## BOOK REVIEWS

Jeffrey A. Barrett, ***The Quantum Mechanics of Minds and Worlds.*** Oxford: Oxford University Press, 1999 (Hardcover), 2001 (Paperback), xv + 267 pp., $21.95 (paper).

This book is a discussion of the Everett relative-state interpretation of quantum mechanics and related "no collapse" interpretations. The book presumes that its readers will have some familiarity with quantum mechanics and with the interpretational issues connected with it. It would be suitable for use in an introductory graduate course on the philosophy of quantum mechanics, although even experts are likely to enjoy its clear summaries of the material in its purview.

The Dirac-von Neumann collapse postulate, which has it that a quantum system undergoes a state transition upon measurement that is radically different from the continuous, linear, deterministic evolution it undergoes at all other times, has long been regarded as problematic. One of the problems to which it gives rise is the *measurement problem,* the problem of explaining what it is that distinguishes measurements from other physical interactions. If the collapse postulate is rejected, however, we are faced with the problem of accounting for determinate outcomes of experiments, as opposed to the superpositions of outcomes to which the linear, unitary Schrödinger evolution would typically lead. Rejection of the collapse postulate seems to entail regarding the quantum-mechanical state description as incomplete; as Bell put it, "Either the wave function, as given by the Schrödinger equation, is not everything, or it is not right" (Bell 1987, 201).

As is well-known, Hugh Everett III (1957 a, b) proposed an interpretation that, if successful, would avoid both horns of Bell's dilemma. On Everett's proposal, the quantum-mechanical state vector yields a complete account of physical reality, and it obeys the Schrödinger dynamics at all times. Reactions to this proposal have included both perfunctory dismissal and uncritical acceptance. Barrett's book finds the Aristotelian mean between these two opposing vices—it offers a sympathetic account of the Everett interpretation and related "no collapse" interpretations that nevertheless does not turn a blind eye to their shortcomings.

After a brief introduction to quantum mechanics and a historical account of the incorporation of the collapse postulate into what has become the standard formulation of quantum mechanics, there follows a close

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reading of Everett's own presentation of his theory, a reading that, if nothing else, makes it abundantly clear just how ambiguous Everett's account is. Barrett goes on to survey some of the more interesting examples of theories that purport either to be elucidations of Everett's interpretation or to be improvements on Everett's interpretation; what these theories have in common is the claim that the Schrödinger evolution holds at all times. Some of these theories hold, with Everett, that the quantum mechanical state description is complete; others add extra quantities to pick out a distinguished "branch" of a superposition. In the former class are what Albert (1992) calls the "bare theory", the many-worlds interpretations, and approaches that attempt to base determinacy of experience on environmentally induced decoherence; in the latter class fall the "single-mind" and "many-minds" theories of Albert and Loewer (1988), as well as the Bohm theory (one might add that the various modal interpretations belong in this class, also; although these are mentioned at various points in the book, discussions of the often intricate details of modal interpretations is beyond its scope).

Any interpretation of quantum mechanics, or any theory that takes quantum mechanics as its starting point, is deserving of our serious consideration to an extent that cannot exceed the extent to which quantum mechanics itself is so deserving. This, in turn, is based on the empirical success of quantum mechanics; the evidence that quantum mechanics may have something to tell us about the way the world is lies in experimental results and in records of such results. Any theory that tells us that experiments do not, in fact, have determinate outcomes, and that we do not have determinate records of experimental outcomes, is self-undermining (even if the theory also explains why we falsely believe that we have such records) because, if the theory is true, we could have no evidence that the theory is true. Barrett calls such self-undermining *empirical incoherence.* According to Barrett, it is on grounds of empirical incoherence that the bare theory and many-worlds interpretation ultimately fail.

Since much of our evidence for quantum mechanics is statistical in nature, a particularly acute symptom of empirical incoherence lies in the difficulty of interpreting the Born-rule probabilities on no-collapse theories, or at least on the no-frills variety that refrains from adding extra structure to the quantum-mechanical state description. The problem is not, as some advocates of such theories seem to think, one of obtaining the correct probabilities in a non-circular way; it is a problem of finding something for the probabilities to be probabilities *of.* Quantum-mechanical probabilities are standardly interpreted as probabilities that this or that possible outcome will be the result of a specified measurement, given a specified preparation procedure. If the result of a measurement interaction is, with certainty, a superposition of what we usually regard as the possible out-

comes—interpreted as a splitting of worlds, or not—then (as Barrett puts it), "Whence probability?" (163). This point has, of course, been made before, but it is one that bears repeating, as advocates of Everett-style interpretations continue to attempt to side-step it.

The quest for empirical coherence is a recurring theme throughout the book, and this is one of its strengths—when Barrett rejects an interpretation as inadequate, this is done not on the basis of violations of a set of prejudices labeled "intuitions," but on the grounds that the interpretation undermines the very reasons we might have for seriously considering it.

The lesson that interpretations of quantum mechanics are to be taken seriously only insofar as we have evidence that quantum mechanics is correct can, perhaps, be taken further than Barrett takes it, to indicate that we should also seriously consider theories that modify the quantum dynamics. As Abner Shimony has remarked, "in view of the fact that the experimental confirmation of that dynamics is almost entirely based on the behaviour of microscopic systems [ . . .] it is very hazardous indeed to extrapolate the validity of that dynamics to the universe as a whole" (Shimony 1989: 393, quoted by Barrett: 156). Barrett's book is an exploration of the consequences of such an extrapolation that clearly reveals some of the hazards the extrapolation faces. Although the book does not pretend to decide between the horns of Bell's dilemma, it makes it abundantly clear that the attempt to evade both horns does not succeed.

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Kim Sterelny, ***The Evolution of Agency and Other Essays.*** Cambridge, England: Cambridge University Press (2001), xvi + 310 pp., $54.95 (cloth).

This volume includes many of Kim Sterelny's previously published papers on philosophy of biology and the evolution of cognition and agency.