Scientific realism from the bottom-up

Review of Michel Ghins: Scientific Realism and Laws of Nature: A Metaphysics of Causal Powers. Cham: Springer (Synthese Library, Volume 483), 2024, 224pp., €128.39 (Hardcover), ISBN: 978-3-031-54226-8

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In *Scientific Realism and Laws of Nature: A Metaphysics of Causal Powers*, Michel Ghins offers an ambitious and wide-ranging contribution to the philosophy of science. The book aims to articulate a systematic philosophical framework that combines a defence of a moderate empiricist form of scientific realism with a metaphysical account of the laws of nature grounded in causal powers. At its core lies the attempt to reconnect epistemological questions about the justification of scientific belief with a broader metaphysical picture of the entities and properties described by scientific theories.

Ghins' project is distinctive in two respects. First, he proposes a defence of scientific realism that deliberately departs from the dominant explanationist strategies that appeal to inference to the best explanation (IBE) or abduction. Instead, Ghins advocates what he calls a bottom-up strategy grounded in inductive reasoning from observationally established causal relations. According to this approach, belief in 'detectable' entities (comprising directly observable but also non-directly observable ones) is justified not because their existence provides the best explanation of the success of science, but because empirical investigation can progressively establish reliable causal connections between observable phenomena and the entities posited by scientific theories. Second, Ghins integrates this epistemological position with a metaphysical framework that combines categorical properties and causal powers. Observable properties constitute the categorical structure of the world, while dispositional properties—understood as causal powers—ground the necessity of the laws governing natural phenomena.

The opening chapter (Chapter 1) sets the stage by developing Ghins' account of the nature of scientific theories. Here he introduces what he calls the 'synthetic' conception of theories, according to which theories include both propositions—such as laws—and models that represent systems of properties. Models play a dual role: they make certain propositions true and simultaneously function as representational structures that capture aspects of the world. Ghins situates this account within a broader reflection on what he calls the objectifying attitude characteristic of science, according to which phenomena are approached as systems of properties organized by relations and abstracted from the richer context of everyday experience. The chapter further discusses the nature of modelling, representation, and mechanistic explanation, emphasizing the role of models in both representing systems and grounding explanatory relations.

Chapters 2 and 3 turn to the central epistemological issue of the book: the justification of scientific realism. Chapter 2 clarifies what is at stake in the realism debate and examines

several traditional arguments, including the no-miracles argument. Ghins argues that realism should not be understood as a scientific hypothesis explaining the success of science, but rather as a philosophical position justified through normative reflection on the rationality of belief in scientific entities.

Chapter 3 develops his positive alternative to explanationist defences of realism. The proposed bottom-up strategy begins from observed properties—either directly perceived or detected through experimentally validated instruments—and proceeds inductively by identifying stable causal connections between those properties and further properties attributed to detectable (even only indirectly) but not yet observed entities. Ghins articulates this view through four conditions for justified belief—Observation, Causality, Invariance, and Measurement—which together form the OCIM requirements. These are then condensed into Requirement R (p. 80): we have good reason to believe in a detectable property when it has been measured sufficiently often, by various reliable methods, on the basis of empirically and inductively confirmed causal links between that property and directly observed properties, and when the results are concordant.

Ghins holds that "These conditions, and crucially the causality condition, allow ascending from directly observed properties to the properties that cause them" (p. 80), but stresses that this method is bottom-up in the sense of being completely justified through induction, rather than through abductive steps.

In contrast, we should stay agnostic towards purely theoretical properties like spin or colour in quantum physics. Ghins illustrates this strategy through historical scientific examples, most prominently Jean Perrin's work on Brownian motion and Le Verrier's prediction of Neptune. Within this framework, realism takes a selective form, in that we are justified in believing in the reality of those entities whose properties stand in reliable causal relations to observable phenomena.

The second part of the book shifts from epistemology to metaphysics. Chapter 4 investigates standard philosophical accounts of laws of nature within an ontology restricted to categorical properties. Ghins examines both regularist and necessitarian approaches, discussing in particular the Humean line associated with Lewis and the categorical necessitarian account associated with Armstrong. He reviews standard objections to these accounts and concludes that both accounts are lacking, although in different ways.

Chapter 5 develops Ghins' own positive proposal: a dualist metaphysics of nature combining categorical properties with causal powers. Categorical properties correspond broadly to observable or measurable features of objects, while dispositional properties—understood as causal powers—account for the capacities of entities to produce certain effects under appropriate conditions. Scientific laws, on this view, are not themselves ontologically fundamental entities but are grounded in the regular manifestations of these powers. Ghins situates this position against other neo-Aristotelian views, especially Brian Ellis's dispositional essentialism. While sharing with Ellis the claim that powers are crucial for grounding the necessity of laws, Ghins rejects Ellis's commitment to irreducible natural kinds and strong essentialist metaphysics. Natural kinds, for Ghins, can instead be treated as sets of properties.

A number of Ghins's claims are stimulating precisely because they are so systematic, but some of them also invite further scrutiny. One question concerns the status of the "synthetic"

conception of theories introduced in Chapter 1. Ghins presents this as an alternative both to the syntactic and to the semantic view, since theories, on his account, include both propositions and models. Yet it is not clear that this marks out a genuinely new position. Much recent work has suggested that the old syntax/semantics contrast is thinner than once supposed, and perhaps partly pragmatic in character (see [1]). Moreover, semantic approaches themselves need not deny the presence of laws or propositions within scientific theorizing. Rather, an approach such as van Fraassen's ([2]) state-space semantic view seems to explicitly rely on them. In that respect, one may wonder whether Ghins's "synthetic" view is best understood not as a substantive alternative to the semantic view, but as a particular way of spelling out one version of it.

