The Fundamentality of Physics: Completeness or Maximality?

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1. Completeness Physicalism

Why is it reasonable to try to explain consciousness in physical terms, in terms of information integration, ion channels, or resonant frequencies? Or to search for the origins of life in the principles of thermodynamics? To look to the spin states of elementary particles for a means of early cancer detection? Or to think that what is accelerating all galaxies away from each other must be some kind of physical force?

Although the answers to all of these questions vary in their details, there is a working assumption underlying them all. This is an assumption the scientist (the neuroscientist, biologist, medical researcher, or cosmologist) takes for granted and rarely if ever will explicitly discuss. The assumption is that *our world is fundamentally physical*, that *physics is a fundamental science* and so there are physical truths that can serve to explain even the most complex (and animate) scientific phenomena. As the philosopher would put it, the working assumption behind this and so much else of scientific research is that some sort of physicalism is true.

My aim in this paper is to put this basic assumption under philosophical scrutiny and ask what is the right way to understand physicalism. There is a standard way of interpreting it, certainly in the philosophical literature, but also I think more broadly in the scientific community. This is as a completeness thesis of some kind. Let's characterize the view I will call *completeness physicalism* disjunctively in the following way:

> *Completeness physicalism*: all facts or entities consist of or are dependent on or supervene on or are realized by or may be completely explained by or grounded in the facts or entities of physics.

Completeness physicalists believe that there is or in principle could be some future physics that plays this role of providing a complete explanatory or ontological basis for our universe.[1] And this provides a basis for claiming that physics is special among the sciences, that it is fundamental. There is in principle some physical theory that alone provides supervenience bases or realizers or grounds for all facts or entities, or that describes a class of independent entities on which all else depends, or that is explanatorily privileged in some way, in being explanatorily complete. My main aim in this paper will be to show why we as physicalists should move beyond completeness interpretations of physicalism and the completeness of physics.

Typically those who have raised critiques of positions like completeness physicalism do so in order to motivate some version of dualism, pointing to phenomena like phenomenal consciousness that seem to resist explanation in physical terms. Yet it is easy to show that completeness physicalism is unjustified, if not outright false, without making any appeal to consciousness or other intractable mental phenomena. Completeness physicalism is problematic already for its reliance on questionable assumptions about physics, many of which have been widely recognized as questionable in the philosophy of science for decades. Moreover, completeness physicalism is

[1] Or perhaps, our concrete universe.

untenable in failing to provide the physicalist with any usable guide to ontology or metaphysical commitments. This undermines the entire point of adopting a position like physicalism: to give one an empirically motivated metaphysical framework that can then be put to work in directing one's philosophical and scientific projects.

Before I develop these points, I want to make it clear that my aim in criticizing completeness physicalism, unlike that of others who have raised some of these concerns (Crane and Mellor 1990, Koons and Bealer 2010, Stoljar 2010), is not to try to convince us to discard physicalism. I am a physicalist, and I think physicalism is an important position worth defending because it is a position that has done a lot of good for us, motivating philosophical programs, bodies of scientific research, and technological innovations that have improved our lives.[2] Thus, it is important for us as physicalists to be clear about the flaws with the standard, completeness interpretations of physicalism so that we may move past them and formulate versions of physicalism that can withstand critical scrutiny.

To that end, I will propose a formulation of physicalism that could be used to replace the standard completeness interpretations. I will contrast the standard *completeness physicalism* with what I regard as a more plausible *maximality physicalism*. While completeness physicalism asserts the ontological or explanatory completeness of some future or in principle formulable physical theory, maximality physicalism instead only requires the ontological or explanatory maximality of our current physical theories. That is, it requires the ontological or explanatory superiority of physics, in certain

[2] I will not therefore be advocating we reject physicalism and replace it with some kind of dualism. I am optimistic, based on progress in the philosophical and scientific study of consciousness, that we will be able to explain conscious experience in physical terms.

respects, over all other scientific theories or epistemic frameworks. I think the maximality physicalism I develop below is a promising way to go, but my primary goal in this paper will not be to convince the reader to adopt my specific form of maximality physicalism. The main point here is rather that completeness physicalism ought to be replaced, and something like my maximality physicalism takes us in a more promising direction, more in line with what we know about physics and what we want from physicalism, than completeness physicalism does.

I will rely on one fixed point in the discussion that follows since it is important to have some fixed point when we are asking questions about how to interpret some key concept or position. This is a claim I have already made and now want to underline about the practical import of physicalism: physicalism is worth defending for its success and future promise in motivating explanatory, predictive, and engineering projects in philosophy, science, technology, and public life that have in the past and continue to improve our lives in many ways. The adoption of physicalism drives ways of understanding ourselves and many previously puzzling aspects of reality, motivating an impressively broad range of explanations. It motivates frameworks for modeling and predicting the behavior of complex systems, including biological systems, with an extraordinary level of precision, leading to innovations with medical and other practical benefits too numerous to mention.[3] This is the physicalism we are trying to characterize.

