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Does the Mathematical Nature of Physics Undermine Physicalism?

Abstract: *I argue that for the physicalist to provide an adequate account of the reductive (supervenience, realization, etc.) base, the physicalist needs to deal with a serious problem arising from the mathematical nature of physics. To arrive at a physicalism that doesn't face direction of explanation worries, physicalism needs to embrace Platonism. But a platonistic physicalism is a form of dualism, and it is highly problematic. Inter alia, physicalism loses traditional advantages over competing theories, such as ontological economy and having a superior account of mental causation. Mentalistic monisms fare better, overall.*

The most heated debates over physicalism tend to concern the fundamental nature of consciousness. I will concentrate on physicalist positions in philosophy of mind, but I'll raise a new problem for physicalism from different quarters, one stemming from the mathematical nature of fundamental physical theories. This new problem impacts the debate over the fundamental nature of consciousnss in significant ways, as we'll see.

I shall argue that for physicalists to provide an account of the nature of the fundamental physical entities in their *physical base* (i.e. the properties and particulars in their supervenience, reductive, or realization base) that doesn't face direction-of-explanation worries, they must embrace Platonism as an account of the nature of mathematical entities. This marriage of physicalism and Platonism may strike you as not being a form of physicalism, for Platonism holds that immutable,

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acausal entities exist outside of space and time, and indeed, play an important role in physical theories. I agree. But even if you insist that this is a *bona fide* physicalism, I shall argue that, for other reasons, this is no physicalism worth having. I call this problem *the Problem of the Physical Base*, or more simply, *the Problem of the Base*.

The Problem of the Base is key to the debate over the nature of consciousness. Philosophers of mind tend to organize the landscape of solutions to the mind–body problem in terms of the opposition between physicalism and dualism, especially a dualism of mental and physical properties, as opposed to a dualism of substances. But as I'll explain, the Problem of the Base suggests that the ontological status of abstract entities has crucial implications for the debate over the nature of consciousness. For the problem strips physicalism of two of its main advantages over dualism: ontological economy and mental causation. And as we'll see, the problem also suggests that physicalism has trouble avoiding a dualism of the abstract and concrete. For, if physicalism has to be Platonistic, *it is not a monistic position at all. It is a dualism of the abstract and concrete*. Further, the property dualist will need to consider the ontological status of abstract entities in framing her position on the nature of consciousness. Namely, she will have to decide whether to be a *pluralist*.

I begin by explaining the Problem of the Base in more detail (Section 1). I then turn to a response to the Problem of the Base that conflates my view with the Mathematical Universe Hypothesis — the hypothesis that reality is solely mathematical (Section 2). Next, I consider the intriguing constellation of nominalist programmes in philosophy of mathematics (Sections 3, 4, and 5). Surprisingly, appealing to nominalist programmes will not help the physicalist solve the problem. Then, Sections 6 and 7 devise a physicalism that is Platonistic, holding that reality is both abstract and concrete. I argue that this view, which I call *Platonistic physicalism*, is an ill-conceived position that faces serious problems. I close by illustrating how my results impact the debate over the nature of consciousness, tipping the balance in favour of non-physicalist views that regard mentality as basic (Section 8).

If my argument is correct, then a major obstacle to a satisfying physicalist answer to the mind–body problem arises from physics itself. Physics is highly abstract, and the physicalist lacks physically kosher truthmakers for its claims. Physics is not physicalistic, if you will.

1. The Problem

My objection to physicalism begins with an observation: fundamental physics is deeply, if not exhaustively, mathematical.

Suppose you are eating a ripe, sugary pomegranate. Why does it have the properties it has — its juiciness, its tartness? Answer: it has the properties it does because it is made of atoms configured in a certain way; and atoms have the structure they do because of their configuration of fundamental particles. And, according to quantum field theory, fundamental particles are merely ripples or thickenings in the quantum field, which is explained mathematically.[1] And if, for instance, string theory is employed to explain particle natures, the particles are vibratory frequencies of strings, which is again mathematical. In short, fundamental physics is *mathematized physics*. As Timothy Williamson has remarked: 'What, for a start, is the natural world? If we say it is the world of matter, or the world of atoms, we are left behind by modern physics, which characterizes the world in far more abstract terms' (Williamson, 2011).

The mathematical nature of fundamental physical theories raises a previously unnoticed problem for physicalism, I believe. For consider that the physicalist generally sees her ontological universe as one of *concreta*, consisting in spatio-temporal objects, events, and property instantiations. But fundamental physics is highly mathematical, and mathematical entities purport to be *abstract* — they seem to be non-spatial, atemporal, immutable, acausal, and non-mental. (Here, I am merely employing the standard definition of an abstract entity.) Consider, for instance, the Schrödinger equation. And consider the heavily mathematical approaches to quantum gravity, such as string theory and loop quantum gravity. Indeed, these two approaches to quantum gravity are so abstract — so divorced from the concrete physical world — that space-time does not seem to be fundamental; space-time, and objects in space, only emerge at a higher level of resolution.[2] In essence: because fundamental physics is highly mathematical, mathematical entities, which are anything but 'concrete', are playing a key role in physics. And mathematical entities do not come for free.

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1 I am here modifying an example of Max Tegmark's (2014).

2 As we'll see, my argument does not hinge on the fundamental physical level being non-spatio-temporal, but the situation with theories of quantum gravity is a nice illustration of how abstract current microphysical theories are.

Physicalism holds that everything is physical, or is composed of physical entities (where, to a first approximation, physical entities are generally regarded as being those discovered by a completed physics). As such, it is a metaphysical hypothesis about the fundamental nature of reality. It is reasonable to ask the physicalist to enquire into the nature of mathematical entities, for they are doing heavy lifting in the physicalist's theory, describing and identifying the fundamental physical entities that everything that exists is said to reduce to (supervene on, etc.). The key question today will be whether the physicalist in fact has the resources to provide a satisfying account of the nature of these mathematical entities, given existing work in philosophy of mathematics on nominalism and Platonism that she would likely draw from. And the answer will be: she does not.

Here's the problem, in more detail. Let us call a supervenience, reductive, or realization base that contains that which is identified by a given physicalist programme as fundamental a 'physical base'. The physicalist holds that everything is physical, being either a fundamental physical entity or depending upon fundamental physical entities in the base.[3] Now, in the face of the abstract nature of physics, one could raise the following worry. It seems that the fundamental properties and particulars in the physicalist's base — the building blocks of the physicalist's ontological universe — are *individuated* mathematically. That is, mathematical entities seem to make the objects and properties figuring in the physical base the types of objects and properties they are. And if something individuates something else it is generally considered to be part, or even all, of the entity's nature, unless an argument is provided to the contrary.[4] Without an argument, the presumption is that the individuative entity does, at least in part, contribute to the nature of the entity whose nature is in question. So, the objector could ask: why is the physical base not abstract, at least in part, if fundamental physical entities seem to be individuated by abstracta?

Here's another way to put the issue. *Prima facie*, mathematical entities play a key role in the identity conditions for entities in the

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[3] Depending upon the reductive, realization, or supervenience thesis the 'base' can be as large as all of space-time or as small as the neural basis of a type identity claim. Although there are major debates in the physicalism literature about these matters, the present discussion does not require a particular account of the size of the base nor a specific sort of dependency relation.

[4] We shall consider such arguments shortly.

physical base — the conditions of sameness and difference of entities within a given metaphysical category (e.g. events, properties) at a given time or over time. For an example of an identity condition, consider the psychological continuity theory of the nature of persons, which offers an identity condition involving psychological continuity over time. Psychological continuity is a proposal about how to *individuate* persons, presenting an identity condition in which the survival of a person is determined by their psychological continuity over time. An entity individuates something else when it figures in its identity condition. The presumption is that if something individuates something else, it is part of its nature, at least without an argument to the contrary. So why aren't the entities in the physical base abstract, given that fundamental theories in physics are heavily mathematical?

