sent volume is a total success, because the author was given free rein to cover his subject matter in extensive detail. Consequently, the reader can easily follow all the arguments and derivations, which makes the book ideally suited for self-study. This approach, however, contributed to the great length of the volume—almost 1100 pages—which is too long for a standard course textbook.

This new volume is certainly a worthy successor to the original. All the mechanics of the shell model are here, including Racah algebra, the transformation for the harmonic oscillator Hamiltonian from two-particle to relative center-of-mass coordinates, coefficients of fractional parentage and seniority, along with much new material on second quantization and group theory. There are extensive sections on topics to which the author has been a major contributor, such as seniority and generalized seniority.

The work on generalized seniority provided a natural bridge for Talmi to the interacting boson model, hence the new chapters on this model, its applications and microscopic interpretation. All material is given in sufficient detail to direct the nonexpert reader beyond superficial facts. The thorough coverage of each topic should allow the more advanced reader to skip known material and proceed to individual sections that are unfamiliar.

Talmi's special perspective and philosophy about nuclear physics permeate the book and add insight to his subject. Although he is a theorist, Talmi considers nuclear physics to be rooted in the experimental data, which should always take priority over mathematical formulas no matter how elegant and attractive the formulas may be. The results of complex calculations cannot be trusted quantitatively, and the success of the assumptions of any nuclear model is justified only by their agreement with experimental data.

The book ends with an excellent 107-page appendix, containing all the principal formulas, relationships and tables of coefficients. The bibliography is short for a book of this size. (Even the author comments on this fact in the preface.) This is a minor drawback, however, for a work of this magnitude.

One can only hope that Talmi's fine book will receive the same consideration and interest as its predecessor.

Bruce R. Barrett
*University of Arizona*
*Tucson, Arizona*

## Quantum Field Theory

**Lowell S. Brown**
*Cambridge U. P., New York, 1992. 542 pp. $100.00 hc*
*ISBN 0-521-400-066*

## Quantum Field Theory: A Modern Introduction

**Michio Kaku**
*Oxford U. P., New York, 1993. 785 pp. $49.95 hc*
*ISBN 0-19-507652-4*

Quantum field theory was introduced by Paul Dirac, Werner Heisenberg and Wolfgang Pauli in the late 1920s, surprisingly soon after the birth of quantum theory. It is a generalization of quantum theory that allows the description of systems with many (even infinitely many) degrees of freedom and of systems in which particles are created and destroyed; it was originally constructed to study quantum electrodynamics, the interactions of electrons with the electromagnetic field.

The "ultraviolet divergences" that once plagued the theory were vanquished after Willis E. Lamb and Robert C. Retherford's measurements in 1947 revealed disagreements with the energy levels of hydrogen calculated using Dirac's theory of the electron. These measurements stimulated the celebrated renormalization program of quantum electrodynamics.

The subsequent applications of quantum field theory to strong interactions failed, because both the coupling constant was too large and the quark structure of hadrons was unknown. Applications of the mathematical techniques of quantum field theory to the many-body problem in nuclear and condensed matter physics were more successful. Quantum field theory vindicated itself in the elementary particle domain with the development of gauge theory and its application to the construction of the "standard model."

The development of symmetry breaking propelled quantum field theory into cosmology and the study of the early universe. Thus much of contemporary physics is in the domain of quantum field theory. Recent developments, including supersymmetry and supergravity, are explicitly formulated in the language of quantum field theory. Even string and superstring theory, which can (and perhaps should) be expressed without the language of quantum field theory, can be considered its outgrowth.

Quantum field theory has also stimulated, and in turn has been influenced by, developments in mathematics in such areas as the theory of distributions and operator theory. It will continue to occupy a central place in theoretical physics for the foreseeable future.

Quantum field theory is notoriously difficult. Witness Warren Siegel in his *Introduction to String Field Theory* (World Scientific, Singapore, 1988): "When I was a grad student, books titled *Introduction to Quantum Field Theory* were the most difficult and advanced textbooks available, and I always feared what a quantum field theory book which was not introductory would look like."

Lowell S. Brown's book is such a book. It is among several recent books to consider quantum field theory using modern methods, such as functional integration, dimensional regularization and the renormalization group. Brown's book is distinguished by the care and clarity with which he treats the topics discussed. I sense that he has rethought everything afresh, starting from basic principles; his descriptions of topics are almost invariably better than those of earlier authors.

I particularly like the derivation of the scattering cross section using wave packets, as well as the exposition of the Lehmann–Symanzik–Zimmerman reduction formula for the scattering amplitudes, in which Brown shows the crucial role played in the derivation by the Riemann–Lebesgue lemma. An exception to this care is the too-brief treatment of the basic ideas of gauge theory. The book discusses only abelian gauge theories, except for lowest-order processes in nonabelian theory for which the calculations are closely analogous to the abelian case. Some topics one would expect to find, such as Noether's theorem, are omitted.

Brown calls his book "half a book on quantum field theory." We can hope for a later book on nonabelian gauge theory, written to the same high standard.

Michio Kaku's book is a polar opposite to Brown's. Kaku discusses a mind-boggling variety of topics: If Brown's book is "half a book," Kaku's is three books. Part I discusses the basic ideas of quantum field theory through perturbation theory and renormalization in quantum electrodynamics. Part II introduces path integrals and uses them to discuss the standard model. Part III treats a collection of more advanced topics, such as lattice gauge theory, phase transitions and critical phenomena, quantum gravity and superstrings. The presentation in Parts I and II follows standard lines and is remarkably concise. In Part III, the exposition is too sketchy. For example, two pages on the two-dimensional Ising model and one page on the heterotic superstring do little more than make the reader aware of the existence of these topics.

Both books are valuable references; I have already found them useful. Indeed, I have placed them on reserve in the library for a course on quantum field theory that I am teaching this coming spring.

O. W. Greenberg
*University of Maryland
College Park*



## Quantum Theory of the Optical and Electronic Properties of Semiconductors

**Hartmut Haug and Stephen W. Koch**
*World Scientific, River Edge, N. J., 1993. 473 pp. $84.00 hc ISBN 981-02-1341-7; $42.00 pb ISBN 981-02-1347-6*

Since the early 1950s, electrical engineers have been interested in band gaps, electrons and holes, quantum efficiency and other elements of the quantum theory of solids. But the language of electronics has remained predominantly classical, using concepts such as capacity, mobility, diffusion length, current–voltage characteristics and so on.

The next step in the technological revolution seems to involve the implementation of elements that are on a mesoscopic scale. Even the names of some of the building blocks of new electronic components refer to quantum mechanics: quantum wells, quantum wires and quantum dots. The widely used term *mesoscopic*, although sometimes differently understood, essentially means elements or specimens that are large on an atomic length scale but small in comparison with some quantum length scale, such as the de Broglie wavelength of electrons, localization length or the mean free path. So it is no accident that the proceedings of recent semiconductor conferences are full of material that reminds us of illustrations in elementary quantum mechanics textbooks—a rectangular potential well, tunneling through barriers of different forms, a double quantum well and so on. Electronic processes in such devices can hardly be considered in classical terms.

There is another important trend