established researchers. Overall, it is an interesting and important book on a topic central to nuclear and hadronic physics.

THOMAS D. COHEN
University of Maryland at College Park

Beam–Wave Interaction in Periodic and Quasi-Periodic Structures

Levi Schächter
Springer-Verlag, New York, 1997.
356 pp. $99.50 hc
ISBN 3-540-61568-7

Today's accelerator physicist or engineer needs a kit packed with a variety of intellectual tools to successfully ply the craft. Certainly among the most important of these tools is a more-than-superficial understanding of the interaction of charged particles with the electromagnetic fields in or near metallic and dielectric structures. This knowledge is fundamental in designing the high-power radio-frequency sources needed to drive storage ring cavities and linac structures and in understanding the dynamics of particle acceleration in these cavities and structures.

Beam–Wave Interaction in Periodic and Quasi-Periodic Structures by Levi Schächter is directed primarily toward providing the conceptual and mathematical tools needed for research in the first of these areas, namely high-power microwave source design. Although a variety of rf devices are treated at varying levels of detail, the emphasis is on high-voltage, high-power traveling-wave amplifiers and oscillators, where relativistic effects are important. (All the expressions in the book explicitly take relativity into account.) The author has selected a limited number of devices for detailed treatment so as to have, in the author's words, "a coherent and thorough presentation of the beam–wave interaction in a few modern devices with most, if not all, the mathematical details associated with the models which explain their operation."

Not surprisingly given the title, the core of the book deals with the beam–wave interaction in periodic and quasiperiodic structures. The stage is set by a useful chapter on wave propagation in closed periodic structures (for example, a disk-loaded waveguide) and on the surface of open structures (such as a corrugated rod). Two examples of quasiperiodic structures are treated: a finite length of axially symmetric periodic structure with input and output radial waveguides and a set of coupled pillbox cavities (not necessarily identical) terminating in an output radial waveguide. Such structures, driven by a density-modulated beam, also serve as output structures for the current generation of high-power (50 to 75 MW) X-band klystrons designed to drive a linear collider.

Almost all of the structures treated are axially symmetric; in addition a strong, longitudinal magnetic field is assumed, so that the particle motion is confined to the longitudinal dimension. With these simplifying assumptions, the author is able to develop analytic expressions for the beam–wave dynamics in the linear regime, where beam density variations are small. In the nonlinear regime needed to describe a source operating at high output efficiency, the author changes to an approach in which the beam is modeled by tracking the energy and position of a collection of macroparticles. The next step (which the author does not take) would be to introduce a self-consistent two-dimensional macroparticle simulation in which transverse particle motion with realistic focusing fields is allowed. This is the way that high-power, high-efficiency microwave power sources are actually modeled. Unfortunately, work on a 2D generalization was completed only after publication of the book.

The book also contains a useful introductory chapter on elementary electromagnetic phenomena and sections on classical dynamics and relativity. These sections are slanted toward the specific material covered later in the book. A chapter on free-electron lasers follows the core material on the beam–wave interaction. This is a logical extension since, as the author points out, there is a "full equivalence between a free-electron laser and a traveling-wave amplifier."

A final comment on content: The first and the last chapters in the book bear little relation to the core content. The first chapter, which presents a brief overview of microwave power sources, is in fact too brief to be of much use to the intended reader (an advanced graduate student or someone beginning research in the design of high power microwave sources). The same can be said for a concluding chapter covering linear accelerator concepts and advanced accelerator concepts, such as wakefield accelerations. In both chapters, brevity leads in places to confusion; an example is the treatment of beam loading in a linac structure.

Although it does not interfere with the technical content, irritating evidence of editorial carelessness (missing articles, improper punctuation) appears at least once per page. Following a current trend in technical book publication, the author was asked to supply a complete electronic file of the manuscript in final form. Apparently the budget for producing highly technical books—books that are directed toward a limited market—is so tight that it doesn't allow for any professional editorial support from the publisher. Authors whose first language is not English can suffer in particular.

Despite these minor faults, I can recommend this book to the advanced student who wants an authoritative, in-depth treatment of the material described by the title. The excellent chapter on free-electron lasers is a bonus.

PERRY B. WILSON
Stanford Linear Accelerator Center
Stanford, California

Supersymmetry in Disorder and Chaos

Konstantin Efetov
Cambridge U. P., New York, 1997.
441 pp. $100.00 hc
ISBN 0-521-47097-8

The quantum statistical properties of systems that are random, or disordered, have been the subject of considerable attention in areas of physics ranging from nuclear to condensed matter. The recent recognition that phenomena associated with mechanisms of quantum coherence in disordered conductors are manifest in quantum chaotic structures has renewed interest in this area. Among the different approaches that have been applied to the study of coherence phenomena, perhaps the most successful has been a field-theoretic approach, which has come to be known in the literature as the "supersymmetry method." The main aim of Konstantin Efetov's *Supersymmetry in Disorder and Chaos* is to provide a substantial introduction to this general technique in the arena of mesoscopic quantum physics.