Most physicalists will cringe at the thought that abstract entities are part of the nature of their base, of course. Their reality is not Pythagorean! Mathematics merely describes the universe; the universe isn't mathematical. *I agree*. I am playing devil's advocate here, pressing the physicalist to explain why the entities in the base are metaphysically distinct from mathematical entities — why all the mathematics is merely descriptive. What ontological resources are up the physicalist's sleeve? Here, we need to know what the metaphysical nature of the base is, given that the primary physical characterization of fundamental entities is mathematical.

David Lewis once remarked that his physicalist Humean supervenience programme aims to '…resist philosophical arguments that there are more things in heaven and earth than physics has dreamt of' (Lewis, 1994, p. 474). Given the mathematical nature of fundamental theories in physics, the physicalist should be wary of Lewis's dictum. Mathematical entities must be reckoned with, and, as we'll see, this is the domain of philosophy of mathematics, not physics.

In essence, the physicalist faces the following challenge:

The Problem of the Base:

Premise 1. Abstracta individuate at least some of the entities in the physical base.
Premise 2. If abstracta individuate at least some entities in the physical base, then those entities have (at least partly) abstract natures.
C1: Thus, some entities in the physical base have (at least partly) abstract natures.
Premise 3: Abstract entities are non-physical.

C2: Therefore, some entities in the physical base have (at least partly) non-physical natures.
Premise 4: If some entities in the physical base have (at least partly) non-physical natures, then physicalism is false.
C3: Therefore, physicalism is false.

Again, my point in raising this argument is to encourage enquiry into the resources the physicalist has for defining the entities in the physical base, for, as we will see, the resources cannot be abstract. For, as I will soon argue, stripped of its unjustified appeal to abstracta, physicalism collapses into circularity or Platonism, and a Platonistic physicalism is no physicalism worth having. So: what physically kosher resources can the physicalist appeal to in order to define the entities in the physical base, in order to avoid the grim conclusion of the argument?

First, four clarifications.

(i) I've added the expression 'at least partly' to various lines of the argument to take into account a scenario in which the physicalist proposes that something else, in addition to abstracta, individuates some or all of the entities in the physical base. In this scenario, these entities would have partly non-physical natures. I am being generous here: it strikes me as incoherent for an entity to be a metaphysical composite of something abstract and concrete. How can something be both in and not in space-time, or be both changing and unchanging? In any case, if entities in the physicalist's base are partly non-physical, having non-physical constituents, because physicalism takes its base to be entirely physical, physicalism seems false.

(ii) My argument doesn't require that the physicalist quantify over a particular ontological category, but I will concentrate on the categories of properties and substance, because an ontological commitment to these categories is quite common. A commitment to properties, in particular, is rife throughout contemporary metaphysics and philosophy of mind, especially when one bears in mind that, nowadays, events are most commonly construed as property instantiations. Indeed, substances themselves are often bundled out of properties, and certain realist theories of laws, such as D.M. Armstrong's, take laws to be higher-order relations between properties.

(iii) Notice that my argument does not rely upon a particular manner of individuating properties and objects. Physicalists often do not specify how they intend properties and objects to be individuated, so this openness is intentional on my part. However, physicalists tend to

be sympathetic to some kind of 'property ontology', that is, an ontology that takes a mosaic of universals or tropes (nomic or otherwise) instantiated across space-time to be basic. On this view, the fundamental physical properties tend to be individuated by the role they play in the physical laws.

Clearly, candidate basic laws in physics, such as the Schrödinger equation, are heavily mathematical. Abstracta thereby threaten to be part of the nature of fundamental physical properties. Property ontologies build objects out of properties, so, by extension, objects turn out to be at least partly abstract as well (*mutatis mutandis* for ontologies that bundle objects out of properties, together with a substratum or thin particular).

(iv) You may observe that there is nothing special introduced by contemporary theories like string theory and quantum mechanics, for it is the mathematical nature of physical theories that gets the problem off the ground, and physics has long been mathematical. Indeed, perhaps even models of macroeconomic behaviour and climate change present a similar problem, as they can involve a good deal of mathematics.

To clarify, I agree that the problem may not be unique to contemporary physics, although there is something distinctive about the contemporary case, as I'll explain shortly. For the problem would arise for any microphysics that seems to individuate its fundamental entities mathematically. Here, it is important to bear in mind that the problem doesn't have to be unique to contemporary theories, it just has to be a problem. Further, for our purposes there is something distinctive about current microphysical theories in comparison to a case like Newtonian mechanics, for instance, in which Newton's laws can be stated without much mathematical apparatus, if any. The fewer non-mathematical entities figuring in the theory, the more difficult it becomes to answer the problem by trying to explain away mathematical entities in terms of something in the physical theory that is non-mathematical (such is a strategy nominalists about mathematical entities pursue, as we'll see). For instance, I will explain that, given that space-time seems to be emergent in theories of quantum gravity, it is now difficult to nominalize mathematical entities by appealing to space-time points and regions (see Section 4).

Regarding the observation that special science models can also be mathematical, while I agree that a similar concern arises, the Problem of the Base is best articulated in terms of microphysics — the problem is about the physical base, after all. The physicalist holds that

macroscopic entities depend on microphysical ones, and so the matter of whether special science entities must be individuated abstractly, and whether this would indeed be a challenge for physicalism, largely boils down to whether the ultimate constituents are abstract. This brings us back to the original problem for fundamental physical entities.

Now let us turn to responses. In response to the Problem of the Base, the physicalist will likely retort by arguing, *contra* Premise 3, that abstract entities can be physical. Alternately, the physicalist could claim that abstracta do not individuate the entities in the physical base, so Premise 1 is false. In both cases, the physicalist may appeal to a natural strategy for solving the Problem of the Base: show that the nature of numbers is not, in fact, abstract. Physics, although heavily mathematical, is not *about* abstract, immutable, non-physical entities: *physics is about entities in the world*. So, what should the physicalist say mathematized physics is about, if not the otherworldly realm of abstract entities? To answer this, the physicalist needs an account of the *truthmakers* for mathematical sentences.

This is the domain of philosophy of mathematics. Here, the leading approaches to the nature of mathematical entities are Platonism and a certain brand of nominalism (i.e. fictionalism) that I will discuss shortly. *Platonism* in philosophy of mathematics holds that there are mathematical entities, that is, entities that fall in the domain of mathematics, such as numbers, sets, and mathematical structures.[5] According to the Platonist, mathematical entities are abstract: they are non-physical, non-causal, immutable, non-spatio-temporal, and non-mental. *Nominalists* in philosophy of mathematics deny the truth of Platonism, holding that there are no abstract entities.[6]

It is natural for the physicalist to turn to a version of nominalism to challenge Premise 3 and urge that mathematical entities are ultimately physical entities, or to challenge Premise 1, claiming that abstracta do not individuate entities in the base. All of the nominalist approaches contend that mathematics, and fields that employ mathematics in their proprietary vocabularies, do not have abstract mathematical entities as truthmakers; to the extent that the discourse is even true — and some

5 Different Platonist theories take different kinds of entities to be basic.

6 Herein, when I speak of 'nominalism' I have in mind nominalism in philosophy of mathematics, not nominalism about universals. Although nominalism in philosophy of mathematics is a distinct position from nominalism in the universals debate, the positions are similar in that they both eschew abstracta.

nominalist theories deny this, as we will see — the truthmakers are concrete. For example, according to the Millian approach, mathematical statements are about physical objects. A far more popular approach is the leading alternative to Platonism, *fictionalism*, which takes mathematical discourse to be a type of fiction (fictionalists regard mathematical statements as being strictly untrue, although they can allow that the statements are true in the fictional language of mathematics). In any case, nominalists contend that mathematics is merely a device for classifying reality, it is not part of fundamental reality itself. Statements of a mathematized physics are ultimately about concrete entities, e.g. space-time regions, particles and strings, or properties of a non-Platonistic nature (tropes, immanent universals).

