# BOOK REVIEWS

**Selection of books for review is based on the editor's opinions regarding possible reader interest and on the availability of the book to the editor. Occasional selections may include books on topics somewhat peripheral to the subject matter ordinarily considered acceptable.**

### Topics in Applied Physics

*Editor* S. L. Shapiro

*Publisher* Springer-Verlag New York Inc. (1977)

*Pages* 389

*Price* $42.70

*Reviewer* Edward M. Eyring

This book consists of seven chapters: The first is a short historical introduction by S. L. Shapiro of Los Alamos Scientific Laboratory that will particularly interest those actively engaged in the measurement of rates of any fast processes. This field has a much longer history than most of its modern practitioners probably realize. For instance, Shapiro points out that Wheatstone, in 1834, captured the essence of a streak camera in a determination that the duration of an electric spark is $<10^{-6}$ s. (The working concept of the streak camera is the conversion of photons arriving at differing time intervals into images at differing spatial positions.) In the same vein, Shapiro notes that as long ago as 1899, Abraham and Lemoine had a device based on the Kerr effect that measured time intervals as short as $10^{-9}$ s. This book focuses on the progress made since 1965 with modelocked lasers, streak cameras, and other techniques in measuring events on a picosecond ($10^{-12}$ s) time scale. Thus, the notion of "ultrashort light pulses" does not enter the still shorter time realm of nuclear vibrations ($\sim 10^{-24}$ s).

Some overlap exists in Chaps. 2 and 3: "Methods of [picosecond light pulse] Generation" by D. J. Bradley and "Techniques for Measurement" by E. P. Ippen and C. V. Shank. This is not surprising, since Bradley is internationally known for his contributions to the development of streak cameras. Since laser fusion experiments will require more durable red or near-infrared sensitive streak cameras, the subject matter of these chapters must interest the nuclear engineering community.

The fourth chapter, "Picosecond Nonlinear Optics" by C. H. Auston of Bell Laboratories, concludes with an interesting section on "Device Applications." Semiconductor devices are limited in their switching capabilities to times longer than $\sim 10^{-10}$ s. Picosecond optical pulses promise to extend electronic measurement capabilities into the picosecond regime, and Auston describes switches he has himself worked on that, with further miniaturization, appear to have a practical speed limit of ~1 ps operable at rep rates of up to 1 GHz. Holographic information storage in crystals using picosecond pulses to read the information in and out promises to yield particularly high-density optical memories. The use of picosecond pulses to transmit information along optical fibers over great distances is, on the other hand, deemed much less probable by Auston. For chemists who have been awed by the overwhelming productivity of Rentzepis and his Bell Laboratories co-workers in the picosecond spectroscopy field, Auston has provided valuable insights to the motivation of Bell Laboratories managers in fostering this basic research.

In Chap. 5, "Picosecond Interactions in Liquids and Solids," D. von der Linde describes, for example, the use of picosecond Raman probes to determine optical phonon lifetimes and the energy relaxation times of individual normal modes of vibrations of molecules. Fundamental processes in semiconductors are heavily emphasized. Von der Linde's own important work on the writing of holograms with picosecond pulses appears only in Auston's chapter.

The concluding chapters on "Picosecond Relaxation Processes in Chemistry" by K. B. Eisenthal and "Picosecond Relaxation Measurements in Biology" by A. J. Campillo and S. L. Shapiro constitute slightly over one-fourth of the book's pages and provide a fairly exhaustive coverage of the literature, with a few references to works published as recently as 1976. The essence of Einstein's coefficients for absorption and emission of light that we recall from quantum mechanics is that what goes up easily (in energy by absorption of photons) will come down quickly (by fluorescence reemission). Thus, it is no accident that these concluding chapters are focused on peculiarly deeply colored compounds such as rhodamine 6G, chlorophyll a, and rhodopsin. The technological importance in solar energy and vision, respectively, of the latter two compounds makes this review of their picosecond spectroscopy fascinating. However, picosecond spectroscopy of molecules is not a limitless frontier, either from the point of view of a potential diversity of interesting subject molecules or because ever shorter time scale measurements promise to tell us more about their chemistry. The definitive objection to the latter hope is the Heisenberg uncertainty principle that tells us the molecular spectroscopists will report absurdly imprecise absorption or fluorescence wavelengths when they are eventually able to make measurements on a femtosecond ($10^{-15}$ s) time scale. Thus, the successor to this book, possibly entitled *Ultra-Ultrashort Light Pulses,* will probably be co-authored exclusively by physicists and may contain a great deal more of interest to nuclear engineers than does the present text.