2. Hempel's Dilemma

[3] See Dove and Elporidorou (2019), and also Melnyk (2009) on naturalism, both of whom also emphasize the positions' roles as research programs.

We can begin to see the problems with completeness physicalism by considering a question about the formulation of physicalism raised by Hempel (1980). This is commonly called *Hempel's dilemma*. Hempel asked, if we are to be physicalists and claim that physics occupies a privileged position among the sciences – in the positivistic terms of his day, that it be regarded as the unitary language of science – then which "physics" are we talking about?

> The physicalistic claim that the language of physics can serve as a unitary language of science is inherently obscure: The language of *what* physics is meant? Surely not that of, say, 18th century physics; for it contains terms like 'caloric fluid', whose use is governed by theoretical assumptions now thought false. Nor can the language of contemporary physics claim the role of unitary language, since it will no doubt undergo further changes, too. The thesis of physicalism would seem to require a language in which a *true* theory of all physical phenomena can be formulated. But it is quite unclear what is to be understood here by a physical phenomenon. (1980: 195)

Hempel's dilemma is the problem that if physicalism is understood in terms of current physics, then it is false, because current physics will likely be replaced with a better theory, and physics presently doesn't have the resources to characterize all phenomena. But if physicalism is understood in terms of future physics, then it is difficult to know what physicalism comes to, because we don't yet know what the future completed theory is.[4]

[4] For discussions of Hempel's Dilemma, see Papineau and Spurrett (1999), Ney (2008c), Stoljar (2010), and the essays in Dowell (2006a).

Most physicalists who address this issue today do not regard it as much of a problem because they think the answer is obvious. Surely physicalism is a claim about the ontological or explanatory completeness of some *future* physics. Past physical theories were all in some way false, and current physics, if it isn't false, is at least incomplete.[5] So physicalists go about characterizing their position in terms of the completeness of some future physical theory. For example, according to Loewer, "physicalism claims that all facts obtain in virtue of the distribution of the fundamental entities and properties – whatever they turn out to be – of completed fundamental physics" (2001, see also Dowell 2006b, Pettit 1993). And Lewis defined physicalism (he preferred the term 'materialism') as the view that "physics – something not too different from present-day physics, though presumably somewhat improved – is a comprehensive theory of the world, complete as well as correct" (1983: 361).

We can see Lewis here as being cautious here, hoping that this future completed physical theory is close enough on the scientific horizon that we already have some idea of its theoretical commitments. Lewis's characterization of physicalism thus attempts to navigate between the two horns of the dilemma. But given the magnitude of the open problems in current physics, it is not likely physics will reach completion without significant revolutions. To cite just two examples, physics still has no idea what makes up dark matter, which is supposed to constitute 85% of the total mass in our universe (Duda and Garrett 2011). There was an early near-consensus that dark matter could be explained by the postulation of a supersymmetric particle, the neutralino, but as of yet, there has

[5] Only Melnyk (1997, 2003) seems to recommend viewing physicalism as the view that current physics provides a complete explanatory or ontological basis for reality. He takes current physics to provide a complete set of realizers for all entities.

been no evidence for supersymmetry at the LHC (Redlinger and de Jong 2017). So, the empirical evidence does not seem to point toward understanding dark matter as constituted by supersymmetric particles. In addition, although physicists would very much like to have a quantum theory of gravity, there is no consensus here either of what is even the right starting point from which to develop such a theory. String theories, strategies based on canonical quantum gravity, and approaches like causal set theory all have very different theoretical starting points and arrive at very different fundamental ontologies ranging from strings to spin foams to causal sets (Smolin 2001). Given the significance of these problems, a completed physics seems very much in the future, and its nature obscure.[6]

I want us to be clear now just how problematic this is for the kind of physicalist Hempel has in mind, one whose claim is that physics should serve as the unitary language of science. This is a physicalist like Carnap (1934, 1936) or Neurath (1931) whose core claim is that one should aim to translate all other sciences into the one language of physics, or the physical language, thus promoting the unity of science.[7] Since a formulation in a single language makes more transparent the connections between different fields, and translation into the language of physics in particular allows a science's claims to be intersubjectively testable, this sort of physicalism was not intended merely as a linguistic claim, but one that had the potential to be practically useful in improving science as we know it. [8] How is this physicalist supposed to go about her task

[6] See Smolin (2007) for an overview.