We can now state the dialectical situation that the physicalist faces in terms of a dilemma. On the one hand, it is natural for the physicalist to turn to nominalism to answer the Problem of the Base. But, as I will explain, even well-received nominalist theories, such as fictionalism, introduce severe direction-of-explanation worries into the physicalist's programme. Unless a viable theory is found, the physicalist must avoid nominalism.

On the other hand, the physicalist could challenge Premise 3 by turning to Platonism as an account of the nature of mathematical entities, urging that abstract entities are physical, and developing a 'Platonistic physicalism'. But this version of physicalism (if one can even legitimately call it that) is dualist: it holds that immutable, non-spatio-temporal entities exist, and indeed, play an important role in physical theories. This is a heavy ontological commitment for the physicalist, and I will illustrate that it leaves the physicalist unable to explain causation and meaning, and with a theory that fails to rule out intuitively non-physicalistic scenarios, such as panpsychism and being in a simulation. In essence, the dualist version of physicalism features a metaphysical realm of the concrete that is far less well understood than the realm of the abstract. For Platonism in philosophy of mathematics offers a well-developed account of the nature of mathematical entities.

So this is where the Problem of the Base will lead us. Before turning to fictionalism and Platonism, though, it will be instructive to consider a common first reaction to the problem.

2. Discarding the Mathematical Universe Hypothesis

You may suspect that the Problem of the Base is fuelled by the Mathematical Universe Hypothesis (MUH): the position that holds that the universe is entirely mathematical. This sort of position dates back to the Pythagoreans and is advanced in a recent book by the physicist Max Tegmark (2014). The MUH is said to justify Premise 1 of my argument, the premise that physicalism has a supervenience (reduction, realization) base that is abstract.

I reject MUH, however, for reality can't be *entirely* mathematical. Mathematical entities are by definition (*inter alia*) acausal, immutable, atemporal, and non-mental. The world contains mentality, and while I suppose it is possible that minds (selves, persons) are non-spatial, as, for instance, Cartesian minds are said to be, it is difficult to see how minds could reduce to a solely mathematical reality. For how can mentality be explained in terms of an unchanging, acausal, timeless realm? Minds have sequences of thoughts which seem to change and be causal, or at least supervene on something that is causal.

In any case, MUH is not required for Premise 1 of the argument to hold. Entities in the base can be individuated by abstracta even if MUH is false, for Platonism could be true. If Platonism holds, mathematical statements in physics are about abstract entities; they are not about the world of mid-sized objects or even particles and strings. For, according to Platonism, mathematical statements have abstract entities as their truthmakers. So, the challenge gets off the ground. Of course, Platonists in philosophy of mathematics do not defend the view that all is number, they take other metaphysical categories to be fundamental as well.

My point is not to defend MUH then. It is to enquire into the resources the physicalist has for defining the entities in the physical base. So again: what physically kosher resources can the physicalist appeal to in order to define the entities in the base? A common physicalist answer is the following.

3. Fictionalism

When pressed about the nature of mathematical entities, physicalists tend to say that they suspect that fictionalism is correct. And indeed, fictionalism is regarded by most philosophers of mathematics as being the most plausible form of nominalism. Fictionalism agrees with Platonism that our mathematical sentences and theories purport to be about mathematical entities, but, *contra* Platonism, it denies that there

are abstract entities. Our mathematical statements are not true (however, fictionalists can allow that the statements are 'true in the story of mathematics').[7] Further, sentences like '2 + 2 = 4' are not true for the same reason that sentences like 'Lady Macbeth was tormented' are not true — there are no such things as the number 2 or Lady Macbeth. Both are fictional (Balaguer, 1998; Field, 1980; 1989).

Mark Colyvan aptly describes the sense in which mathematical entities are said to be fictional by the fictionalists:

> …fictionalism in mathematics does not mean that 'anything goes.' Authors of mathematical theories, like writers of good literary fiction, are not free to develop their fiction in any way they please. For a start, consistency is usually thought to be strongly desirable. Beyond that, there are also requirements not to introduce unnecessary items. In good mathematics, like good literary fiction, posited entities contribute to the story. But perhaps the greatest constraint on writing mathematical fiction is that the latest installment must be consistent with all previous installments. Previous generations of mathematicians introduced such 'characters' as sets, functions, natural numbers and so on. The current generation of mathematicians must develop these 'characters' in ways that are consistent with what went before. It is as though current mathematicians are all contributing to a multi-authored series of books. Just as Tolkien was heavily constrained in the last book in *The Lord of the Rings* trilogy by what went before in *The Hobbit* and the previous two books in *The Lord of the Rings* series, so too modern mathematicians cannot develop the fiction of mathematics in any way they please. (Colyvan, 2011)

The difference between sentences like '7 is odd' and '3 is even' is that the former, and not the latter, are part of the story of mathematics — the story that's made up of our mathematical theories. In the words of Colyvan, fictionalism has '…a very straightforward epistemology: there is nothing to know beyond the human-authored story of mathematics. And coming to know the various fictional claims requires nothing more' (*ibid.*).

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7 Field and Leng hold that '7 is odd' and '3 is even' are both strictly untrue, '7 is odd' is *true in the story of mathematics*. More specifically, to be true in the story of mathematics for Field and Leng is to follow from mathematical axioms accepted by humans. For Mark Balaguer, the story of mathematics can go beyond the currently accepted axioms, encompassing the *full conceptions* (in his own words) that humans have of mathematical entities. So, a sentence is part of our story of arithmetic when it follows from our *full conception of the natural numbers*, for instance, which encompasses the mathematical axioms and can encompass more beliefs as well (Balaguer, 1998; Field, 1989; Leng, 2010.)

Why do we use certain mathematical stories, and not others? Mark Balaguer explains: 'The reasons are that this story is pragmatically useful, that it's aesthetically pleasing, and most important, that it dovetails with our "way of thinking"' (Balaguer, 1998, p. 13).

As influential as fictionalism is, it will not solve the Problem of the Base, and physicalists should not appeal to it. Fictionalism takes mathematics to be a purely human story, and it explains mathematical discourse in terms of mental phenomena such as pragmatic and aesthetic interests. This gives rise to two problems. First, physicalist positions in philosophy of mind become circular, for mental phenomena are being explained by reference to physical properties and particulars that are themselves individuated by mental phenomena. Secondly and relatedly, a putative physicalist solution to the mind–body problem must employ a reductive or supervenience base that is itself *physicalistically kosher* — free of mental or otherwise non-physical entities. A base of physical entities that is individuated by mental entities is not physically acceptable. Further, in so far as a law or prediction in fundamental physics is couched in a mathematical vocabulary, it will turn out to be untrue, that is, either false or vacuous. While physicalists believe that current physics seems false, for relativity theory and quantum mechanics contradict, it would be an undesirable result if the physicalist had to say that even the claims of a completed physics will turn out to be untrue, or merely true within the fictional story of mathematics! There is a general lesson here for anti-realist approaches to mathematical entities, where anti-realists deny that mathematical statements are about anything. For this reason, the physicalist should locate a viable realist theory, finding nominalistically (and physically) kosher truthmakers.