A second question concerns Ghins's contrast between bottom-up reasoning and inference to the best explanation. His reconstruction of the Neptune case is especially revealing here. Ghins explicitly reformulates the case as a deductive argument from observed anomalies, inductively confirmed causal correlations, and an inductively verified association between bodies of the relevant kind and planets, concluding that Neptune exists:

> "As an alternative to explanationist reasoning, a sound deductive argument based on observation results and inductively verified laws can be framed thus:
>
> 1. F: Facts: Anomalies in the trajectory of Uranus
> 2. C: Inductively confirmed causal correlations: According to Newtonian theory, such anomalies imply the presence of a body with specific mass orbiting the sun along a definite trajectory, which is the cause of these facts.
> 3. A: Inductively verified association: Planets, defined as bright spots moving periodically along the zodiac etc., also have a mass and obey the Newtonian theory.
>
> Conclusion: a new planet, named "Neptune", exists." (p. 82)

This is an elegant reconstruction, but it is not obvious that it fully eliminates the explanatory step rather than relocating it into the premises (a concerned shared by [3] too). The move from perturbations in Uranus's orbit to the postulation of a new body still seems to involve, at least implicitly, an inference to the cause that would make best sense of the data. If so, Ghins may be showing not that IBE disappears, but rather that realist justification in science involves a closer interplay between induction and explanatory inference than his sharp contrast initially suggests.

Ghins anticipates this concern. In particular, the challenge is that no amount of induction will eliminate all the possible alternative causes, and at some point some degree of IBE will be needed to choose the best candidate. At page 92 he stresses, in order to emphasize the distinction between the bottom-up and IBE approaches: "I do not deny, of course, that various plausible causal connections can—and even should—be considered. But I claim that some possible causal connections should be discarded not because they are less beautiful, but rather because they do not conform to the observations." This still appears abductive enough—even if the leap is smaller. What the argument and Ghins's observations about the role of induction in the historical examples prove is therefore the essential role of induction in scientific practice—and I agree that Requirement R is in part a good guiding principle for scientific realist justification of scientific entities—but I am not convinced this gets rid of abductive steps. I understand the motivation behind this desideratum—namely, to avoid

appealing to abduction within an empiricist framework. However, it seems that Ghins already grants a considerable amount to positions that are not strictly empiricist, such as belief in entities that are not directly observed and the adoption of a neo-Aristotelian ontology of causal powers. Given these concessions, the complete avoidance of abductive reasoning in scientific practice does not appear to be an especially pressing requirement.

A related and already hinted difficulty concerns the distinction between detectable and purely theoretical properties. Ghins's framework depends on the claim that some properties—mass, charge, temperature, and many instrumentally detected features—can be brought within empirical reach, whereas others, such as spin, remain beyond possible observation in principle. But once indirect observation is construed broadly, this line becomes harder to draw in a non-pragmatic way. It would seem that spin can be experimentally accessed in cases such as Stern–Gerlach (as also [3] stresses). The difference between accepted and excluded properties may therefore look less like a principled epistemic boundary than like a difference in the complexity and theory-ladenness of the detection procedure. At least, Ghins owes the reader a fuller account of why some theory-mediated detections count as observationally respectable while others do not.

This same issue also bears on the broader anti-IBE program of the book. If the postulation of entities such as Neptune, atoms, or even charge already involves a modest explanatory step, then the real issue may not be whether abduction is present at all, but what sort of explanatory inferences are epistemically acceptable, and under what constraints. Framed this way, Ghins's contribution may be read less as a wholesale rejection of explanationist realism than as a call to discipline it more tightly by empirically grounded causal and measurement constraints.

A further question concerns the relationship between Ghins's epistemology and the metaphysical framework developed in the final part of the book. The bottom-up strategy defended in Chapters 2 and 3 places considerable emphasis on empirically established causal connections between observable properties and the properties attributed to scientific entities. Yet the metaphysics developed in Chapter 5 introduces causal powers as dispositional properties that are, by Ghins's own admission, unobservable in principle (as he equates observable properties with categorical ones). While Ghins argues that the existence of such powers can be indirectly supported by experience, the transition from empirically grounded detection of properties to a metaphysics that posits irreducible powers may appear less straightforward than the earlier methodological discussion suggests. Relatedly, Ghins identifies categorical properties with observable or detectable properties, while powers remain by definition beyond observation. But if the notion of observability is already broadened to include sophisticated forms of indirect detection, it becomes less clear why certain properties beyond the reach of direct observation should count as observable while powers must remain excluded from that category.[1]

More precisely, I would say that either we accept that belief in powers is indirectly justified in the same way as the properties discovered via Requirement M, but this would make them observables, or they are obtained via a kind of abductive step, as our best candidate to posit for the explanation of regularities, but that seems to go against the anti-IBE empiricist spirit of the first part of the book. Either strategy would seem plausible, I think, but they lead either to a non-dualist metaphysics (as the categorical-power distinction would collapse) or to an

[1] See [4] for a review of the book primarily focused on the metaphysics of powers proposed by Ghins.

IBE-friendly framework. Hence, as they stand, these issues point to an interesting tension in the book between the empiricist motivation of the bottom-up strategy and the metaphysical commitments introduced to account for the necessity of laws that needs to be tackled explicitly.

Despite these questions, *Scientific Realism and Laws of Nature* is a stimulating and ambitious contribution to contemporary debates on scientific realism and the metaphysics of science. Even where one may remain unconvinced by some of the specific arguments, the book succeeds in bringing together a wide range of debates and presenting them in a clear and accessible manner. For this reason, it will be of interest not only to specialists working on scientific realism and the metaphysics of laws, but also to students and readers interested more broadly in the methodological and metaphysical foundations of scientific knowledge.

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