Indeed, given the importance that this method has assumed in recent years, a reference text on the subject seems long overdue. Moreover, as the principal architect of the supersymmetry method, the author seems uniquely qualified to write on the subject. However, although the text provides a sound introduction to the general method, it perhaps fails to convey fully the depth and significance of this area of research as well as the breadth of potential applications in more general areas of physics.

The nonlinear σ-model of spectral statistics has assumed a central role in the theory of disordered conductors

ever since the early work of Franz Wegner. This model provides a firm basis for the scaling theory of localization and has largely supplanted conventional diagrammatic approaches to coherence phenomena. However, perhaps the main strength of this approach in the present context lies in the ability of the supersymmetric incarnation of this model to describe nonperturbative aspects of the theory. It is to the derivation of the supersymmetric action that the author devotes the first part of his book.

Beginning with a compulsory introduction to the mathematics of supersymmetry, the first four chapters of *Supersymmetry in Disorder and Chaos* are concerned with the introduction and development of the functional field integral and the construction of the σ-model action. After a preliminary investigation of the renormalization group properties of the action and its connection to the one-parameter scaling theory of localization, the book in its remaining chapters focuses on the current principal applications of this approach: quantum coherence phenomena in weakly disordered structures and chaotic quantum dots.

Although it has not been rigorously established at a mathematical level, overwhelming evidence suggests that quantum statistical properties of systems that are classically chaotic are described by random matrix theory, at least over some range of energy scales. The triumph of the supersymmetry method, and the subject of chapter 6, is to establish this result rigorously for the particular class of weakly disordered metallic grains, a result first obtained by the author himself. It is the coincidence of this universal limit that establishes a firm connection to quantum chaos and motivates further discussion of universal spectral and transport properties in chapters 7 and 10.

Apart from a discussion of the open question of persistent currents in mesoscopic rings, the remaining chapters of the book are largely divided between transport properties and Coulomb blockade in mesoscopic devices and the phenomenon of strong localization in low- and high-dimensional structures. The former complements and extends the existing literature on quantum coherence phenomena in disordered structures; the latter provides a firm theoretical basis in which the concepts of Anderson localization in high-dimensional systems and multifractality in two-dimensional systems can be explored.

In summary, this book will ultimately prove its usefulness neither as an introduction to disordered conductors nor to quantum chaos. But,

rather, it will become recognized as the first comprehensive reference text for researchers working in both fields.

BEN SIMONS
University of Cambridge
Cambridge, England

Optical Properties of Semiconductor Quantum Dots

Ulrike Woggon
Springer-Verlag, New York, 1997. 251 pp. $159.00 hc
ISBN 3-540-60906-7

Scientists from disciplines ranging from condensed matter physics to cell biology are currently exploring the properties of nanocrystals. The fascination with these structures stems from their strongly size-dependent physical and chemical properties—intermediate between those of molecules and bulk solids. The systematic variation of properties with size follows simple scaling laws, and nanocrystals are often described as artificial atoms, or quantum dots, to emphasize the extent to which they may be viewed as elementary building blocks for more complex materials.

Semiconductor nanocrystals display a wealth of fascinating size-dependent characteristics. In cadmium sulfide, for example, the bandgap can be tuned from 4.5 to 2.5 eV as the size is varied from the molecular regime to the macroscopic crystal. The energy above the bandgap required to add an excess charge decreases by 0.5 eV, the melting temperature increases from 400° to 1600° C, and the pressure-induced phase transition from a four- to a six-coordinate phase decreases from 9 to 2 GPa. It is remarkable that this richness of effects is observed in a material with the same chemical composition merely by virtue of changing the crystal size.

Such semiconductor quantum dots show potential for applications in optoelectronic devices and electrical circuits. In her book *Optical Properties of Semiconductor Quantum Dots*, Ulrike Woggon covers concisely recent research on some of these remarkable size-dependent properties and their applications.

One of the interesting characteristics of nanostructures is that high-quality material may be prepared by a wide range of methods from molecular beam epitaxy to colloid chemistry. In the book, Woggon focuses primarily on optical properties of quantum dots grown in glassy matrix, a topic to which she has made substantial contributions.

As noted in the introduction to the book, the growth of quantum dots in glasses dates back as far as the 1930s, and today these samples are commonly found in many labs, where they are used as sharp-cut color filter glasses in optics. The perfected growth techniques are well described, and the book could serve as a convenient tutorial on this topic.

