

books written by authors who have made important contributions to a broad range of research topics.

Gerry Mahan has chosen to cover as wide a range of topics as possible. He introduces field theoretic techniques and applies them not only to electron gas and liquid helium, two subjects which have become *de rigueur* in many-body texts, but also to polarons, to transport properties and to optical properties in insulators and semiconductors, as well as to metals.

There is a very long chapter on exactly soluble models. The analysis of many such models, extremely thorough, forms an excellent foundation for the study of interaction physics. The reader who dismisses these exercises as trivial would miss a mine of information that hitherto has been either struck with haphazard blows or explored in darkness. Step-by-step solutions demonstrate the power of several different techniques: canonical transformations, the Baker-Hausdorff theorem and Green's functions for noninteracting particles. Mahan spares no opportunity in milking all possible physical conclusions from these mathematical developments. From these, the reader can gain an understanding of a range of phenomena and concepts: electron-impurity scattering, resonance states, the Frank-Condon effect, charge- and spin-density waves in a model electron gas and polaritons, to name a few. Later chapters, in which interaction effects play an indispensable role, show the value of understanding these soluble models. For example, thorough discussions of "independent Boson models" prepare one well for Holstein's small-polaron theory and the features in the x-ray spectra of metals.

The treatment of the interaction physics is thorough in all facets: in the use of simple models to draw out important physical features, in minute discussions of all associated physical ideas, in careful explanation of sophisticated methods and in consideration of exact relations such as conservation, symmetries and Ward identities. This is best illustrated by the section on the x-ray spectra in metals. First, we are treated to an account, by the originator himself, of how term-by-term consideration of the excitonic effect in a metal leads to a sum with an unusual singularity at the adsorption edge. Then, Mahan shows the effect of Anderson's orthogonality catastrophe on the spectra. Finally, he provides a thorough treatment of Nozière and deDominicis' exact solution of the problem. One can also easily trace all these characteristics in the treatment of the small polaron.

The flaws of this book are entirely minor. One might wish for a more

systematic treatment of the second quantization, particularly the relation of the wave function representation of the state to the number representation. There could also be a linkage of the Fermi liquid theory to the properties of metals.

The impossibility of treating modern many-particle physics comprehensively is nicely illustrated by the fact that, despite the length of this book, many topics are untouched. I suspect that it really does not matter. Anyone willing to study this book thoroughly will be well equipped for research and for further reading of the many excellent monographs available on such topics as superconductivity, the renormalization group and Landau-Fermi liquid theory and of research papers. It is hoped that the length and price of the book will not deter the serious student from using the book: studying the first four chapters thoroughly, solving the set of problems and then reading a selection (if not all) of the rest of the topics. It is also a useful reference book for those already familiar with the many-body formalism who wish to look up some applications in condensed matter.

As the title indicates, *The Physics of Elementary Excitations*, has a unified theme. Many of the observations on the condensed state deal with excited states, which may be described in relation to weakly interacting quasiparticles, as Landau described liquid He^3 and He^4 . These quasiparticles are called the elementary excitations in this book. Although this approach eliminates the consideration of some important questions of the ground state, such as cohesion and structure, it does encompass a wide range of phenomena. Thus, the condensed-matter physicists can happily hunt for their own particles: phonons, magnons, excitons, polarons, polaritons, defectons and so on, without further particle-envy toward the high energists. The latter would undoubtedly insist that, though all particles are elementary, theirs are more elementary than others!

Behind the name of each particle is an important physical concept: phonon for lattice vibrations, magnons for spin "oscillations," excitons for bound electron-hole pairs. This book leads the reader directly and succinctly to a wide range of important concepts concerning elementary excitations. Then it goes on to the relations of these excitations to physical phenomena. Such discussions as those of phase transitions and elementary excitations are particularly interesting.

Although a knowledge of second quantization is assumed, many-body techniques are introduced as needed, so that the illustration of the technique and the treatment of the system or

phenomenon at hand are accomplished simultaneously. The treatment is briefer than in Mahan's book. Sometimes the reader is fed just enough to whet the appetite. After the authors introduce an extremely interesting idea, the defecton, they say only that it plays an important role in nuclear spin relaxation in solid He^3 but provide no details. However, for a student who wishes to gain relatively quickly a range of important concepts in condensed-matter physics, this book gives an excellent introduction. It equips students for studies of further details elsewhere and, indeed, for further development of their own theories.

To the question of what is the best way to study condensed matter as a many-body system, these two excellent books, starkly contrasting, provide perhaps the answer that all roads lead to Rome equally well, provided that they are paved by good cobblestones.

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Particle Physics and Introduction to Field Theory

T. D. Lee

865 pp. Harwood, New York, 1981. \$59.50 cloth, \$19.50 paper

This excellent book evolved from lectures on particle physics that T. D. Lee first gave in Beijing in 1979. It is the first in a new series called *Concepts in Contemporary Physics* that is "addressed to the professional physicist and to the serious student of physics." With its authoritative and lucid presentation of the whole gamut of modern particle physics, this book will serve as an indispensable reference for researchers in particle physics.

