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What is Scientific Realism?*

Anjan Chakravartty[†] and Bas C. van Fraassen[‡]

I. ABSTRACT

Decades of debate about scientific realism notwithstanding, we find ourselves bemused by what different philosophers appear to think it is, exactly. Does it require any sort of belief in relation to scientific theories and, if so, what sort? Is it rather typified by a certain understanding of the rationality of such beliefs? In the following dialogue we explore these questions in hopes of clarifying some convictions about what scientific realism is, and what it could or should be. En route, we encounter some profoundly divergent conceptions of the nature of science and of philosophy.

II. BvF:

When the term appears, as it does quite often, cursorily in an introduction or comment, it is easy to gain the impression that a scientific realist is a true believer, someone who holds currently accepted science to be true and its postulated unobservable entities to exist. If the entry is more guarded, that tends to be with qualifications such as “approximately” or “for the most part,” which leaves intact the main impression, that scientific realism is the opposite of science skepticism. If that were so, science-denying politicians would be philosophers, if scientific realists are.

I find this very puzzling, for surely, in our present context, scientific realism is a philosophical position. Is it appropriate for a philosophical position to include answers to the sort of questions that scientists investigate? A philosophical position may certainly include some factual theses. For even if it is a stance, some cluster of attitudes, intentions, and commitments, that will be so if only because these will quite typically have and require factual

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presuppositions. If a position is called “realist,” we are reminded first of all of the venerable problem of universals: the medieval realists, nominalists, and conceptualists disagreed on what was real, on what exists. None of these positions was simply and merely an assertion or denial of existence. Neither was the twentieth century debate about the reality of mathematical entities among Goodman, Church, and Quine. But their disagreements were centrally on questions of existence.

So a belief in a specific scientific theory, such as Dalton’s or Bohr’s atomic theory, or in the reality of Dalton’s molecules or Bohr’s atom, could not *automatically* disqualify a position from being philosophical. But there is a startling difference, in that here the entities are concrete, conceived to be as concrete as rocks and planets, and the theories are explicitly taken as hostage to the outcomes of future experiments, measurements, and observations. Could such a belief really be a matter of philosophical debate, or of metaphysical argument? How should we conceive of philosophy if we were to say that it is?

Universals, abstract entities, are not the sole historical background for an understanding of “realism,” at least not in the past century. The debates over classical versus intuitionist or constructivist mathematics, over modalities and counterfactuals, over possible worlds, over quantum logic—these have all had their “realist” and “anti-realist” sides. But note: to take a realist position on questions about counterfactual conditionals or modalities does not involve the assertion of any *specific* such conditional or modal statement. It may involve a factual thesis, but nothing comparable to the assertion that a specific theory is true.

Much of the past century’s debates of this sort were cast within a “linguistic turn,” and so Dummett proposed a usage for “realist” adapted to this context: to take a realist position on some topic is to hold that a certain associated discourse has “objective” truth conditions. To explain this is not easy, but illustration is: for example, a non- or anti-realist position concerning counterfactual conditionals holds that they are to be evaluated in terms of not just the facts but certain contextually relevant parameters in the speaker or occasion of use.

What Dummett thus terms realism is also called “semantic realism.” Scientific realism tends to come with semantic realism about the language of science, though with qualifications. (Think of McMullen on metaphor, Hesse on analogy, Suarez on representation, to name a few.) There are contraries to scientific realism that are not realist in Dummett’s sense, about the language of science, but at least one, constructive empiricism, is not so. Taking the language of science literally, and its truth conditions as objective, does therefore not amount to scientific realism. The question is what more it takes, and specifically whether that more will be a belief about contingent

facts about concrete entities.

I started with the impression gained from cursory use of the term “scientific realist.” What of careful formulations in the literature?

Hilary Putnam’s famous statement, that scientific realism is the only philosophy of science that does not leave the success of science a miracle, does not settle the matter. For even if we assent to it, we can arrive at a belief in the truth of any scientific theory only via Inference to the Best Explanation, which is one of the main bones of contention in the scientific realism debates.