Of course, there are objections.

4. Objections: Mapping to Space-time Regions and Other Nominalisms

The Space-time Objection. One response to my remarks on fictionalism is to observe that, although fictionalism is mind-dependent, the fictionalist Hartry Field also proposed a promising nominalization procedure that is separable from his fictionalism. Field argued that it is not necessary, in producing a physical theory, to quantify over abstract entities. Drawing from Hilbert's axiomatization of Euclidean geometry, Field provided a formalization of Newtonian gravitational theory in which the quantifiers range over space-time regions

(including points) and point-particles. He provided relational predicates that, as applied to spatio-temporal intervals, allows one to mimic the operations of multiplication, addition, and so on (Field, 1980). According to this response, Premise 1 can be rejected on the basis of this sort of nominalization programme.

I quite like Field's programme, but the physicalist cannot appeal to it. Theories of quantum gravity are more fundamental than quantum mechanics, seeking to unite Einstein's theory of general relativity and quantum mechanics, which are at odds. According to two leading theories of quantum gravity (string theory and loop quantum gravity) space-time is not fundamental, it is emergent (Seiberg, 2006; Huggett and Wuthrich, 2013; Swingle, 2012). Although physicists tend to use the expression 'emergent' without defining it, these discussions paint a picture in which space-time is what philosophers have called '*strongly emergent*' (Chalmers, 2006), in which spatio-temporal truths are not deducible from truths at the fundamental level, even in principle.[8] Consider, for instance, holographic theories that map all the information from a 3D structure to a 2D boundary, preserving all the same information, leading people to ponder whether the universe is a hologram. The point here is that there seems to be no unique spatio-temporal structure that is fixed by the base-level physical laws and facts.

The situation with these theories of quantum gravity raises a problem for the space-time objection. The space-time regions and points would be individuating the fundamental properties and substances posited by these theories — fundamental entities like strings and spin networks. But space-time *emerges* from the fundamental entities, so it is puzzling to say that the fundamental entities are also individuated by them, as I'll explain.

If something emerges from some emergence base, it is supposed to be due to the nature of the entities in the base that the emergent entity exists, otherwise it wouldn't be correctly said to emerge from the base. If macroscopic spatio-temporal features individuate fundamental microscopic entities, then, aren't these features part of the nature of the microscopic entities? If this is the case, then the features of the emergent space-time would trace back to the configurations of

[8] I am not claiming that advocates of the view that space-time is emergent suggest there is downward causation, however. I am merely claiming that they hold that the spatio-temporal truths are not deducible, even in principle.

microscopic entities, but then, since a given microscopic entity would have one or more spatio-temporal properties as part of its nature, space-time would seem to emerge from itself. For space-time is individuating that which it 'emerges' from. I find this puzzling, especially since the string theorists are saying that space-time is *not* found at the fundamental level, merely appearing 'as approximate semiclassical notions in the macroscopic world' (Seiberg, 2006). Further, even setting aside this direction of explanation concern, it isn't even clear how space-time, given that it is said to merely be an *approximation* that is not even applicable to phenomena at the microphysical level, could reasonably be said to individuate the fundamental entities in string theory. Why would a mere approximation play such a major role? In any case, it is important to bear in mind that theories of quantum gravity are under constant development. Perhaps these issues will be clarified upon a fuller elaboration of the sense in which space-time is emergent on the part of physicists and philosophers of physics. But, for now, the space-time response seems to face a serious direction-of-explanation worry.

Of course, the physicalist can respond that there are many other nominalist approaches to choose from. Unfortunately, I have been unable to locate a nominalist approach that is both independently plausible and physicalistically kosher. One problem is that mind-dependency seems rife in the nominalism literature in philosophy of mathematics. Any mind-dependent approach will not work for the same reason fictionalism does not. For instance, *psychologism* claims that mathematics is about mental objects. E.g. '2 + 2 = 4' is about the ideas of 2 and 4. This is clearly mind-dependent. *Conventionalism* holds that mathematical sentences are analytically true, e.g. '2 + 2 = 4' holds solely in virtue of the meanings of the expressions. Notice that this would not yield a physicalist answer to the mind–body problem because mental phenomena are supervenient upon (or reducible to, etc.) physical entities individuated by intentional properties. *Game formalism* holds that mathematics is a symbol manipulation game. Again, this is mind-dependent, as these 'games' are human creations, and, as an anti-realist theory, much of even a future physics would turn out to be false.

Moving beyond all this mind dependency, the physicalist may be inclined to appeal to a version of mathematical structuralism. *Structuralists* hold that mathematical objects (numbers, sets, etc.) are individuated by the relations they bear to other objects. It is important to note that structuralist theories in philosophy of mathematics are

generally not nominalistic. For structures are the abstract forms of systems. As Stewart Shapiro explains: 'The same structure can be exemplified in multiple systems, and the structure exists independent of any exemplifications it may have in the non-mathematical realm. The difference between structures and the more usual kind of universal, such as properties, is that structures are the forms, not of individual objects, but of systems, collections of objects organized with certain relations' (Shapiro, 2008).

Geoffrey Hellman's *eliminativist modal structuralism* bills itself as nominalist, however, for it eliminates structures entirely in favour of primitive logical modality (Hellman, 1989). According to modal structuralism, mathematical propositions do not refer to mathematical objects. Instead, they are implicit generalizations over logically possible systems. A given statement, P, of a mathematical theory is analysed as 'Necessarily, for all systems of type so-and-so, P' (where the theory holds it to be logically possible that there be systems of type so-and-so).

Hellman's proposal will not help the physicalist. For, in order to avoid Platonism, the physicalist must appeal to primitive logical modality. Taking modality as primitive is an unmotivated expansion of the physicalist's ontology, for the physicalist has at her disposal attractive reductive theories of modality, such as D.M. Armstrong's well-developed combinatorial theory of modality, which explains modal statements in terms of this-worldly immanent universals and thin particulars (Armstrong, 1989a; Schneider, 2003). In addition, primitive modality is abstract. Modal operators are *types* of operators within a logical system (specifically, Hellman appeals to S5 modal logic); this is as abstract as abstract gets. This will not solve the physicalist's problem. Although entities in the physical base would not be individuated by mathematical entities, they would still be individuated by abstract entities, so the same problems would apply.

Clearly, a different nominalist approach is needed. We have already ruled out several proposals as being mind-dependent. What about an approach that takes the truthmakers for mathematical statements to be objects or properties? After all, objects and properties do not need to be mind-dependent, and they are entities that physicalists generally believe in. Let us first turn to a familiar object-based approach.

5. Object- and Property-Based Approaches to Abstract Entities

According to J.S. Mill, mathematics is the most general of the sciences, giving us laws about physical objects. For example, '2 + 2 = 4' tells us that whenever we add two objects to a pile of two objects, we will end up with four objects (Mill, 1973). Let us call these objects 'Millian objects'. Notice that according to physicalism the entities in the physical base are supposed to be the building blocks for everything that exists. Because the physicalist is looking to individuate these building blocks, the individuative entities cannot be macroscopic physical objects, for the fundamental building blocks are supposed to compose macroscopic objects. If the physicalist appeals to macroscopic objects to serve as truthmakers for statements in mathematized physics, his approach would be circular.

