

Philosophy of Science and Metaphysics

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When one man speaks to another man who doesn't understand him, and when the man who's speaking no longer understands, it's metaphysics.

*-Voltaire, **Candide**, 1759*

Philosophy of science has a complicated – almost schizophrenic – relationship with metaphysics. Studying topics such as the nature of causation, laws of nature, and spacetime, it clearly engages in activities that deserve to be classified as metaphysics. Yet the academic discipline itself was born in opposition to the field. Carnap, Reichenbach, Feigl, Neurath, and Popper, for example, were united in a shared distrust of metaphysics. Their suspicion ran so deep as to motivate a search for a demarcation between science and non-science, and science and speculative metaphysics in particular. Philosophy of science appears caught in what Einstein (1933) calls the "eternal antithesis between the two inseparable components of our knowledge—the empirical and the rational" (271). It wants to employ metaphysical speculation, but impressed with the methods of the subject it studies, it fears over-reaching. Philosophy of science thus tries to walk a fine line between scientifically motivated or grounded metaphysics and its more speculative cousins.

Here I will try to draft some of the contour of this boundary, along the way introducing the student to some of the relevant issues. Doing so is critical today, for we are in the midst of a major collision between two very large forces in philosophy that has a significant bearing on metaphysics. Very generally speaking, mainstream analytic metaphysics has moved further away from scientific concerns at the same time that philosophy of science has moved closer to science. Philosophers of science face a choice about what kind of metaphysics they should take on. Making this choice in an informed way means that we should think through some rather deep questions: Are there specifically metaphysical questions? How should science relate to metaphysical investigation?

I'll begin by laying my own cards on the table. I come at the question simultaneously convinced that many debates in analytic metaphysics are sterile or even empty while also believing that metaphysics is deeply infused within and important to science. I think of the quantum measurement problem and ensuing confusion as Exhibit A in the long case for the importance of metaphysics. Bohr and Heisenberg's efforts to ignore metaphysics were unsuccessful, and were, upon

reflection, just bad metaphysics. Metaphysics can be very important. But I also think it can go badly wrong.

How do we draw the line between the two paths? In principle, I think the answer couldn't be simpler. When trying to figure out what to believe about what there is, there are better and worse theories available to guide one. Not surprisingly, I urge that we rely on the best ones. How do we recognize these? A generation's worth of philosophers sought and failed to find a clean demarcation between science and non-science. For our purposes, it's better to think of this as the line between epistemically worthy and unworthy pursuits. No plausible necessary and sufficient conditions were ever found for being epistemically worthy. That doesn't mean there isn't a difference, however. There is a large difference between the modern synthesis in biology and creationism, between chemistry and homeopathy, and so on. The failure to articulate a sharp division means only that what we count as epistemically worthy is quite diverse and assessed along so many dimensions that it's hard to narrow the criteria down to something simply state-able. The marks are clear enough: empirical adequacy, simplicity, novel predictions, novel explanations, unification, consilience, and more. The metric by which we tolerate trade-offs among these virtues is less clear.

Now, as it happens, we have these concepts, 'metaphysics' and 'science'. There is no sharp difference between the two. To a rough approximation, we can think of metaphysical claims as more abstract and distantly related to experiment than scientific claims. Bear in mind that there is of course a lot of theory and meta-theory in science, but at some point we start classifying the theory and meta-theory 'metaphysics'. Based on this understanding, we can then classify some claims as metaphysical and some as scientific.

With these two divisions – that between epistemically worthy and unworthy pursuits and that between metaphysics and science – I can make two claims. First, the metaphysics we ought to strive for should fall on the epistemically worthy side of the first divide. Or using older terminology, it ought to count as "science" rather than pseudo- or non-science. Here I hasten to add that this means only that it passes muster with our standards for good theories.

Second, I then claim that the metaphysics on the right side of this criterion nearly inevitably will be responsive to and deeply connected with the science also falling on the right side of this line. This result is almost inescapable because in our theories we prize unification, cohesion, and so on, but also empirical virtues. For a theory to be a good one, it had better meet with some empirical success; but since we value unification, cohesion and so on, the "metaphysical" aspects of the theory will be sensitive to the aspects responsible for empirical success. Our demand for theories on the right side of the demarcation line means that our best

theories will possess certain theoretical virtues. These virtues then provide a kind of glue between the more and less metaphysical aspects of our best theories.

I say that this result is "nearly" inevitable because of course it's logically possible to detach aspects of the best theory from the theory itself. Experimentalists, statisticians and theorists can also detach themselves from the big picture of the standard model being tested at (say) CERN. Similarly, mathematicians, scientists and philosophers can detach the Lagrangian framework or the propensity interpretation of probability from any particular theory and study it alone. This is simply the normal division of cognitive labor. Work on both of these examples is, to a large extent, independent of particular scientific theories. But if we're actually going to believe in the Lagrangian framework or propensities, then they still need to earn their way into the best theory like everything else.

My picture is entirely symmetric between metaphysics and science.¹ Science, of course, ought to be on the right side of the demarcation line between epistemically worthy and unworthy pursuits. When it is, it too will inevitably be responsive to and deeply connected with metaphysics. Indeed, I think that what we conventionally call science in ordinary affairs is inextricably infused with metaphysics from top (theory) to bottom (experiment). If this is right, metaphysics is deeply important to science. Laying bare the metaphysical assumptions of our best theories of the world is a crucial and important part of understanding the world. And metaphysical speculation, when anchored in systematic theorizing connected to epistemically worthy pursuits, can aid our search for new and better theories of the world, and hence, better science.

One might reply that science proceeds perfectly well while leaving many metaphysical questions unresolved. In a sense that may be correct, especially if one regards "perfectly well" as merely making good predictions. However, if we count explanation and understanding as crucial parts of a good theory, as we should, then I don't agree. Bohr's quantum mechanics is an excellent predictive theory, but it's leaving so many metaphysical questions open or confused comes at great cost to explanation and understanding.

In slogan form, my claim is that metaphysics is best when informed by good science and science is best when informed by good metaphysics.

