standard model, including the undiscovered top quark, the Higgs mechanism of electroweak symmetry breaking and detailed tests involving radiative effects. The book concludes with a brief account of ideas that extend beyond the standard model, such as left–right symmetric models, grand unified theories, compositeness, supersymmetry and string theory.

The book has some shortcomings. Although the book was published in 1990, experimental results obtained after 1986 are, with very few exceptions, not presented. Its usefulness as a course textbook is somewhat handicapped by a complete lack of problems and exercises. As indicated above, experimental techniques of elementary particle physics are also excluded. However, the book is an extremely valuable compendium of standard-model results and is strongly recommended as a reference to active researchers and to students and teachers of high-energy physics at the graduate level.

RUDOLF P. THUN
University of Michigan, Ann Arbor

Theory of Coherent Atomic Excitation

Bruce W. Shore
Volume 1: Simple Atoms and Fields
Volume 2: Multilevel Atoms and Incoherence
Wiley, New York, 1990.
1735 pp. $123.00 hc
ISBN 0-471-52417 (set)

Bruce Shore has made many significant contributions to the theory of the interaction of radiation with matter. In this two-volume work, comprising approximately 1700 pages, Shore has attempted to assemble the basic components necessary to construct a theory of the interaction of laser radiation with atoms. The book is written at a level readily accessible to graduate students and researchers in the field. The exposition is clear and well organized, enabling anyone with a knowledge of elementary quantum mechanics and electromagnetism to follow the development of the theory. Owing to the diversity of topics covered, these volumes will become a useful reference to researchers in laser spectroscopy and quantum optics.

The book, which consists of 22 chapters, is divided into six sections, respectively entitled Basic Principles and Definitions; Two-State Atoms; Photons and Radiation; Multistate Atoms; Angular Momentum and Complex Atoms; and Incoherence. To a large extent, each chapter is self-contained, with limited reference to prior chapters. Among the topics covered are elementary quantum mechanics (state variables, probabilities, observables, the density matrix and the Heisenberg and Schrödinger pictures); angular momentum theory, including irreducible tensor operators; dynamics of two-state and multistate atoms driven by one or more laser fields; transitions to the continuum; properties of the electromagnetic field, including a detailed treatment of the multipole expansion of the field; atomic structure; semiclassical and fully quantized descriptions of the atom–field interaction; pulse excitation and pulse propagation; and the interaction of stochastic fields with atoms.

By design, the emphasis of the discussion is on the temporal response of the atoms to the fields. In light of Shore's many contributions to the field, it is not surprising that one of the major strengths of this book is the extensive treatment of the transient response of two- and multi-level atoms to incident radiation fields. The section on incoherence also provides an excellent introduction to stochastic processes as applied to atom–field interactions. It is interesting to find in a book at this level a derivation of the density-matrix equations of motion that uses an irreducible tensor basis. Equally surprising and welcome is a discussion of recently discovered pulse shapes for which an analytic solution to the two-state problem can be obtained.

This book can be invaluable as a general reference. Choose almost any topic and you can find the basic theory and bibliography associated with that topic. On the other hand, I do not believe the book to be an appropriate text for a graduate course unless it is supplemented by additional material. Rarely is the development motivated on physical grounds. Someone not already familiar with the subject matter would have difficulty speculating on the relative importance of the various calculations. One gets the feeling that topics are not followed to their logical conclusion in terms of the experimental implications of the results. There is no reference to experiments in the book. Even the excellent and extensive bibliography would be of limited use to a beginning student unless he or she had some guidance from someone experienced in the field.

As a final note, I might add that Shore typeset and prepared all the figures for this text. This extraordinary undertaking has resulted in a book that should prove useful to researchers for many years to come.

PAUL R. BERMAN
New York University

Mathematical Analysis and Numerical Methods for Science and Technology

Robert Dautray and Jacques-Louis Lions [Translated from the French by Ian N. Sneddon (Vols. 1 and 2) and by John C. Anson (Vols. 3 and 4)]
Springer-Verlag, New York.
Volume 1: Physical Origins and Classical Methods
1990. 695 pp. $89.90 hc
ISBN 0-387-50207-6
Volume 2: Functional and Variational Methods
1988. 561 pp. $89.90 hc
ISBN 0-387-19045-7
Volume 3: Spectral Theory and Applications
1990. 515 pp. $98.00 hc
ISBN 0-387-50208-4
Volume 4: Integral Equations and Numerical Methods
1990. 465 pp. $89.00 hc
ISBN 0-387-50209-2
Volume 5: Evolution Problems I
Due December 1991. 728 pp. $120.00 hc ISBN 0-387-50205-X
Volume 6: Evolution Problems II: The Navier–Stokes and Transport Equations, and Numerical Methods
Due spring 1992.
ISBN 0-387-50206-8

Physicist Robert Dautray and mathematician Jacques-Louis Lions, with the assistance of several mathematicians and engineers of the French Atomic Energy Commission, have written a monumental and remarkable treatise. To serve physicists, chemists and engineers, the authors have combined the power of modern mathematical analysis and numerical analysis to bear on a wide range of physical problems.

