The members of the plurality are not spatiotemporally located (from P7*, P6*).

P9* Members of the plurality are parts of the cosmos (from P2*, P6*).

P10* The cosmos is not spatiotemporally located (from P4*, P9*).

Therefore,

C1* The cosmos both is and is not spatiotemporally located (from P10*, P5*).

There is a straightforward version of priority pluralism that avoids this argument. Notice first that the inheritance of location is a conditional principle: *if* the parts are located, *then* the whole is located where the parts are. Accordingly, if the parts are not located then the principle is trivially satisfied.

Next, suppose that pluralism works this way: the members of the fundamental plurality together compose the cosmos along with all concrete, spatiotemporally located entities (recalling that the cosmos, according to pluralism, is not a basic entity). Now, if we interpret P4* to mean that if the parts of the cosmos have locations, then the cosmos at least overlaps those locations, then that principle is trivially true in the manner noted above. For the members of the plurality that are parts of the cosmos

have no locations. However, so far as we can see, there is no way to derive P10*.[11] That's because from the fact that members of the plurality are parts of the cosmos, plus the fact that those members are not located it does not follow that the cosmos is not spatiotemporally located. To see why, consider that P5* may still be true, perhaps because the cosmos has spatiotemporal parts and thus is spatiotemporally located. In short, given the version of pluralism outlined, there is no way to get both P5* and P10*, and thus no way to derive a contradiction.[12]

As discussed, there are two things to note about our argument against priority monism. The second thing to note is that an argument along these lines has been developed before, by Le Bihan (2017). Le Bihan also argues against priority monism on the grounds that spacetime is emergent. However, his argument assumes that the cosmos—in the sense introduced by Schaffer's monism—just is spacetime. He then argues as follows:

P1' Spacetime is fundamental (from Monism)

P2' Spacetime is not fundamental (from quantum gravity)

Therefore,

C1' Spacetime both is and is not fundamental (from P1' and P2').

We think this is an important argument. However, while our argument against priority monism is similar, it differs in a key respect: it is more general. The argument that we offer does not assume that the cosmos—the fundamental one in Schaffer's monism—is spacetime. While Schaffer does seem to hold the view that spacetime is fundamental at one point (Schaffer, 2009), he does not generally incorporate this view into his account of priority monism, and it is not an essential feature of priority monism either. This can be seen from the statement of the view provided in §2, where we see no mention of spacetime.

This point is worth pausing over: at its most minimal, priority monism does not require that the cosmos is a spatiotemporal entity. There is thus a response to Le Bihan's argument available to Schaffer: simply give up the idea that the cosmos is spacetime, taking it instead to be whatever is posited by a more fundamental theory of quantum gravity. This solution does not work against our argument, since our argument applies regardless of what the cosmos is taken to be, so long as the cosmos is fundamental. Indeed, strictly speaking our argument doesn't even rely on the idea that it's the *cosmos* that is fundamental. What matters is that there is one fundamental

[11] As a referee notes, there may be another way to secure P10*, using a slightly different inheritance principle, namely:

$$\forall x(\neg\exists y\exists z(Pyx \wedge WLyz) \rightarrow \neg\exists w WLxw)$$

Roughly: if no part of x has a weak location, then neither does x. We agree that a principle along these lines might pose a problem for pluralism. We suspect that there are other inheritance principles that can do this work too and that there is an intricate relationship between inheritance principles and spacetime emergence. We aim to pursue this relationship in future work.

[12] Note that there may be a non-atomistic version of pluralism that is susceptible to the argument. Suppose, for instance, that the members of the fundamental plurality are not mereologically simple. Rather, they *decompose* into spatiotemporally located entities. Perhaps these entities are spatial atoms that then recompose into a manifold. Then the picture would conflict with the inheritance of location: each basic whole of the plurality would fail to be spatiotemporally located along with its parts. This is a particularly strange view, though, and so we set it aside.

thing, and everything else that is concrete is a part of it. Thus, the argument applies to quite a minimal version of priority monism indeed.

That being said, it is notable that we must still give up on the idea that the cosmos is spatiotemporal (and indeed, we do this below). That the cosmos is not spatiotemporal is a consequence of combining priority monism with the idea, coming from work in quantum gravity, that what's fundamental is not spatiotemporal. It is likely that any reasonable version of priority monism that accords fundamental status to the cosmos must also give up on its status as spatiotemporal, since work from quantum gravity suggests that what's fundamental is not spatiotemporal. Thus, it is not the case that the solution to the argument we outline below requires that the cosmos is non-spatiotemporal, rather it is the non-spatiotemporality of the cosmos that drives the argument, and that forces a solution to be given.