David Papineau begins his discussion with a characterization of realism, for any putative body of knowledge, as required

to involve the conjunction of two theses: (1) *an independence thesis*: our judgments answer for their truth to a world which exists independently of our awareness of it; (2) *a knowledge thesis*: by and large, we can know which of these theses are true. (Papineau 1996, 2)

Together these do not imply that anything thus regarded is true, only that we *can* know, that it is possible to know, whether or not it is. So this position of scientific realism could be held by someone who adds that we (could but) do not know, and that s/he does not believe. On this characterization a scientific realist may well be, to use Peter Forrest’s terms, not a *scientific gnostic* but a *scientific agnostic*.

So here I am left still with this open question: why do practically all presentations of their side give the impression that being a scientific realist involves being a scientific gnostic? And secondly: what is needed, besides semantic realism about the relevant discourse, to arrive at scientific realism?

III. AC:

One might be tempted to strengthen your thought, Bas, that scientific realists often give the *impression*—commonly associated with the idea that some theories, models, or claims derived from them are true—that having certain beliefs is part of what it is to be a scientific realist. Where some merely hint, others are explicit.¹ Despite a number of finer-grained presentations of what realism can and should be, some of which may contest the notion that belief is central to scientific realism, it is safe to say, I think, that this notion is part of the currently received view.

Is this puzzling? Does it not answer (in part) your question of what more is required, in addition to semantic realism in the realm of scientific

¹ Some examples of the latter are Smart 1963, Boyd 1983, Devitt 1991, Kukla 1998, Niiniluoto 1999, Psillos 1999, and Chakravartty 2007.

discourse, for scientific realism? I would suggest that, on reflection, it is not so puzzling after all, though it is easily bound up with entirely reasonable and ample puzzlement about issues surrounding the nature of these beliefs. I would maintain as well that the addition of beliefs only partially answers the question of what more is required for scientific realism, for reasons that have emerged already, above.

Let us consider first the notion that beliefs, often associated with truth claims, are part and parcel of scientific realism. (I will take for granted here qualifications in terms of approximate truth and deviations from truth via abstraction, idealization, and other representational practices, noting *en passant* that questions of whether and when these qualifications are severe enough to compromise realism is one of the puzzles to be grappled!) Indeed, historical conceptions of realism in other domains are helpful for starters: in each such case “realism” connotes the reality of something. Realism about universals is the view that properties conceived as abstract entities exist. Mathematical realism is the view that there are mathematical entities. Holding such views goes hand in hand with belief: realism about universals, or numbers, or x , connotes belief in universals, or numbers, or x .

Now, certainly, universals and numbers are (putatively) abstract, and if the objects, events, processes, and properties described by scientific theories are anything at all, they are part of the world of the concrete. Affirmations of their existence are not typically merely *supported* with empirical evidence (a determined interlocutor might assert the same for universals, numbers, *de re* modality, and so on) but also take potential *risks* in the face of such evidence—even if this potential must await the future development of science for actualization. But does this difference *qua* risk mark a difference *qua* realism? It would not appear so. The abstract/concrete distinction, while relevant to questions of how telling certain kinds of evidence are for certain kinds of propositions, bears not at all on the notion that to endorse the reality of something involves believing it to exist.

Perhaps this misses the point in a spectacular way. No doubt it is one thing to believe that there are electrons, and quite another to think that such belief is philosophical. Herein lies a possible disanalogy with universals and their ilk: in cases where belief takes no risk in the world of empirical investigation, philosophical modes of assertion and denial may be the best we can do; conversely, putative scientific entities belong to the realm of the empirical, the domain of science, where belief is hardly a matter of philosophical debate. This diagnosis separates science and philosophy in an untenable way, however. Whether belief is the appropriate doxastic attitude to take toward entities putatively described by scientific theories and models is *precisely* what is at issue between scientific realists and some of their critics, for theories and models are multiply interpretable regarding questions

of ontology.

