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REVIEW

EVANDRO AGAZZI and MASSIMO PAURI (*eds*)

The Reality of the Unobservable: Observability, Unobservability and Their Impact on the Issue of Scientific Realism

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Anjan Chakravartty
Department of Philosophy, University of Toronto

There is perhaps no more succinct a way of describing the controversy between scientific realists and antirealists than to say that it turns on the reality of the unobservable. Less concisely, it turns on whether we have reason to think that scientific theories tell us the truth (or something close to it) about some of the underlying, unobservable bits of a mind-independent, external reality, among other things. Claims to knowledge of such a reality have traditionally been a bone of contention between realists and empiricists. Two decades ago, this ongoing debate was inflamed by the introduction of Bas van Fraassen's particular brand of empiricism. Wholesale idealists and phenomenalists have been increasingly marginalized. The reality of the observable is now generally taken for granted by most parties to the debate. The epistemic status of the unobservable, however, remains controversial.

The most recent instalment of the Boston Studies in the Philosophy of Science series gives the impression that there is very little work to be done on the issue. *The Reality of the Unobservable* gives this impression because practically nothing in it concerns the reality of the unobservable—at least not as it relates to the issue of scientific realism! There is no extended discussion of the relative epistemic merit of claims about putative observable and unobservable entities and processes. This is not at all to say that the book is without merit. But it is only fair that prospective readers be warned that the title is misleading. Those hoping to find a significant concentration of considered ideas relating to the title subject will be disappointed.

The book is a collection of essays comprising revised versions of papers presented at a colloquium in Parma in 1995. There are 26 essays plus an introduction by the editors, and the contents are divided into four main sections: a general section on realism, one on observation, and two on quantum theory. The introduction contains 21 pages of detailed summaries of each of the papers in turn—a series of *de facto* abstracts, very handy for

previewing particular papers or sections. The quality of the essays is highly variable, and given the brevity of most, provocative suggestion rather than developed insight is the norm. Many of the essays, some of which are intriguing in their own right, have nothing to say about observability or realism (e.g. Paul Churchland on a proposed model for cognition, Peter Galison on 'random' number generators). Several do broach these subjects, but mostly *en passant* and primarily by recapitulating well-known arguments (or begging questions against them). A handful have no argued philosophical conclusions at all. Nevertheless, those attracted by the title of the book may find themselves stimulated by threads that run through it, some of which I will trace here.

In 'Testability and Empiricism', Dudley Shapere notes that much current research in particle physics and cosmology concerns things that are not amenable to observation. In keeping with his earlier work on observation, Shapere here intends something other than the traditional philosophical distinction between things that are detectable by the unaided senses and things that are not. For Shapere, observation occurs whenever information is transmitted directly (without interference) from the entity in question to an appropriate receptor. Thus, capturing solar neutrinos here on earth allows us to 'directly observe' the core of the sun, as opposed to indirect detections of the stellar core which might be carried out by examining electromagnetic radiation emanating from the solar surface. Neutrinos generally pass unaltered from the core to our instruments of detection; information carried by photons, on the other hand, is 'profoundly altered' along the same journey.

In the context of the book, it is interesting to consider whether Shapere's distinction between observation and mere detection has any bearing on the question of realism. That is, we might ask: is it epistemically significant, or is it merely a terminological distinction? Shapere's distinction between observation and mere detection depends, it seems, on a distinction between direct and indirect evidence. What distinguishes direct from indirect evidence is the causal history of the information carrier. Neutrinos in the above example are 'unaltered', by which I take it that Shapere means they undergo no causal interactions which change the relevant informational content (the values of certain of their properties) prior to capture. Their photon counterparts, conversely, undergo countless interactions which alter the information they carry.

My suspicion is that these distinctions are not by themselves epistemically significant. The reason that they are not has to do with the fact that, if one believes that we can have information about things not detectable by the senses, the desired information may be retrievable regardless of whether the informational content of a carrier has been altered. The reliability of information retrieval does not depend on there being no prior interfering

causal interactions; rather, it depends on the quality of our knowledge of these interactions. Shapere is quick to emphasize the role of background information in determining whether or not a detection counts as an observation. As Brigitte Falkenburg notes in her piece, 'How to Observe Quarks', these assumptions must include theories of the entities involved, the detector, and the transmission of information. What is crucial epistemically, I suggest, is the quality of our background knowledge. The previous causal interactions experienced by an information carrier may make retrieving the desired information computationally more complex, but it does not follow that this complexity will, in general, prove a greater epistemological challenge than measuring the properties of an unaltered carrier. Neutrinos, for example, are particularly elusive.

One of Shapere's motivations is to give an account of the concept of observation as it functions in the scientific context as opposed to the philosophical one. What his demarcation between the observable and the unobservable contributes to the issue of realism is a separate, appropriately philosophical question. Criteria for warranted claims are, of course, of central importance to the realist. Recall Ian Hacking's influential position that realists should be realists not about scientific theories, but about certain scientific entities—namely, those that we can manipulate and use as tools to intervene in the phenomena. In 'Measurability, Computability and the Existence of Theoretical Entities', Mauro Dorato holds that experimental practice harbours implicit standards for the endorsement of specific, postulated entities. In addition to manipulabililty, he suggests *measurability* as a sufficient condition for existence claims regarding unobservables in the traditional sense (things not detectable by the unaided senses).