[7] Carnap and Neurath went back and forth over the years discussing whether it was the language of physics, or some other language that should serve as the unitary language of science.

[8] See Ney (2008a) for further discussion and references.

of translating the statements of all other sciences into the language of physics, if the relevant physics is one of the distant future? The problem is, Hempel's physicalist is trying to *do something* with physics. And she can't do something with a physics she can't get her mind around.

If we are going to take seriously the idea of physics as a unitary language of science, then we have to be talking about some version of physics we have access to. This will be current physics. But this then takes us back to the first horn of the dilemma. Current physics is likely to be replaced. It isn't the final theory. It isn't a complete theory. But now it becomes natural to ask: for the role Hempel's physicalist wants physics to play, does it need to be a final theory? Does it need to be a complete theory? To these questions, the answer is clearly "No." Physics doesn't need to be final or complete for it to be reasonable for us to begin the process of unifying science with it. For it to be "the best we have" in certain salient respects is enough to motivate us to use it in this respect.[9] And so the first horn of Hempel's dilemma isn't a problem after all, at least for the version of physicalism Hempel was concerned with. It is only a problem if we make the false assumption that for the language of physics to be the unitary language of science, physics must be complete or a final theory.

I hope this is clear enough for the version of physicalism that Hempel had in mind. What should we say about more contemporary versions of physicalism, versions that instead take physics to be a fundamental science in some respect, where this doesn't mean that we should try to translate the statements of all other sciences into the language

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[9] Carnap (1934) and Neurath (1931) certainly didn't think a theory needed to be final or complete to play this role. Both often took seriously the idea that the unitary language of science should be the language we use to describe ordinary material objects. But the folk theory of ordinary material objects is surely not a final or complete theory.

of physics? My claim is that we reach a similar conclusion. If physicalism motivates us to *do something* with physics, then the second horn of the dilemma is still a problem: we can't do anything with a theory we can't get our mind around. Indeed, as we will see, there are more problems with taking the "physics" in physicalism to be some future, completed physical theory than this. And yet, the first horn does not present a problem. For what the contemporary physicalist needs physics to do, it does not need to be a final or complete theory.

3. Maximality Physicalism

It is now time to put a proposal on the table for what a more promising and useful formulation of physicalism could look like, a position I call *maximality physicalism*. Maximality physicalism gets us what we want from physicalism without facing the problems completeness physicalism faces. However, I recognize the proposal I will make is only a start. It is just one way to go in developing a version of physicalism that is well-supported and can play the roles the physicalist needs it to play.

According to maximality physicalism, physics holds a privileged status among the sciences not in being ontologically or explanatorily complete, but in being ontologically or explanatorily maximal, or superior in some respect. The version I recommend takes physics to be *maximal* in the sense that it provides a successful class of explanations that are broader, deeper, and more precise than those of any other science or explanatory scheme.[10] Its explanations are broader in the sense of covering more phenomena. Its

[10] There may be a way of developing an ontological sense of maximality for physics, a way that improves upon supervenience, realization, or grounding formulations of completeness physicalism. However, I will focus only on an explanatory construal here.

explanations are deeper in tracing the constitutive bases of phenomena further than other explanatory schemes. Its explanations are more precise in having more mathematical specificity (e.g. are given to more decimal places) than those of other explanatory schemes.

Note that to say that physics is fundamental in this sense, that it is explanatorily maximal, is not to say that its explanations are all things considered *better* than the explanations provided by other sciences or explanatory schemes, nor of course that the other sciences should or could be eliminated. It is a complicated and vexed issue what makes for the best explanation of a given phenomenon, indeed it is a complicated and vexed issue what makes for *an* explanation of a given phenomenon. In claiming that the explanations of physics are maximal, my claim is only that as a whole they are broader, deeper, and more precise than that of other sciences. To claim that physics is fundamental is not therefore to claim that physics is better than other sciences.

When one holds the claim that physics is privileged or fundamental in the sense of being explanatorily maximal, this will then justify a set of attitudes that make up what I have elsewhere called *the physicalist attitude* (Ney 2008b; see also van Fraassen 2002 for a predecessor position and Stoljar 2015 for critique). For the completeness physicalist, the physicalist attitude is just the belief that the world is the way (the completed) physics says it is, or that everything supervenes on the physical facts, or is grounded in the physical facts, or… But given the maximality physicalist's assessment that the world isn't simply the way physics says it is (nor does it supervene on or is wholly grounded in the physical facts or…), she won't have this sort of belief. For her, the physicalist attitude will amount to something different. As a first pass, we may characterize the physicalist attitude in the following way:

- the disposition to take on commitment to the kinds of things our best current physical theories say exist, that is to use them in one's philosophical and scientific projects
- the disposition to not take on commitment to the kinds of things that one thinks won't be explained by current physical theories[11]
- the expectation (given that current physics is not yet complete) that near future physical theories will continue to improve in their ability to guide explanatory, predictive, and technological projects

These are all attitudes we expect of a physicalist reasonably informed about the character of current physics.[12] Although the completeness physicalist attempts something more, this something more is not reasonable in light of the arguments I will provide in the next three sections.

