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REVIEW

ANJAN CHAKRAVARTTY
A Metaphysics for Scientific Realism: Knowing the Unobservable
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Scientific realism has been at the heart of contemporary philosophical discussions regarding the intellectual enterprises collectively called 'science'. Very approximately, it is the view that we are entitled to accept our best scientific theories at face value, as providing a literally true description of reality, observable or not. Though this view may seem commonsensical at first glance, it has invited numerous powerful criticisms from skeptics with the result that there is a growing agreement among philosophers that it now requires considerable refinements and careful metaphysical backing. The thought is that scientific realism must be considerably refined such that what is susceptible to realist commitment is carefully circumscribed; and, further, that it is in need of metaphysical support that involves suitable clarifications of metaphysical notions like causation, properties, laws of nature, kinds, and so on, which scientific realists often make recourse to in their defense. This is a tremendous task, which is squarely tackled by Anjan Chakravartty's *A Metaphysics for Scientific Realism.*

The book, whose goal is to supply the requisite metaphysical machinery for scientific realists and thereby tell us how to be a sophisticated scientific realist, divides into three carefully coordinated parts. The first part is devoted to the issue of developing semirealism, Chakravartty's own brand of realism, by bringing together what he thinks are the best insights of entity realism and structural realism. He holds that scientific realism has been beset with a variety of challenges, one of which is the pessimistic induction on the history of

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science (henceforth, PI). PI is the idea that, looking back at the history of science, we observe that most scientific theories of the past, though once held true by their proponents, subsequently turn out to be false, often dramatically so; and that this observation can serve as a basis for inductive reasoning leading to the conclusion that in all probability present-day scientific theories will meet the same fate, recognized as false by future scientists. PI is the focus of the early part of Chakravartty's book as he believes that it has worked as a driving force for the recent evolution of realism.

Chakravartty suggests that the most promising response to PI is to isolate the part of a given scientific theory for which we have best epistemic warrant and restrict a realist commitment to it. He labels the position that emerges from this response 'selective realism'. There are two pre-existing forms of selective realism, entity realism and structural realism. Chakravartty takes it that they are basically on the right track for defending realism from PI though they ultimately founder. Their failure is instructive, though. By bringing together the best features of them, he proposes a new form of selective realism, his so-called 'semirealism', according to which realist commitment is restricted to concrete structures that are minimally required to interpret the mathematical formalism of a theory in the context of detection. Here the concrete structures are constituted by detection properties understood in terms of dispositions for relations to other properties. The response to PI from semirealism is, first, to divide a scientific theory into two parts, one of which concerns detection properties and the other of which concerns auxiliary properties; and, second, to claim that what a theory says about detection properties is preserved across theory change (provided that it is empirically successful) although it may turn out to be wrong about auxiliary properties. As scientific theories in a given domain develop, their auxiliary content may be subject to radical change. But what they say about detection properties remains the same, which ensures that they take the same particulars as their subject matter. This is why we are justified in taking a realist stance to the concrete structure. Semirealism, claims Chakravartty, thus offers a plausible way to cope with PI.

The second part of the book deals with a variety of foundational issues in metaphysics, intended to provide a metaphysical base for semirealism. On the issue of causation, first, Chakravartty promotes his own version of a process theory of causation according to which causation is understood not in terms of relations between events but in terms of continuous processes. Causal processes are systems of 'continuously manifesting relations between objects with causal properties and concomitant dispositions' (p. 114). Chakravartty holds that his theory of causation offers compelling responses to three serious charges of incoherence against causal realism, while the traditional conception of causation as relations between events does not.

The next metaphysical concept Chakravartty takes on is causal properties, the properties that confer on their bearers the dispositions whose continuous manifestations constitute the causal processes that can be used to warrant knowledge of them. The question in focus is what it is that makes a property the property it is. Turning down the so-called 'categorical theory of properties' according to which properties are individuated in virtue of their fundamental, unanalysable, and primitive natures, independently of the behaviours of particulars having them, Chakravartty upholds what he calls the dispositional identity thesis (DIT), the view that properties are identified as the properties they are in virtue of their relations to other properties or, as Shoemaker puts it, 'the identity of a property is completely determined by its potential for contributing to the causal powers of the things that have it'. The first selling point of DIT comes from the epistemology of properties, which is that it requires no appeal to abstruse 'fundamental natures of properties'. What is more, from DIT, an account of *de re* necessity naturally emerges without any further excess metaphysical baggage: two properties, which are identified with the dispositions they confer on their bearers, are *necessarily* related in virtue of the fact that if they were not so related they would no longer be the properties they are. Chakravartty proceeds to defend this conception of causal properties from several charges, for instance, Richard Swinburne's charge of infinite regress. I will discuss the charge of infinite regress more later.

