The human story behind Everettian quantum mechanics

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Peter Byrne
The Many Worlds of Hugh Everett III

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Hugh Everett III was an unappealing character with a remarkable mind. His Princeton doctoral thesis on the foundations of physics transformed our understanding of quantum-mechanical reality, and he made original contributions to military operations research and to game theory. His domestic life was less inspiring; he died young after a lifetime of over-indulgence in food, alcohol, tobacco and sex, leaving behind a somewhat dysfunctional family with which he had little emotional connection.

For good reason, then, this biography by Peter Byrne focuses mainly on Everett's work on quantum theory. Byrne's ambition is a lofty one: to explain the ins and outs of Everettian quantum mechanics – including treatments of decoherence and of probability – without using any mathematics and while simultaneously telling a family history. Given the subtlety and difficulty of the conceptual material, he inevitably meets with limited success in explaining it unambiguously – readers totally unfamiliar with quantum mechanics will struggle to follow more than the general outlines of Everett's vision.

But the likely readers of a book like this are not new to quantum mechanics. For physicists and for philosophers of science with an interest in the quantum world, Byrne's work will be very valuable. The author is the first to

have obtained access to the Everett family archive, and he also draws on a large number of conversations and correspondences with people who knew Everett during the genesis of his theory and through the years following its publication. The book is admirably researched; and it is authoritative both on Everett's opinions about his own theory and on its reception by others.

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Certain long-running misapprehensions are conclusively refuted by the evidence Byrne unearths. John Bell, David Bohm, David Chalmers *inter alia* have presented Everett as an idealist who only recognized the reality of observed correlations; but Everett's notes for his thesis assert clearly that all worlds are 'equally "real"', even those which contain no observers. Alternatively, Everett has been misinterpreted as proposing to add a probabilistic dynamics of world-splitting to the quantum formalism; but in a draft of the thesis he emphasizes that the worlds emerge directly from the unsupplemented fundamental reality, the wavefunction. It is clear he intended no new law governing splitting of worlds. These conclusions are not new to Everett scholarship, but the evidence that Byrne brings to bear provides them with decisive support.

The book also reveals much about the physics community through its account of the reception of Everett's work. Niels Bohr and John Wheeler in particular come across in a bad light; Bohr for aggressively using his (considerable) influence to squelch ideological opposition, and Wheeler for offering at-best-ambivalent support to his doctoral student's idea for essentially political reasons[1], despite being firmly convinced of its importance. The picture that emerges of the physics community in the 50s and 60s strongly resembles that painted by Mara Beller [1999]: a conceptual mess, held together by the personal charisma of Niels Bohr and aggressively defended by Bohr's followers. The *status quo* stunted or destroyed the careers of those unwilling to toe the party line and it set back clarification of the conceptual foundations of physics by several decades.

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Times change; and much of the initial resistance to Everett's theory has faded. Indeed, the last two decades have seen a surge of interest in Everettian quantum mechanics, recently culminating in two major conferences to commemorate the 50th anniversary of the publication of Everett's ideas. Byrne reports on proceedings at these events, and he covers the central results of the emerging school of 'Oxford Everettians': the decision-theoretic analysis of

[1] Wheeler was also apparently for a time 'a Nazi-sympathizer', and had a 'long time devotion to the task of proliferating nuclear weapons.'

Everettian probability developed by Deutsch and by Wallace and the structuralist decoherence-based account of Everettian ontology defended by Wallace and by Saunders. We also learn about recent claims by Mersini-Houghton and others to have found support for Everettian quantum mechanics in observations of the cosmic microwave background radiation, and about Max Tegmark's multi-layered multiverse theory. The result is a lively cross-section of contemporary work in the Everettian tradition.