Hempel's Dilemma is avoided when one claims only the maximality, not the completeness of physics. To the question of what should be the unitary language of science or what should be considered the fundamental science, the answer for the physicalist is of course the language of current physics, the only physics that is presently formulated and reasonable to use in one's projects. As Melnyk notes:

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[11] This disposition is made plausible by the vast scope of physical explanations, their depth in providing constitutive explanations of a diverse range of phenomena, and a kind of exclusion reasoning, that it would be unreasonable to believe in phenomena that aren't explained physically (cf. Kim 2005). For more, see Section 7. Further development of this connection between the maximality thesis and the physicalist attitude is work in progress. Again, my main aim here is to show why completeness physicalism should be rejected and to give an initial sketch of what a reasonable replacement position would look like.

[12] See Maddy (2007) for an approach to naturalism in a similar spirit.

> Physicalists who hold, as I do, that current scientific findings provide support for physicalism must at the least have a formulation of physicalism whose content is determinable by us now. But it is hard to see how else they can get one other than by defining "physical" by appeal to current physics; so that is what I shall do. (Melnyk 2003, p. 14)

Which part or version or interpretation of current physics provides a metaphysical framework for one's projects is a matter left up to the individual physicalist. Scientific practice underdetermines the content of current physics in several ways (French 2014, Chapter 2). So there are many satisfactory ways to be a physicalist.

4. The Vacuity Objection

Now that we have these two contrasting versions of physicalism to consider, we can begin to see the significant problems facing completeness physicalism and how moving in the direction of something more like maximality physicalism can help to better capture the view the physicalist is trying to put forward.

I am going to start by returning to the challenge for completeness physicalism raised on the second horn of Hempel's Dilemma because it has not been recognized by most physicalists just how serious this challenge to their position is. Indeed it has been used by philosophers such as Crane and Mellor (1990), Van Fraassen (2002), and Stoljar (2010) to argue that we should not be physicalists. Crane and Mellor use it in part to argue that "physicalism is the wrong answer to a meaningless question," Stoljar to advise us that the places in philosophy where we have used physicalism to try to state a thesis or motivate a project would be better off if we avoided talk of physicalism altogether. As

I've already said, I am convinced that adopting physicalism and using it to motivate work not just in philosophy, but in science, engineering, and public life, is very much a good thing. The physicalist attitude has yielded for those who adopt it many epistemic and practical benefits. So we should not be so quick to give it up. Nonetheless the philosophers I just mentioned are all correct that the current dominant form of physicalism faces a significant challenge.

The challenge again is that we don't know what a future completed physics looks like and so this makes physicalism framed as the view that a future, completed physics provides a complete explanatory or ontological basis vacuous, or at least lacking in sufficient content. To this, one might reply that of course the phrase 'a future, completed physics' has content. We know what physics is, what 'future' and 'completed' means. What this shows is that the vacuity objection requires a bit more spelling out so that we may see the problem.

In my view, there are two significant issues raised by the vacuity objection. First, our ignorance of what a future, completed physics will look like undermines the ability of completeness physicalism to play the role in guiding philosophical, scientific, and engineering projects that physicalism is supposed to play. Second, this ignorance undermines the justification for completeness physicalism.

Again, physicalism is good and worth defending because of the role it plays in motivating projects that have enhanced our understanding of ourselves and other organic and inorganic systems, as well as our place in the universe, in promoting advancements in scientific research, and in providing a framework that guides us towards certain engineering strategies that have improved our lives in numerous ways. For this to work, research and development must begin with certain facts about what our physical theories posit, the kinds of principles they employ, as well as those they do not. Thus, Hempel's concerns are just as relevant for the contemporary understanding and use of physicalism, not just the form of physicalism explored by the logical positivists. Just as much today as in the past, physicalism guides us to *make use of physics* because it has some special features other theories do not. But we can only make use of a physics whose formulation we have at hand.