Dorato's contention is that measuring the values of two or more properties of a putative entity is sufficient to warrant an existence claim. As standards go, this one is significantly more permissive than Hacking's, for it is easy to imagine situations in which we might take measurements of things that we are unable to manipulate or use as tools. This suggests a hierarchy of possible realist criteria with respect to questions of ontology. Hacking's is most conservative. Anyone holding that we should believe only in those unobservables that are observable in Shapere's sense would admit a larger ontology. On Dorato's scheme, we would believe in yet more things, on the assumption that in some cases we are able to measure properties of entities that are not observable in Shapere's sense. More or less strict criteria, not to mention variations on the above, are no doubt easy to multiply. Two sorts of questions spring to mind here from the perspective of the realism debate. The first concerns whether any of these pieces of advice for where to draw the line between what is and is not reasonable to believe engage in a non-question-begging way with antirealists such as instrumentalists or constructive

empiricists. My guess is that these kinds of speculations engage only the already committed. In any case, on what epistemic basis should realists prefer one to another? Some further advice on how to weigh Dorato's prescription against those of others is required.

Of course, being careful to admit only well grounded entities into one's ontology is not the only way to be a sophisticated realist. In 'Observation, Contextuality, and Realism', Bernard d'Espagnat takes a different tack. He harks back to the 19th century when (in his estimation) physicists adopted the wise policy of suspending concern over the fundamental natures of things, and instead concentrated on giving an account of their behaviours. It is debatable whether this is a fair historical portrait. D'Espagnat cites the example of Fourier, who gave an equation for the propagation of heat, but apparently did not take sides on the issue of whether heat is caloric or molecular agitation. But of course there *were* physicists who were concerned with precisely this latter question. Nevertheless, the picture is striking for its sketch of a position that has returned to contemporary discussions in the philosophy of science: structural realism. In d'Espagnat's view, nineteenth-century scientists could be realists about heat as an entity without worrying about its nature, for we have an idea or sense of what heat is independently of any scientific definition, thus obviating the need for one. The same cannot be said, however, of most of the putative entities of modern physics. We have no sense of what they are apart from their scientific descriptions.

D'Espagnat recommends that we interpret much of science, in keeping with his nineteenth-century moral, as describing the behaviours of systems, but in disanalogous fashion, as making no existential claims. Physics makes existential claims only to the extent that it reveals what *cannot* exist. To accept this recommendation is to give up on the idea that 'science aims at the description of reality in itself, ''the real such as it truly is'' ' (p. 252). The neo-Kantian tenor of these words echoes in Charles Paul Enz's contribution, 'Observability and Realism in Modern Experiments with Correlated Quantum Systems'. Considering experiments in condensed matter physics, Enz concludes that we should view the wave function, Ψ, as standing for a real but to an extent noumenal, unknowable thing. This position is less restrictive than d'Espagnat's, in that Enz does at least countenance the existence of theoretical entities based on our knowledge of various properties. In his words, '[w]e do not know what the object behind its properties really is' (p. 306).

What Enz and d'Espagnat have in common is a scepticism about the natures of the entities that 'lie behind' our observations and detections. Without attempting to do justice to the current literature on structural realism, let me strike one note of caution. What is it that the authors above think we are missing when we characterize entities and processes in terms of their behaviours or their properties (these may well amount to the same thing,

since behavioural relations might be construed as relations between properties). It is questionable whether there is any principled distinction to be had between behaviours and properties on the one hand, and natures on the other. Presumably it is in the nature of heat, for example, to behave in certain ways. Presumably properties, which are dispositionally responsible for the phenomena we investigate, are part of the natures of things as well. D'Espagnat and Enz are not merely observing that our knowledge is incomplete; complete knowledge was never a necessary condition for realism. What they are suggesting is that the sciences (in particular, physics) give us one *kind* of knowledge, but not another. It is unclear, however, that there is any distinction in kind of the sort they suggest.

The Kantian theme emerges provocatively to pose further questions elsewhere. Mario Casartelli considers the use of scientific notation in 'Formal Representation and the Subjective Side of Scientific Realism', hinting that notational representations may influence our views on ontology. This is certainly possible—notation may determine what we think it reasonable to quantify over, and thus what sorts of entities and processes we recognize. But do our notations condition our understanding of reality, or are they conditioned *by* such understanding? Perhaps this is one chicken-and-egg dispute we need not resolve. A certain amount of taxonomic relativity need not be an anathema to realism. In '"Scientific Realism" and Scientific Practice', Roberto Torretti disputes a view that he believes is typical of modern scientific realism: the idea that reality is 'well-defined', in some privileged way, independently of human thought. In the language of Plato's non-vegetarian metaphor of cutting nature at the joints, the idea is that there is only one correct, objective, natural kind description of the contents of reality. Torretti advocates something a little more pragmatic, along the lines of Putnam's internal realism.

I am not sure that the sort of realism Torretti contests is, in fact, especially typical of contemporary scientific realism. It is certainly one option, and there are realists who believe it. But many I think (including some who dispute Putnam's account) see nothing inconsistent in the idea that knowledge of the world, including its unobservable elements, can be perfectly objective in the sense of the realist, yet characterizable in terms of different ontological conventions. The truth is out there, external and mind-independent; we can know it and cut it up how we like. The challenge for the realist, particularly with respect to the reality of the unobservable, is in knowing where along the line to stop, on the continuous spectrum which runs between old-school realism and full-blown Kantianism.