Perhaps a scientific realist could hold beliefs of only a highly generic, noncommittal sort, abstaining from affirming any particular scientific descriptions. Consider the analogy of a mathematical realist who says that she believes in mathematical entities, but not in any of them in particular. In response to questioning about the number 7, or sets, she would say: “No, I don’t believe in any particular mathematical entity, I just believe that there are mathematical entities.” Likewise, regarding the things ostensibly at issue between scientific realists and antirealists of an empiricist or instrumentalist bent—things ostensibly too small or too big or otherwise undetectable by the unaided senses—our imagined scientific realist would say: “I don’t believe in electrons, or DNA, or major depressive disorder, *or any other such thing*, but I do believe in scientific entities that are undetectable using the senses alone.”

How peculiar! Granted, peculiarity all by itself is rarely fatal. Perhaps we could accept as realists those who believe in the existence of a class of things while simultaneously having no beliefs in the existence of any members of that class. These extraordinarily mild-mannered realists would eschew supererogatory beliefs. But we have never thought of this sort of humility as constituting versions of realism. Locke (1975/1689) believed that there are real essences of objective categories of things in nature, but he did not think that we can know any. *A fortiori*, he did not believe assertions of real essences, satisfying himself with conventions in the form of nominal essences instead (book III, chapter III, §15). Locke offered an influential exemplar of antirealist accounts of natural categories. Belief in real essences at his level of abstraction was insufficient for realism.

The mention of conventions raises a further point about other facets of realism which are typically viewed as constitutive. There is the commitment to the idea of a mind-independent world, such that the things in which realists believe and the truth of propositions describing them do not depend on our thoughts. There is the related semantic commitment to objective truth conditions as well as to taking scientific descriptions at face value, rather than interpreting them as elliptical for some other domain of discourse. Puzzles abound in articulating these commitments, but acknowledging them is crucial to understanding the character of belief for scientific realists in contrast to others who are also happy to speak of scientific knowledge, but only under the auspices of contrary metaphysical or semantic commitments.

With ample puzzles surrounding belief, we may yet hope to dissolve others: it is no wonder that politicians who deny scientific knowledge are not philosophers merely in virtue of denying scientific realism, a position that affirms scientific knowledge. Just as there are different ways of affirming science, not all of which are realist (the instrumentalist, the neo-Kantian, the

pragmatist, and the constructive empiricist all affirm scientific knowledge in their own ways), there are different ways to deny realism about science. Is it the metaphysical dimension that is problematic, or the semantic, or the epistemological, or some combination thereof, and how precisely? It is only when the denials are articulated that one wears a philosopher's cap in this sphere.

Thus we see that the opposite of scientific realism is not science skepticism, though certain forms of skepticism—regarding the existence of an external world, or objective truth conditions, or taking scientific claims at face value, or the epistemic reach of descriptions extracted from theories and models—are ways of articulating opposition. That these forms of skepticism need not amount to skepticism about science as a producer of knowledge and thus of belief is evident in the many admirers and champions of science who, all the same, do not find it within themselves to be scientific realists.

IV. BvF:

You are quite right, Anjan, to point out that quite a few scientific realists take having those beliefs as part of what it is to be a scientific realist.

What matters, though, is this: is it a distinctive part of that position, an identifying part, a crucial part, or just something incidental? Could someone be a scientific realist and not have such beliefs to the effect that certain unobservable entities are real, or that certain theories, which could be empirically adequate without being true, are actually true?² The answer is *yes*, on my understanding of scientific realism as the view that the aim, the criterion of success in science is to arrive at true theories, rather than merely empirically adequate ones. This has no implication for whether that criterion is met in any particular case, or whether even our best theories today are successful by that criterion.

I suspect quite strongly that the typical scientific realist self-image is confused. You mention, I think with reference to my brief discussion of Hilary Putnam's and David Papineau's formulation, "finer-grained presentations of what realism can and should be." If confusions in the currently received view were to come to light, those might remain, and form the basis of a new scientific realist self-understanding.