Perhaps Millian objects should be fundamental physical objects like particles and strings, rather than macroscopic ones. This broadly Millian approach will not suffice for several reasons, however. (i) If the physical base contains physical substances, then the broadly Millian approach will be circular, for one cannot individuate fundamental objects by reference to themselves. (ii) I've mentioned that many physicalists have property ontologies, taking a spatio-temporal mosaic of properties as basic (where such can have causal natures or be entirely categorical or non-nomic, as with Humean supervenience theses). Pure property ontologies need to take physical objects as metaphysically derivative, even objects that physics itself regards as fundamental. Objects are instead bundled out of properties or they are properties, together with a substratum or thin particular (see Armstrong, 1997; Schneider, 2012; 2013a). Bearing this in mind, notice that the Millian approach puts the ontological cart before the horse. For objects, not physical properties, would be basic. And the nature of the physical properties would depend upon the Millian objects. Substances (including minds) could not be bundles of tropes or propertied substrata then. (iii) Finally, this view presupposes the very concepts of number and addition — notice the objects are already numbered, and they are added together — so, upon reflection, it doesn't really explain the nature of number. And because this position presupposes the concepts of units and addition, it makes covert appeal to human classifications and concepts. As discussed, the physicalist must avoid mentalistic approaches to the nature of mathematical entities.

What about explaining numbers in terms of properties, rather than objects? This would be in keeping with the physicalist's preference for a property ontology. Keith Campbell defends this type of approach in his important book, *Abstract Particulars*. Campbell suggests:

> Let our apples all be Granny Smiths and so all a matching, uniform shade of green. Now consider the set of those green tropes. It is also a triplet. Being a triplet does not seem to depend at all on the fact that it is greens we are dealing with. This is what makes the idea of numbers as Platonic attractive. But there is no need to take that view. Our green tropes are particular natures. We can, by an act of selective attention ignore the nature — that they are all green and focus on the particularity that they are this and this and this. The *three-foldness* of our triple is thus a *hyper-abstraction*, distinguishable in thought but not in fact from its *three-greenness*. (1990, p. 89)

He continues:

> Taking into consideration only the particularity of the particular natures, the tropes, which are the members of our sets of lowest type, we can introduce counting, hence cardinality of sets. (*ibid.*)
>
> This yields the numerical adjectives — being a pair, or a triple, etc. To move to numbers, the numerical nouns, we have at hand familiar strategies. Russell's is the most attractive from our point of view: the number three is the class of all three membered classes (triples) and more generally the number n is the class of all n-tuples. By allowing n-tuples to become, in turn, members of sets of higher type, we can generate sets corresponding to all integers and transfinite cardinals. (*ibid.*, p. 91)

Tropes are a well-respected alternative to universals. But if the physicalist prefers immanent universals, she can follow Campbell's basic strategy, simply substituting universals for tropes.

Unfortunately, Campbell's approach relies upon an antecedent understanding of number. For there is *one* individual trope, and then *another*. This somehow makes *two*. Together with another trope, we somehow have *three* tropes. Notice that this presupposes the concept of a single unit, as well as the concept of addition — that individual units can stand in the addition relation and generate a new number. The addition relation does not supervene on the tropes themselves, and it needs to be accounted for in a mind-independent manner, not presupposed. It seems abstract. Further, the mental operations of abstracting away from particular tropes to grasp the unique particularity of each trope are mentalistic.

We have discarded a variety of nominalisms in pursuit of a nominalist answer to our problem. At this point, perhaps it is best to consider a response to the argument that does not appeal to nominalism. According to Platonistic physicalism, the physicalist does not have to turn to nominalism in the first place, for physicalism can be Platonistic. So, Premise 3 of the argument is false, for abstract entities can be physical. Is this a plausible approach?

6. Platonistic Physicalism?

The Platonistic physicalist responds to my argument thus. You claim that it is damning for the physicalist to be a Platonist. But Platonism is compatible with a physicalist answer to the mind–body problem for two reasons. First, the mathematical structures that characterize the physical base are part of a completed physics and are thereby physical. Second, there are no mental entities in the base, and it is this issue, in particular, that philosophers of mind are concerned with when they debate the plausibility of physicalism (Montero, 2009; Papineau and Montero, 2005). So Premise 3 is false: abstract entities can be physical.

In response to the first point, although the mathematical statements that describe the physical realm may be within the explanatory domain of a completed physics, this is not a scenario in which physicalism is true. Platonism is incompatible with the view that everything is physical, or composed of physical entities, for, according to Platonism, mathematical entities are *non-physical.* This is not an idiosyncratic understanding of Platonism on my part; this is a commonplace understanding of what abstract entities are — they are non-physical. Consider, for instance, the entry on Platonism in the *Stanford Encyclopedia of Philosophy*:

> Platonism is the view that there exist abstract (that is, non-spatial, non-temporal) objects. Because abstract objects are wholly non-spatio-temporal, it follows that they are also entirely non-physical (they do not exist in the physical world and are not made of physical stuff) and non-mental (they are not minds or ideas in minds; they are not disembodied souls, or Gods, or anything else along these lines). (Balaguer, 2014)

Regarding the second point, it is important to ask: is this really physicalism, or is it just the rejection of mentality as an ontologically basic element of reality? Calling this view ‘physicalism’ misses the point: that which seems to individuate the ‘physical’ entities is irreducibly *non-physical*. If the language of physics refers to objects

and properties that are individuated by irreducibly non-physical entities, unless we are given an account of why the individuative entities are not part of the object and property natures, and what the true natures are, then physics, upon reflection, is not physicalistic, even if mentality is not basic. Similarly, if physics discovered that consciousness is basic, or that there are ghosts or Gods, many would say that, although these entities can be said to be part of the domain of physics, there is an important sense in which physicalism is false. Physics would not be physicalistic.

Still, there is no consensus among physicalists about how to define physicalism (see, e.g. Melnyk, 2003; Ney, 2008; Stoljar, 2010). And some physicalists formulate their physicalist view as a position about contingent entities only, and they may insist that Platonism is compatible with physicalism. So, to those who insist that Platonistic physicalism is *bona fide* physicalism, I'll argue that Platonistic physicalism is no physicalism worth having. It avoids the Problem of the Base but ruins physicalism. But first, it is crucial to note an important feature of Platonistic physicalism. *It is not monistic* — it features a dualism of the abstract and concrete. There is, on the one hand, a realm of abstract mathematical entities, as per Platonism, and, on the other, a realm of concrete entities, such as ordinary objects and their dispositions, as per physicalism.[9] Hence, we must contrast *physicalist monism*, which repudiates abstracta, from *physicalist dualism*, which quantifies over both abstract and concrete entities.

This being said, the conjunction of Platonism and physicalism faces the following three problems (where the second problem itself divides into three sub-problems). These problems strike me as very serious. But, in the case of the third problem, I will suggest a response to it that requires a modification to Platonistic physicalism. This modification is crucial: it avoids an implausible view of substance that the Platonistic physicalist would otherwise need to occupy, and it also helps with the second problem, avoiding two of the three sub-problems. But it will introduce tropes into the Platonist's ontology, believe it or not.

(1) The Problem of Lost Ontological Economy. Perhaps the strongest consideration in favour of physicalism is that it promises to

9 Although Platonism in philosophy of mathematics does not entail that there are concrete entities, our Platonist is a physicalist, so she will surely include *concreta* in her ontology, although she will face problems concerning their nature, as we'll see.

be the most parsimonious account of reality. According to the physicalist, competing views of the nature of mentality, such as property dualism, substance dualism, and panpsychism, posit extra ingredients to reality, above and beyond those posited by science, and are less economical than physicalism.[10] But Platonistic physicalism cannot deliver on this promise, for it posits extra ingredients outside of space-time that are not part of physics itself, but which are arrived at on the basis of philosophical reflection about the nature of mathematical entities. Indeed, this form of physicalism is a kind of dualism; there is, on the one hand, the concrete realm of objects and their properties, and, on the other, an abstract realm of Platonistic entities. The final section of the paper will highlight the significance of this issue to the debate over the nature of consciousness.