¹ Note how sharply this view therefore contrasts with Ladyman and Ross 2007. Although similarly motivated, they would make metaphysics inherently parasitic upon science: "Any new metaphysical claim that is to be taken seriously should be motivated by, and only by, the service it would perform, if true, in showing how two or more specific scientific hypotheses jointly explain more than the sum of what is explained by the two hypotheses taken separately, where a 'scientific hypothesis' is understood as an hypothesis that is taken seriously by institutionally *bona fide* current science" (30)

Unfortunately, this is not the best of all possible worlds and what conventionally goes by "metaphysics" and "science" doesn't always live up to these ideals, especially so today. Whereas metaphysics and science were once one and the same field, natural philosophy, today there is a worrisome divide between the two areas.² This is no doubt due to developments within *both* science and metaphysics. Physics, for instance, in part due to its culture and distribution of incentives since World War II, is far less "philosophical" than it used to be (Holton 1986). Nineteenth century physicists debated the reality of the electric field, but today few physicists debate the updated counterparts of this question for gauge fields. The same goes for the measurement problem in quantum mechanics. Sometimes dubbed the "reality problem", the issue is really about the proper ontology suited to quantum theory. Not all physicists ignore this problem, but it's hard to imagine so many ignoring a question of comparable importance in previous times. The same could be said for problems in many other fields of science too. As a result, metaphysical insight is especially needed now.

Yet instead of offering to fill the breach, many metaphysicians have adopted an approach to the field that makes it more or less autonomous from science. Not only is this a shame, given the current context within science, but it is also a bad idea. In what follows I concentrate on the philosophical side of this increasing gulf between science and metaphysics. I trace the origin of this gap in part to the resurgent idea that metaphysicians have a wider domain of study than scientists. I will suggest, if not properly argue for, that philosophers of science ought not treat this domain as genuinely insulated from empirical study. If this is granted, then metaphysical investigations ignore science only at their peril.

1. The Current Clash

There is a long tradition of worrying about overreaching by metaphysics. Kant famously attacked metaphysics as an assortment of empty sophistical tricks, a kind of perversion of the understanding. Later, seeing themselves as heirs to

² It is no accident, I think, that many of the greats of metaphysics were reacting to the science of their day, e.g., Aristotle, Descartes, Leibniz, Kant. I also think that the standard philosophy curriculum fails to convey not just that many of the greats were conversant in then contemporary science, but also that many made seminal contributions to it. As an exercise for the reader, connect the following scientific works with the metaphysician. The contributions are: a. price theory in economics, b. a steam engine and calculator (but also much more, including the calculus and advances in physics, geology, embryology, and hydrodynamics), c. the (alleged) medical benefits of pine tar, d. advances in thermodynamics and the vacuum, e. optics and analytic geometry (but also almost everything else), f. experimental properties of potassium nitrate, h. the physics of elliptical nebulae and galactic clustering, and physical geography (but also much in the foundations of physics). Answers are in the second to last footnote.

Kant, Carnap, Reichenbach and others took the measure of metaphysics and saw it as strikingly different than science:

Most of the controversies in traditional metaphysics appeared to me sterile and useless. When I compared this kind of argumentation with investigations and discussions in empirical science or [logic], I was often struck by the vagueness of the concepts used and by the inconclusive nature of the arguments." (Carnap 1963, 44-45)

Metaphysics came under attack for having lost contact with the empirical.

Today metaphysics is again the target of deep suspicion. In fact, we are in the midst of a flare-up of historic proportions. Evidence of this comes from my bookshelf. Many recent books in philosophy of science possess entire chapters strongly condemning contemporary analytic metaphysics.³ What's especially remarkable about this is that the authors aren't logical positivists. They don't even embrace a common empiricist ideology—for whom a distrust of metaphysics is expected. Rather, the authors run the full gamut of positions in philosophy of science, and each seeks to make room for some types of metaphysics. What did analytic metaphysics do to upset so many would-be fellow metaphysicians? Evidence for this flare-up also exists in metaphysics. Never a good sign for a field, here the literature is in part devoted to whether there *are* answers to certain types of metaphysical questions. So-called "metametaphysics" is all the rage in conferences, books, and journals.⁴ There is so much of it that soon metaphysicians keen to defend their field won't have time for any first-order work at all (which would, ironically, make the metaphilosophical debate moot).

Clearly something is up. Just as earthquakes are evidence of tectonic plates colliding, so is this dust-up evidence of a collision between two large and slow-moving trends in philosophy. Let me briefly describe the positions that are at odds.

The logical positivists' critique of metaphysics provides the backdrop. Recall that Carnap understood ontological questions as ultimately about which framework (theoretical structure) one should use. Crucially, he was a framework pluralist. Are there atoms? According to Carnap, one is always working within a framework and hence also the entities presupposed by the framework. So if the framework presupposes atoms, the 'are there atoms?' question doesn't arise. The question to ask instead is why use the framework one is using, but Carnap thought this a purely practical decision. Ontology gets pushed into pragmatics.

³ E.g., van Fraassen 2002; Maudlin 2007; Ladyman and Ross 2007; Maddy 2007.

⁴ E.g., Chalmers, Manley and Wasserman 2009; Braddon-Mitchell and Nolan 2009.

The work of Quine and Kripke, however, pulled it out of pragmatics. In our cartoon-like history, we might say that Quine cleared the room for metaphysics while Kripke furnished it.⁵

Quine's part in this is primarily his famous assault on the analytic-synthetic distinction, the line between truths in virtue of fact and truths in virtue of meaning. If Quine 1951 is right, then there isn't a sharp distinction between conceptual/linguistic truths and factual/contingent truths. This was bad news for the conceptual analysis that dominated philosophy then (since there would be no purely conceptual truths). But it was good news for the possibility of metaphysics. The reason is that Carnap's notion of a framework presupposed the analytic-synthetic distinction. No frameworks, no framework pluralism – and no place to banish metaphysics. For Quine, the concerns of metaphysicians are not any different than the concerns of scientists:

The question of what there is is a shared concern of philosophy and most other non-fiction genres...What distinguishes the ontological philosopher's concern and [the zoologists, physicists's and mathematician's concerns] is breadth of categories (1960, 275).

Quine tells us that ontological "Are there X?" questions make sense, but only once the statements involved are regimented in decent logical form. That done, one learns that a theory is committed to X's just in case X's are in the domain of the variables of the theory. Add to that the claim that the theory is true, and we are doing ontology. The positivist attack on metaphysics is repelled.