First, then, believing any or all currently accepted scientific theories cannot be an identifying characteristic of scientific realism. We can imagine a scientific realist Raoul and a constructive empiricist Antiny both listening to some eminent scientist who takes the opportunity (acceptance of a Nobel

² Clifford Hooker told me, in a conversation in 1995, that he felt quite sure that none of the main currently accepted scientific theories are even empirically adequate, and that his version of scientific realism did not require any such belief.

Prize perhaps?) to outline what is currently accepted scientific theory. Some things he mentions are obvious: the theory of evolution and the global warming scenario, for example. Many theories he mentions involve postulation of unobservable entities, and the scientist speaks very favourably of them.³ At this point each philosopher may state quite explicitly that he believes everything that this scientist said. In Antiny's case that will tell us something quite independent of his philosophical position; what about Raoul's?

There will be one clear difference between them: not in what they believe about the natural world, but *what they say about this belief*. Raoul says his belief is based on the conviction that the great scientific successes described would be a miracle (something unexplained) otherwise and that it is part of his philosophical position that this cannot be. Antiny says that he arrived at his own belief in those very propositions by rationally permissible leaps of faith. He adds that, with respect to the success of the scientific enterprise, those beliefs are *supererogatory*. He even adds rather nonchalantly that if that success had been gained by useful fictions, so that those beliefs would be false, that would not bother him very much. I'm sure that I telegraphed the punch a long time ago: the difference between these two philosophers appears *at the meta-level of analysis and interpretation* directed first of all to the question of what science is, and only secondly to what the norms of rationality are for belief. The truth of any scientific theory is just not what is really at issue in the scientific realism debates. If it is continually raised, that may be, whether unconsciously or intentionally, a damning association of empiricism with science skepticism.

Perhaps someone might retort that Antiny could have kept his philosophical position while giving up those beliefs, whereas Raoul could not give them up without ceasing to be a scientific realist. But surely he could give up belief in any one part of the sciences without ceasing to be a scientific realist? Then why not if he becomes agnostic about the existence of anything postulated by the sciences that is unobservable?

The difference between Raoul and Antiny, if they reached this stage of debate, would definitely be at a meta-level. Raoul would hold that to be scientific, whether a professional or lay member of the scientific community

³ Being a scientist rather than a philosopher he is guarded: he claims that classical physics, quantum mechanics, quantum field theory, and general relativity are accurate to at least a remarkable degree in specified domains. As to whether electrons are real, he says certainly, provided the question is understood in the sense in which it could be understood in quantum field theory, which in his opinion almost makes a question about individual electrons disappear altogether. Despite those nuances, however, he is including the reality of certain unobservable entities and the truth of certain statements about them in accepted scientific theory.

(as we all aspire to be, after all), requires belief in some unobservable reality behind the phenomena. Antiny would deny this. But all that would be significant would be the rationale each offers for this difference. The rationale for Antiny would be that the actual criteria of success in scientific practice (which reveal its defining aim, its *telos*) are purely empirical. I can imagine a rationale for Raoul, but only one that I would regard as too far-reaching a metaphysics.

And here I think we have come perhaps to the realization that behind these debates we see the great divide in philosophy, about our conception of philosophy itself, that has always pertained to the status of metaphysics. I think I will take that bull—minotaur?—by the horns, and just say straightforwardly how it looks to me.

Whether Norwegians, electrons, or witches exist, those are not philosophical questions. There are philosophical questions in the neighborhood: questions to be answered by conceptual analysis. For example, is a naturalized Norwegian citizen a Norwegian? Is there anything in quantum field theory that can properly be called by the same name as those negatively charged particles in Bohr's model of the atom? But the questions of fact and existence are not philosophical questions: such questions we must bracket, to use Husserl's term.

Mutatis mutandis, this is the case for the truth of theories that imply the existence of concrete entities, such as scientific theories or empirical hypotheses generally.