(2) Three Naturalization Challenges. Platonistic physicalism undermines the physicalist's naturalistic aspirations in the following three ways, each of which relates to the acausal nature of abstract entities. (2a) First, if the Problem of the Base remains unsolved and the base threatens to be abstract, then externalist, naturalistic theories of meaning, intentionality, and reference will be unavailable to the Platonistic physicalist. For how can events and property tokenings, even microphysical ones, figure in the nomic or causal relations that the externalist/naturalist claims determine meaning, intentionality, or reference? For the physical events and property instances seem to have abstract natures, and abstract entities have traditionally been a problem for naturalistic theories, after all. As a result, externalist theories that rely upon a nomic/causal connection will be unavailable to the Platonistic physicalist. Let us call this 'the first naturalization challenge'.

(2b) A related problem is that, in so far as the nature of the entities in the physical base seems abstract, both mental and physical causation become a mystery, for how do abstracta enter into causal relations? Abstracta are by definition immutable, acausal, and outside of space and time. While the physicalist has traditionally had an advantage over property dualism in the domain of mental causation, claiming that mental properties are epiphenomenal if property dualism is true, the physicalist's situation is even *worse* than the epiphenomenalism of the mental. For the physicalist cannot explain physical

[10] Of course, it may be that positing an extra ingredient is justified because doing so provides the best explanation of consciousness.

causation, in so far as the base seems abstract. Further, because the physicalist holds that the mental is just the physical, mental causation will be mysterious as well.

(2a) and (2b) both assumed that the physical base is abstract. But I've stressed that the physicalist will likely want to deny this. To do this effectively, she must provide an account of the nature of the entities in the base, one in which the basic entities are clearly concrete. We've ruled out various nominalist approaches to making the base concrete. In a moment, we'll see how the Platonistic physicalist might try to render the base concrete as well. But for now, let us simply assume that the physicalist can prove her point.

(2c) This leads me to the third naturalization problem, which is closely related to (2a). If Platonism is in force, even if the base is concrete, and even setting aside appeals to particular naturalistic theories of meaning and reference, there is still an issue of how statements about the concrete world can be meaningful or true. For recall that Platonism claims that statements in mathematized physics are about abstract entities, for their truthmakers are abstracta. But a problem emerges, for the physicalist wants the world of concreta to be merely described by the mathematics, rather than having a mathematical nature. But how, given Platonistic physicalism, do statements in mathematized physics even get to be about the concrete world to begin with? Aren't they instead about the Platonistic realm of abstract entities? Indeed, since the physicalist claims that everything depends upon the realm of fundamental physics, wouldn't even claims about ordinary objects and living things be about abstract entities as well, for wouldn't macroscopic truthmakers just be complex entities that are made up of microscopic physical entities that have abstracta as truthmakers? But, of course, abstracta are the wrong kind of truthmakers for statements about the world of microphysics, let alone the world that supervenes on it. I shall refer to this problem as 'the third naturalization challenge'.[11] Again, unlike (2a) and (2b), (2c) assumes that the base is genuinely concrete, illustrating that a related naturalization problem still ensues.

Finally, our last problem will lead me to suggest an important modification to Platonistic physicalism.

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[11] This point strikes me as being a general objection to mathematical Platonism, in fact: abstracta are the wrong kind of truthmakers for mathematized physics, but they turn out to be the truthmakers, if Platonism is in force.

(3) The Problem of Object Natures. According to Platonism, an object's having a property is its bearing a relation of instantiation to a transcendent universal or form in the abstract realm. Now, notice that the leading theories of substance, the bundle and substratum theories, are *constituency views* of substance — that is, they do not regard objects as metaphysically basic, but instead hold that they are made up of items from another category or categories (their constituents). According to the bundle theory of substance, an object is a bundle of universals. The substratum view, in contrast, takes objects to be properties, together with a thin particular, or substratum (Schneider, 2012; 2013a). Peter van Inwagen recently noted that it is bizarre to say that an immanent universal is a *constituent* of a substance: '…if properties, like propositions and proper relations, are abstract objects, there is no possible sense of "constituent" in which a property can be a constituent of an individual like a boulder or a dog' (van Inwagen, 2015, p. 52). Indeed, it is puzzling how something abstract could be a constituent of a spatio-temporal object. This suggests that the Platonistic physicalist will have to reject the two leading theories of substances in metaphysics, the bundle and substratum theories, for these are constituency views.

The problem, however, is that these are the natural positions on substance natures for the physicalist to occupy, and there are few other viable options of particularity that are both independently plausible and compatible with physicalism (see Schneider, 2013a). Further, many physicalists regard properties as being metaphysically basic, such as proponents of Humean supervenience. These physicalists tend to treat objects as metaphysical constructs of properties, as with the bundle theory, or from propertied substrata, as per the substratum view. Competing views of the nature of mentality, such as pan-psychism and emergent property dualism, do not have to reject the leading theories of substance. This is yet another strike against Platonistic physicalism and, given that these leading theories are unavailable, Platonistic physicalism needs an alternate theory of substance.

What could substance natures be, given a commitment to Platonism and given that the bundle and substratum views are unavailable? Here, D.M. Armstrong comments:

> It is interesting to notice that a separate-realm theory of universals permits of a blob as opposed to a layer-cake view of particulars. For on this view, what is it for a thing to have a property? It is not the things having some internal feature, but rather its having a relationship, the

> instantiation relationship, to certain universals or Forms in another realm. The thing itself could be bloblike. (Armstrong, 1989b)

While Armstrong agrees with van Inwagen that the Platonist needs a blob theory of objects, unlike van Inwagen Armstrong objects to the blob view, finding it implausible to deny that properties are internal features of objects. I agree. For objects have the causal powers they do because the property tokenings are internal to the objects, not because they bear a relation to a universal that is outside of space-time. Something outside of space and time cannot cause objects to behave the way they do. Nor can it account for the fact that things in nature resemble each other, for that matter.

A blob theory of objects would be a major drawback for a Platonistic physicalism, but perhaps there is a way to avoid it. Armstrong suggests that the Platonist commit to tropes, in addition to the category of transcendent universals: 'It is true that the thing could also be given a property structure. But then the properties that make up this structure cannot be universals, but particulars. They would have to be tropes' (*ibid*.). In this way, the Platonistic physicalist can say both that mathematical entities are abstract *and* that properties of spatio-temporal objects are tropes. Let us call the trope/universals position the *mixed view*, and the original view *pure Platonism*.

Although the mixed view is less parsimonious than pure Platonism, it is a better option for the Platonistic physicalist, I believe. For the physicalist can explain the resemblance and causal powers of objects in terms of tropes, and is free to adopt either the bundle theory or substratum theory of substance. Further, the first and second naturalization challenges do not arise for the mixed view, for unlike transcendent universals, tropes are part of the concrete, spatio-temporal manifold, and thus can enter into causal relations. But the other aforementioned problems arise, and it is natural to wonder how these tropes are to be individuated, for as per the Problem of the Base, they cannot be individuated via abstract entities.

I will press the matter of trope individuation shortly, but for now let me note the dialectical significance of our results, thus far. Before discussing the Problem of the Base, it is likely that the reader had not appreciated the significance of debates in philosophy of mathematics to the debate over the plausibility of physicalism. We've learned that the physicalist seems barred from embracing even the finest nominalisms, and we've learned that physicalism needs certain costly ontological commitments to get off the ground at all: transcendent universals as well as tropes. While tropes are fine, taken alone, the

problem is that they come in tandem with transcendent universals, leaving the physicalist with two separate categories of properties. Further, given that physicalists tend to frame their positions in terms of immanent universals, this is all very surprising, and, for those who have principled reasons to reject tropes or transcendent universals, this matter may lead them to rethink physicalism altogether. It is also surprising that, assuming nominalism is indeed off the table, physicalism turns out to be less economical than many of its competitors, being a form of dualism. Further, I've explained that it may have problems with naturalistic accounts of meaning, and even mental and physical causation itself.