Still, one might wonder: what is the cosmos if it is not a spatiotemporal entity? Well, notice that priority monism—at least in the most general form, as it is usually stated—commits to no view of what the cosmos is in general. The cosmos is just defined as the set of the basic, concrete entities, where the set is a singleton. That being said, most priority monists do currently specify what the cosmos is, namely: it is the most inclusive basic entity that there is.

Moreover, typically priority monists answer the question of what the cosmos is via deference to science. For Schaffer, the cosmos is spacetime, because he takes spacetime to be the most inclusive, basic concrete entity posited by physics. Schaffer does not—and, indeed, to our knowledge no priority monist does—presuppose any more detailed metaphysical account of the cosmos. That is, the monist need not commit to what the nature of the most basic entity must be, beyond being the most inclusive basic entity posited by physics.

We take the same approach: whatever the most inclusive, basic entity posited by the physics of quantum gravity happens to be, that is what we should identify with the cosmos. Thus, the question of what the cosmos might be, given that it is not a spatiotemporal entity, is left to physics to answer. Ultimately we remain agnostic toward a more detailed metaphysical picture of the cosmos, however we gesture toward some candidate options here, drawn from two different theories of quantum gravity.

First, in loop quantum gravity, the fundamental structure is a spin-network: a complex system of quantum loops. These can be represented, mathematically, as undirected graphs connecting basic elements that can be thought of as the 'atoms' of spacetime. These atoms can, in turn, be thought of as non-spatiotemporal concrete parts of the large relational structure of quantum loops that is a spin-network. Exactly what the ontology of loop quantum gravity is, remains an open question (see Norton 2020). However, for our purposes this does not matter. What matters is that in this large relational structure, the basic relations are not spatiotemporal in nature, but only approximate spatiotemporal relations at certain energy scales (see Rovelli 2004; Rovelli and Vidotto 2014).

Next, in causal set theory, the fundamental structure is a causal set, which is a partially ordered set of primitive elements (see Dowker 2006, 2013). This too is a large relational structure, this time united by a type of causation that is not spatiotemporal in nature. As with loop quantum gravity, the elements of this structure can be thought of roughly as non-spatiotemporal atoms that make up spacetime. Beyond that, the

ontology of causal set theory remains contested (see Wüthrich and Callender 2017). Again, what matters here is that the most basic physical relations that unite the most inclusive structure are not spatiotemporal in nature.

Given the differences in what the most inclusive, basic concrete entity might be on these views, it is not possible to say much more about what the cosmos is, except that it is likely to be a system of non-spatiotemporal relations, where the precise nature of those relations is specified by the physical theory at issue. That being said, if we look across the various theories of quantum gravity, we can discern one common element. Namely, the most inclusive, basic concrete entity in each case has a continuum approximation. This means that it gives rise to spacetime at some level of description. We thus assume that whatever the cosmos is, it must be at least capable of giving rise to spacetime in this way.

Later on we will talk of the non-spatiotemporal parts of the cosmos (though this will not play a large role in our account). The concrete parts of the cosmos just are the constituents of these basic structures from phyiscs. Thus, the parts of the cosmos, if loop quantum gravity is assumed, are the individual quantum loops posited by the theory—the components of a spin-network. Similarly, the parts of the cosmos under causal set theory are causal set elements, and the unique causal relations between them.

One final point before we move on: the notion of being concrete is often tied to being spatiotemporal. If the cosmos is non-spatiotemporal and it is the most inclusive, basic concrete entity, then there is pressure to think that being spatiotemporal and being concrete must come apart. But the pressure comes from the physics of quantum gravity. Approaches to quantum gravity seem to reject the idea that every concrete entity is spatiotemporal. Thus, what it is to be concrete must be pulled apart from spatiotemporality anyway, and we are simply drawing out the consequences of this schism. Besides, the way priority monism is defined does not generally presuppose a spatiotemporal notion of concreteness. The notion of concreteness specified by Schaffer relies only on parthood. That said, as we shall now see, even this weak definition of concreteness should be given up.

4 The solution

As we see it, there are four main ways to resist the argument presented in the previous section. First, one could deny the existence of spatiotemporally located, concrete entities. Second, one could give up the claim that to be concrete is to be part of the cosmos. Third, one can deny the inheritance of location. Finally, to relieve the tension in C1 directly, one could give up P6 or P7. Giving up P6 is to deny the central claim of monism: that the cosmos is the one fundamental entity. So this leaves rejecting P7—the claim that the fundamental entities are not spatiotemporal—as the only monist-friendly option.

The goal in this section is to present a version of the second solution, which involves rejecting P2. In the next section, we will defend the solution by arguing that it is better than the alternatives just outlined.

