Getting Real with Quanta

By Anjan Chakravartty

Christopher Norris, *Quantum Theory and the Flight from Realism: Philosophical Responses to Quantum Mechanics.* London: Routledge, 2000. Pp. ix + 266. £15.99 PB.

The interpretation of quantum mechanics has always been a pain in the backside of scientific realism. Throughout its history, various anti-realist doctrines have dominated, associated with such luminaries as Niels Bohr and Werner Heisenberg, and referred to collectively as 'the Copenhagen interpretation'. The voice of realist dissent was thus marginalised, but never silenced. In recent years, renewed interest has attached to the possibility of a realist interpretation of quantum theory. Christopher Norris's book is an effort in this tradition.

Norris takes issue with anti-realism in the context of quantum mechanics (QM), but also more generally. His aim is to promote realist notions of reality and truth, and to do so in particular by giving arguments in favour of David Bohm's alternative formulation of QM, which instantiates, claims Norris, the desired realist principles. The overarching argument goes this way. The orthodox (Copenhagen) interpretation of QM is confounded by unresolved difficulties and constitutes a radical shift from earlier, sensible (realist) principles of scientific knowledge. Bohm's theory, conversely, solves outstanding difficulties, and requires no such radical shift. Clearly, then, Bohm's theory is to be preferred. At least two things are crucial to Norris' enterprise here: a precise description and defense of the position he calls scientific realism, applicable to pre-quantum physics, and a compelling argument to the effect that Bohm's theory may be interpreted in accordance with this position. I will focus on these points in turn.

It is widely known that there are roughly as many versions of scientific realism and anti-realism as there are realists and anti-realists. This is not a condemnation of the debate; it is a testament to the subtlety of the issues at stake, and the care required in discussing them. Norris's account of realism is unfortunately diffused throughout the book, but appears to hinge on three central claims. First, truths concerning reality are 'verification transcendent': the meaningfulness of propositions as true or false does not depend on our having means of determining their truth status. Second, science imparts knowledge of an observer-independent reality. Third, good scientific theories yield the best established of their predecessors in certain limits; an interpretation of QM should demonstrate some continuity with the important causal-explanatory principles of 'classical' physics, through to and including the work of Maxwell and Einstein. I will take up Norris' discussion of the latter two of these proposed elements of realism below, in the context of Bohm's theory. First, however, let us consider the issue of verification transcendence.

Norris advocates an alethic approach, according to which the truth-makers of our claims about reality are mind- and language-independent, as opposed to an epistemic approach, according to which truth is understood in terms of warranted assertability. The slide from an alethic to an epistemic conception, he argues, enables anti-realists to infer from the fact that QM gives no determinate values for various properties of quantum systems to the contention that reality is itself indeterminate, in violation of sensible realist principles. But Norris' emphasis on the existence of verification transcendent truths obscures the fact that many anti-realists grant an alethic approach to truth. Verification transcendence does not by itself constitute a compelling argument for scientific realism. Other pressing and well known anti-realist concerns do not figure at all in the discussion. Consider the following:

> [T]he strongest case for scientific realism is that which starts out from particular examples of the growth in knowledge typically achieved through a deeper (causal-explanatory) account of objects, events, processes, properties, microstructural features, etc. For such advances would themselves lack any remotely plausible explanation were it not for the fact that the object terms and predicates in a valid scientific theory can be taken as referring to (or quantifying over) a real-world physical object domain and its various integral attributes (p. 55).

This apparently strongest case for realism begs several questions against standard anti-realist arguments, in which the need for an explanation of the 'advance' of science (let alone in terms of a realist ontology), and the plausibility of realist explanations are precisely what is denied.

In a similar vein, Norris elsewhere claims that the 'decisive' argument in favour of a realist attitude toward QM is that the theory can explain otherwise mysterious phenomena such as chemical bonding and superconductivity. But little indication is given as to what sorts of explanations these are, and why an anti-realist could not provide her own explanations. Realism, we are told, is to be preferred on the basis of an inference to the best explanation, since it provides the most "complete and rational" explanation of quantum phenomena (p. 231). But in the absence of an argument for what is rational, here, not to mention an acknowledgement of the fact that many anti-realists contest the virtues of inference to the best explanation, Norris's defense of realism preaches only to the converted. Neither realists nor anti-realists will be happy with way their positions are described, and anti-realists will mainly find arguments to which they have already responded (see, for example, the discussion of van Fraassen's constructive empiricism, p. 28 ff.).

