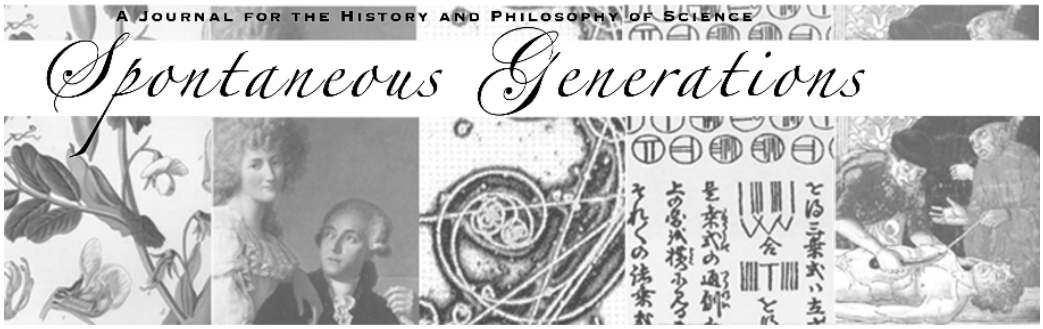

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E D I T O R I A L O F F I C E S

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Focused Discussion Invited Paper

Being Realistic: The Challenge of Theory Change for a Metaphysics of Scientific Realism*

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In recent years, philosophers have taken pains to emphasize the relevance of modal metaphysics for the debate over scientific realism. While I have no wish to deny that a well-worked out defence of scientific realism will likely require substantive modal commitments at some stage, I nevertheless worry that emphasizing the continuities between scientific and metaphysical theories risks obscuring the profound differences between them. One such difference, I would argue, is that while it seems entirely uncontroversial—at least from a realist point of view—to hope that science can discover truths about the unobservable prior to the emergence of a fundamental scientific theory, it seems that paradigmatic claims of *metaphysics* must await such a theory before we can assert them with any naturalistic justification. Given that we do not yet possess this sought-for fundamental theory, were modal theories really necessary for scientific realism then the prospects for justifying realism *in the present* would seem to darken considerably.

I take the debate over realism to be the debate over which, if any, of the claims constitutive of contemporary scientific theories we are justified in believing. In my own domain of interest—high-energy physics—the question seems particularly acute. Its high degree of phenomenological remove renders its claims all the more inferential in character, and correspondingly all the more likely to diverge wildly from the truth. But its high degree of mathematicalization means that it can be hard to put into words what the propositional content of those claims is in the first place. Those holding out hope for a realist interpretation of particle physics must therefore ask, firstly, what portions of our present physics theories are justified objects of belief, and secondly, what is it exactly that we are believing in when we believe in those claims?

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Recent landmark works in the realism debate—perhaps most explicitly that of Anjan Chakravartty (2007)—have argued that answering both of these questions requires the development of a theory of modal metaphysics. It does after all seem incumbent upon realists to provide, at a minimum, a coherent story about how knowledge of the unobservable could even be possible, let alone realized in fact; indeed given van Fraassen's attacks on realism's key inferential strategies, many now regard this as all for which realists can reasonably hope (van Fraassen 1980). And it also seems clear enough that success to this end requires the development of a metaphysics of laws, properties, and causation. But one could also make an argument that metaphysical annotation is required merely in order for our beliefs regarding high-energy physics to serve as proper objects of belief in the first place. For it seems that in order for us to believe p we need to be in a position to say what the world would have to be like in order for p to be true; and for that to be the case in the physics context, some story about what physical objects are, what laws are, and how each relates to the other, etc., seems to be necessary. Certainly, a merely disquotational approach to belief seems distinctly unconvincing when what are disquoted are highly abstract mathematical expressions purportedly describing items with which we will never be acquainted.

For all that this engagement between scientific and modal metaphysics is well-motivated, however, it presents a considerable and so-far largely unaddressed problem for the realism debate (an exception here is Monton 2011). While one can question the extent to which "thick" modal commitments are necessary prerequisites of realism—there are plenty of Humeans who at least aspire to realism after all—let us suppose that some kind of necessitarian view naturally accompanies realism.[1] As often noted, there are two principal kinds of approaches to understanding natural necessity to be found in the literature: those that postulate dispositional essences—that is, that analyze the nature of properties in terms of certain subjunctive conditionals—and those that posit a primitive relation of "contingent necessitation" between universals (Chakravartty 2007, 128). Although located in different "places," each theory thus posits primitive modal connections between fundamental kind properties. Moreover, each regards the kind properties themselves as intrinsic properties of objects.[2] Since the two theories are incompatible, at most one can be true, and the standard lore is that which theory this is is a fact underdetermined by the physics. But it is by now part of the "metaphysical stance" to be comfortable

[1] Arguments parallel to those about to follow may be mounted in the Humean context.