Having survived the attempt on its life, metaphysics was left dangling. Quine's attack on positivism removed a reason *not* to do metaphysics, but it didn't provide a particularly clear rationale for engaging in it (nor was the savior much of a fan). However, in the 1960's and 70's modal logic was put on stronger foundations and counterfactuals given a rigorous semantics. Modality becomes respectable again. Better than that (from the perspective of metaphysics), using various thought experiments Kripke 1980 shows that we have robust intuitions about what is possible and that these intuitions carve out a realm of modality not obviously reducible to logical or scientific possibility, namely *metaphysical modality*. A kind of essentialism is resurrected. If water is actually H₂O, we are told, then it couldn't be anything else. The *couldn't* represents *metaphysical* necessity, and Kripke is credited with discovering *a posteriori* necessities.

Emboldened by this success, metaphysicians found their subject matter and one can now find claims such as:

⁵ For a more thoughtful account of the role of metaphysics and Quine's debate with Carnap, see Price 2009. See also the many fine papers on this time period and earlier by authors connected with HOPOS: <http://www.hopos.org/>.

metaphysics is most perspicuously characterized as *the science of essence*— a primarily a priori discipline concerned with revealing, through rational reflection and argument, the essences of entities, both actual and possible, with a view to articulating the fundamental structure of reality as a whole (Lowe 2009).

Although not all metaphysicians would agree with Lowe, many would endorse a related division of labor, namely, that metaphysics differs from science in terms of its breadth. Whereas scientists excavate dusty field sites and mix potions in laboratories to tell us which states of affairs are *actual*, metaphysicians are concerned with what is actual and *metaphysically possible*. Philosophical intuition about metaphysical possibility unleashed, the journals gradually became filled with increasingly speculative metaphysics, much of it going well beyond Kripke's *a posteriori* necessities. These philosophers, I hasten to add, do not take themselves to be exploring, Strawson-style, the architecture of their concepts, but instead feel deeply that their work is no less about mind-independent reality than science is.⁶

Meanwhile a parallel set of trends grew – also emanating from Quine – that are by their nature suspicious of such metaphysics.⁷ I'm thinking here of the growth of naturalism, broadly conceived, in the forms of naturalized philosophy of science and Quine's naturalized epistemology. One sees the attitude expressed nicely (and earlier) by Reichenbach:

Modem science...has refused to recognize the authority of the philosopher who claims to know the truth from intuition, from insight into a world of ideas or into the nature of reason or the principles of being, or from whatever super-empirical source. There is no separate entrance to truth for philosophers. The path of the philosopher is indicated by that of the scientist...(1949, 310).

There is, as Quine puts it, no "first philosophy", no "supra-scientific tribunal" justifying the results of science (Quine 1975, 72). Maddy 2007 calls on us to pursue "Second Philosophy" instead. The Second Philosopher "simply begins from commonsense perception and proceeds from there to systematic observation, active experimentation, theory formation and testing, working all the while to

⁶ The so-called "Canberra Plan" (see Braddon-Mitchell and Nolan 2009) applied to metaphysics is a bit of a halfway house between traditional and Strawsonian metaphysics. Conceptual analysis determines the Ramsey sentence that best describes the role we want some X to play, e.g., causation, but then science tells us what the world is like and whether there is anything that actually realizes that role. The enterprise of metaphysics is then very modest, for Canberra Plan metaphysics assumes that we know what the world is like. But that was what metaphysics originally was supposed to tell us!

⁷ For a general review, see Papineau 2009 and Ritchie 2009, but also Maddy 2007.

assess, correct, and improve her methods as she goes" (2).

This perspective is reinforced by the attack on conceptual analysis by Stich 1991 that inspired later so-called experimental philosophers. Although contemporary analytic metaphysicians do not see themselves as engaging in conceptual analysis, still they lean heavily on certain modal intuitions. Experimental philosophers doubt the reliability and pervasiveness of many of these intuitions that guide much of contemporary analytic philosophy, even some of those that Kripke so famously marshals in support of his views (Knobe and Nichols 2008).

Finally, another important strand is the increasing number of philosophers of science directly engaged with actual science. While this last group is a motley one, to be sure, many philosophers studying a particular scientific field feel themselves and their projects as closely allied with and even continuous with the goals of that field.

The collision between these two "plates" was more or less inevitable. Knowledge of the modal structure of reality, based largely on reflection and intuition, potentially offends against much of what those in the second group believe. Naturalists will want to know how creatures like us gain reliable modal knowledge, Second Philosophers will not see a separate pathway to ontology apart from science, experimental philosophers will challenge the pervasiveness of many of the modal intuitions needed for analytic metaphysics, and those engaged with actual science will see (I suspect) a radical difference between the explanatory and confirmatory aspects of science and of some metaphysics.

2 Metaphysics Walling Itself In

What aspects of contemporary metaphysics have bothered so many? Since "metaphysics" encompasses a wide range of topics and philosophers of science possess diverse epistemological scruples, there is perhaps not one move or doctrine that is objectionable to most. Nevertheless, if I'm right, there is a particular conception of metaphysics that causes –or should cause – some apprehension. This is the idea that

Metaphysics is about *the most explanatorily basic necessities and possibilities*. Metaphysics is about *what could be* and *what must be*. Except incidentally, metaphysics is not about explanatorily ultimate aspects of reality that are actual... (Conee and Sider 2005, 203)

In metaphysical modality, metaphysics has found the subject matter over which it has "exclusive claim" (203). Notice the subtle change of emphasis from earlier

metaphysics (nicely noted but not necessarily endorsed in the last chapter of Conee and Sider 2005). Prior metaphysical investigations were primarily directed at providing reasons for believing that the *actual* world has particular entities or properties in it, e.g., God, substantival space, creatures with free will, a moving now. Today so limited a concern is passé. Metaphysics is after something bigger and more abstract, the structure of metaphysical modality. What it investigates can tell us about the actual world, but only – "incidentally" – because the actual world is one possible world of many.

I submit that this shift in metaphysics' direction is one major reason for the current clash between metaphysics and philosophy of science. This alternative style of metaphysical theorizing brings with it many unstated changes that offend those more connected to science. Being about what (metaphysically) must and could be, metaphysics needs to be very general and abstract. Metaphysicians aren't primarily interested in whether this world *just happens* to have certain entities, or in mustering the usual reasons for thinking this about something. Rather, it is forced by the change of target into studying more general abstract principles, such as whether two objects must never occupy the same place and same time. If the concern is whether this principle holds in the real world, science will be relevant to assessing its truth. But why should science be relevant to assessing its truth in metaphysically possible worlds wherein science is very different? Plainly it's not: science, after all, is mostly about the metaphysically contingent (on the usual way of thinking).