Second, physicalism is a position that is empirically justified. It is a myth that some anti-physicalists use in their polemics that physicalism is nothing more than a dogma arising due to some kind of unreasonable physics fetish. As Papineau showed in his 2001 paper "The Rise of Physicalism," physicalism is not a dogma. It is a position supported by empirical argument, one citing the predictive, explanatory, and other scientific successes of our current physical theories, successes that have not similarly been achieved by other epistemic frameworks.[13] These successes are of course the successes of physical theories that have actually been formulated and put to work. They are not successes of some future, completed physical theory. And so we can only build a case for the special explanatory or ontological status of our current physical theories, for the *fundamentality* of our current physical theories, not for any future ones, because they haven't had any successes. To remain committed to some unformulated physical theory, one that hasn't met any empirical successes, should strike one as deeply unmotivated.

[13] I have raised issues for the details of the argument that Papineau formulates in that paper (Ney 2016, 2019), relying as it does on a claim about the causal explanatory completeness of physics, but the big point Papineau is making in that paper about physicalism being supported by the empirical track record of physics in explaining a broad and diverse range of phenomena is correct. See Section 7 for more discussion.

This plays right into the hands of the anti-physicalists who accuse physicalists of clinging to dogma.

Here I should comment on some alternative strategies that have been used to address the vacuity objection, different than my own proposal, which is to characterize physicalism in terms of the maximality of current formulated physics, rather than the completeness of future as-of-yet unformulated physics. Some try to respond to the vacuity objection by filling in the conception of what a future, completed physics will look like, saying physical theories are theories of a certain kind: theories that postulate a certain class of entities or theories that engage in explanations of a certain kind. One might then try to use such a more substantive characterization of physical theory in order to formulate responses to my two vacuity-related concerns about completeness physicalism.

There are three kinds of characterization of physical theories that recur in the literature: (a) those that characterize physical theories as theories that provide microscopic bases for other phenomena (e.g. Pettit 1993, Dowell 2006), (b) those that characterize physical theories as theories that describe a class of entities spread out somehow in spacetime (e.g. Poland 1994, Dowell 2006, Howell 2013), and (c) those that characterize physical theories as those that make appeal only to entities that are (fundamentally) nonmental (e.g. Montero and Papineau 2005, Wilson 2006). Using one of these characterizations, one might respond to my first concern by saying it is true, one doesn't know what the final completed physics will look like in its details, but since physical theories are theories that characterize phenomena ultimately in terms of [microscopic bases or entities in spacetime or nonmental phenomena], then completeness physicalism recommends projects that start from a class of [microscopic constituents, or entities in spacetime, or nonmental entities] because we know now that is what a final, completed physics will postulate. To answer the second worry, one would point to the empirical support that has accrued to theories formulated in terms of [microscopic bases or entities in spacetime or fundamentally nonmental phenomena]. One can then claim that this provides empirical support for a completed theory that is a theory of [microscopic bases or spacetime entities, or fundamentally nonmental phenomena] and this in turn can provide empirical support for completeness physicalism.[14]

Although the response to the first worry is interesting and worth spending some time on, the response to the second clearly fails, for any such strategy of filling in the notion of the physical. For it just isn't the case that all or even most theories formulated in terms of microscopic bases or spacetime entities or fundamentally nonmental phenomena have empirical support. Some do. Some do not. Just the fact that a theory is formulated in these terms doesn't on its own serve to garner that theory any empirical support. And so there is no empirical support for the claim that any as of yet unformulated future theory describing [microscopic bases or entities in spacetime or fundamentally nonmental phenomena] will be empirically supported. So any such characterization of the physical will not suffice to answer the vacuity objection. Nonetheless let's address the response to the first worry.

This was that we can see completeness physicalism as recommending particular kinds of philosophical and scientific projects in the following way. Since we know that a final, completed physics will describe the world in terms of [microscopic constituents or

[14] This is indeed what is done in Papineau and Spurrett (1999), appealing to a notion of the physical as (c) the fundamentally nonmental.

entities in spacetime or fundamentally nonmental entities], we can see that completeness physicalism recommends projects that address the world in these terms. The problem is we can't know that the final, completed physics will describe the world in these terms. Indeed there are physical theories today, widely accepted physical theories, that fail to meet these philosophers' criteria of what physical theories look like. In physics, wholes are not always explained in terms of the features of microscopic parts. Appeals to emergence are rampant. Physics challenges the notion that spacetime is fundamental and routinely appeals to more basic frameworks that can explain the appearance of spacetime in certain regimes (Hugget and Wüthrich 2013). And irreducible mental phenomena are appealed to throughout physics, not merely in claims of consciousness collapsing the wave function, but more widely in use of unexplained notions of information and anthropic principles. There are certainly physicalists who frown upon or lament these facts, especially the last. But they are facts about what real, mainstream physics looks like. And so the claim that the proposed criteria correctly characterize what it is to be a physical theory simply fail, because they fail to characterize actual physical theories in use by actual physicists.[15] This is an illustration of the point put well by Van Fraassen that:

> Whenever philosophers take some general feature of physics and use it to identify what is material, what happens? Physics soon goes on to describe things that lack that feature and are altogether different. (2002)

[15] This isn't to say that there aren't positions in the neighborhood of physicalism that one might want to defend. In the spirit of seventeenth century corpuscularianism, one might want to advocate for the use of microscopic explanations or explanations in terms of spatiotemporal or nonmental entities. But one shouldn't confuse this with physicalism, a view that takes physics to have some privileged ontological or explanatory status among the sciences, since physics frequently violates such restrictions.