Sample quality affects directly all of the properties of quantum dots, and the optical ones in particular. For example, high photoluminescence yields are required for applications using quantum dots as chromophores in light-emitting diodes. Emission yields also depend on the surface quality and, since in the quantum dot regime the surface-to-volume ratios are extremely large, proper passivation of surface dangling bonds is a particular concern. It is thus appropriate that, although the preparation and characterization of quantum dot samples are not the focus of the book, the current technologies are amply described.

Alternative approaches to preparation of semiconductor quantum dots are their growth in solution and their strain-induced growth in a semiconductor matrix. Both approaches are the subject of intense present investigation in many laboratories around the world. The coverage of such an active and rapidly evolving research subject in a book obviously has inherent dangers. Woggon evades them by providing ample references to very recent results. (The interested reader is still advised to consult the most recent literature on these topics.)

In the description of electronic states of quantum dots, detailed explanations are provided. Beginning with the simplest particle-in-a-box models, the electron and hole quantum-dot electronic states are calculated as eigenstates of the spherical potential well described in many quantum mechanics textbooks. This simple description predicts the blue shift associated with quantum confinement and the appearance of discrete electronic states.

More advanced descriptions for the level structure of quantum dots are also discussed. Among these, the most important topics treated are the effects of band mixing, the fine structure of the exciton close to the bandgap and nonlinear optical properties of quantum dots.

The book works well in its intended use as a reference source for experts in the field. It is also appropriate for graduate-level researchers who are interested in learning more about the optical properties of quantum dots.

PAUL ALIVISATOS
University of California, Berkeley

NEW BOOKS

Acoustics

Encyclopedia of Acoustics, Vols. 1–4. M. J. Crocker, ed. Wiley, New York, 1997. 2017 pp. $395.00 set *hc* ISBN 0-471-80465-7

Astronomy and Astrophysics

Advances in Stellar Evolution. *Cambridge Contemporary Astrophysics.* Proc. Wksp., Elba, Italy, Jun. 1996. R. T. Rood, A. Renzini, eds. Cambridge U. P., New York, 1997. 341 pp. $69.95 *hc* ISBN 0-521-59184-8

Annual Review of Astronomy and Astrophysics, Vol. 35. G. Burbidge, ed. Annual Reviews Inc., Palo Alto, Calif., 1997. 699 pp. $70.00 *hc* ISBN 0-8243-0935-9

The Extragalactic Distance Scale. *Space Telescope Science Institute Symposium Series 10.* Proc. Symp., Baltimore, Md., May 1996. M. Livio, M. Donahue, N. Panagia, eds. Cambridge U. P., New York, 1997. 325 pp. $69.95 *hc* ISBN 0-521-59164-3

Nucleosynthesis and Chemical Evolution of Galaxies. B. E. J. Pagel. Cambridge U. P., New York, 1997. 378 pp. $74.95 *hc* ($29.95 *pb*) ISBN 0-521-55061-0 *hc* (0-521-55958-8 *pb*)

The Physics of the Interstellar Medium. *The Graduate Series in Astronomy.* 2nd edition. J. E. Dyson, D. A. Williams. IOP, Philadelphia, 1997. 165 pp. $38.00 *pb* ISBN 0-7503-0460-X

Tools of Radio Astronomy. *Astronomy and Astrophysics Library.* 2nd edition. K. Rohlfs, T. L. Wilson. Springer-Verlag, New York, 1996 [1986]. 423 pp. $69.50 *hc* ISBN 3-540-60981-4

Atomic and Molecular Physics

Chaos in Atomic Physics. *Cambridge Monographs on Atomic, Molecular and Chemical Physics 10.* R. Blümel, W. P. Reinhardt. Cambridge U. P., New York, 1997. 326 pp. $80.00 *hc* ISBN 0-521-45502-2

X-Ray Radiation of Highly Charged Ions. *Springer Series on Atoms and Plasmas 19.* H. F. Beyer, H.-J. Kluge, V. P. Shevelko. Springer-Verlag, New York, 1997. 233 pp. $79.95 *hc* ISBN 3-540-63185-2

Biophysics and Medical Physics

Intermediate Physics for Medicine and Biology. *Biological Physics Series.* 3rd edition. R. K. Hobbie. AIP Press (Springer-Verlag), New York, 1997. 575 pp. $79.95 *hc* ISBN 1-56396-458-9

Physics in Medical Diagnosis. *Physics and Its Applications 11.* T. A. Delchar. Chapman & Hall, New York, 1997. 360 pp. $99.95 *hc* ISBN 0-412-61680-7

Chemical Physics

Annual Review of Physical Chemistry, Vol. 48. H. L. Strauss, G. T. Babcock, S. R. Leone, eds. Annual Reviews Inc., Palo Alto, Calif., 1997. 875 pp. $64.00 *hc* ISBN 0-8243-1048-9