In any case, whether or not these arguments are compelling, many of us who are interested in realism are further interested by the question of whether Bohm's theory does in fact constitute a viable realist interpretation of quantum theory. Perhaps the most discussed scenario in philosophical discussions of QM concerns an experimental setup in which two previously interacting particles travel apart from one another and may be measured for values of some or other property (i.e. an EPR-type experiment). According to the Copenhagen interpretation, such particles cannot be thought to possess properties such as position, momentum, or spin, except in the context of a measurement. This contravenes the second of Norris's elements of realism—that of observer independence. Bohm's theory, conversely, preserves a more realist-sounding ontology of determinate properties within or without the context of measurement. Surprisingly, however, given the centrality of the aim to promote it, the text offers no detailed description or analysis of Bohm's theory. Norris frequently asserts that the theory is characterised by a realist ontology and causal-explanatory structure, but he does not show this to be the case.

That Bohm's theory should fly the flag for realism in the quantum domain is a common refrain. It is also a fascinating proposition, worthy of philosophical exploration. Let me raise just a few of the issues that might have merited attention. Recall that one of the elements of Norris's realism involves the continuity of present and past theories. It is difficult to ascertain precisely what is intended here, but Norris seems to indicate both a mathematical continuity (recovering old equations in specified limits), as well as a continuity of causal-explanatory mechanisms. But Bohm's theory is a nonlocal theory. This means that not all of the properties that determine the outcome of an object measurement are those of the object being measured; rather, they include properties of other, spatially distant objects. In other words, the behaviours of distant objects have an instantaneous effect on the object in question. Furthermore, it may well be a mistake to think of certain properties as belonging to particular objects at all. As Bohm himself indicated, it might make more sense to think of some properties as potentialities dependent on a greater whole. Norris criticises the orthodox interpretation of QM for requiring us to give up our 'classical' concept of causality and revise our understanding of physical reality, but the important challenge for the realist is to face head on the extent to which Bohm's theory does the same.

One worry about Bohm's theory is that instantaneous effects over arbitrarily large distances may conflict with relativistic considerations. As Norris observes, there is a standard response to this sort of difficulty in the literature: so long as the non-locality of QM cannot be used to convey 'information', the tension with relativity theory may be resolved. This is not uncontroversial in the case of Bohm's theory, but suppose it is true. Is this rejoinder sufficient as regards the issue of causality? Norris asserts that Bohm's theory does not conflict with special relativity or causal realism "on a suitably modified (i.e. nonlocal) construal" (p. 185). But whether a nonlocal construal of causality is compatible with causal realism is the very point requiring elaboration and argument. On the face of it, the idea of non-local effects is distinctly non-realist. It is, as Einstein said, a kind of 'spooky' action at a distance, and *hypothesis non fingo* is presumably a terrible motto for the realist. What sort of *explanation* is provided here? It is, furthermore, a matter of some debate whether the causal relation posited by the theory between quantum particles and the y-field which guides them is 'classical', that is, whether it can be understood in terms of anything like a classical force.

As mentioned above, another element of Norris's realism concerns the observer independence of theoretical knowledge. In some states, values attributed by Bohm's theory to dynamical properties such as momentum fall outside those permitted by standard QM. Fortunately these values cannot, in principle, turn up in actual measurements; they are in principle undetectable. Bohm's theory is thus empirically equivalent to standard QM. One might wonder whether realists should be realists about all of the values that Bohm's theory attributes to states that are inaccessible to measurement, despite the contradictions with standard QM. Observer independence suggests that they should. Is this a problem? Questions like this are potentially fruitful for reflections on the question of what realism should mean. What a defense of realism requires here is an honest reckoning. In the absence of such engagement, Norris' efforts are primarily polemical.

It is difficult to suggest the most appropriate audience for this work. The book is non-technical throughout, yet QM novices are unlikely to appreciate its messages, because it provides no significant background explanations of standard QM, Bell's theorem, Bohm's theory, quantum logic, and other key concepts. Anyone possessing this background, however, will find the discussion lacking in arguments, and misleading in certain respects. For example, the realist visions of Einstein and Bohm are repeatedly conflated. Norris speaks often of non-local hidden variable theories in terms of a "realist interpretation along the lines proposed by Einstein and Bohm" (p. 234). But after a brief dalliance with the hidden variables approach in 1927, Einstein gave up the idea, and was never an advocate of Bohmian mechanics. Einstein, it seems, yearned for a theory that appeals to quite different, non-classical concepts altogether, that would yield standard QM as a limiting case approximation. Despite its admirable clarity, the writing meanders and is often repetitive, lacking a well-organised argumentative structure. At various points, particularly in the early chapters, there is a heavy reliance on quotations from other authors endorsing similar conclusions, which gives the impression of appeals to authority in lieu of argument. There are also questions of emphasis. Norris has no sympathy with David Deutsch's (or any other, presumably) version of the many worlds interpretation of QM, finding it fantastic and ontologically extravagant. But despite its relatively minor relevance to the overarching argument, this discussion occupies almost a quarter of the book.

Can QM be interpreted in a way that is consistent with scientific realism? No doubt, on a weak enough construal of realism, it can, but on more substantive accounts, things prove more difficult. What realists need to explore are the details of what forms of realism are most appropriate to the quantum domain. The devil remains to be exposed in these details.

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