Recall that P2 follows from Schaffer's definition of concreteness, which we repeat here:

$Cx =_{df} Pxu$ (Concreteness)

Note that some notion of concreteness is needed, since priority monism is an account of how concrete entities are metaphysically structured. Doing away with the notion of concreteness entirely would thus result in a rather different theory.[13]More importantly, the definition forces all concrete entities into a mereological relationship with the cosmos. Simply put, the great chain of being leading from the fundamental one ends up being a mereological chain. This is what generates the tension between priority monism and spacetime emergence: the mereological dependence forces the cosmos to have non-spatiotemporal parts, which conflicts with the inheritance of location for parthood. The non-spatiotemporal cosmos cannot be located wherever its spatiotemporal parts are located.

The challenge then in rejecting P2 is to replace Schaffer's definition of concreteness with a new notion of concreteness that can still provide a basis for priority monism, and that is also compatible with spacetime emergence. Is there a suitable replacement available? We think there is:

$Cx =_{df} Pxw$ (Concreteness as worldly parthood)

This says that to be concrete is to be part of the world. There are two things to note about this definition. First, we retain this definition alongside the definition of basic entities proposed by Schaffer. Thus, we still maintain that something is basic when there is no concrete entity upon which it depends. Second, this definition relies on a distinction between the *cosmos* and the *world*. Here's how to sharpen this distinction: the world is the mereological sum of everything that there is.[14] Both derivative spatiotemporal entities and fundamental non-spatiotemporal entities are mereological parts of the world. The cosmos, by contrast, is the sum of all that is basic—in line with Schaffer's original definition. The cosmos and the world are distinct because there are entities in the sum of the world that are not in the sum that is the cosmos.

[13] Concreteness is central to monism, but it is possible to formulate monism without it by just using the following two theses:

$Bx =_{df} \neg\exists y Dxy$

$\exists!x(Bx \wedge Bu)$

This leaves it open that the cosmos-the one fundamental thing-is a concrete object. Thus monism of this form is compatible with priority platonist monism, the view according to which there is one basic object, the cosmos, and it is an abstract object. It's also the case that when combined with:

Sum:$x(Bx) = u$

The absence of the concreteness constraint means that the cosmos includes all basic concrete and abstract entities.

[14] One might worry about this definition of the world. For if the world is the sum of all things, and being concrete is to be part of the world, then the world has only concrete parts. If sets are part of the world (or universals, or numbers) then these would end up being concrete objects. In order to avoid this problem, we can modify our definition of concreteness to say that to be concrete is to be a *contingent* part of the world. This prevents sets and other abstract objects from being concrete on our definition, on the assumption that such objects exist necessarily if they exist at all.

One might object to the proposed cleavage between the cosmos and the world. We have said that the world is the sum of all entities, and the cosmos is the sum of all basic entities. But suppose there is exactly one basic entity and no derivative entities. Then, in that situation, there is no distinction between the cosmos and the world. Assuming that if the world and the cosmos are distinct, then they are necessarily distinct, then such a possibility seems to undermine the idea that the cosmos and the world are distinct.

This point can be addressed by returning to the discussion of the cosmos offered at the end of Sect. 3. There, we noted that the cosmos is supposed to be whatever the most inclusive, basic concrete entity posited by a theory of quantum gravity might be. We also noted that for any such theory, any entity of this type must have a continuum approximation: this is taken to be one of the requirements of a theory of quantum gravity. Which is to say, that any such entity must give rise to spacetime at some non-fundamental level.

What this means, though, is that there cannot be a world in which there is just one basic entity that is the cosmos, in our sense. For if the cosmos exists, then so does at least one derivative entity, namely spacetime. This means that in every world in which the cosmos exists—where the cosmos is identical to the most inclusive, basic concrete entity posited by quantum gravity—the world and the cosmos diverge, since the world will include the cosmos and spacetime, whereas the cosmos will be exclusive of spacetime.[15]

Given the new definition of concreteness, the world and the cosmos are both concrete entities. The world is concrete by the reflexivity of parthood, that is, it is part of itself. The cosmos is concrete in virtue of being part of the world—the most basic part. Note therefore it is not always the case on our view that if x is part of y then x depends on y because the cosmos is part of the world and yet there is nothing on which it depends (more on this in a moment). This means that we can retain Schaffer's original definition of priority monism as the view that the cosmos is the one basic, concrete entity. Thus, on our view, as on Schaffer's, there is no concrete entity that the cosmos depends upon and, moreover, everything else concrete depends on the cosmos.

Note also that using a new definition of concreteness is necessary but not sufficient for addressing the argument outlined in Sect. 3. By replacing Schaffer's definition of concreteness with our own, the cosmos is no longer forced to have spatiotemporally located entities as parts. But, of course, it could still have such entities as parts, for all we've said thus far. Accordingly, in addition to our definition of concreteness we also need a general injunction against mereological relations between spatiotemporally located entities and the cosmos. We thus impose this further constraint. The upshot is that there are no mereological relations of the kind that would generate a conflict with the inheritance of location.