If Kant, Reichenbach and Carnap worried about metaphysics before, they would really agonize over its contemporary form. Where do we acquire the "modal intuitions" that are the currency of the field? How do we know that they're reliable? What are they *of*? Shouldn't intuitions of what is possible make some contact with science? (From the history of science don't we learn that many "impossibilities" end up possible, and vice versa?) Others may be inclined to react defensively. Even if it pretends to have walled itself off, still this style of metaphysics does make threatening forays into the land of the actual. Independently of what science tells us about the actual world, it purports to tell us what must and must not actually be. One needn't be Kant or a logical positivist to worry about this development in metaphysics.

That said, granted the assumptions behind the modern analytic metaphysicians project, independence from science does follow. If we're going to criticize the project, we must take issue with one or more assumptions underlying it. Before doing so, let's take a closer look at the problem.

3. *The Phenomenology of Shallowness*

To evoke what he calls the "phenomenology of shallowness" afflicting some of today's metaphysics, Manley 2009 uses a metaphysical "problem" that he borrows from Eli Hirsch: when I bend my fingers into a fist, have I thereby brought a new object into the world, a fist? In contemporary metaphysics, a question such as this is viewed as deep, interesting and about the structure of mind-independent reality. Comparable questions in the literature are whether a piece of paper with writing on one side by one author and another side by a different author constitutes two letters or one (Fine 2008), whether roads that merge for a while are two roads or one, and whether rabbit-like distributions of fur and organs (etc) at a time are rabbits or merely temporal parts of rabbits.

Other philosophers, by contrast, react in horror at the suggestion that these questions are deep and important. Instead they find them shallow. The reason is that it's hard to imagine what feature of reality determines whether a fist is a new object or not. How would the world be different if hands arranged fist-like didn't constitute new objects? And if there are debates, aren't they easily solved? Call temporally extended distributions of fur and flesh in bunny shaped patterns 'rabbits₁' and non-temporally extended such patterns 'rabbits₂'. Use 'letter₁' for letters individuated by author and 'letter₂' for those individuated by paper. And so on. Now is there any residual disagreement about the non-semantic world? If fists really are new objects, then one imagines that philosophers of science bring two new objects into the world whenever they read this work.

Since the actual world is a possible world, surely the ontological debates are substantive when they imply what the actual world is like? Well, yes and no. Often the debates initially feel substantial, but it turns out that we're subjected to a bait-and-switch. It's worth thinking through one example in some small detail.

Consider the popular topic of simples. A simple is an object with no proper parts. One question that has attracted attention is whether simples with spatial extension are possible. Some philosophers argue that spatially extended simples are not metaphysically possible. Various arguments are marshaled for this conclusion. For instance, suppose the simple has heterogeneous properties, that at one region it is red and at another region it isn't. Well, doesn't it then have two parts, the red part and the non-red part, thereby contradicting the idea that it is a simple? Certainly that's so if one invokes the principle that

Necessarily, something's red in that way only if it has a proper part that is red simpliciter. (Spencer 2008)

Although we can easily find other examples in the literature, let's use this no-extended-simples argument for an illustration.

The no-extended-simples argument makes claims about the actual world, namely, that anything actually extended is not simple. How does this connect up with the science of our world? On its most natural interpretation, superstring theory – one of the more promising attempts at a theory of quantum gravity – posits extended simples. I say "most natural" because the theory was initially motivated by the fact that the topology of interacting continuous one-dimensional extended entities avoided the ultraviolet divergences that plagued graviton-graviton scattering. The one-dimensionality of strings really is a significant part of the original attraction of the theory. Despite criticism, string theory is a live possibility for describing the entities of our world; however, if you don't like this example, feel free to switch to any other theory with non-point-like fundamental entities.

Interestingly, if they exist, superstrings have some of their properties heterogeneously distributed, e.g., nontrivial energy densities across a string. The no-extended-simples argument therefore applies to superstrings. Followed through to its conclusion, we know that superstrings are not the basic building blocks of the world for they have parts. Reflection on the nature of parts and simples tells us that superstrings are composite. And to the degree that superstring theory leaves out the parts, it is incomplete and hence, strictly speaking, false. For recall, this argument is not about the regimentation of our concepts; if the argument is right, then strings really are composite. No new colliders need be built to test this -- think of all the tax dollars potentially saved by modal metaphysics!

Despite this result, metaphysicians accepting the no-extended-simples argument don't seem prepared to demand that resources be diverted away from string theory. Why not? Being charitable by nature, philosophers allow that physicists are confused: superstrings aren't really extended simples.⁸ Although the metaphysical debate is officially over the nature of the world and not a regimentation of language, in a way it becomes a kind of regimentation: for when we meet conflict with science, the conflict is avoided by re-interpreting the science in a way compatible with the terms of art used by metaphysicians. Superstrings must be re-interpreted as composites of points obeying strange new laws that ensure continuity and more (to keep them stringy). This theory of zero-dimensional entities is metaphysically possible. So string theory would be saved

⁸ "One can also find physicists who apparently endorse the actuality of extended simples, but I can't help but think that this endorsement often arises from confusing the concept of an indivisible object with that of a mereological simple. Whereas having no parts may certainly be one explanation of the indivisibility of a material object – a law of nature prohibiting certain kinds of separation is another, and one that does not immediately license verdicts on mereological structure. It may be the physicists's job, for example, to tell us whether the fundamental entities that physics appeals to are physically indivisible one-dimensional strings, but it is the job of the metaphysicians to tell us whether those uncuttable things are composite." Hudson 2005, 107.

by being empirically equivalent to or best interpreted as a metaphysically possible theory after all.

What is objectionable about these metaphysical parts? I'll develop my complaint in subsequent sections. Right now let me quickly mention that I do not find anything necessarily improper about metaphysicians suggesting to physicists an interpretation of the physics. Philosophers may have good reasons to reinterpret or even challenge some of the physics, just as people working on the measurement problem aren't absurd to challenge the Copenhagen understanding of quantum mechanics. I also don't think the lack of a clear tie to observables is necessarily a problem, nor the use of new technical terms of art. Theoretical entities and terms can be posited to achieve greater theoretical virtues.