Applying this to the scientific realism issue, I will take as a typical scientific realist position one that Jose Diez recently described to you and me in correspondence:

(SSR—Selective Scientific Realism) Really predictively successful theories (i.e., that make true, novel, and risky predictions) have a part of their non-observational content that is:

- (i) responsible for their successful predictions;
- (ii) approximately true;
- (iii) approximately preserved by posterior theories which, if more successful, are more truth-like.

I do not think that this, by itself, has any testable content that relates to its being a realist position.

The factual content I see is a partial characterization of scientific practice:

[Norm] for T^* to be a candidate for the status of successor theory to a given theory T , T^* must “preserve” the empirical predictive success of T , and account for both the (limited) success of T and for its (relative) failures in the empirical predictions, by showing how calculations based on T and empirical data approximate but do not reach the results of calculations based on T^* itself.

This is not about what the world is like, nor about which current theories are true. Instead it is about norms that are in force, constitutive even, in scientific practice. This position is accountable to the relevant facts, to be sure. The relevant facts here are facts about scientific practice, and not facts about nature.

I could say more about why, just by itself, SSR has no empirical content. But it will serve me better to just raise the question: how would one tease some philosophical realism out of this [Norm]? I surmise that to do so, realists would provide an account of “responsible for” (in the formulation of SSR) that has much to do with what they regard as “genuine” explanation rather than calculation, description, or empirical prediction. Don’t you think so? And that would effectively put the matter beyond testing.

Finally, to take up in closing the idea that we are touching on a deep and fundamental divide in philosophy, I want to emphasize that my concern with scientific beliefs as putative parts of philosophical positions is not really about academic compartmentalization, not about lines between philosophy and other disciplines, not about “turf.” Though it is easy to put it in such terms, the better way to think of it is to appropriate, momentarily, some much more traditional terminology.

The philosopher’s only equipment is Insight and Reason. How much can Insight and Reason discover about the world, on their own? Kant insisted: a great deal, within our purely human/conscious sphere. Insight is possible into the sciences, mathematics, religion, politics, and the arts because we (jointly laymen and practitioners) engage, participate in these, and through this participation constitute what they are. But when it comes to the natural world, whether observable or hidden, Insight and Reason deliver nothing except the forms of our thinking about them.

As an aspirant-empiricist, I take Kant’s point (with only the protest that he himself overestimated what can be gained even in that limited sphere).

There truly is a great divide in philosophy still today, so I cannot expect all philosophers to agree to this. The seventeenth-century metaphysics that Kant thought he had defeated came back within twentieth-century analytic philosophy. But the Kantian philosophical orientation is hospitable to much: to what metaphysics can be now and equally to what empiricism can be now.

V. AC:

Ah, now I think we have come to the heart of the matter—in fact, three matters whose clarification would go a long way to answering the question our title poses. Let me consider them in what I take to be an order of increasing philosophical depth. The first issue concerns what we *call* scientific realism and why. The second builds on the issue of naming but in a deeper way, concerning what a realist should think, if anything, about whether whatever distinctively realist beliefs she has are required or merely permissible. The third and deepest issue brings us to the heart of the heart of the matter: “metaphysics” and the philosophy of science.

When you ask, Bas, whether believing in (for example) the existence of specific unobservable entities is crucial or merely incidental to scientific realism, I am reminded that despite my suggestion of a currently received view, not all self-avowed scientific realists have such beliefs. One might ask whether these outliers are confused, or whether it is the majority that is confused in taking such beliefs to be crucial, as I think they do. Here we have a shallow but nonetheless important issue. Does “bachelors” refer to unmarried men? Well, yes, if that is what we have stipulated, and if we cannot agree on how to stipulate then there is no agreed fact of the matter. Let us think for a moment about what motivates the outliers, and the majority, and see if there is anything more here than disagreements about stipulation.