[15] Note that on our view, you cannot have a cosmos that does not give rise to spacetime. So any world without spacetime, is a world that lacks a cosmos in our sense. One might worry that this unduly limits the modal scope of priority monism, since it simply won't apply to worlds in which there is no spacetime. We don't see this as much of a cost: priority monists already identify the cosmos with spacetime, and so already operate under this limitation.

By imposing this further constraint, we are forced to give up Schaffer's picture of completeness (see Sect. 2). Recall that, for Schaffer, the dependence of all derivative entities on the basic entities is mediated by mereological relations. Given this way of thinking about completeness, if the basic entities are non-spatiotemporal and derivative entities are spatiotemporal entities, then spatiotemporal entities will be forced into a mereological relation with basic entities. Thus, by giving up the idea that spatiotemporal entities are parts of the basic entities, Schaffer's picture of completeness needs to go as well.

While we have given up the idea that the dependence of spatiotemporally located entities on the cosmos is mediated via mereological relations, we do not give up completeness.[16] The basic entities on our picture still provide a complete blueprint for reality. It is just that the completeness requirement is not to be understood in purely mereological terms: other notions of dependence must come into play. Fortunately, a range of other dependence relations exist that can be used to fill out the dependence of derivative, concrete, spatiotemporally located entities on the cosmos. The options include ontological dependence, non-mereological relations of constitution, essential dependence, functional dependence and grounding. For now, we leave this open, and take the dependence of concrete, derivative spatiotemporally located entities to just be a general notion of dependence, which can be further cashed out in any of the ways just mentioned.

Why leave this open? Well, we think that the question of how spatiotemporally located entities depend on some more fundamental, non-spatiotemporal entity is not something that can be settled *a priori*. Rather, we must look to physics to fill out this story. Indeed, it is likely that we must look to a particular theory of quantum gravity to understand how it is that spatiotemporally located entities emerge. For now, it is enough to note that there is important work in this direction being conducted already that does not appeal to mereology. One of the most widely discussed options involves appealing to functional realisation instead (see, for instance, Lam and Wüthrich (2020)).

All up, then, the version of priority monism just described has five core features (depicted in Fig. 1):

1. The world is concrete and is the sum of all entities.
2. The cosmos is concrete and is the sum of all basic concrete entities.
3. The cosmos and all concrete entities are parts of the world.
4. All concrete entities except for the world non-mereologically depend on the cosmos.
5. The world depends on the cosmos by virtue of having it as its most basic part.

[16] Nor do we give up the tiling constraint. We thus continue to accept that the cosmos is the fusion of the basic entities (covering), and that the basic entities don't share any parts in common (no overlap). Note that the tiling constraint does not force a mereological picture of completeness of the kind discussed above. The tiling constraint is compatible with a range of ways for the derivative entities to depend on the basic entities, of which the picture we develop below is one.

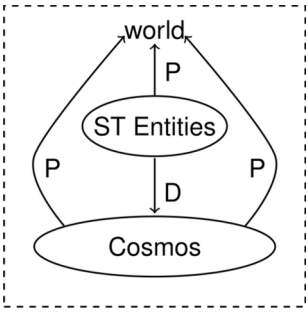

Fig. 1 Priority Monism Rebooted D = generic dependence; P = parthood

Clearly, this is a departure from Schaffer's original priority monism. To show this, let us briefly consider the main differences between the two versions of monism. As we see it, there are three.

The first difference relates to the distinction we drew between the world and the cosmos. For our account and for Schaffer too, the world is distinct from the cosmos. The world is the sum of all things and the cosmos is the sum of all basic concrete things. Despite these similarities, we think about the relationship between the world and the cosmos in slightly different ways. For Schaffer, the world is "the material cosmos and its planets, pebbles, particles, and other proper parts." (Schaffer, 2010b, p. 33). Everything is part of the world by virtue of being part of the cosmos. On our picture, by contrast, spatiotemporally located concrete entities are parts of the world, but they are not parts of the cosmos. This difference is not very significant but it does highlight a second, perhaps more important, difference.

The second point of difference between our view and Schaffer's is in how we view the dependence structure of the world. We agree with Schaffer's original view that everything concrete depends on the cosmos. Where the view differs from Schaffer's is that this dependence cannot be parthood. We present a hybrid dependence structure: On our view dependence relations in the world are both mereological and non-mereological. The world mereologically depends on its parts, whereas derivative concrete entities non-mereologically depend on the cosmos.

This point of difference has relevant consequences for *explanation.* We assume that explanations track dependence. We make use of two dependence relations and each have their own explanatory pathway. Explanations about the world in terms of its derivative parts will be mereological. By contrast, explanations of spatiotemporally located concrete entities in terms of a single, fundamental non-spatiotemporal entity will be non-mereological. So our version of monism will make trouble for a view committed to the idea that all dependence-based explanations should be analysed in terms of composition. We don't think this is a problem, however. On the contrary, physics suggests that this is exactly the right kind of trouble to make.