To begin to see the problem, compare the parts we have just found with the "partons" Feynmann famously suggested in 1968. Partons are the point-like elementary constituents of hadrons that eventually became interpreted as quarks. Both entities are supposed to be genuine elements of certain real wholes. Both are discovered theoretically. Both are even immune, in a certain sense, to direct observation (thanks to the later development of quark "confinement", free quarks never show themselves). But there, it seems to me, the similarities end. The parton hypothesis is discriminating, applying to hadrons, not everything with extension. Even though initially incomplete – how partons interacted via the strong force was missing – parton theory was very richly detailed, containing both novel predictions and novel explanations, e.g., especially explaining the "scaling phenomena" found in inelastic scattering of electrons off protons at high energies. Very generally put, its virtues depended sensitively upon what the rest of the physical world looked like. Parts, by contrast, do not. Unlike the crumbs in cookies or the nucleus of the atom (or even hidden variables in quantum mechanics), these parts are nomologically indivisible from their wholes. Biting the wholes of which they are part or scattering alpha rays off them a la Rutherford won't signal the presence of these parts. Maybe they serve some theoretical purpose? I suspect not. Partons emerged "red in tooth and claw" from the competitive jungles of science, possessing all the virtues one would expect, e.g., novel prediction/explanation of scaling phenomena, unification of some of the particle zoo, and more. The metaphysical principle about parts, by contrast, arises from peaceful reflection on ordinary objects and language. Metaphysical parts increase the complexity of our systemization of the world without any compensating gain in generality or other virtues. They appear idle in our theory. Any decent theory of scientific confirmation threatens to weed them away.⁹

⁹ Indeed, I imagine that the above parts would be treated the same way the gruesome forces G and H (that combine so as to look like Newton's F) are treated by Glymour's 1980 bootstrapping theory, for instance.

4. *What's Gone Wrong?*

Kant, Carnap, Reichenbach and others criticized metaphysics and found it often similarly superficial. They despaired when they compared it to the results of science. Then they tried to do something about it, namely, forge a criterion that separates "good" metaphysics from "bad" metaphysics. However, neither Kant's nor the positivists' criteria have survived evaluation. Neither has any other attempt.

Recently, the popular topic known as "metametaphysics" tries to diagnose what, if anything, goes wrong in these debates. Are two metaphysicians arguing over whether extended simples are metaphysically possible disagreeing about two genuinely different possible worlds? Or is the debate merely verbal? The metametaphysics community is currently divided on this question. Some think that debates like the above are genuine (Sider 2009), others that it is not (Chalmers 2009; Hirsch 2009), others that it is genuine but irresolvable (Bennett 2009), and still others who believe that it's genuine but only in the way debates about fiction are genuine (Yablo 2009).

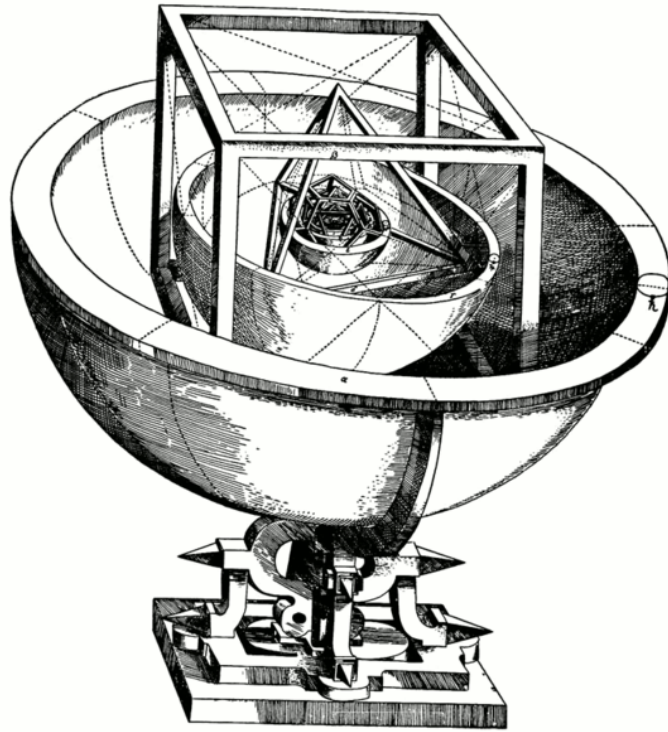
Some ontological deflationists suggest a criterion to separate the verbal from non-verbal. A debate is verbal, Hirsch 2009 claims, just in case "each party ought to agree that the other party speaks the truth in its own language" (239). The idea is natural enough: those who deny extended simples can agree that people using "part", "composite", "simple" in their opponent's language speak truly when claiming that there are extended simples; but theists and atheists won't agree that the other speaks truly. Interpretative charity will map part-talk into something true, but charity only goes so far: atheists won't find a referent for God in their ontology.

While I admire much of this work, we shouldn't expect to obtain practical guidance for detecting merely verbal debates from it. What is needed is, in effect, a theory of metaphysical equivalence. When do two semantically distinguishable but observationally undistinguishable theories describe two truly distinct metaphysically possible worlds and when are they notational variants? History with related equivalence criteria suggests that the problem is irredeemably tricky, that we won't get anything like useful necessary and sufficient conditions for equivalence. Philosophy of science has grappled with the related question about physically possible worlds for a long time. When do empirically underdetermined theories describe the same world? Positivists deflated the question: according to a verificationist theory of meaning, two theories that can't be observationally distinguished "say" the same thing. Absent such a criterion, however, we have a problem. We know that many theories that are observationally equivalent don't describe the same world. For instance, arguably Putnam's brain-in-a-vat

hypothesis and the Standard Model are observationally equivalent, yet no one would take them to describe the same world. What about Einstein's curved spacetime interpretation of general relativity and Weinberg's flat spacetime plus gravitons interpretation? English and French versions of natural selection describe the same world, but do Hamiltonian and Lagrangian versions of classical mechanics? None of these are settled questions. The problem, in brief, is that there are too many moving parts. What is observable is partly theory-laden, what needs and gets explanation is partly theory-laden, and more. I expect all these problems will arise again at the metaphysical level. *When the facts themselves are under dispute, interpretative charity for one group may be uncharitable for another.*

Nor do I think we can claim that "bad" metaphysics results from asking the wrong questions (which is what Kant thought) or from relying too heavily on speculative intuition (a common claim). It's important to stress that these types of criteria might unnecessarily constrain science into taking a too conservative stance.