[2] To my knowledge, this is only implicit in Armstrong's view but follows from their being subject to free recombination.

with that.

However, while both of these views (explicitly or otherwise) present themselves as a metaphysics of modality applicable to fundamental laws and properties, a case can be made that the modal landscape at the most fundamental levels—at least, the most fundamental levels we are currently equipped to theorize about—has a very different structure from that which these views present.[3] While I am by no means the only person to have made this point, I will focus here on my own work on laws and kind properties in the context of fundamental quantum field theories.[4] What one means by a "fundamental law" in this context is, at a minimum, a law that is consistent with the basic principles of quantum theory and Lorentz invariance, and that remains so even in the limit in which interaction energies grow arbitrarily large. It turns out that this is an extraordinarily difficult constraint to satisfy, as it may be shown that only special combinations of fields and special forms of interaction can actually succeed in doing so. In other work, I have argued that as a result there is room for an interpretation of fundamental laws that is at once *necessitarian* and *Humean*. It is necessitarian in the sense that there is only one way for a given set of fundamental fields to behave, at least up to determination of the constants, but Humean in the sense that, once we have posited fundamental quantum fields, it is merely *mathematico-logical* constraints that do all the work in determining the unique laws with which they accord.[5] But since mathematico-logical constraints are regarded as kosher for Humeans, it seems there is scope to argue that this necessity is one a Humean can accept. I have also argued that—due to the delicate balance in field content necessary for maintaining consistency—it is extremely difficult to maintain the posit that the fundamental kind properties are *intrinsic features* of the fundamental objects that possess them (McKenzie 2016). However, note that neither of these positions seems to find any motivation in classical physics, or indeed any theoretical context other than fundamental quantum field theories: we have no reason to think it is anything other than fundamental theories, framed in the language of quantum theory and relativity, for which these conclusions can be drawn. It seems, then, that there is good reason to think that the two main views discussed in the metaphysics

[3] That it is fundamental laws that are of interest is explicit in, e.g., Armstrong (1993, 242). Since an image of a Feynman diagram appears on the cover of Chakravartty (2007) I assume he takes his metaphysics to be applicable in quantum field theoretic domains too.

[4] See, e.g., Cei and French (2014), or any critics of the framework of Lewisian modal metaphysics appealing to features of quantum theory.

[5] See McKenzie (2014). Since writing that paper I have realized that this argument requires modification, for reasons that I do not have space to enter into here. Suffice for now to say that the basic moral, for present purposes, of this argument remains.

of science are at best further underdetermined by, but more likely simply incompatible with, the most fundamental science that we know of.

While all of this is (predictably) contestable, the basic moral should not come as a surprise to any metaphysician with naturalistic sympathies: as physics changes, certain metaphysical interpretations of the world can become increasingly unnatural or even untenable. So far, my argument simply underlines that modal metaphysics is no different in this regard. Thus in contrast to what seems to be implicit in much metaphysical practice, we cannot use modal theories developed in the context of non-fundamental science as a reliable guide to the modal options appropriate to more fundamental domains. And since most of us would (I take it) hold that the true metaphysics of the world is that which is appropriate at the most fundamental level, and since we know—given the problem of gravity—that even *quantum field theory* is unlikely to truly describe such a level, there is clearly reason to think that the options will change in future once again. Of course, there is a sense in which we might see it as a *plus* that our modal metaphysics, far from being disengaged from physics, turns out to be sensitive to it (even if not in general wholly determined by it). But the price of that engagement is that metaphysical theories likewise become subject to a problem of theory change analogous to that often taken to pose the greatest challenge to scientific realism—namely, Laudan's "pessimistic induction" (1981). As such, anyone who regards the provision of an accompanying modal story as necessary for realism must have something to say about how this problem of theory change in the case of *metaphysical* theories is to be circumvented. But here the prospects are not good.