The last metaphysical concept Chakravartty attempts to come to grips with is that of kinds of particulars. The significance of the concept of kind consists in the fact that an appeal to natural kinds is required to justify scientific practices of inductive generalization and prediction. To give an account of kinds, Chakravartty introduces the notion of sociability, the idea that a given property is more likely to come together with some properties than others. He says: 'The highest degree of sociability is evidenced by essence kinds, where specific sets of properties are always found together. In other cases, lesser degrees of sociability are evidenced by the somewhat looser associations that make up cluster kinds. In either case, it is the fact that members of kinds share properties, to whatever degree, that underwrites the inductive generalizations and predictions to which these categories lend themselves' (p. 170). On the assumption that causal properties are understood in terms of dispositions for relations with other properties, Chakravartty's proposal seems to give a nice account of how to explain inductive or predictive success. To the extent that members of a given kind have in common a family of causal properties, they are likewise disposed to behave under various circumstances, which seems to ground inductive generalizations and predictions concerning them.

Having worked out a proposal for how to understand concepts like causation, properties, dispositions, kinds and so on that serves as a metaphysical

foundation for semirealism, Chakravartty proceeds to forge a conceptual connection between the metaphysics of semirealism and its epistemology. For one thing, Chakravartty turns his attention to the issue of how to construe scientific theories. Some philosophers take the syntactic view, considering scientific theories as axiomatic systems of statements closed under deduction, while others take the semantic view, considering them as families of models, where a model is a set-theoretic entity that satisfies the linguistic formulations of the relevant theory. Chakravartty's striking thesis on this matter is that one's view of the nature of theories has no bearing on what stand one should take on the issue of realism. In support of this thesis, he hits out at those philosophers who believe that the semantic approach to scientific theories facilitates a commitment to realism. The key idea of Chakravartty's argument is that we cannot express realist commitments unless we make recourse to linguistic formulations of theories, that is, that non-linguistic representations do not serve realists in expressing their realist commitments. From this, Chakravartty concludes that the semantic conception of scientific theories gives no special boost to realism.

The last section is devoted to clarifying the sense in which realists can say that scientific theories are, though strictly false, approximately true. Chakravartty suggests that the notion of approximate truth is not the same across different manners of representation. To argue for this suggestion, he highlights the distinction between abstraction and idealization. In cases of abstraction, one includes not all but only some relevant factors present in an aspect of reality into a model or description with which scientists represent the aspect of reality. Meanwhile, in cases of idealization, one incorporates into such a model or description some factors that (not merely do not exist but also) cannot exist as represented. With this distinction at hand, Chakravartty claims that the notion of approximate truth should be articulated in cases of abstraction differently than it is in cases of idealization. To be specific, he claims that the notion of approximate truth must be understood along two dimensions: 'how many of the relevant properties and relations one describes (abstraction), and how accurately one describes them (idealization)'.

This is a brief summary of Chakravartty's book. As is clear in this summary, it covers a vast ground in metaphysics and philosophy of science, a variety of topics from pessimistic induction on the history of science, to the individuation of properties, and to the notion of approximate truth. What is more, Chakravartty has achieved a high degree of coherence and cohesiveness among the theses he puts forward regarding them. Indeed, I have found it highly admirable to discuss such a broad range of topics and, at the same time, maintain a high level of consistency and interconnectedness. What is still more, many of Chakravartty's arguments are presented with outstanding care and clarity. Having read it, I am convinced that his semirealism has the

potential to answer a number of challenges that are traditionally known to beset realists and therefore is worthy of careful consideration. This book will thus be recognized as advancing the debates concerning scientific realism substantially. Unfortunately, however, this is not to say that I agree with all of Chakravartty's arguments. And so I will discuss some of them I have found particularly worrying.