Lee's approach is pragmatic and includes many of his own recent research contributions to the basic problems of modern particle theory. The first six chapters are a self-contained and straightforward introduction to standard quantum field theory, with QED quantized in the Coulomb gauge. Next comes a substantial chapter on solitons that includes a discussion of their quantization. Lee completes the first half of the volume with a set of nine chapters describing symmetry considerations in particle physics. He develops the discrete symmetries—P, C and T—and the continuous ones— U_1 (in QED), isotopic spin and SU_3 —and analyzes their important physical applications (mass formulas, the $K - \bar{K}$ systems, and so on). This part concludes with a discussion on symmetry breaking and the role of the vacuum as a source of the asymmetry that serves as the bridge to the discussions of the most recent progress

in the study of interacting particles in modern field theory that comprises the second half of the book. Lee develops the formalism hand-in-hand with the physical ideas of non-Abelian gauge theories and QCD. He illustrates the need to specify gauges when carrying out the quantization and the origin of the Gribov ambiguity (corresponding to the vanishing of a Jacobian in making gauge changes) with a simple and illuminating mechanical model of point particle motion. This is just one example of very recent original research by the author that frequently appears in this volume. Lee also describes and traces the confinement and asymptotic freedom problems in QCD. He develops in detail path integration methods that lead to the Feynman rules for calculation, including the origin of the Faddeev-Popov ghosts and the construction of the effective Lagrangian of QCD, which he recently derived in collaboration with N. H. Christ.

The book concludes with extensive applications of QCD. Lee considers quark models of the hadron, the gauge theory of weak and electromagnetic interactions, high-energy processes and the quark-parton model, jets and the gluon sector in QCD, and chiral symmetry. These chapters carry the reader through many practical calculations, such as the discussion of correlations in analyses of three-jet events. There is also a variety of good exercises for the serious student.

The students in Beijing privileged to hear Lee's lectures in 1979 had a rare and very valuable treat. Many more can now share that treat.

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Electromagnetic Radiation

F. H. Read
345 pp. Wiley, New York, 1980. \$58.50

It has been said that one who knew everything about one thing would know everything about everything! Though the task that Frank H. Read has undertaken in the book *Electromagnetic Radiation* is a discussion of less than everything about light, he does cover the classical and quantum aspects of electromagnetic radiation in a thorough yet concise fashion. He has written this textbook for advanced undergraduates or first-year graduate students (for whom the level of mathematical sophistication and physical explanations is probably more appropriate). The book can, however, also suit the wider audience of practicing physicists and engineers interested in an initial "look-see" into such topics as the coherence of laser light. The careful presentation in the text and the

well-chosen references will help satisfy such an interest.

Starting with Maxwell's equations, the author discusses the propagation of electromagnetic waves and their generation by moving electrical charges. After formulating the concepts of the quantum theory of radiation and atomic energy levels initially in a theoretical manner, he applies them to intrinsically interesting technical developments. To cite an example, he presents the idea of the stimulated emission of radiation according to the classic derivation of Einstein and subsequently uses it in the explanation of the laser and the maser. Similarly, in the chapter on the scattering and absorption of radiation he looks in a general way at Compton scattering of a photon by a free electron; in a later chapter, he analyzes the role that Compton scattering plays in the detection of gamma rays with scintillation counters. This procedure, which includes obtaining numerical estimates for the significant quantities, clearly gives added insight into the physical process being considered.

Although I enjoyed reading the book, I sometimes felt that its emphasis should have been a bit different. The discussion of the classical electromagnetic field on the basis of Maxwell's equations would have been improved with greater emphasis on the equations in vacuum and with a subsequent discussion pointing out that the customary way of defining the phenomenological permeabilities and the effective fields is just a very convenient, but limited, model for treating the complex interaction of radiation with matter. This is the approach followed in the *Feynman Lectures in Physics, Vol. II, The Electromagnetic Field*. It does minimize the confusion that can arise in differentiating between the B and H (E and D) fields, particularly when the presentation employs MKS units.

In short, this fine textbook may well start a student of physics on "the yellow brick road" to everything about light.

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Acoustics: An Introduction to Its Physical Principles and Applications

A. D. Pierce
642 pp. McGraw-Hill, New York, 1981.
\$28.95

Publication of a new advanced text on the foundations and principles of acoustics is so rare an event as surely to elicit great curiosity. A book as successful as this one earns praise as well. One anticipates that many of a new genera-

tion of graduate students will form their skills through Pierce's *Acoustics*; when they have mastered it, they will be well and broadly founded in physical acoustics.

Allan Pierce based this book on his own years of experience in research and teaching in acoustics at MIT and the Georgia Institute of Technology. Preliminary versions have been used as class notes for a three-term (one academic year) introductory course in acoustics for graduate students in various fields of engineering, physics and mathematics. While this is the audience for which the book is designed, the author indicates that it is also suitable for a one-term senior-level course if the instructor avoids the more highly mathematical sections. Several such selections are suggested. Professional acousticians concerned with analysis should also profit from reference to this book, especially with respect to those areas in which they are not fully aware of current work.

Organized into eleven chapters, the book develops those concepts appropriate to application in such areas as audio engineering, noise control, architectural acoustics, propagation in the atmosphere, and remote sensing. Other areas—propagation in the ocean, interaction of sound and structural vibration and arrays of sources—are touched on more or less briefly. Pierce has quite properly resisted the temptation to be encyclopedic in favor of a thorough and coherent development of basic principles through more nearly "classical" areas of application.

Two chapters and parts of a third are devoted to radiation from small objects, baffled sources, and flexural waves on an infinite plane. They include the expected theorems and examples, but also introduce the method of matched asymptotic expansions in application to small bodies. A fine chapter on room acoustics treats the statistical description of high-frequency response in considerable detail. A chapter on low-frequency transmission in tubes and horns precedes excellent chapters on ray acoustics (including inhomogeneous and moving media) and on scattering and diffraction. The latter, the longest chapter in the book, very thoroughly covers the principles of wedge diffraction, creeping waves, fields near caustics, and bistatic scattering measurements. The final two chapters constitute a thorough introduction to the nonideal phenomena of real fluids: viscous effects (vorticity and entropy modes, acoustic boundary layer, attenuation in tubes and porous media, and relaxation processes in gases) and nonlinear effects (weak shocks, N waves, ballistic shocks, but not parametric arrays).

We can illustrate what Pierce's