To see why, it pays to compare the problem at hand with the ordinary problem of scientific theory change. To take a central example, we all know that the transition from the classical to the present quantum mechanical theories of matter involved enormous conceptual changes. Without reason to think that present quantum theories are immune from future supplanting, there is reason to think that some change of comparable proportions will be visited upon us once again. And if we come to believe in the process that the world is profoundly different to the way our current best theories describe it, then anti-realism about current theories seems the only honest intellectual option. But such a conclusion would of course be too harsh should our present theories turn out to be *approximations* of those more fundamental descriptions, or—more precisely—approximations of what those theories imply as we tune their parameters between relevant limits. Moreover, there is good historical reason to think this is indeed going to be possible, since such continuity has in crucial cases been secured in the past—in particular, in the case of the quantum-classical transition. For thanks to the development of decoherence theory, we now have a compelling story

about how the laws and ontologies of these two frameworks relate, since we can by this point affirm that many paradigmatic classical systems are, with respect to both their ontology and their dynamics, approximations of what relevant paradigmatic quantum-theoretic models imply in an appropriate limit (Rosaler 2016; Myrvold 2015). Since—in this crucial historical case at least—continuity at both the nomic and ontological levels can be restored, there are grounds to regard Laudan's pessimistic conclusions from the facts of theory change as overly despondent. Although this obviously requires a much fuller defence and discussion than I can give it here, let us suppose that we can grant the point. What matters for present purposes is that even if we can grant this much in the scientific context (at least in paradigmatic cases), it nevertheless may not, and indeed arguably simply *cannot*, make sense to say that a metaphysical theory—say, a dispositional essentialist view, with its commitment to properties both intrinsic and essentially dispositional—is an "approximation" to any other modal view. The reason is that being *intrinsic* is contrasted only with being *extrinsic*; but since the latter is its logical complement, there seems to be nothing "in between" intrinsic and extrinsic for the former to approximate. Nor, from the point of view of modal metaphysics, would there be any clear purpose served by introducing some notion "intermediate" between intrinsic and extrinsic: for one thing, any external dependence on fundamental property instantiation *whatsoever* will preclude the applicability of principles of free recombination lying at the heart of Lewis and Armstrong's metaphysical systems (see, e.g., Armstrong 1989, 47-48). Similarly, a property's being *essentially dispositional* is typically contrasted only with its being *categorical*—that is, with being such that it does *not* essentially involve any dispositional element (Bird 2007). Nor again is it clear that there is any room for any notion "in between" categorical and dispositional here: it simply doesn't make sense to speak of just a "dash" of primitive modality in the nature of a property, for example. As such, there would seem to be little sense to the claim that being essentially dispositional "approximates" some other way that a property could be, and similarly with "intrinsic" and "extrinsic."

In sum, then, it seems that a metaphysical claim cannot meaningfully be viewed as an "approximation" of some other claim, but rather only as *alike or different* in certain respects. For similar reasons, it is difficult to fathom (for me anyway) how a metaphysical interpretation of a physical theory could be said to "imply" that of another in the limits that take us between the physical theories themselves. For in comparison with the carefully quantified subject matters of the theories produced by science, the metaphysical categories we impose upon them have a crude or "clunky" character that makes them in principle unamenable to the manipulations through which more fundamental laws and properties gradually "deform"

into their less fundamental counterparts. Hence with regard to theories involving paradigmatically metaphysical concepts, it seems one could *only* have displacement and not any kind of continuity, and moreover on *a priori* grounds—for so long as metaphysics deals in these "clunky" categories the notion of continuity between them simply makes no sense.

Here then is the problem. It is held that some kind of modal story must accompany our articulations and defences of realism. But the history of physics suggests that we cannot identify, on the basis of current theories, even the appropriate options for how such a story might go. Moreover, unlike in the scientific case, it seems incomprehensible how any modal theory developed on the basis of current theories could be thought of as an "approximation" to anything that a more fundamental modal theory implies, and hence also how there could be anything resembling cumulative progress toward that goal of developing the right metaphysics. Since it seems likely that an as-yet undiscovered, fundamental scientific theory will be significantly different from our present theories *and* that that difference will have correspondingly significant implications for the modal theory appropriate to it, it seems foolish to believe that developing a metaphysics apt for current theories is an activity that can generate any knowledge at all. Unless simply as a warm-up exercise or a way to pass the time, what purpose is currently served by agonizing over metaphysical questions is very much an open question.

The history of philosophy is peppered with observations that science seems to make stunning progress while metaphysics does not. But perhaps there are grounds to think that it could not be any other way. The above considerations prompt a thought about what makes science, particularly mathematicalized science, uniquely powerful from an epistemic point of view: it suggests itself as the only form of theoretical activity that puts us in a position to say that we know anything before we know we've got things exactly right. But it also leaves us asking whether, instead of arguing over the metaphysical interpretation of theories that we know are not fundamental, our time as philosophers would be better spent addressing those problems in institutionalized science that might impede our progress toward the elusive fundamental theory. For it seems only when we have that fundamental theory will there be any reason to do metaphysics at all.

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