half of the book.

The first interpretation that Hughes considers is the well-known statistical interpretation, according to which a state vector describes an ensemble of similarly prepared systems, rather than an individual system. (One of its merits is a resolution of the measurement problem, although Hughes does not discuss this aspect.) After a brief description of this interpretation, he says "a natural, *though not necessary* [emphasis added] concomitant of this is the view that quantum mechanics is a classical statistical theory." He then demonstrates that this view cannot be maintained in light of the Kochen–Specker theorem. Unfortunately there is a danger that the reader may infer that this conclusion applies to the statistical interpretation, when in fact it applies only to the author's caricature of it.

After a discussion of quantum logic, which Hughes regards as useful in formally characterizing the Hilbert-space structure but physically unhelpful, Hughes turns to probability. Here he commits an elementary (but unoriginal) error in treating the two-slit experiment. He considers the formally well-defined but unmeasurable probability p(X&A) that a particle reaches position X on the screen via the slit A. His notation does not emphasize the fact that quantum mechanical probabilities are conditional on the state preparation, and hence on the configuration of the apparatus. Hence he illegitimately reinterprets p(X&A) as the probability that the particle would reach X if the other slit, B, were closed. This leads him (and has led others before him) to deduce a contradiction that does not exist.

After discussing several aspects of the measurement problem, Hughes asserts that a satisfactory solution of it must have the following characteristics: a measuring apparatus must have a set of orthogonal possible states corresponding to the possible outcomes of the measurement (pointer positions), and no nontrivial superpositions of those states are allowed. But the latter requirement is just what the analysis of the measurement process, from Schrödinger's cat paradox until the present day, has shown to be impossible. Small wonder then that he is forced to conclude that he can provide no explanation of how that state of affairs is to come about! The book ends on this rather unsatisfactory note. Hughes does not consider that, rather than follow the failed attempts to exclude superpositions of states with different pointer positions, one should seek an interpretation that is not embarrassed by them.

This book may be compared with Michael Redhead's recent book *Incompleteness, Nonlocality and Realism* (reviewed in PHYSICS TODAY, September 1988, page 104). Both treat the same subject, and at similar levels of sophistication. Hughes's style is more readable. Both treat the consequences of the Kochen–Specker theorem well. Redhead discusses Bell's theorem more adequately, but he does not treat the measurement problem. Hughes considers the measurement problem, but he fails to find an interpretation that is satisfactory in the light of it.

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Experimental Techniques in Condensed Matter Physics at Low Temperatures

Robert C. Richardson and Eric N. Smith
Addison–Wesley, Redwood City, Calif., 1988. 338 pp. $45.25 hc ISBN 0-201-15002-6

It has been more than a decade since the last practical book on experimental techniques in low-temperature physics was written, and during that period there have been advances on several fronts. *Experimental Techniques* is a current book that attempts to bring these techniques up to date. In addition to background pedagogy, the book includes some discussion of principles. It gives practical insight as well as tricks of the trade. The book is filled with recipes, practical data and advice; it reflects certain prejudices that are obviously based on some bad experiences.

The book is edited by Robert Richardson and Eric Smith and grew out of a collection of notes written originally in 1981 by students and research associates at Cornell. These manuals for designing and performing experiments became so popular internally and in the outside community that in 1984–85 a new generation of students upgraded and revised them. *Experimental Techniques* is the result of those efforts. Cornell has the reputation of training some of the best students in the design, construction and measurement of low-temperature experiments, and so I expected a book that reflected this expertise. I was not disappointed.

The book is divided into four major

chapters, entitled "Cooling and Cryogenic Equipment," "Cryogenic Design Aids," "Experimental Techniques and Special Devices" and "Thermometry." Within each of these chapters are several more-specialized articles, written by individuals or groups, that discuss separate subtopics quite extensively. It is difficult to encompass all the techniques used in low-temperature physics, and this book makes no claims to doing so. What it does discuss, it discusses in detail: It even goes so far as to give at the end of each section such useful tips as a list of reliable manufacturers in this area and what to expect from each of these suppliers as to delivery, price and so forth.

I think this book belongs in every lab that uses cryogenics, and in most condensed matter physics labs. Investigators should use it as a reference source when thinking about how to design a new experiment. Most of the articles are very easy to read, begin at the beginning and lead the reader through to fairly sophisticated techniques. There are a couple of exceptions, but in general it is straightforward to find the subject of one's interest quickly, and learn the tricks of a successful laboratory.

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Neutron Scattering at a Pulsed Source

Edited by R. J. Newport, B. D. Rainford and R. Cywinski
Adam Hilger, Bristol, UK (US dist. AIP, New York), 1988. 413 pp. £32.50 ($65.00) hc
ISBN 0-85274-388-1

Neutron scattering is by now established as an essential tool in condensed matter, materials science and certain areas of chemistry and biology. Indeed, it is hard to imagine the progress in these fields over the past 20 years taking place without the detailed microscopic information that neutron diffraction, small-angle neutron scattering and inelastic neutron scattering have been able to provide. However, unlike many comparably important research techniques, which are available in the typical university or industrial laboratory, neutron scattering has to be carried out at national or international research facilities. Thus it has always seemed somewhat mysterious and distant to the average graduate student, and often to more senior staff and faculty as well; this is even more true for researchers in the average industrial research laboratory.

It is therefore gratifying to find this book, the result of a summer school organized at the Rutherford Appleton Laboratory in 1985. Aimed at the researcher with little or no experience of the theory or practice of neutron scattering, the book captures the flavor of a hands-on workshop, supplying many details of practical importance for carrying out experiments and analyzing data. As the title implies, it is geared to researchers intending to use a pulsed spallation neutron source rather than a nuclear reactor. Such neutron sources are still relatively novel to the scientific community. Because the instrumentation is rather different from what one generally finds at reactor-based neutron sources, involving time-of-flight rather than more conventional crystal spectrometry, there is some point to documenting its principles and use in books such as this.

The reverse side of the coin is that the informality of workshop lectures (which is often compensated for by follow-up detailed discussions, question-and-answer sessions and hands-on demonstrations) makes for a rather bare and sometimes even a bit confusing presentation when simply published more or less verbatim for posterity. In particular, several of the chapters suffer from many careless errors, typographical and otherwise; poor cross-referencing, and generally poor editing. This is particularly unfortunate in a book aimed at beginners.

The introductory section by Michael Gunn is devoted to a discussion of neutron scattering formalism. The approach taken is based mainly on plausibility arguments from a semiclassical picture of waves interacting with static or dynamic scattering centers. This may be a more palatable physical picture of the scattering process for the beginner. The quantum mechanical theory is then introduced, but the full power and elegance of the formal theory in terms of operators and correlation functions is not developed, perhaps because it was judged too advanced for the intended audience. There is a brief discussion of magnetic scattering, total reflection of neutrons and even scattering from fractals. A list of references is unfortunately missing from this chapter.

The chapter on neutron scattering instrumentation by Colin Windsor looks like a 15-page condensation of his impressive 400-page *Pulsed Neutron Scattering* (Wiley, New York,