To fully show this would take us too far afield. For now it is enough to note that there is evidence from physics that composition cannot serve as a general explanatory strategy for understanding dependence relations between physical phenomena. Healey (2013), for instance, presents examples from quantum theories of light, quantum field theory and cases of quantum entanglement in which composition cannot

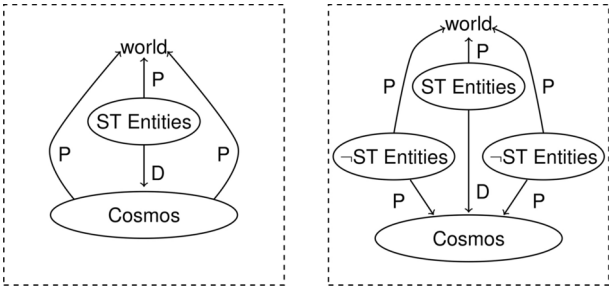

Fig. 2 Two Forms of Monism D = generic dependence; P = parthood

plausibly be used to 'connect the levels'.[17] That's because, in these cases, there is often no fact of the matter as to what composes what. Indeed, Healey argues that, at the quantum level in particular, there does not appear to be any compositional hierarchy according to which things decompose into their atomic and subatomic parts, meaning that any dependence relations between quantum phenomena cannot be easily understood in mereological terms.[18]

This brings us to the third difference between our view and Schaffer's. The third difference relates to the nature of the cosmos. On Schaffer's view, the cosmos is a composite object, with all other concrete entities as parts. On the face it, however, our view seems to presuppose that the cosmos is mereologically simple. After all, on the picture we are presenting, concrete, spatiotemporally located entities depend on the cosmos by virtue of some non-mereological dependence relation.

Ultimately—and unlike Schaffer's view—our picture is compatible with a mereologically simple cosmos, but this is not required. Our picture does not rule it out that the cosmos has proper parts. What it rules out is the cosmos having proper parts that are spatiotemporally located. It is thus open, on our view, that the cosmos has proper parts that are not spatiotemporally located. We can thus discern two broad pictures (Fig. 2).

In the picture on the left, we have a situation in which concrete spatiotemporally located entities depend on the cosmos, but the cosmos has no parts (though it is a part of the world). In the picture on the right, by contrast, concrete spatiotemporally

[17] Wallace (2004, p. 635) expresses a similar view, writing:

> Dennet, by regarding macro-objects as patterns in the micro-ontology rather than as mereological sums of that micro-ontology, provides the sort of account of compositionality that is not hostage to contentious or downright false pictures of physics.

Here Wallace seems to suggest that the relation between the (more) fundamental micro-ontology and the derivative macro-ontology is not always mereological in the context of physics.

[18] Other examples in the literature point in a similar direction. Mckenzie (2017), for instance, presents the case of S-dualities in physics. S-dualities are mathematical transformations between distinct formulations/presentations of a single theory. It turns out that in different presentations of one and the same quantum field theory, a single particle can be basic in one presentation and composed in another. This suggests that facts about composition are relative to the presentation of a theory. The presence of S-dualities may be evidence that there is no single fundamental mereological relation that operates in all presentations of a single theory. It's possible that S-dualities further suggest that dependence is not purely mereological.

located entities depend on the cosmos, but the cosmos has parts, where those parts and the cosmos are also parts of the world.

Note that in the picture on the right, there is no relationship between the concrete, spatiotemporally located entities and the non-spatiotemporal parts of the cosmos. This need not necessarily be the case. It could be, for instance, that concrete, spatiotemporally located entities depend on the cosmos by virtue of depending on its non-spatiotemporally located parts (as long as this dependence in turn is non-mereological).

Note also that in these pictures the *direction of dependence* is not unique, in the following sense: it does not always go from wholes to parts. In some cases the whole depends for its existence on the parts. This is the case with the world on our view: it depends on its parts, and this dependence is mereological. In the case of the picture on the right in Fig. 2, dependence also sometimes runs from parts to wholes. For instance, the non-spatiotemporal entities that are parts of the cosmos, must depend on it for their existence (or else the view is no longer a priority monist view).

One might worry about this feature of our view: shouldn't dependence always run from parts to wholes or from wholes to parts? One could hold the view that it should. Steinberg (2015) has argued that a non-unified direction of dependence violates an important assumption about monism. The assumption is that no composite objects depend on their parts. But this assumption is by no means forced (see Calosi 2020).