Chakravartty's semirealism suggests that the concrete structures of a theory, which are constituted by its detection properties and their relations, are likely to be retained in some form in a later theory and hence prescribes that we restrict a realist commitment to those concrete structures. The notion of a detection property thus bears heavy theoretical weight on Chakravartty's approach, which underscores the importance of giving a precise account of it. Then what are detection properties as opposed to merely auxiliary properties? Chakravartty's answer is given in terms of causal properties that are defined to be first-order quantitative and determinate properties whose relations comprise concrete structures. He says: 'Detection properties are causal properties one has managed to detect: they are causally linked to the regular behaviours of our detectors' (p. 47). The causal processes connecting detection properties to our means of detection are usually described in terms of mathematical equations. And, the detection properties are required to give a minimal interpretation of the mathematical descriptions of the regular behaviours of our detectors. Chakravartty goes on to say 'Anything that exceeds a minimal interpretation, such as interpretations of equations that are wholly unconnected or only indirectly connected to practices of detection, goes beyond what is minimally required to do the work of science: to make predictions, retrodictions, and so on' (p. 48)

Chakravartty's definition of detection property is in need of further clarification, though. As I quoted earlier, he says 'detection properties are causal properties one has managed to detect'. That is, detection properties at a certain time are causal properties that have been actually detected before t. This is to be contrasted with a definition according to which detection properties are causal properties that can be detected in some appropriate sense of 'can' or a definition according to which detection properties are causal properties that have been or are or will be detected, which does not require that they have been actually detected before t. The introduction of this requirement is quite understandable because the two alternative definitions of detection property do not seem to ensure that the notion of detection property sustains the theoretical weight it is asked to bear. Chakravartty's definition of detection property seems to have its own problems.

It is indisputable that not all specific masses have been actually measured in the past. According to Chakravartty's definition, some specific masses are thus detection properties, while some others are not. If so, not all properties

designated by 'm' in Newton's law of motion $F = ma$ are detection properties. Newton's law of motion in its entirety is therefore not included in the concrete structure of Newton's theory as the concrete structure is supposed to be constituted solely by detection properties and their relations. This has an awkward consequence that a realist commitment is recommended for some part of Newton's law of motion but is not for some other part of it, depending on whether the specific mass occurring in it has been actually detected.

Perhaps I have read Chakravartty's sentences too literally. Given that we have accurate detecting instruments for a vast range of mass, it might be claimed, we have solid ground for thinking that the determinable property of mass is a detection property, as a consequence of which whatever determinate masses exist are detection properties. Although the property of weighing 10^{-100} kg has never been actually detected, it can be said to be a detection property. Why? Because we have detected an extensive range of mass and therefore it is sensible to say that mass in general is a detection property. Thus understood, we are permitted to maintain that Newton's law of motion as a whole is amenable to a realist commitment since the determinable properties, mass, force, and acceleration are detection properties. This is so although some determinate properties falling under those determinable properties have never actually been detected.

Once it is acknowledged that some determinate properties count as detection properties in virtue of the fact that many other determinate properties falling under the same determinable properties as they fall under have been detected in the past, however, this weakens Chakravartty's suggestion that the concrete structures of a given theory, characterized in terms of detection properties, are likely to be preserved through theory change. Why? There is a good sense in which some of the most theoretical statements that were unequivocally discarded by later theories only involve detection properties understood as above.

Consider, for example, a theoretical statement in Ptolemaic astronomy that describes the movement of a planet on a multiply epicyclic orbit. There is no doubt that this statement was not retained in any form in later astronomical theories. Nonetheless, however, it involves physical quantities such as angular velocity, angle, length, and so on, all of which are detection properties in the sense that a vast majority of determinate properties falling under each of them have been detected in the past. That said, Chakravartty is pressed to say that they must be preserved in later theories to describe regular behaviours of detectors.

Note that this is not an isolated case in the history of science. I think most theoretical statements that have proven downright wrong and hence have been categorically rejected by later theories only involve detection determinable properties in the sense advanced before, that is, in the sense that an extensive

range of determinate properties falling under them has been actually detected in the past. What this consideration reveals is that the epistemic status of a given property varies from instances to instances. When we speak of a person's mass, we can reasonably consider it as a detection property, a property required to describe regular behaviours of detectors. But when we speak of the mass of a top quark, it is best thought of as an auxiliary property, not a detection property from the viewpoint of the present-day physics. Indeed, I believe that it must be ruled out from the interpretation of mathematical equations that is minimally required to make sense of practices in the present-day physics. But Chakravartty's semirealism has no resource to differentiate one instance of mass from another with respect to epistemic status.

Another worrying feature of Chakravartty's project is his defence of DIT. One potentially scathing objection to DIT he tries to deflect is the charge that it generates a vicious infinite regress. There are two forms of it, the epistemic form and metaphysical form. To give a concise presentation of them, though, there is a need to disambiguate DIT with respect to whether causal properties are nothing but dispositions or something else that confer dispositions on their bearers. I will assume, *arguendo*, that causal properties are just dispositions. But nothing will turn on it.