For example, Kepler's model of the solar system, given the context, was perfectly good science or metaphysics, despite the fact that it was both wildly speculative and from our perspective asked the wrong questions. Kepler wanted to know why there are six planets (the number then known) and why they are spaced as they are. His answer, on which he struggled for years, was that planets are attached to concentrically placed spherical orbs, each one of which inscribed and/or circumscribed one of the five Platonic solids (three-dimensional polyhedra). See the figure. By ordering these spheres, from outer orbits to inner, via octahedron, icosahedron, dodecahedron, tetrahedron, and cube, Kepler was able to devise a model that was within 5% accuracy of the then observed planetary orbits. This work was tremendously clever, in fact so impressive that arguably it led to his being hired by Brahe.



Unfortunately for Kepler, there are more than six planets. Even worse, there is no grand symmetry principle dictating the number of relative distances between planets.¹⁰ The pattern of distances between planets is due to contingent initial conditions and isn't the result of any deeper principle. Intuitions about symmetry led him to tackle the wrong questions and also to propose a truly wild metaphysics of the solar system.

Yet intuitions about what patterns need explanation and what questions are fruitful are the lifeblood of science. In other cases, for instance, Gell-Man's 1962 symmetry argument for the omega-minus particle, intuitions of symmetry were successful: two new particles were successfully predicted. One attempt panned out, one didn't. And unlike the discovery of parts described above, Kepler always

¹⁰ Kepler was hardly alone in thinking this. Even later astronomers were impressed by the distances between planets described by Bode's Law. From the sun, the planets have distances in proportion to the numbers 4, 4+3, 4+2.3, 4+4.3, 4+16.3, and 4+32.3 (and later, with the discovery of Uranus, 4+64.3). Where is the planet corresponding to 4+8.3, the planet between Mars and Jupiter? Symmetry and intuition tell us it must be there; and to good measure, astronomers agreed. However, as pointed out by Hegel, who is unjustly accused of having decreed that there are necessarily seven planets (Craig and Hoskin 1992), another progression of numbers fits the data just as well, namely, the series 1,2,3,4,9,16,27 from the *Timaeus*. According to this series, there should not be a planet between Mars and Jupiter.

had an eye on empirical matters. His theory sought an account of an empirical pattern not otherwise explained and also made novel predictions. Importantly, Kepler's model was also rich in novel explanatory detail, offering explanations for empirical patterns that the model was not originally designed to explain. The model, for example, was able to explain features of the orbital period: proceeding from inner to outer planets, the difference in orbital period is twice the difference in orb radii. Overall, despite asking the wrong questions and being extremely speculative, it was a serious attempt to model the causal furniture of the actual world.

5. *Leveling the Field*

Instead of attacking our speculative abilities or pretending we know what questions are real ones, I submit that the basic problem with some metaphysics today is the idea that the philosopher and scientist doing ontology are performing fundamentally different and separate jobs. The metaphysician's picture that the scientist works in the lab, discovering the actual world's features, while the metaphysician discerns the wider universe of possibilities, isn't right. The error is thinking that the science of the actual world doesn't affect what one thinks is possible or impossible. The history of science and philosophy amply displays that what we think is possible or impossible hangs on science.

Analytic metaphysicians of course will grant that the science of the day affects what we think is *physically* possible, but remind me that their claim is about metaphysical possibility and assert that their intuitions are about this wider domain. We have modal intuitions about parts and composites, and these intuitions reveal what is metaphysically, not conceptually or physically, possible.

Against this, I want to claim that there is no interesting species of metaphysical modality that is largely immune to science. Our modal intuitions are historically conditioned and possibly unreliable and inconsistent. The only way to weed out the good from the bad is to see what results from a comprehensive theory that seriously attempts to model some or all of the actual world. If the intuitions are merely "stray" ones, then they are not ones to heed in ontology. *In metaphysics e should take possibilities and necessities only as seriously as the theories that generate them.*

Those relying on metaphysical modality as a path to secure the independence of philosophy from science are placing their bets on an uncertain source. The nature of metaphysical modality is murky. Currently it is at the juncture of many disputes in philosophy of language, philosophy of mind, and philosophical logic, not to mention the subject of direct investigation with respect to its relation to

conceivability and logic. So-called modal rationalists debate modal empiricists (with many internecine disputes) and they in turn debate conventionalists and others. I cannot tackle these large issues here. All I can do is make a couple of small points.

First, let's agree that Kripke gives us reasons to posit the category of metaphysical modality in the first place. Does the existence of this realm imply the independence of metaphysical modality from science? The answer is that there is nothing to be found in Kripke's examples that would warrant thinking of metaphysical possibility as something immune to actual science. Kripke himself remarks at the end of his second lecture that it may be possible to understand the intuitions he is trying to capture using only *physical* possibility. True, on a narrow reading of physical possibility then physical possibility can't handle the claim that 'water is H₂O' -- for arguably physics doesn't have 'water' in its vocabulary. Yet this doesn't provide any ammunition for one thinking of metaphysical possibility as immune from science. The interesting feature of Kripke's necessities, after all, is that they are *a posteriori*. And the claim that water is H₂O comes from some science if not solely physics. We might, following Edgington 2004, posit a realm of necessity that includes claims about the constitution of water, necessities from the non-physical sciences, and more, and refer to it with the more inclusive moniker "natural necessity". But this natural modality will be sensitive to science.

Second, there are philosophical positions on metaphysical modality that fit well with the views expressed here. One congenial view, from the present perspective, is Leeds 2007 theory that metaphysical possibility is simply *conceivable physical possibility*. On his view, the thought that the laws of nature might have been different is given an epistemological explanation, much as Kripke explains the thought that water might not be H₂O. Edgington's views on metaphysical possibility also fit well with the position here. Assuming such positions are at least plausible contenders, the mere appeal to metaphysical modality by itself does nothing to suggest that metaphysics is autonomous from science. Some of those who rescued modality in the 1960's and 70's never intended for metaphysical modality to become largely autonomous from science (as we'll hear about in Ruth Barcan Marcus' forthcoming Dewey Lecture).