Moreover, Schaffer appears to take priority monism to be compatible with dependence running in two directions since "...none of the views as defined say anything about the relative priority ordering among derivative entities" (Schaffer 2010b, p. 44). He does not require that monism treat "whole-to-part priority with constancy all the way along the mereological hierarchy" (Schaffer 2010b, p. 45). He thinks that composite objects may legitimately differ with respect to the relative priority of parts and wholes. For him, the whole depends on the parts when the whole is a mere aggregate—a disunified heap—whereas the proper parts depend on the whole when the whole is an organic unity (Schaffer, 2010a, p.347), which the cosmos is supposed to be. Our picture does have the implication that the world must be a mere aggregate, but so far as we can tell this is a feature of Schaffer's priority monism as well, and in any case doesn't seem to be a cause for concern.

5 Alternatives

So far, we have outlined an argument against priority monism based on spacetime emergence. Then we provided our solution: redefine the notion of concreteness, thereby rejecting the second premise of the argument. As mentioned, there are other premises that might be rejected, and so other ways of resolving the argument. In this section, we will consider these alternatives. Note that our aim is *not* to argue that the alternatives cannot possibly work. Indeed, as we'll see, each option does present a possible solution to the argument. Rather, our goal is to argue for the more modest conclusion that these alternative solutions are not as successful as the one we have presented above. Our claim, then, is that our solution is the best available option, and should be preferred for that reason.

Option 1: Deny P1

First, we could give up P1 and deny that there are any concrete spatiotemporally located entities. Not many will be inclined to adopt this option: of course there are such entities! But one way to make this approach more palatable is to adopt mereological nihilism. The thought then is that there is one fundamental object, the cosmos, and it is both mereologically simple and not spatiotemporally located. This resolves the argument because if the cosmos has no proper parts, it has no proper parts that are spatiotemporally located, and so there is no potential conflict with the inheritance of location for parthood.

This view is costly, however. For one, we are forced to accept mereological nihilism. This position is controversial. Many are inclined to think that there are parthood relations in the world, especially given the apparent prevalence of explanations that appeal to composition. Another potential cost relates to observation. Spatiotemporal location appears to be necessary for observation in two ways. First, entities must be spatiotemporally located in order for them to be observed. An observation is a measurement of something at a particular place, at a particular time. Second, observers must be spatiotemporally located in order to make observations: an observation is always made by an observer at a particular place and time. On the nihilist view under consideration, however, nothing is spatiotemporally located, so nothing is observable. The reason for this is that there is just one fundamental entity, and it is not spatiotemporally located. Since it has no spatiotemporally located parts, there seems to be no basis for observation.

By contrast, our solution does not have this outcome: there are concrete, spatiotemporally located entities available to couple as observer and observed. Nor does our view commit to controversial theses about composition. So, it is a better way forward.

Option 2: Deny P4

The second way of resisting the argument in Sect. 3 is to give up P4: The inheritance of location. Recall that the inheritance principle implies that the cosmos is located where its parts are. This means that we expect the cosmos to be spatiotemporally located if it has spatiotemporally located parts. If we give up this principle, there is then no obligation for the cosmos to be spatiotemporally located just because its parts are.

We admit that giving up the inheritance of location is an option. The question, however, is whether it is a better option than the one proposed in Sect. 4, namely: giving up the definition of concreteness in terms of parthood and applying an injunction against the cosmos having spatiotemporally located parts. We do not think that it is. Giving up on the inheritance of location poses a substantial risk to the conceptual integrity of parthood, whereas giving up on the definition of concreteness and using a non-mereological notion of dependence to connect the cosmos with spatiotemporally located entities does not.

To a certain extent, we've seen the reason for this already. In Sect. 2, we briefly noted that parts and wholes seem to be 'intimately' related in a way that the relata in other relations are not. For instance, as Sider (2007, p. 54) claims, "parthood has a unique status as an especially intimate relation... The whole is nothing over and above the parts... A part is just some of a whole". Cameron (2014) also notes that parthood is 'peculiarly intimate'. Parthood differs from relations like parenthood,

ownership, or marriage in so far as wholes inherit their properties from their parts, are spatially located where their parts are, and are no added ontological commitment over their parts, features that these other relations generally lack.

Some have claimed that the intimacy of parthood is explained by the fact that composition is the relation of identity. If composition just is identity, then the inheritance of location seems hard to deny. For if the inheritance of location is false, then parts can have different locative properties to wholes, presenting a straightforward argument against the identity claim from Leibniz's law.

However, even if composition is not identity, it is very much *like* identity, in the following two respects. First, the identity relation constitutes a peculiarly intimate relation between an object and itself. So too does the whole seem to bear a peculiarly intimate relation to its parts. Second, the relation joining an object to itself seems to be a very different relation from one connecting distinct objects. So too does the relation joining an object to its parts seem a very different relation from one connecting an object to entities that are not its parts.