In any case, let me press on — there are a few key moves the Platonistic physicalist can yet make. I will now consider two new responses to the Problem of the Base that urge that the base is concrete. Along the way, I will comment on the outstanding matter of trope individuation.

7. Two Routes to a Concrete Physical Base

I've noted that a common Platonistic physicalist reaction to the problem is the following: mathematics is an epistemic device for *describing* the behaviour of concreta — mathematical entities are not literally part of the nature of the base. It will be useful to distinguish two kinds of responses along these lines.

(1) The Non-essential Individuator Approach. On this view, mathematical entities individuate concreta (so Premise 1 of the argument is granted), but that which individuates is said to merely sort properties and objects into classes, rather than identify the underlying nature of things.[12] This amounts to a denial of the second premise of the argument, the premise that held that if abstracta individuate some entities in the base, then those entities have (at least partly) abstract natures.

This approach leaves the nature of entities in the base unspecified. (In contrast, the second approach will take individuation seriously, allowing that the job of individuation is to specify an entity's nature. But the second approach, unlike the first, denies that abstracta individuate.) The first approach says the identity conditions are only conceptual, just telling us how to sort entities of a given category into

12 These two positions were suggested to me, in broad strokes, by David Robb and Philip Goff.

types. Consider, for instance, individuating a Matisse painting with respect to the painter, Matisse, while denying that Matisse is literally part of the nature of the painting. This leads to an important response to the Problem of the Base: if Platonism is true, mathematical entities are outside of space-time, but certain mathematical systems are apt for describing the world. It is useful to *describe* the behaviour of concreta in mathematical terms, but these are descriptions only; abstracta are not part of the nature of the base. A proponent of the mixed view will say that the descriptions systematize the universe of tropes; the advocate of pure Platonism will say that they describe the behaviour of bloblike substances, as unsatisfying as this may strike you.

Do the three earlier problems still arise for the non-essential individuator approach? The approach surmounts the first and second naturalization challenges, for the base is not abstract, even for advocates of pure Platonism. But the third naturalization challenge still arises. The non-essential individuator approach still embraces a 'two realm theory', positing both abstract and concrete entities, so it still faces the problem of lost ontological economy. Finally, since objects are concrete, the object problem still arises for pure Platonism.

The approach introduces new problems as well. I find this approach dubious, for identity conditions are almost always ventured to make a claim about the nature of the entity in question. Indeed, even the example of the painting can be reframed to say something informative about the painting's nature — it is plausibly individuated by the historical property of being painted by Matisse, and it has this property as a constituent, rather than Matisse himself. But perhaps this view constitutes an exception.

There is a more serious problem, however. Given that the very resources of mathematized physics are off the table as an account of the metaphysical nature of the base, it is unclear what, if anything, physicalism can say about the base. But this first approach says nothing about what individuates the base in any case: it merely denies that the individuators (i.e. the abstract entities) are part of the nature of entities in the base. Now notice that, when Platonism is in force, many intuitively non-physicalist scenarios are compatible with the truths of mathematized physics, for physics is said to be about abstracta, rather than being about the inhabitants of the spatio-temporal manifold. For instance, the truth of the entire body of statements comprising a completed physics is compatible with the situation in which the fundamental spatio-temporal properties or particulars are all mental (a kind of *idealism* about concreta combined with Platonism about *abstracta*).

Alternately, experience could be part of the nature of fundamental entities (*panpsychism*), or fundamental entities could have non-physical properties that are precursors to consciousness and that can collectively constitute consciousness in sophisticated systems like brains (*panprotopsychism*). Or, our physics could describe abstract states and processes in a computer simulation (Bostrom, 2003). In each of these scenarios what many intuitively consider to be physicalism is false, yet Platonistic physicalism is true.

In response, the Platonistic physicalist can add clauses to her definition of physicalism and, in so doing, exclude these scenarios. This can be done, but this merely sharpens her definition of Platonistic physicalism. We can just reframe the problem as the *epistemological* challenge of how we can know that this sharpened version of Platonistic physicalism is true. I will call this 'the problem of epistemic over-inclusiveness'. The problem is that the Platonistic physicalist needs to show that her view is likely true. Otherwise, why be a Platonistic physicalist at all? According to the traditional physicalist picture a key reason why physicalism is true is that it offers the most parsimonious explanation of reality, requiring a commitment to nothing over and above what physics delivers up. But remember, Platonistic physicalism is a form of *dualism*, and involves a commitment to a realm of abstracta outside of space-time. A monistic panpsychism is more economical, for instance, and property dualism is arguably as economical as a dualism of the abstract and concrete. (Section 8 will discuss this matter in more detail.)

What is needed is an alternate individuation condition, not an approach that merely urges that the individuators are not part of the nature of the entities in the base. For something more needs to be said about the nature of the base. This leads me to the second response.

(2) The Alternate Individuator Approach. What if the Platonistic physicalist provides a different kind of individuation condition — one that doesn't appeal to mathematical entities — rather than merely denying that mathematics individuates? (We can call this second kind of approach *the alternate individuator approach*, to distinguish it from the earlier approach, which does not supply an individuation condition.) This kind of approach denies Premise 1 of the argument, which claimed that abstracta individuate at least some of the entities in the physical base.

Here, we must ask: what physically kosher alternate individuation condition is available to the physicalist? (Recalling our discussion of the mixed view, it is useful to bear in mind that, if this view is in

force, our answer to this question would speak to the matter of trope identity.) Our discussion of nominalism in philosophy of mathematics led us to rule out spatio-temporal individuation and individuation via appeal to macroscopic objects and properties, for both faced direction-of-explanation worries. And a phenomenological handle on physical objects and properties is off limits, as the physicalist cannot say that the nature of the base is mental.

What about claiming that the entities in the base are individuated *solo numero*, having no essence above and beyond their numerical distinctness? Here, I'll focus on properties, for, as mentioned, property ontologies are common, and, as noted, the mixed view must appeal to tropes. I have elsewhere criticized the position that properties are merely numerically distinct (Schneider, 2003). It is well-known that a key phenomenon that a theory of sparse properties is employed to explain is the apparent existence of identities in nature between different objects (including fundamental entities like particles and strings). Proponents of both universals and tropes have long urged that the only adequate account of the fact that objects appear to be identical in certain respects appeals to properties. In addition, sparse properties have long been appealed to in order to explain why objects have the causal powers that they have (Armstrong, 1978; Lewis, 1983). Platonistic physicalism will have special interest in the properties identified as fundamental by a completed physics. These play the theoretical role of the sparse properties, and are the properties in the physicalist's base. But bare numerical distinctness doesn't allow for a conception of sparse properties. For what accounts for the fact that different objects appear to be identical in certain respect(s) while others do not? It cannot be in virtue of a universal's numerical distinctness that objects that have it appear to be identical in a certain respect. If every universal only differs numerically, then objects having any property should resemble each other equally. But this is obviously not the case.

Further, how do objects have the causal powers that they have and which serve to identify the properties? It cannot be in virtue of the nature of a property, F, that an object has causal power P; otherwise F would not merely be numerically different from other properties, as something peculiar to the nature of F is needed to determine that F confers on objects the particular causal power(s) that it confers. After all, if every property is merely numerically distinct, why don't they all simply confer the same causal powers (Schneider, 2003)?

