considerable mental effort necessary to grasp them is unlikely to balk at a half-dozen strategically chosen equations in the text, (particularly since the reader, on page 155, is assumed to have the mathematical background necessary to appreciate the fact that minus one raised to the power zero is plus one!).

Within this self- (or publisher-?) imposed constraint, Milburn has by and large done a first-class job in explaining in nontechnical terms the "weirdness" of quantum mechanics. If he has a fault, it is perhaps in aiming for a level of completeness that is not obviously necessary for his purpose and may on occasion be confusing to the intended readers (I would myself have settled for the oversimplification of a real but signed probability amplitude). But the exposition of the Bell–EPR results is as lucid as any I know, and, indeed, I somewhat prefer it to Herbert's, for example, in that it focuses more tightly on exactly how a quantum description enables one to evade John Bell's argument. Much of the discussion of the motivation for and nature of quantum computation is also first-rate. To be sure, by the time Milburn gets to Shor's algorithm, the going has become pretty heavy for a novice reader, but I suspect that is inherent in the material.

I have only two reservations of any substance regarding this book. The first relates to the author's enthusiasm, in chapter 4, for the notion of complete "simulability" by computer of physical reality—an attitude that I suspect will seem rather implausible to anyone dealing with any area of science (or even of physics) whose subject matter is less closely circumscribed than that of the author's primary field of quantum optics; in such fields, the problem lies not in the solution of the equations once obtained but in writing down the "relevant" equations in the first place.

My second reservation is the absence of any meaningful discussion of the quantum measurement problem—despite its obvious relevance to the interpretation of the "quantum randomness" on which the author repeatedly insists. On page 175, in the course of a discussion of decoherence, we read: "The mere fact that we can look at [the alien qubit] and decide which of two previously indistinguishable alternatives is realized destroys the superposition state." Who would guess that those three little words "can look at" conceal an issue over which some of the world's leading physicists, from Erwin Schrödinger to John Bell, have agonized for six decades?

ANTHONY J. LEGGETT
University of Illinois at Urbana-Champaign

Architectural Acoustics: Blending Sound Sources, Sound Fields, and Listeners

Yoicho Ando
AIP Press (Springer-Verlag), New York, 1998. 252 pp. $49.95 hc
ISBN 0-387-98333-3

Acoustical design is an ancient art; some fundamental although subjective notions of sound-field evaluation and the linkage of acoustical quality to dimensional factors, concepts of reverberation, interference, echoes, and loudness go back to Vitruvius (ca. 25 BC). But for centuries little changed. From the Middle Ages until the beginning of this century, the design of theaters and concert halls, on which Yoicho Ando's *Architectural Acoustics* focuses, continued to be based entirely on empirical knowledge.

The first successful attempt to quantify the acoustic properties of the sound field was by Wallace C. W. Sabine, who, around the turn of this century, defined the sound decay in a hall in terms of reverberation time; he later derived a formula for its calculation based on the enclosure dimensions and sound-absorbing properties of the walls. Sabine also found that, for optimum listening conditions, there is an optimum reverberation time, which depends on the volume of the hall and nature of the acoustical signal (speech or music, for instance). Far into this century, the optimum reverberation time was the only acoustical criterion for concert hall and theater design.

Historically, concert hall and theater design has been dominated by architects, and acousticians have usually played only a secondary role. Nonetheless, some European concert halls designed around the beginning of the century have been subjected to sound-field studies using contemporary measurement and signal processing techniques and found to be acoustically outstanding. (Vienna's Musikvereinsaal and Amsterdam's Concertgebough are among them. The Boston Symphony Hall is also highly valued for its outstanding acoustical properties.)

It is now well known that optimal reverberation time is a necessary but not sufficient criterion for designing a good concert hall. What are the other essential sound-field properties required for an optimum listening environment? Architectural acousticians have been working on this problem for the last 50 years, but, compared to rapid developments in many other areas of physics, progress on concert-hall acoustics has been relatively slow.

This admittedly lengthy introduction helps to place in context the mission, importance, and potential impact of Ando's *Architectural Acoustics*, an outstanding book that provides deep insight into the subjects of its subtitle: blending sound sources, sound fields, and listeners. Ando summarizes his research and that of his collaborators. His approach to concert hall design dwells on psychological and physiological preferences for optimal values of a few sound-field descriptors to achieve optimal listening conditions. Using computer modeling for sound-field predictions of the selected field descriptors, the shape of the hall boundaries can be optimized and the work of the acoustician can be brought into harmony with that of the architect.

The book is divided into 12 sections that cover four principal areas. The first area covered involves those physical properties of sound sources and sound fields that are linked to sound perception. The source properties are examined in terms of their power spectra and autocorrelation functions. The important and relevant sound-field quantities include impulse waves that provide temporal information and the spatial cross-correlation that is essential for spatial–binaural criteria based on interaural cross-correlation.

The second area presents the results of the latest research into subjective preferences as an overall impression of the sound field. Here, the author discusses optimum delays and intensity of initial reflections and the need for a dissimilarity of the sound fields at each of the listener's ears, as expressed by interaural cross-correlation. Ando puts these topics into the context of the auditory–brain system. Based on his extensive research, he has created a model of the auditory–cognitive system in the brain and formulated a theory of subjective preferences.

The third area is devoted to practical matters of sound-field control by design, including the effects of wall and ceiling configurations, sound diffusers, lateral reflections from canopies, sound attenuation by seats, and interactions with the floor. The author ascribes great importance to individual listeners' subjective preferences and seat selection, which vary strongly from one person to the next, as Ando shows by many examples.