Third, some "modal rationalists" believe that metaphysical possibility is more or less the same as conceptual or logical possibility. In this case one can well imagine that some metaphysical possibilities about the fundamental nature of the world are in some sense autonomous from actual world science. All sorts of things are conceivable. However, if metaphysical possibility is reduced to logical or conceptual possibility, then it just raises the question of why it should be a guide to the nature of the world.

I admit that there is a lot more to be said on this topic. Still, the murky realm of the metaphysically but not physically possible doesn't provide any obvious reasons for buying immunity from science in study of the fundamental nature of the world.

6. *Are There Laws of Metaphysics?*

If the strict autonomy of metaphysics from science is abandoned, then it may still be thought that claims about parts and such described above are vindicated by the same methods that science uses. Perhaps there are laws of metaphysics comparable to the laws of science? I am here thinking of the metaphysician who claims to be using the same methods as the scientist, namely, a form of inference to the best explanation.¹¹

Before tackling this question head-on, let's step back and ask why physical possibility is so special. I have acted as if physical (or biological or economic...) modality is acceptable, but why? Hume, of course, denied that there is any necessity apart from logical or conceptual necessity. Nowadays philosophers are more accepting of physical modalities, but still their source and status are very controversial. Fodor 2004 asks what fact *about water* makes it the case that it is essentially H₂O. He insinuates that this fact is about our concepts and not about water. But to be fair, let's ask a similar question about physical modality:

What *about light* makes it true that it can't go more than 299,792,458 m/s?¹²

The answer doesn't rely on our concept of light. We had that concept well before we knew how fast light goes. We instead think it's a feature of light, and even better, spacetime structure, that makes this limitation on possibilities true. Let's begin, then, with the most natural answer: the laws of relativity make this restriction true. What are laws? That, of course, is very controversial.¹³ Yet note: no matter how they are understood, laws represent the central core of

¹¹ [Metaphysicians'] "methodology is rather quasi-scientific. They treat competing positions as tentative hypotheses about the world, and assess them with a loose battery of criteria for theory choice. Match with ordinary usage and belief sometimes plays a role in this assessment, but typically not a dominant one. Theoretical insight, considerations of simplicity, integration with other domains (for instance science, logic, and philosophy of language), and so on, play important roles" (Sider 2009).

¹² Hudson 2005, incidentally, argues that 'objects' can go faster than light after all. Fortunately for relativity, none of these objects have well-defined masses, energies, etc.

¹³ If you're a philosopher of science who doesn't believe in laws, you have no debate with me here. You probably still believe in causal principles, mechanisms, invariances, or other counterfactual-supporting generalizations, and any of these can be substituted for laws in the following argument.

theories, and these are theories that try to systematize/explain the world. We only treat events as possible if they are parts of good systematizations of the world.¹⁴ We think it's impossible that photons go faster than relativity claims. Why? Because our most powerful theories, the theories upon which we base our explanations and predictions – upon which we even stake our lives – say so. The possibilities for photons don't arise from stray intuitions or attempts to systematize only semantic intuitions.

What is the source of the possibilities? Some, like modern day Humeans, will think the possibilities arise from the systematization itself. For Humeans, laws are the central core principles of the best systematizations of nature. The modality flows from the systematization. We can think of this as a specific version of Putnam's 1962 claim that possibilities and necessities are always relative to a background theory. Never are claims possible or necessary simpliciter. Others, like non-Humeans, will proceed in the opposite direction: the systematization flows from the modality, not vice versa. Ontologically, the modality is basic and independent of a systemization. Spacetime just doesn't allow light to travel faster than 299,792,458 m/s. Nonetheless, non-Humeans think that explanations and theories appealing to the genuine modalities explain better than those that do not. In fact, that a law explains something well is taken as a symptom that it is representing a genuine modality.

Whatever the story is here regarding the deep question, the source of physical modality, all hands agree that the reason we have to think photons have certain properties arises from their role in a powerful, explanatorily and predictively accurate theory. Being connected to a good systemization of the world is either *constitutive* or *symptomatic* of serious possibilities.

We don't have to be too strict about this. Scientists are free to devise models of the world wherein (say) the absolute speed of light is not constant. To be taken seriously, however, the comment is not an idle one but rather one embedded in an alternative systematization of a comparable range of phenomena. It's a conceivable physical possibility. In fact it's interesting that one way this possibility is challenged (e.g., Ellis and Uzan 2005) is by pointing out how much the rest of the system hangs on the speed of light being constant – it's a way of pointing out that the scientist hasn't yet discharged her obligation to fit the new possibility into a large and equally good system.

¹⁴ Compare with Leeds 2007, 463: "What gives the physical modalities their specific content – what makes them the physical modalities – are their rules of use: the kind of reasoning that the physicalist takes to be relevant to a claim of necessity or possibility. Most importantly, our physicalist will take as supporting a claim of necessity the kind of reasoning we all use when we argue that a particular statement is a law of nature... What leads us to classify a statement as a law are, in addition to our conviction that it is true, considerations having to do with its generality, its systematic import, its simplicity and explanatory power."

We may have all sorts of intuitions about the "essence" of light, but my proposal is that we take such intuitions only as seriously as the theory of which they are a part. And we should only take a theory seriously if it falls on the epistemically worthy side of the demarcation with which I began the paper. Although it's impossible to state necessary and sufficient conditions for the difference between science and non-science, as I said, there are plenty of symptoms of a theory being serious: e.g., temporally or atemporally novel predictions, cohesion, unification, explanatory power, breadth of coverage, and more. There are trade-offs among these, so both string theory and experimental condensed matter physics both count as science. Notice that as this "line" is really a fuzzy one, there will be many borderline cases. Is time travel possible? Currently science can't decide: general relativity by itself seems to allow it, but many seek to supplement general relativity with constraints that would rule it out.

Are there laws of metaphysics? Why not? Why deprive the metaphysician the tools of science? Posit gods, universals, tropes, quiddities, and more. So long as they pay their way, they are fine. There is nothing *intrinsically* wrong with any of them as posits about the world.