Earlier I labeled as “mild-mannered” those realists who believe in the existence of a class of things but have no beliefs in the existence of any member of that class. Some outliers who claim to be scientific realists are mild-mannered in this sense. John Worrall (2007), for instance, thinks that scientific realists should believe only the Ramsey sentences of theories meeting certain criteria. On this view one replaces various terms for things in which scientific realists commonly believe, like DNA molecules and electrons, with existentially quantified predicate variables, the striking move here being that the variables refer in only a highly indeterminate way—we are in no position to say to which thing or things in the world they refer. Likewise, a few self-avowed scientific realists, some no doubt inspired by your own (1980, 8) characterization of their view in terms of science aiming to give a literally true story of what the world is like, may think that endorsing this aim is sufficient, absent belief in any of the putative (unobservable) entities of scientific discourse, with the understanding that such endorsement fits naturally with the belief that there are such entities if only generically speaking.

Now, are these Ramsey-sentence realists and aspirational realists also scientific realists? One can imagine a motivation for thinking so. When they claim that *there are* unobservable things in the world, even without believing in any one of them in particular, their beliefs extend beyond those of scientific

antirealists such as constructive empiricists (those of them who are agnostic), logical empiricists (who translate terms for unobservables into terms for observables), and other instrumentalists (those who attribute no semantic content to terms for unobservables at all). But one may also understand the exclusionary motivation of those who take the relevant beliefs to be crucial to realism. For one thing, there is the peculiarity I noted earlier of insisting that there is a class of things and yet abjuring belief in any member of the class, since often it is at least some alleged knowledge of the latter that serves as evidence for the former. For another thing, the generic idea that there are unobservable entities is hardly distinctively scientific; most scientific realists think that the distinctive contribution of *science* is to tell us which ones there are.

With this in mind, perhaps it is no surprise that the mild-mannered are regarded by the majority as overly timid, epistemically speaking. In watering down the commitments involved the very idea becomes unpalatable to many. At a certain point in the effort to make healthy choices, the “light” mayonnaise becomes so divested of anything flavourful that most people are apt to say: “That just isn’t mayonnaise anymore.” The reason that the received view is in the majority is that even if one were to grant that by going just beyond what a scientific antirealist would say, one is thereby a scientific realist, most think that such a position is not realism *enough* to qualify as scientific realism *in their sense*. But now we are simply legislating for terms.

That said, acknowledging that there is an element of stipulation about the currently received view is not to grant that it is confused. There is a confusion in the neighbourhood, but I would suggest that it is not, Bas, the one that you suspect. The actual confusion is one of conflating the contrast between scientific realism and antirealism with a contrast between impermissive and permissive accounts of rational belief. These two contrasts are, I believe, independent of one another, and once we appreciate this, the thought that there is an inherent confusion in taking belief in at least some (unobservable) scientific entities to be an important part of scientific realism should, I think, dissipate.

Let me broach this contention with our friends, Raoul and Antiny. You present one telling difference between them *qua* scientific realist and constructive empiricist, respectively, in terms of meta-level thinking about norms of rationality. This is a crucial reminder of something that once escaped me: it is a view about the rationality of belief and not agnosticism about unobservable things (in the context of science) that is essential to constructive empiricism. So Raoul holds that rationality requires some beliefs about scientific unobservables where Antiny takes these beliefs to be rationally permissible, not compelled—but here is the conflation! If Raoul and Antiny differ in their conceptions of rationality, this is idiosyncratic to

them, not to scientific realism and antirealism. Regarding rationality, Bas, I'm with you. I too am a voluntarist in epistemology and see as mistaken any suggestion to the effect that believing in molecules of DNA is somehow irresistibly impelled by constraints of rationality. I am a scientific realist nonetheless because *I do* believe in such things, and here I would say that I stand apart from antirealists, who choose not to extend belief in this way.