For instance, the metaphysical charge of infinite regress begins with the observation that dispositions are dispositions to give manifestations but manifestations are further causal properties. If so, according to DIT that equates causal properties with dispositions, causal properties are dispositions to bring about further causal properties. But this reasoning can be repeated indefinitely, which entails that, on DIT, causal properties are dispositions to bring about dispositions to bring about dispositions to bring about, [. . .] *ad infinitum*. We thus have the makings of an infinite regress.

In response to this charge, Chakravartty says:

> [. . .] dispositions are not *constituted* by the various developments they facilitate in causal processes [. . .] Dispositions are distinct from and should not be confused with their manifestations. A specific disposition may facilitate the instantiation of another, which then facilitates the instantiation of another and so on throughout a causal process, but this does not entail that the original disposition is constituted by the sequence, be it actual or merely hypothetical. (p. 139, emphasis in original)

The gist is that DIT by no means maintains that dispositions depend on their corresponding manifestations for existence; and hence that, although it is true that manifestations are just further dispositions, this does not make for an infinite regress of a metaphysical kind.

But I worry that here Chakravartty fails to address the heart of the charge of infinite regress. I agree with him that DIT does not subscribe to the thesis

that dispositions are metaphysically constituted by their manifestations—for brevity, call it the 'Constitution Thesis'. Hence insofar as the metaphysical charge of infinite regress attributes the Constitution Thesis to DIT, it is a mistake. I hold, though, that a much more powerful form of charge of infinite regress, which has been discussed by Bird ([2007]) and Lowe ([2010]), is left unaddressed by Chakravartty. The key thought in bringing up this charge of infinite regress is that the essential characterization of a disposition must include a reference to its corresponding manifestation—henceforth, call this thought the 'Essential Characterization Thesis'. We cannot essentially characterize the dispositional property of fragility without mentioning its characteristic manifestation, i.e., the event of breaking. This is so despite the fact that it can be characterized accidentally, for instance, by saying that it is the property we need to be attentive to when we move things abroad. This Essential Characterization Thesis is in keeping with the generally held belief that one individuating principle of dispositions is their manifestations: two dispositions are not identical unless they have the same characteristic manifestation.

It is important to keep in mind that the Essential Characterization Thesis has no direct bearing on the Constitution Thesis, the thesis that dispositions are at least in part constituted by their manifestations. To draw an analogy: it is claimed that events are individuated by their causes and effects, which may drive one to say that the essential characterization of an event must cite its causes and effects. This, however, does not commit one to the abominable thought that an event is metaphysically constituted by its causes and effects: an event c cannot be a cause of an event e unless they are metaphysically distinct entities in an appropriate sense of 'distinct', which means that one cannot be a constituent of the other. I thus take it that it is a perfectly consistent position that, although we ought to cite the characteristic manifestations of a disposition to offer an essential characterization of it, nevertheless it is not constituted by those characteristic manifestations.

I take it, though, that the Essential Characterization Thesis suffices to pose a bad enough problem for DIT. The pivotal observation from which the charge of infinite regress occurs is that dispositions are dispositions to bring about certain manifestations; but that, according to DIT, those manifestations are none other than further dispositions. Barring a viciously circular move, then, we cannot provide a finite characterization of a disposition in terms of its manifestations as we ineluctably find ourselves embroiled in an infinite regress. When this observation is put together with the Essential Characterization Thesis, it does potentially catastrophic harm to DIT. For we are left with the view that we cannot provide an essential characterization of a disposition on pain of infinite regress. To put it another way, we cannot state what a given disposition is. *A fortiori*, this infinite regress is vicious, as can be seen from the fact that, however long the characterization 'the

disposition to bring about the disposition to bring about the disposition [. . .]' we extend, this tells us nothing informative about what the disposition at issue is after all. In this sense, I take it, the charge of infinite regress, when combined with the Essential Characterization Thesis, has the potential to bring down DIT.

I take it that this line of thought, which may be seen either as an improvement of the metaphysical or epistemic form of infinite regress considered by Chakravartty or as an entirely new form of infinite regress, is the main worry we have when we raise the charge of infinite regress against DIT. Given that it is not properly discussed by Chakravartty, therefore, he fails to mitigate our worry from the problem of infinite regress.

The few concerns I have voiced so far, I should stress, do not at all diminish the value and significance of Chakravartty's admirable work. *A Metaphysics for Scientific Realism* is full of innovative and intriguing ideas carefully regimented to form a coherent and systematic position that encompasses numerous issues around the realism debate, making outstanding contributions not only to the realism debate but also to the philosophy of science, epistemology, and metaphysics in general. There is no question that it is highly recommendable reading.

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