One of Byrne's most prominent themes is that even theoreticians who are reluctant to take on board the metaphysical implications of Everett's theory are generally convinced that there is something right about it. Few physicists interviewed profess outright belief in the concrete reality of 'many worlds', but most agree that quantum cosmology cannot exist except in the context of a broadly Everettian quantum mechanics. Wojciech Zurek sums up this attitude nicely: 'It was Everett who gave us permission to think about the universe as wholly quantum mechanical'.

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Byrne makes a valiant attempt at describing the features of quantum mechanics that are needed to understand Everett's contribution. Unfortunately, for every careful semi-technical discussion (for example, the treatments of decoherence and of idealism) there is also a throwaway remark which may well mislead a less-informed reader. Byrne's approach to explaining difficult concepts is generally to put the issue in as many different ways as possible – which is fine, except when the various formulations are in tension with one another. An instance of this is the discussion of the preferred basis problem, which is characterized using nine straight rhetorical questions, including the patently unhelpful 'why do we not see dinosaurs shopping on Fifth Avenue?'

Still, the pedagogical failings of the technical side of the book should not be judged too harshly. Popularizing science without distorting it is an enormously difficult task, requiring scientific brilliance as well as eloquence. Compared to most portrayals of Everettian quantum mechanics in the media and online, Byrne's account is a model of faithful accuracy. Those who desire a more rigorous presentation and critical philosophical appraisal of Everett's theory should look instead to Saunders *et al.* [2010], a collection which complements Byrne's biography very well.

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Everett's work in operations research was mostly in quantifying the expected results of nuclear campaigns, and in designing computer algorithms to optimize strategies for distribution of warheads to maximize destruction. Horrifying as this sounds, he was a servant to the war machine rather than a

warmonger himself. Everett saw his work simply as a route to money and to a decadent lifestyle. Inevitably, his (mostly successful) quest for financial success is less gripping than his (mostly unsuccessful) quest for scientific recognition.

The joint implications of Everett's operations research and his approach to quantum mechanics are chilling. If his theories in these areas are even approximately correct, then, in countless worlds, life on planets just like ours was mutilated or extinguished by nuclear holocausts. Wisely, Byrne avoids too much moralizing, leaving readers to draw their own conclusions.

Relatively little attention is paid to Everett's personal life – quite appropriately in an academic book, since many of the details are sordid and unedifying, and since Everett espoused a one-dimensional philosophy of life – rationally-justified hedonism. We learn that Everett averaged three cocktails at lunchtime; that he was a CB radio enthusiast who called himself 'Mad Scientist'; that at college he composed an argument against the existence of God which caused one of his Catholic professors to lose faith; that he hired a lawyer to defend a prostitute friend who was arrested as she greeted him; that he was interrogated by the FBI over a practical joke. While such details are alternately amusing and depressing, they give the reader little real insight into Everett's psyche. His closest friends and family found him impossible to empathize with; what hope has a reader of his biography?

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Some parts of the book contribute little of value. Everett's extended family is catalogued in perhaps unnecessary detail in the first chapter, and ignored after that. The discussion of game theory is very limited (Everett only worked seriously on the subject while a graduate student); although Byrne frequently appeals to game-theoretic metaphors for Everett's own philosophy of life and decision-making. The account of Everett's cold-war operations research is interesting but lacks detail (perhaps unsurprisingly, as the most interesting parts of his output remain classified). My favourite Everett rumours, that he drove a black Cadillac with horns, and that he did research on UFOs, are neither confirmed nor denied.

Some rare biographies are works of literature; this is not among them. Byrne's prose is certainly readable, but it reads like an extended magazine article. Some elements of the style begin to grate – in particular the frequent ending of a section with a portentous one-sentence paragraph.

There is no need to add artificial drama to Everett's story.

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Quibbles aside, *The Many Worlds of Hugh Everett III* deserves to be widely read. It is comprehensive as a biography; satisfactory as an introduction to EQM; illuminating as a study in the psychology of physicists and of operations researchers; and engaging as a human story. I recommend it to anyone with an interest in quantum theory.

References

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