An adequate subject index, but no author index, concludes the present volume.

*Edward M. Eyring (BA, physics, 1955, PhD, physical chemistry, 1960, University of Utah) is professor and formerly chairman of chemistry at the University of Utah. His research involves the determination of rates and mechanisms of reactions in liquid solutions and at solid-liquid interfaces. Nanosecond laser flash photolyses, laser Debye-Sears ultrasonic absorption measurements, and laser photoacoustic spectroscopy (but not picosecond spectroscopy) are numbered among his frequently used laboratory techniques.*

## A Shell Model Description of Light Nuclei

*Author* I. S. Towner

*Publisher* Oxford University Press (1977)

*Pages* 383

*Price* $24.50

*Reviewer* Sidney A. Coon

This book is one of a series, titled "Oxford Studies in Nuclear Physics," aimed at the beginning research student. It presents the traditional calculational apparatus of the shell model in a form accessible to the student, but its true subject is of great interest to the general nuclear structure theorist and experimentalist. Or, in the author's words, "the central theme of this book is to trace the steps from the free nucleon-nucleon interaction to the properties of light nuclei." Towner's goal is slightly more ambitious than that of George Bertsch's *The Practitioner's Shell Model* (1972), which emphasized the "qualitative effect of configuration mixing on the physical observables" in terms of the properties of the nucleon-nucleon interaction. This more recent book features a clear, patient exposition with many references for further study, but one sometimes misses the deep intuitive insight and novel results of Bertsch's book. The evident care that has gone into Towner's derivations, in many cases an improvement in pedagogy over the originals in the literature, and a wider range of subjects make this book more suitable for self-study.

After a chapter on mathematical preliminaries, Towner begins by discussing the computation of the binding energy of a spherical closed-shell nucleus in the Hartree-Fock approximation. The free nucleon-nucleon interaction features strong short-range components. They were tamed by Brueckner with the construction of a reaction matrix that expresses the interaction between a pair of nucleons in a background of spectator nucleons. This weakened effective interation can be used in a Hartree-Fock-like mean field theory (misnamed Brueckner-Hartree-Fock theory) to compute the binding energy and static properties of closed-shell nuclei. The simple particle-hole excitations of these nuclei are then discussed with a schematic effective interaction rather than a realistic (i.e., derived with the Brueckner approach) interaction.

In the second half of the book, the author discusses the shell model approach to the calculation of the properties of closed-shell nuclei with one or more additional particles, the so-called open-shell nuclei. He gives a readable presentation of the Bloch-Horwitz demonstration that degenerate perturbation theory could be used to produce an effective Hamiltonian in a truncated model space whose eigenvalues were the true energies of the system. The often-confusing business of eliminating the energy dependence of the resulting effective interaction by the introduction of "folded" Goldstone diagrams receives an especially clear treatment here.

The final two chapters are more phenomenological in that the discussions could be made without reference to the free nucleon-nucleon interaction. Angular momentum considerations dominate the calculation of observables from the eigenfunctions of a Hamiltonian chosen to describe a nucleus or set of nuclei with more than two particles outside a closed shell. The last chapter develops shell model expressions for spectroscopic factors of direct nuclear reactions in which one or more nucleons are transferred from a target to a residual nucleus.

The first half of this book relies heavily on review articles already in the literature. It is good, however, to have this material together with the standard, but daunting, treatment of the Racah angular momentum algebra. Valuable features are the short histories of results and applications at the end of each chapter. These histories seem to end in most cases with papers published in 1974, although the publication date of this typewritten book is 1977. This time lag between the literature cited and the publication date leaves the reader with more pessimism than warranted about progress toward the goal of calculating the properties of nuclei from the two-nucleon interaction. Work in the last four years inspires a modest hope that it is not an unrealistic goal. At any rate, the groundwork is well described in this book.

*Sidney A. Coon (PhD, physics, University of Maryland, 1972) is the author of papers on the free nucleon-nucleon interaction, static properties of closed-shell nuclei, and simple open-shell nuclei. He has worked at the University of Liège and the Technical University of Hannover and is currently a research associate in the Physics Department at the University of Arizona.*

## The Subnuclear Zoo

*Author* Sylvia Engdahl and Rick Roberson

*Publisher* Atheneum Publishers

*Pages* 101

*Price* $5.95

*Reviewer* Hugh F. Henry

This is an *extremely* broad-brush treatment of the entire field of atomic structure. In some 98 rather small pages