Thus we lay bare two very different conceptions of scientific realism. Raoul and Antiny share some beliefs about scientific unobservables and differ in some beliefs about what rationality requires. What about Antiny's sister, Anandi? She feels the same way as Antiny about rationality (*pace* Raoul) but is agnostic about scientific unobservables. On your understanding of the distinction between scientific realism and antirealism, where conceptions of rationality are telling, Raoul is a realist and the siblings are antirealists (of the constructive empiricist sort). On my understanding, where belief is telling, Raoul and Antiny are scientific realists and Anandi is not. This, I maintain, is what puts the "real" into "realism": a belief in the reality of something. Having such belief is necessary and sufficient, and this is precisely what Anandi lacks.

A scientific realist might take her belief in DNA to be rationally compelled or merely rationally permissible—it is the naked fact that she believes that makes her a scientific realist about at least some part of molecular biology. If Antiny thinks that this belief is rationally permissible but not compelled, it would not be this fact but rather the fact that he is agnostic about the existence of DNA molecules that would reflect his antirealism, if he were in fact agnostic (which, as it turns out, he is not). It may be tempting to conflate scientific realism with impermissive norms for rational belief because some people offer rational compulsion as an *argument* for beliefs associated with scientific realism. This is a poor argument, I believe, but it is merely one among others. It is not constitutive of scientific realism.

Could Raoul give up his beliefs in DNA and yet retain his credentials as a scientific realist? Certainly, but only if he has some other such beliefs in connection with some other scientific descriptions of the world, in which case he would be a scientific realist about those things but not with respect to the relevant part of molecular biology.⁴ Let us be careful, though, about what this entails. Surely Raoul need not think that to be *scientific* requires belief in (some specifics of) an unobservable reality behind the phenomena. There is far too much variation in scientists' own attitudes toward their endeavor, historically and today, for anyone to put such constraints on what

⁴ We should remember here that belief for the scientific realist may extend only so far as approximate truth, and since a merely approximately true theory is strictly speaking false, this affords some leeway—enough, for example, to render Hooker's revelation (see footnote 2) compatible with scientific realism.

it means to be scientific. Science is as science does, but what science achieves, epistemically, is open to interpretation by scientist and philosopher alike.

I admit to deriving a little too much pleasure, when teaching my very first course, in putting up a quotation by a local hero cosmologist in which he claimed not to understand what people are asking when they inquire about the truth of his theories—all he is trying to do is come up with models for the data. This sort of view has a celebrated history in the thinking of many, not least scientists, who have sought to validate and endorse the sciences: Mach, Duhem, ... No one should think that being scientific requires belief regarding unobservable aspects of reality, but if one *interprets* science as telling us about such things, one is a scientific realist.

In interpreting the outputs of science this way, is the scientific realist a metaphysician? Here we come to perhaps the deepest matter of all. Ultimately I think that the answer to this question is “yes,” though the scope of this affirmation is easily misconceived. Some apparently explicit targets of scientific investigation, such as proteins and atomic nuclei, cannot be detected using our unaided senses alone, and if believing in such things is metaphysical even though the beliefs themselves are highly informed by and responsive to empirical evidence, so be it. But this does not commit a *scientific* realist to any particular beliefs regarding what are, arguably (at best), implicit subject matters of scientific investigation, such as the nature of properties or laws of nature, let alone other subjects of contemporary metaphysics, many of which pay the empirical dimensions of the sciences little if any regard.

Even so construed, some scientific realist beliefs are surely, if properly called “metaphysical,” metaphysical in a pre-Kantian way, in that they pertain (in intention, at least) to the world itself, the noumenal world, not merely the world as we fashion it through human ways of knowing. This is not to deny the use of human categories of description and other conventions, but to suggest that their use is compatible with at least some things so categorized, and even some of the categories themselves, being “out there” independently of human thought. Holding such beliefs—whether about the existence of Norwegians or electrons—is often philosophical because the forms of analysis and interpretation sometimes invoked to determine whether any given instance of a person or a subatomic particle fits these categories are themselves philosophical. There is a reason that so many philosophers of science were scientists. They were the ones who knew how to make their otherwise implicit philosophical commitments, on which the multiple interpretability of the sciences rests, explicit.

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