This work is remarkable for three reasons.

▷ *The work comprises 3774 pages, yet it is a well-coordinated treatise.* Although many have contributed to it, the series reads like a two-author book. This illustates teamwork at its best: Outstanding leaders gather first-class collaborators, organize and coordinate their work and take responsibility for the final product. (However, the contribution of each collaborator is more clearly identified in the French edition than in the English one.)

▷ *This is a treatise for engineers that is based on sophisticated mathematics.* Most engineers are trained in 19th-century mathematics, and books on numerical analysis rely on the same mathematics. This book is based on the functional methods of the 20th century. In France elite engineers trained by the most prestigious mathematicians will enjoy this book readily, but it will require a serious effort on the part of most scientists with a US college degree. (Recall the creation of the Ecole Polytechnique in 1794. To meet the needs of industrial development, its first directors, Monge and Lazare Carnot, created an institution based on the best possible mathematics and physics expertise. To name but a few of its faculty: Fourier, Berthollet, Vauquelin, Lagrange, Laplace, Arago, Cauchy, Navier, Ampère, Gay-Lussac, Chasles, Hermite, Painlevé, Paul Lévy and Poincaré. The tradition continues, and many engineers at the Commissariat à l'Energie Atomique had the competence to contribute to the present treatise.)

In their preface, Dautray and Lions express the hope that a background in mathematics at the level of the Lebesgue integral and some familiarity with distribution theory are adequate preparation for using this treatise, but sophistication is also needed to translate properties of function spaces into the properties of the solutions of an engineering problem: For example, sophistication is needed to translate "X is dense in Y" into "the limit of the approximate solutions (points in X) is the solution (a point in Y) of the exact equation."

Function spaces, which play a dominant role in this treatise, are seen in basic US college science curricula, but science undergraduates do not think in terms of function spaces. They do not appreciate the distinctive personality of a space characterized by its axioms. They do not marvel at the possibility of finding Banach spaces in the space of distributions. But these are precisely the Sobolev spaces that are indispensable for the theory of partial differential equations: As Laurent Schwartz once said, "Distributions reestablish differentiation as a simple operation of analysis." But the basic theorems of calculus on $\mathbb{R}^n$ generalize easily on function spaces only if they are Banach spaces.

Simple, strategically placed examples would have helped the reader think in terms of function spaces. Two examples (there are many others) come to mind: Given an action S on the space X of paths F with given boundary conditions, say fixed initial and final points, the solutions of the Euler–Lagrange equation (a second-order ordinary differential equation with a boundary) are the functions in X that minimize $S(F)$, a variational problem on X stated in terms of functions and their first derivatives. Another example could be used to relate the difficulties of some boundary-value problems to the difference between the Sobolev spaces H^1 and H^1_0. Without such introductory examples, readers unfamiliar with function spaces can look at the applications (of which there are many—in fluid mechanics, elasticity, electrodynamics, quantum mechanics and neutron kinetics) to find the motivation for functional methods. They will then appreciate that linear algebra and Sobolev spaces form the foundation for the numerical analysis of problems cast in differential or integral equations.

Equipped with the Dautray–Lions treatise, readers will have a tool to move into the 21st century. Which other tools are needed? An obvious one is stochastic calculus. A remark in Volume 1 of the English translation led us to expect later chapters based on stochastic calculus. Not finding them, we checked the original French edition and found that stochastic calculus is mentioned but as a project for the indefinite future. We do hope that this project will be completed and will include Monte Carlo numerical methods, giving readers another equally important but often neglected tool.

A book as sophisticated as this needs a user's manual. The "user's manual" for this treatise is made up of sections scattered throughout the text that deal with current usage of the analytic tools described in the main text and prepare the ground for other possible uses in the decades to come. These include fast Fourier transforms, finite elements (a subject often omitted from texts on numerical methods) and continuous spectrum analysis. The series contains no examples of working computer codes. Some sophistication is needed to locate the numerical techniques; for example, the chapter heading "stationary problems" means to a large extent "eigenvalue–eigenvector problems"; "evolution problems" means "hyperbolic partial differential equations, stability conditions and so on"; and "transport" means "diffusion equations and their application to