The remainder of the book is dedicated to case studies of acoustical design that demonstrate how the defined criteria for optimal listening can be achieved. The author also analyzes multipurpose auditoriums, round-shaped halls and auditoriums with movable walls and ceilings. Separate chapters are devoted to acoustical measurement, physical environment planning theory, and design of electroacoustic systems.

I can highly recommend the book to anybody who is interested in the principles of concert hall acoustics. Readers who wish to explore the subject further will enjoy reading the extensive referenced publications, which substantiate the material summarized in the book.

Jiri Tichy
Pennsylvania State University
University Park, Pennsylvania

RF Superconductivity for Accelerators

Hasan Padamsee, Jens Knobloch, and Tom Hays
Wiley, New York, 1998. 523 pp. $79.95 hc ISBN 0-471-15432-6

The books in the Wiley series Beam Physics and Accelerator Technology, edited by Mel Month, are in large part an outgrowth of courses given at US Particle Accelerator Schools held at major universities around the country. These schools, brought into being in 1987 and nourished since then almost entirely through the efforts of the series editor, are now the main vehicle for the transmission of knowledge in particle beam physics and related technologies, compensating (certainly in the early years) for a lack of formal university courses in accelerator physics. *RF Superconductivity for Accelerators* by Hasan Padamsee, Jens Knobloch, and Tom Hays is a welcome addition to the textbooks catalyzed by the Particle Accelerator Schools.

The text is divided into four parts. Part I gives a descriptive overview of the subject, including a short section on the historical foundations of radio frequency superconductivity, followed by some well-written sections on superconductivity essentials and the electrodynamics of superconducting surfaces. The section on historical background is all too brief, giving little hint of the complex story behind the rather sudden flowering of the field in the mid-1960s. (For the complete story, readers should turn to the 1997 report by Catherine Westfall; *The Prehistory of Jefferson Lab's SRF Accelerating Cavities, 1962 to 1985*, published by the Thomas Jefferson National Accelerator Facility. Westfall's account offers some valuable lessons: First, research is often characterized by long periods of frustration with little noticeable progress; second, bursts of progress often follow the development of new instrumentation and measurement techniques; and third, the entire research process is strongly modulated by a not-entirely-rational human element.)

Part 2 of the text discusses the performance of superconducting cavities. Because the authors have been intimately involved in rf superconductivity technology for many years, this section is much more than a collection of references and recipes. Extensive material on cavity fabrication technology, much of it not available in the published literature, is pulled together here. The interplay between theory and practical technology is nicely illustrated. The highlight of part 2, and perhaps of the whole book, is the excellent treatment of multipactor and field emission. Because these effects are also prominently observed in room-temperature copper accelerating structures and other rf components operating at high field levels, anyone interested in the high-gradient frontier is well advised to become familiar with this material.

Part 3 discusses couplers, tuners, windows, and beam loading, material that will be of great interest to those concerned with the detailed technology of superconducting accelerating cavities. The final part of the book, on frontier accelerators, discusses the application of superconducting cavities to high-current storage rings (so-called B factories), to intense proton accelerators for pulsed neutron sources and nuclear waste transmutation, and to high-energy linear colliders. As might be expected, the attractive features of the superconducting TESLA (TeV Energy Superconducting Linear Accelerator) collider proposal receive top billing. As might also be expected, the authors do not emphasize the main disadvantage of superconducting rf technology: that at present it can achieve (optimistically) an accelerating gradient of perhaps 40 MV/m. Higher gradients will require some sort of major breakthrough, and, although such a breakthrough can never be ruled out, the best bet for realizing a linear collider with an energy above 1 TeV remains with conventional rf technology based on copper accelerating structures. Advocates of muon colliders (briefly mentioned in the book) would claim that they have a better way to reach this energy regime, but that is another story.

The book is richly illustrated (with over 300 figures) and has 378 references. This last feature underscores the book's somewhat ambiguous purpose: Does it aim to be a detailed summary of the current status of superconducting rf research and technology, or is it meant to be a text to introduce a graduate student to the field? Toward the latter goal, as in the other texts in the series, the book includes 57 well-designed problems, which require the student to fill in details of the theory or to work out numerical examples illustrating practical situations. The tutorial aspect of the book is occasionally weak, however, in particular when the text veers from its main topic into beam physics or rf theory. At these points, the student needs to be directed to good tutorial references (rather than research papers), and this is not always clearly done in the text. This is a minor quibble however; *RF Superconductivity for Accelerators* is a useful, important, and even essential reference for anyone interested in this field.

Perry B. Wilson
Stanford Linear Accelerator Center
Stanford, California

Fundamentals of Acoustical Oceanography

Herman Medwin and Clarence S. Clay
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Both of the authors of *Fundamentals of Acoustical Oceanography*, Herman Medwin and Clarence Clay, were trained as applied physicists and then developed their research careers in ocean acoustics. Between them, they have spent many decades on experimental and theoretical investigations of the use of sound to explore the ocean. Medwin is world-renowned for his work on acoustic scattering from bubbles and from ocean surface roughness; he has treated these problems from both the theoretical and laboratory experimental points of view. Clay has contributed to many aspects of ocean acoustics, particularly to understanding the effects of ocean-bottom structure. The authors' research expertise has very much influenced the content of *Fundamentals of Acoustical Oceanography*, both its earlier edition (*Acoustical Oceanography*) and this revised volume, coming just over 20 years later.

The change in title reflects the unavoidable fact that this book, despite its 700-odd pages, only scratches the surface of many of the subjects presented, although a selected subset is covered in detail. Typical introductory presentations of topics—for example, the wave equation, geometrical acoustics, and Snell's law—require familiarity with mathematical physics at the level of an upper-division physics major. Each chapter has a set of problems that make it possible to use the book as a course textbook as well as a research reference.