The question then is simply whether the putative laws of metaphysics truly survive the "red in tooth and claw" selection scientific norms impose. Here there is nothing general to say. We must simply look at examples and see how they play out. Lacking a theory of "metaphysical equivalence" we can expect cases wherein reasonable people sharing roughly the same epistemic values will disagree. Even in science this happens regularly. Superstring theory, for instance, is currently under attack by many for valuing theoretical virtues at the expense of empirical virtues. So is neo-classical economics. Still, in many cases in contemporary metaphysics, I suspect the question of whether the possibilities envisioned survive the normal norms of scientific theory appraisal is as clear as can be. For roughly the same reasons that I don't subscribe to the possibilities and necessities dictated by various pseudo-sciences – the theories lack too many virtues – I don't treat as genuine the possibilities and necessities posited by some metaphysics.

What is known as Locke's Thesis is taken by many to be effectively a law of metaphysics. Locke's Thesis says that no two things of the same sort can be in the same place at the same time. Is this a core principle of a powerful theory? Give the generalization it's due: it's simply state-able and certainly seems true of most commonly acknowledged macro-objects. One needs to look hard for counter-examples from that realm. As a rule of thumb, certainly one could do worse than employ this generalization. I don't want to deny that Locke's Thesis might be a "law" playing a role in the systematization of one's life. Perhaps it plays a role in finding one's keys in the morning. So if one is interested in the metaphysics of

the social world or macro-world, then perhaps a principle such as this may play a role in systematizing.

The same can be said for the generalization that space is Euclidean. Indeed, the case of mereology in metaphysics is usefully compared with the case of Euclidean geometry. So ingrained in our thinking is this geometry that it took two millennia to see that space could be non-Euclidean. And still today for local and macroscopic navigation, the possibilities and necessities in Euclid hold pretty well. But if we're interested in the fundamental modal features of space, and most metaphysicians are concerned with the world's fundamental level, Euclid just isn't right. The parallel postulate doesn't have to hold, no matter how intuitive. How do we learn this? We discover that the world does not conform to our Euclidean intuitions by devising a comprehensive theory of the world. Meeting the standards imposed by good theorizing can overturn even the most deeply felt and *prima facie* modal intuitions.

Assume metaphysicians are after the fundamental structure of reality. In that context, Locke's Thesis plays no role. Not at least since the Pleistocene era has the concept 'thing' been a part of any putatively fundamental theory. 'Things' are way too vague and general to be useful kinds. Substitute 'quantum field' for 'thing' and then we can ask what QED says about the principle. The principle's truth or falsity then follows from a broadly systematized area, not isolated intuitions about whether it's true. Alternatively, one can choose to define 'thing' such that things are, when of the same sort, never in the same place at the same time. That kind of regimentation is fine. Just bear in mind, however, that it then may turn out that there aren't any things.

Return to simples. Do the parts of metaphysicians pay their way? I don't think so. As seen earlier when compared to partons, these parts are truly distinctions without differences. Like angels on the head of a pin, they don't matter to...well, anything. Or if they matter to anything, it is only to a regimentation of our concepts. The claim of some metaphysicians to be using the same standards as science is sometimes far-fetched. Yes, scientists use intuition, play theoretical virtues against one another, and so on. But that is not enough. The pseudo-sciences do this too, and we don't believe in their posits.

Once the playing field is level, there are possibilities and necessities related to principles found in our putatively best theories of the world and those that are not. Only the former need attract our attention.

7. Conclusion: In Praise of Metaphysics

This chapter has focused largely on the negative. I haven't had space to properly motivate a "scientific metaphysics". Let me end, however, by briefly defending scientific metaphysics from a common complaint and hinting at how much productive and exciting work there is to be done.

First, the complaint. Does a scientific metaphysics have room for philosophy, for metaphysics, or does metaphysics become the "handmaiden" of science on my picture? My reply is that there is definitely room for philosophy, indeed, a demand for philosophy and metaphysics. As described at the beginning, good science is informed by good metaphysics. Often critics of "naturalistic" philosophy paint a picture of it as being reducible to science, lacking prescriptive force, or merely dotting the i's in science. I've always thought that this picture has *too narrow a view of science*, and ironically, *too modest a view of philosophy*. It is too modest because sometimes just the reverse direction of influence has been the case: science has followed where metaphysics led. Metaphysical assumptions underlie science, and as Friedman 2001 argues, thinking about these (e.g., absolute simultaneity, infinitesimals) often drives revolutionary science. The view has too narrow a view of science because adopting (in ontology) the same general norms that operate in science leaves us an awful lot to do. Remember, these norms are very wide-ranging—they're just ordinary reasoning ratcheted up in a systematic way. They permit wildly speculative theoretical science like inflationary cosmology alongside experimental science. As for prescriptive force, look at science. It's norms call for unrelenting criticism of rival's views, among other things. The journals are filled with critical reviews, analyses, meta-analyses, and more. To be for scientifically-informed metaphysics is not to endorse a merely descriptive – a glorified journalistic – take on science. Instead, people knowledgeable of science but trained in philosophy, with its emphasis on logic, clarity, norms of following an argument wherever it leads, and so on, can offer distinctive and valuable perspectives on all these questions. The methods of any particular science at any particular time don't exhaust the ways of properly studying the world.

Moreover, science doesn't cover everything metaphysical that it could or even should. As I mentioned at the outset, philosophers but not physicists are currently doing some of the necessary systemization of the physical world. Physics often leaves theories only partially interpreted, or with significant questions unanswered. Serious gaps in our understanding of gauge fields, quantum theory, and more require our attention. The same goes in sciences outside physics. I should stress, however, that metaphysics can be prospective as well as retrospective. It needn't only follow where science leads. It's very optimistic to think that a new quantum theory of gravity, for instance, won't be in part sensitive to the ontology of quantum mechanics or electromagnetism. And by exploring different conceptions of time, philosophers open up new possibilities to consider in devising a theory of quantum gravity. Finally, metaphysics can range generally

over several scientific fields, asking distinctive questions about how they relate and what they have in common. These aren't questions usually tackled in a science itself, for obvious sociological reasons, but they are no less important for it.

There are plenty of significant areas of metaphysics in which to work, philosophers are needed for this work, and one hopes that they can sometimes make a distinctive positive contribution.¹⁵¹⁶

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¹⁵ Answers to the question in footnote 2: a, Hume; b, Leibniz; c, Berkeley; d, Hobbes; e, Descartes; f, Spinoza; g, Kant.

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