The inheritance of location is needed to explain the similarity between parthood and identity (which is similarly intimate) and the difference between parthood and other relations, like causation (which are not). The reason why parthood is particularly intimate is that—like identity—it obeys the inheritance of location. Indeed, so far as we know, no other explanation of the similarity between parthood and identity has been offered; perhaps none is possible. If we therefore give up the inheritance of location, we thus threaten to leave core aspects of parthood unexplained. This in turn loosens our conceptual grip on the nature of parthood as distinct from identity and other non-identity relations.

Note that nothing similar seems remotely true for our definition of concreteness. The difference between a definition of concreteness in terms of cosmic parthood (Schaffer's) and one in terms of worldly parthood (ours) certainly does not seem to pose any immanent threat to our conceptual grip on concreteness. Concreteness seems to be just as easy, or hard, to grasp as it ever was. Similarly, giving up on the idea that spatiotemporally located entities mereologically depend on the cosmos does not seem to pose any conceptual difficulties.

There are two further considerations in favour of the inheritance principle. One consideration stems from mereological harmony. Mereological harmony is roughly the view that parts and wholes should mirror in their locative properties. Harmony is captured by a number of principles, some of which imply the inheritance of location. For instance, consider the relevant harmony principle from Saucedo (2011):

x is a part of *y* iff *x*'s location is a subregion of *y*'s location.

Harmony principles like this imply the inheritance of location: for a part, *x*, of an object, *y*, where *y* is located at region *R*, *x* will not be located at any region that is not a subregion of *R*. Schaffer, among others, has claimed that harmony principles are necessary truths about parthood. If that's right, then giving up the inheritance of location is not an option. A further consideration in favour of the inheritance of location is inductive. All concrete objects identified to date seem to obey the inheritance of location. So we have a *prima facie* reason to suppose that this is how parthood behaves in general.

Adopting our solution means that the inheritance of location can be preserved in the argument for monism, which we think is an advantage. But note we are *not* saying that the inheritance of location cannot possibly be given up. Of course it can, and this is worth exploring. The question is what should we give up to preserve priority monism: the inheritance of location or the specification of concreteness in terms of cosmic parthood along with the mereological dependence of spatiotemporal entities on the cosmos. Which of these appears to carry the greatest cost? We have argued that rejecting inheritance is the worse option: there are three reasons against giving up the inheritance of location and none that we can see against redefining concreteness and mereologically severing the cosmos from spatiotemporally located entities.

Option 3: Deny P7

Third option: give up P7. Recall that this was the claim that the fundamental entities are not spatiotemporally located. If the fundamental entities are in fact spatiotemporally located, then there is clearly no trouble with the inheritance of location of the kind highlighted above.

Note that we took P7 from fundamental physics that is still under development. The idea that spacetime is emergent arises in work on quantum gravity, which is a cluster of ongoing research programs that aim to reconcile our two most successful theories at the moment. We don't yet know what a final theory of quantum gravity will say about what the fundamental entities are like. It remains open, then, that a final theory will leave room for spacetime at the fundamental level. Thus, one might argue, we should simply reject P7 and resolve the argument that way.

But it pays to be careful here. While it is true that we don't have a final theory of quantum gravity yet, the emergence of spacetime has now been predicted for a number of major approaches, including string theory, loop quantum gravity, group field theory, emergent gravity and causal set theory (see Huggett and Wüthrich (2013) for relevant discussion). This convergence of the major programs is striking, and provides good reason to take the emergence of spacetime seriously as a hypothesis about the actual world.

In order to completely defang the argument offered in Sect. 3, one would need to make a case for a bet in the other direction. That is, one would need to argue that spacetime is likely to be fundamental in a final theory of quantum gravity. For it is only if spacetime is likely to be fundamental that one can be sure that no problem will arise for priority monism down the track. This increases the difficulty in defending priority monism, since it requires adopting a view about how ongoing research in quantum gravity will pan out. By contrast, the solution that we offer here allows one to keep priority monism intact without having to bet one way or another on the fundamentality of spacetime. Our view is compatible with spacetime not being fundamental, but it is also compatible with spacetime being fundamental. In general, it is better if priority monism can remain neutral on this issue, since then it is not a hostage to the fortunes of modern physics. We take the relative neutrality of our view with respect to work in physics to be a positive feature of our solution, and a reason to prefer it over rejecting P7.

As before, none of this is decisive, but we should keep in mind that whether we should believe that spacetime is emergent or not is not really the point. What matters is the choice between rejecting P7 and endorsing our solution. Rejecting P7 risks

bringing priority monism into conflict with future physics. We say: better to just avoid this risk.

Option 4: 'Fundamentality' is equivocal in P6 and P7.

Option 4: perhaps there are two notions of 'fundamentality' at play in the argument. What could these two notions be? Here's one possibility:

Metaphysical Fundamentality: *x* does not depend on anything for its existence.