Moreover, such characterizations aren't sufficient for a theory to be a physical theory. A theory that the world was fundamentally built out of tiny nonsentient amoebae, a theory derived from a drug-induced hallucination, would satisfy all three criteria for what it is to be a physical theory, yet this seems obviously not to be what the physicalist is after.

Again, we shouldn't take any of this to lead us to reject physicalism, because to be physicalists we don't need a robust characterization of what it is to be physical or to be a physical theory. We just need a sense of what the physical theories we have look like, and which are empirically well-supported.

5. No Positive Argument for a Future, Completed Physics

We have just considered the first concern with completeness physicalism: the lack of an adequate conception of "physics" with which to evaluate what is meant by a future, completed physics. However, even if the concerns of the previous section could be addressed, there is still a question of why one should grant the assumption that there ever will be a completed physics one day in the future, or that such a theory is in principle possible. This section will consider different arguments that might be used to support the completeness physicalist's assumption that there will be, or in principle could be, such a thing as a completed physics.

First, logic or meaning alone doesn't compel us to believe that physics will one day be complete. As Chomsky once noted, simply defining the fundamental physics as completed, true science makes physicalism trivial, "the material world is whatever we discover it to be, with whatever properties it must be assumed to have for the purposes of explanatory theory" (1998, p. 144). But it is not trivial that we are able to give an account of phenomena as diverse as galactic expansion, the origin of life, and consciousness in terms of a few fundamental features and principles.

A better strategy for supporting the claim that there will one day be a complete physical theory is to look for an inductive argument. But note: the way inductive arguments work is by seeing that there were some cases we observed in the past that all had something in common, and they all or generally turned out to be a certain way, and from there we infer that unobserved things that have that feature in common will also turn out to be that way. So, for example, we note that every raven we have observed up to now has been black and so we infer that the next one will be black too, or that they will all be black, or that ravens are generally black. In the present case, to give an inductive argument for the future completeness of physics, we would have to say something like, every time we have observed something needing an explanation, it has been given a physical explanation, therefore, eventually everything will have a physical explanation. The trouble though (setting aside the fact that the premise is false) is that we don't have a similarity class to support the induction. When we are talking about absolutely everything and anything, there is no similarity that ties together the group of observed instances.[16] So one can't argue inductively to the conclusion that there will be a physical explanation for all facts. So one can't argue inductively to the eventual existence of a complete physical theory.

To exhaust all of the options, we should also consider what may be said for an abductive argument for the claim that there will one day be a completed physics. This

[16] It has been suggested we restrict the induction to the contingently existing things. But one may dispute whether this makes for a similarity class. Are all contingently existing things intrinsically similar in virtue of their contingency?

would require showing that the assumption of a future completed physics provides the best explanation of some fact. But what fact? One might say it provides the best explanation of the fact that we have been able to give physical explanations for a diverse class of phenomena in living and nonliving systems, on Earth and elsewhere in the cosmos. But does the hypothesis that there will be a complete physics provide the best explanation of the breadth of successful physical explanations? Isn't rather the approximate truth of our current *incomplete* physical science a better, safer explanation of this success? I submit that it is. The hypothesis of a complete theory is much more than is needed to explain the history of successful physical explanations.

We have now seen that there is no good argument for the claim that there will one day be a completed physics. We have no positive reason to believe in a future, true and completed physical theory. One might respond that we don't need an argument that there will *actually be* in the future a complete physics, but only that there *could be* such a physics in principle (in a world like ours in certain relevant respects). But similar points apply. This isn't something that is true by definition. A modified inductive argument of the form "All observed phenomena have been given physical explanations, therefore, all phenomena could in principle receive a physical explanation" is blocked again by there being no similarity class on which to base the induction. And the assumption of a possible complete physics is no better at explaining data than the assumption of an actual complete physics. It would thus be better to interpret physicalism in such a way that it is independent of such a completeness assumption. I stress my claim here is not that we know now there won't be a completed physics. I do think there are reasons to be skeptical of this claim. But I am only saying we don't have any positive justification for thinking there will be or in principle could be a completed physics. And so the assumption shouldn't be built into the very meaning of physicalism. Physicalism is better supported and more reasonable without it.

