BOOK REVIEWS

Guido Bacciagaluppi and Antony Valentini, ***Quantum Theory at the Crossroads: Reconsidering the 1927 Solvay Conference***. Cambridge: Cambridge University Press (2009), 530 pp., $135.00 (cloth).

This book is simultaneously a translation of the proceedings of the Fifth Solvay Conference (minus the version of Bohr's Como lecture that was appended to those proceedings), a historical account of the conference and related events, and a philosophical commentary on some of the central issues raised by the proceedings. It begins, quite aptly, by recalling the words from Genesis (about the tower of Babel) written by Ehrenfest on the blackboard at the end of the conference and later succinctly summarized by Langevin—"the confusion of ideas reached its peak" (xv).

The book admirably reconstructs this 'confusion of ideas', proceeding in three parts. Part 1 is largely a historical reconstruction of the events leading up to the conference and a summary of the main ideas from the invited contributions to the conference. Part 2 is an examination of some central foundational issues in quantum theory in relation to their appearance in the contributions and discussions of the conference. Part 3 is the translation. Some appendices reproduce (in translation) notes related to the discussions during the conference. In general, the three parts can be read largely independently of one another, although of course it is useful to have part 3 for reference when reading, especially part 1. (I found it most helpful to read pt. 3 first.) Occasionally, material that seemed more appropriate for one part appears in another, but this fact is also an indication of the surprising organic unity of a book that did run the risk of turning out as three books stapled together.

Setting aside, for a moment, the authors' agenda, the book is already a very important contribution to our understanding of the Fifth Solvay Conference. The translation of the proceedings will make the various voices of the various participants much more accessible to a wide audience, and the historical account of how the conference came to be, how the various participants thought about and prepared their own contributions, and how the proceedings themselves were prepared will be an eye-opener for many readers. The truth about the conference is far more interesting than the fictions that are usually promulgated, and the authors do an excellent job debunking those fictions.

The authors' historical and philosophical discussion has two main

themes. The first, summarized by the words of Langevin above, is that the Fifth Solvay Conference, far from being the moment at which quantum theory became "a theory closed in itself" (quoted from Heisenberg; 243), was instead a diverse assemblage of disparate views, not necessarily clearly or completely understood even by those who held them. The second is that "the meaning of quantum theory is today an open question, arguably as much as it was in October 1927" (246), and that the proceedings of the Solvay conference itself contain the seeds (some ungerminated, some already grown) of many of our contemporary foundational discussions.

Both themes are important. The former is well enough illustrated simply by summarizing the proceedings, as the authors do in part 1. The authors give special attention to the sometimes neglected voices of de Broglie and Schrödinger (as well as Einstein, although Einstein did not make an original contribution). In addition, the book makes it clear that the views of people such as Born, Heisenberg, Bohr, Pauli Jordan, and Dirac, among others—views that today are sometimes lumped together as 'the standard interpretation'—are themselves quite disparate. Contrary to how they are later portrayed (even by themselves), these physicists were indeed struggling with many of the same foundational issues that confront us today.

Which leads us to the second theme. The authors go to some length to convince the reader—although it is not clear who needs convincing—that quantum theory does indeed face foundational challenges. They also go to great lengths to convince the reader that the 'minority' voices from the Fifth Solvay Conference—and especially de Broglie, Schrödinger, and Einstein—have something to add to the contemporary discussion, a fact that has perhaps not been sufficiently appreciated, especially in the case of de Broglie, who is often thought (incorrectly, as the authors show) to have put forward a somewhat immature version of what would later be known as the 'Bohm theory'.

These two themes are not always mutually consistently played out. Perhaps in their understandable eagerness to convince the reader of the viability, or at least historical importance, of views that mainstream physics has apparently abandoned, the authors have imbued those views (as held by the relevant participants in the conference) with a degree of internal consistency and modern sophistication that surpasses what was possible, or at least actual, in 1927, while at the same time showing little if any sympathy for the views of Bohr, Heisenberg, and company.

In chapter 12, for example, we get a very welcome and useful corrective to the fantasy version of the conference, in which debates between Bohr and Einstein, centered on the viability of the uncertainty relations, dominated the meeting. As the authors point out, no official record exists of the informal discussions between Bohr and Einstein. Instead, we have

recollections, many of them long after the fact and pointedly biased. Alas, these recollections have often been taken at face value, the account being that Einstein offered a series of objections to the uncertainty relations—in the form of gedankenexperiments designed to illustrate the simultaneous measurability of incompatible quantities—and Bohr responded with the 'correct' quantum-mechanical analysis of the experiments.

What account do the authors give in its place? Rather than Einstein offering objections to the uncertainty relations, they portray him (following Howard) as focusing on locality and incompleteness, offering variations on the theme of the 1935 incompleteness paper. The result? Bohr and company simply misunderstood Einstein's concern, and this misunderstanding has been propagated to the present day by historians, philosophers, and physicists. They were talking past one another.

This interpretation of events might go too far in the other direction. If Einstein himself were really so clear about the situation, it seems implausible that he would have been unable—over the course of days, not hours—to make them clear to Bohr and others. Moreover, it is not as if the issues of locality, incompleteness, and uncertainty are completely unrelated. On the contrary, they are (to raise yet another relevant concern) highly entangled. It really is no surprise that any discussion of one of them will involve the others in a way that—especially in 1927—is not entirely clear to any of the interlocutors.

It will come as little surprise that these remarks come from one who is somewhat more sympathetic to Bohr and company than the authors appear to be. Perhaps the lesson to learn here is that contemplating the Fifth Solvay Conference is a bit like taking a Rorschach inkblot test. The authors' own contemplation is ambitious, thought provoking, delightfully detailed, and itself deserving of further contemplation.

MICHAEL DICKSON, UNIVERSITY OF SOUTH CAROLINA

Simon Saunders, Jonathan Barrett, Adrian Kent, and David Wallace, ***Many Worlds? Everett, Quantum Theory, and Reality***. Oxford: Oxford University Press (2010), 618 pp., $99.00.

The year 2007 was the fiftieth anniversary of Everett's "'Relative State' Formulation of Quantum Mechanics" (*Review of Modern Physics* 29:454–62) and the birth of the many-worlds interpretation. To celebrate this event, two major conferences were held, one at Oxford and the other at the Perimeter Institute. But this was no mere birthday; it was a coming-of-age celebration for the many-worlds interpretation, a *cincuentañera*.