Physical Fundamentality: the existence of *x* is within the domain of a fundamental physical theory.

Where 'fundamental physical theory' is in turn understood as follows:

Theoretical Fundamentality: *x* cannot be derived from any other physical theory.

The thought, then, is that there is a disconnection between what's metaphysically basic and what's physically basic, in the following sense: just because what's physically basic has certain features, it does not follow that what's metaphysically basic has those features too. This helps, because we got to the conclusion that the cosmos is non-spatiotemporal via an inference of this kind. That is, we established that the cosmos is non-spatiotemporal on the grounds that what's physically basic is non-spatiotemporal, and whatever is metaphysically basic should carry the features of whatever is physically basic. If we break the link between what's physically basic and what's metaphysically basic, there is thus no worry about spatiotemporally located concrete entities being parts of the cosmos, since there is no pressure to treat the cosmos as a non-spatiotemporal entity.

The cost of this way of solving the argument is that it would seem to undermine one of the core arguments in favour of priority monism. Schaffer's main empirical argument for monism is based on quantum holism. Given entanglement in quantum mechanics, it is plausible to suppose that the cosmos forms one vast entangled system (2010b, p. 52), with specific objects formed by decoherence from the entangled whole. From this he draws an inference toward priority monism.

Now, while quantum mechanics is not a fundamental physical theory, quantum gravity is expected to be quantum in much the same way that quantum mechanics is. So we should still expect holism at the quantum level. This means that one of Schaffer's central arguments for priority monism likely survives into the case of quantum gravity as well. This is potentially good news for priority monism, as it shows that the argumentative support for the view can survive the transition from quantum mechanics to a more fundamental theory.

This style of argument, however, relies on there being a connection between what is physically basic and what is metaphysically basic. The argument works by focusing on a feature of what is physically fundamental—the feature being quantum entanglement—and then inferring that whatever is metaphysically basic must have this feature. From there, one infers to priority monism on the grounds that it is the best picture of what is metaphysically basic that allows for what's metaphysically basic to reflect the nature of what's physically basic.

If we are not entitled to assume such a strong connection between what's physically basic and what's metaphysically basic, then arguments like the one from entangled quantum systems appear to be undermined. Cleaving apart the two distinct notions of fundamentality thus seems to weaken the basis for monism. By contrast, our proposed solution comes at no such cost.

Option 5: Location is Equivocal

The fifth and final option is to argue that 'location' is equivocal in P4 and P8. Perhaps in P4, 'location' means weak location, whereas in P8 it means exact location. Then these two premises should be rendered as follows:

P4 The cosmos is weakly spatiotemporally located wherever its parts are located.

P8 The cosmos is not exactly spatiotemporally located.

Because these claims are compatible a contradiction cannot be derived.

A problem for this approach is that the entities in a theory of quantum gravity are supposed to lack spatiotemporal properties altogether. With that being said, it is not clear that that cosmos could even be weakly spatiotemporally located if it is supposed to be fundamental. That's a problem because the weak spatiotemporal location of the cosmos would still follow from P3, P4 and the inheritance of location.

One way forward might be to mark out a distinction between 'having spatiotemporal properties' and 'being weakly spatiotemporally located'. Then, perhaps one could argue that 'being weakly spatiotemporally located' is not a spatiotemporal property of the kind that does not feature in a theory of quantum gravity.

But this distinction is difficult to make precise. If being weakly spatiotemporally located does not count as a spatiotemporal property then it is not clear what does. We're not optimistic about the prospects of sharpening up a distinction between spatiotemporal properties on the one hand, and another kind of property that includes spatiotemporal location, on the other. Of course, it can't be ruled out. But it is a challenge for this particular way around the argument for priority monism, a challenge that our solution avoids.

6 Conclusion

Theories in quantum gravity suggest that fundamental entities are not spatiotemporal. These findings can be used to mount an argument against priority monism. We have presented one such argument. Our solution to the argument is to reject the original notion of concreteness that specifies concrete entities as parts of the cosmos. This definition won't work for anyone who accepts a certain interaction between parthood and location given by the inheritance of location. For that will require concrete spatiotemporal entities and non-spatiotemporal fundamentals to, in some sense, share in their locations.

Instead, we recommend specifying concreteness as worldly parthood. In line with monism, everything still depends on the cosmos, but we specify this dependence in non-mereological terms. The solution works because we no longer rely on parthood to specify how concrete spatiotemporally located entities depend on the cosmos. Thus, the cosmos does not need to be located where concrete spatiotemporally located entities are. Overall, the view we have given here seems to incur less costs than the alternatives. Moreover, the picture of monism we develop, while a departure from the original theory, enjoys substantial advantage over that theory, insofar as our view is compatible with spacetime emergence.

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