In sum, Platonistic physicalism is deeply problematic. It should be rejected. It was important to give Platonistic physicalism its due, however, as we were unable to locate a viable nominalist response to the problem. While nominalism has traditionally been viewed as a natural ally of physicalism, Platonistic physicalism is a strange bedfellow, as it posits abstracta. This just doesn't seem like physicalism — the view that *everything* is physical. After all, it is dualist. Further, we've seen that Platonistic physicalism faces several serious problems. These matters deserved urgent attention, for Platonism is a well-regarded position in philosophy of mathematics, and there are important considerations in its favour, such as the Quine-Putnam indispensability argument, which holds that the indispensability of mathematics to empirical science provides us with good reason to believe in the existence of mathematical entities (Quine, 1976; Putnam, 1979).[13]

In closing, let us consider the impact of our discussion on the debate over the nature of consciousness.

8. Mind, Matter, and Mathematics

The physicalist faces a dilemma. On the one hand, it is natural for the physicalist to turn to nominalism to answer the problem. But even well-received nominalist theories, like fictionalism, introduce severe direction-of-explanation worries into the physicalist's programme. On the other hand, Platonistic physicalism is dualist: it holds that immutable, non-spatio-temporal entities exist, and play an important role in physical theories. I've argued that this is not really a physicalist position, and that, further, Platonistic 'physicalism' faces serious problems. In essence, the dualist version of physicalism features a metaphysical realm of the concrete that is currently less well understood than the realm of the abstract, ironically. For Platonism in philosophy of mathematics is well developed.

This being said, there is still one final matter to address: how the Problem of the Base informs the debate over the nature of consciousness. It will be instructive to consider a well-known alternative to physicalism, *naturalistic property dualism*. Naturalistic property dualism holds that both qualia and physical properties are funda-

[13] Perhaps the Platonist could similarly claim that Platonism is indispensable to physicalism because physicalism lacks suitable nominalistic truthmakers.

mental, and that qualia are macroscopic properties that emerge from certain complex systems (e.g. brains) (Chalmers, 1996). The property dualist urges that she has the best explanation for the explanatory gap between mental and physical properties. Of course, physicalists dispute this, and they charge that their theory is more economical than dualist theories. Property dualists counter that the addition of qualia to one's fundamental ontology is justified because it is the best explanation for the phenomenon of conscious experience. Physicalists counter that the dualist is merely taking qualia as fundamental — this is not really explaining qualia but taking them as basic. And the debate continues.

When it comes to intuitions about qualia, philosophers rarely change their minds. Instead of debating intuitions about consciousness, a different sort of strategy involves showing that physicalism rests on shoddy metaphysical foundations: it doesn't mesh with well-respected positions on properties and particularity in the fields of metaphysics (Schneider, 2012; 2013a,b; 2017), and with theories of the nature of mathematical entities in philosophy of mathematics. It thereby lacks a coherent metaphysical framework.[14]

As mentioned, physicalists traditionally claim that their approach is more economical than dualism. They further claim that they have the upper hand *vis-à-vis* mental causation. For, in the eyes of many, a complete account of the causation of thought and behaviour can be told by appealing to the physical properties of the brain; qualia, being non-identical to physical properties, seem epiphenomenal.

Left unsolved, the Problem of the Base strips physicalism of these two traditional advantages. For, if the physical base threatens to be abstract, the physicalist is in worse shape than the property dualist with respect to causation, as she now has a problem with *both* physical and mental causation. For how can physical objects and properties, including entities built up out of these (such as mental properties), enter into causal relations if their natures are even partly abstract? Further, physicalism is not more economical than property dualism. For an ontology of physical and abstract entities is just another form of dualism, and this is no more economical than traditional property

[14] This is not to say that computationalism about the brain is also problematic. Although many computationalists are physicalists — they tend to be non-reductive physicalists, in particular — one can be a computationalist while rejecting physicalism.

dualism, at least if the property dualist does not add abstract entities to her ontology.

Can the property dualist avoid abstracta, however? If not, she would no longer be a dualist, but a pluralist, and her position would be less economical than physicalism, after all. Indeed, there is a sense in which the traditional property dualist faces the Problem of the Base. For the property dualist quantifies over both mental and physical properties, and perhaps over physical particulars, and given that physics is highly mathematical, it may seem, at least at first blush, that physical entities are abstract. Having naturalistic inclinations, the property dualist should explain why this is not the case. After all, we've noted that if physical entities have (even partly) abstract natures then physical causation would be mysterious, and dispositions would threaten to be unknowable. Further, the dualist may wish to specify the nature of fundamental physical entities in order to provide a well-defined conception of the physical, and, relatedly, to better demarcate the difference between physical and non-physical properties.

It is of course open to the dualist to be a Platonist (in this case, technically, she is not a dualist but a pluralist). And perhaps she should be a Platonist — again, Platonism may be correct. But importantly, *the property dualist need not be a Platonist*; she can regard mathematics as a system of human classifications without succumbing to circularity. For mental phenomena are free to serve as truthmakers for statements in mathematized physics. For, according to property dualism, mental phenomena are already fundamental.

Appealing to mentalistic truthmakers changes the shape of property dualism, however. Here, there are two routes the dualist can take. (i) If mathematical entities are cashed out in terms of phenomena like human classifications, aesthetic concerns, or concepts, then the dualist can claim that macroscopic mental properties, such as concept or belief types, individuate the fundamental physical entities. Although naturalistic property dualism has not been framed herein as a version of panpsychism, this modified dualist position is similar to panpsychism in that mental phenomena are metaphysical constituents of physical entities. However, the view features fundamental mental entities that are macroscopic, not microscopic. The macroscopic mental entities individuate the fundamental physical properties. Now, this may be too much to swallow for some traditional property dualists. If one is willing to live with this feature of the view, however, there are benefits. This brand of property dualism is no less economical than physicalism, as I've noted. Further, there is a sense in

which mental entities are causal. Because mental properties individuate the physical properties the mental is part of the nature of the physical (part, but not all, for presumably the property dualist will want the physical properties to be something more than just mental properties). If the physical depends on the mental and the physical realm is causal, one can devise at least a derivative sense in which mental properties are causal.

(ii) The second route is superior, I believe. The dualist can avoid macrophysical truthmakers altogether by turning to panpsychism or panprotopsychism, and thereby putting mental (or protomental) phenomena into the micro-level itself. Because, in this case, the truthmakers for mathematical statements would supervene upon a base of micro-level mentalistic entities, macroscopic properties are not required to individuate fundamental physical properties and objects. The micro-level properties can do the work.

I cannot develop different versions of panpsychism and panprotopsychism herein, but it is worth noting that there are both monistic and property dualist versions of panpsychism and panprotopsychism (Alter and Nagasawa, 2015; Chalmers, 2014; Goff, 2015; Strawson, 2006). *Ceteris paribus*, a monistic version of either view that repudiates Platonism would be *more* parsimonious than physicalism, and a property dualist/nominalist version of either view stands to be equally parsimonious. Panpsychism and panprotopsychism both tend to fare well with respect to mental causation as well, for the phenomenal properties are at the micro-level.

In sum, this new problem has introduced novel dimensions to the debate over the nature of consciousness. I'll conclude with a suggestion for the physicalist. Platonistic physicalism brings with it a host of problems, and it isn't genuine physicalism in any case. The physicalist should instead strive to locate a workable nominalist theory. If one is found, we could learn a good deal about physicalism, for we would know what statements in fundamental physics are *about*. These truthmakers would surely play a foundational role in the physicalist's theory, but we currently do not know what they are.

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