6. Tensions with Philosophy of Science

We may now turn to the third and final argument against completeness physicalism. There are several reasonable claims that mark important milestones of late twentieth century philosophy of science. When physicalism is viewed as a kind of completeness claim, these can prove disastrous for physicalism. A physicalist ought to provide an interpretation of her position and of the fundamentality of physics that is reasonable in light of these lessons. I will argue this is another reason to prefer maximality physicalism in the sense I have proposed.

The first lesson of late twentieth century philosophy of science is that often the best explanation of a phenomenon is not the microphysical explanation, but rather some "higher level" or "special science" explanation. A classic illustration of this point comes from Putnam (1975) who asked us to consider the best explanation for why a certain peg is incapable of entering a hole:

> Very often we are told that if something is made of matter, its behavior must have a physical explanation. And the argument is that if it is made of matter (and we make a lot of assumptions), then there should be a deduction of its behavior from its material structure… On the other hand, if you are not 'hipped' on the idea that the explanation must be at the level of the ultimate constituents, and that in fact the explanation might have the property that *the ultimate constituents don't matter,*

> that *only the higher level structure* matters, then there is a very simple explanation here. The explanation is that the board is rigid, the peg is rigid, and as a matter of geometrical fact, the round hole is smaller than the peg, the square hole is bigger than the cross-section of the peg… That is a correct explanation whether the peg consists of molecules, or continuous rigid substance, or whatever. (1975, p. 296)

Putnam actually takes a rather hard line here, insisting that the physical explanation is the wrong explanation, because it appeals to features that aren't, in his words, relevant. This attitude has been agreed to by many philosophers of the special sciences. However, a more moderate position, one that is favored by other philosophers of science who have been influenced by Putnam's example, is not that the physical explanation is the wrong explanation and the nonphysical explanation, appealing to higher level structural features, is the only explanation, but rather that the physical explanation provides a worse explanation and the nonphysical structural explanation provides the better explanation.

Both the completeness and the maximality physicalist should agree that the physicalist claim that physics provides fundamental explanations doesn't mean these explanations are better than any others in the senses one might care about for all purposes. That a higher level explanation is better in a given context does not by itself undermine the fundamentality of physics. A metaphysical claim to fundamentality should not be confused with a claim of superiority in all respects or importance. And so if the lesson one wishes to draw from Putnam's example is that often the physical explanation is not the optimal one to use in a given context, then this is compatible with either form of physicalism.

On the other hand, if the lesson is supposed to be not that the nonphysical explanation is sometimes the better one, but instead that it is the correct one, then this does present a challenge. The difference between the higher level explanation being the right one vs. only the better one makes a difference to the viability of completeness physicalism. If the nonphysical explanation is the right explanation, then physics is not explanatorily complete.

Note the maximality physicalist need not take a stand on this issue. She doesn't need physics to be complete, only maximal. Her claim is only that physics provides precise and deep explanations of a wide range of phenomena. And so even if physics does not provide the right explanation of why a certain peg won't go through a certain hole, there will be a host of related facts that the physical details do explain. That is what makes physics maximal. So this first milestone of late twentieth century philosophy of science supports maximality physicalism over completeness physicalism.

Another lesson has to do with the form and intended scope of our scientific theories, including our best physical theories. Philosophers of science in practice note that scientists, physicists included, rarely try to formulate theories of everything from which we could derive all true facts of the universe. Rather their aims are generally to model some local phenomenon or other. This is true even of the most fundamental physical theories, quantum field theories or cosmological theories.

This second point about most physical theories being local theories however provides a challenge to completeness physicalism. In the event that these many local theories (or models) cannot be patched together to form some one complete theory – and why think that they would? why would there not be gaps? – then this straightforwardly undermines the claim that the world is the way some true completed physics says it is. Yet this does nothing to undermine maximality physicalism which relies only on the success, depth, breadth, and precision of physical explanations, not their completeness. I would take issue with the trope one finds in contemporary philosophy of science that physics is just one among many special sciences, that it does not have some special status among the sciences, of being fundamental. This is no doubt caused by the assumption that fundamentality must be cashed out in some notion of completeness. I of course am arguing here that there is a more realistic interpretation of the fundamentality of physics that does not require its completeness. And so the physicalist can uphold the "locavorism" defended by many philosophers of science (Ruetsche 2015), while maintaining the view that physics occupies a privileged status among the sciences, that it's fundamental.

A third milestone comes from feminist philosophy of science, which has questioned the reductionism implied in claims of the fundamentality of physics. To focus on one strand of argument, claims of the fundamentality of one science have been shown to lead to a potentially dangerous monopolization of resources that might be better used on projects that would have a more beneficial impact on our world. As Cartwright puts it:

> … theories that purport to be fundamental – to be able in principle to explain everything of a certain kind – often gain additional credibility just for that reason itself. They get an extra dollop of support beyond anything they have earned. (1999)

Cartwright argues that we should move beyond viewing some theories or branches of science as fundamental and instead recognize that the reliability of any theory, including those offered as "theories of everything," have only limited applicability within a circumscribed domain.

The social consequences of claims of the fundamentality of physics are relevant to this issue of the best interpretation of physicalism and should not be ignored as they often are in metaphysical discussions. The physicalist should think through what a claim of the fundamentality of physics implies for the privileging of certain research projects over others. But it is possible to say a lot about the practical benefits that come with the funding of projects, even very expensive projects, in physics (Ney 2019). My point here, however, is that it is difficult to even begin to formulate these issues if we are taking the fundamentality of physics to imply the truth and completeness of some far distant perhaps unrealizable theory. And so if we are going to have a responsible defense of the claim of the fundamentality of a particular theory, then this ought to be a currently formulated theory we can evaluate for its practical consequences.

7. The Inductive Arguments Again

Taking stock, I have noted two ways in which the fundamentality of physics can be interpreted: as a claim about *the completeness of some (at least in principle) future physical theory* and as a claim about *the maximality of current physical theory*. I have defended the latter interpretation, arguing that physicalism is best interpreted as the claim that physics is fundamental in that sense, combined with the adoption of a set of attitudes. Physicalism should not be interpreted as the thesis that the world is exhaustively and completely the way some physical theory says it is. Part of my argument against the completeness approach was that there is no positive argument for there ever being a completed physics (now or in the future). However, one might ask whether my points in that previous section undermine not just completeness physicalism, but any sort of physicalism, including the version I am advocating here. For the inductive argument I was criticizing looked like this:

1. Many observed phenomena have received physical explanations.

Therefore,

2. All phenomena will receive physical explanations. (Completeness physicalism)

My complaint was that since there is no unified class of phenomena that is the subject of the induction, any argument like this is bound to fail. So it seems the following argument with a substantially weakened conclusion would be equally bad:

1. Many observed phenomena have received physical explanations.

Therefore,

2. The next unexplained phenomenon will receive a physical explanation.

The failure of this argument looks to be a problem even for the weaker maximality physicalism. A maximality physicalist will hold the view that physical explanations should be sought in general. And this is supposed to be an empirically based view, one that is reasonable in light of the past reductive successes of physical science.

But there is no need to panic. Maximality physicalism is fine. To address this concern, we must distinguish between two types of phenomena the physicalist may encounter that do not yet have explanations in terms of physical science: those that are in a genuine sense like those that have already been explained, and those that are unlike those that have already been explained. For the phenomena that are genuinely like those that have already been given physical explanations, there will be an inductive argument available. These arguments will have a narrower scope than those we considered above, e.g.:

1. Many observed macroscopic features of living things have received physical explanations.

Therefore,

2. All macroscopic features of living things will receive a physical explanation.[17]

This sort of inductive argument can be successful to the extent that the premise concerns a unified class of phenomena. I believe that it does.

As for phenomena that are unlike those that have already received physical explanations, here there won't be an inductive argument we can use to underwrite the case for looking for a physics of those phenomena. But that is ok. After all, there isn't an inductive case for looking for an alternative theory of phenomena like those either. Instead, what we can say is that since physics is by assumption the only well-supported game in town for a science of the most general, it is a good starting point. It's a practical point of the "only game in town" variety that supports the development of physical explanations of the unknown and radically unlike what has already been explained (cf. Dawid 2013). There is no need for the maximality physicalist to hold that physics will in the end explain everything. For reasons I've already mentioned, that claim is unreasonable. But at the same time, the physicalist should be optimistic about current physics, and believe it is the right place to start.

8. Conclusion

[17] Note this is very much like the inductive argument for physicalism Papineau (2001) considers.

Although the standard interpretation of physicalism is problematic in the many ways I've noted, this doesn't mean we should discard physicalism, discard the view that physics has a special status among the sciences, that it is fundamental. This would be an overreaction. There is a way of capturing physicalism and underwriting reductive philosophical and scientific projects that doesn't rely on unmotivated assumptions and an outdated philosophy of science. I've called this maximality physicalism.

I've focused above on physicalism's role as a framework guiding certain research projects, those seeking to explain a diverse and initially disunified class of phenomena in physical terms. I don't mean here to say definitively that there is no purpose for which the claim that there will be a completed physical theory may be useful. There is no harm in physics (in some branches) trying to achieve that goal. But this claim is both stronger and less useful than what is needed for the practical aims for which one should promote physicalism.

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