J. W. Mayer (North Holland, New York, 1986); *Low Energy Electrons and Surface Chemistry* by G. Ertl and J. Küppers (VCH, Weinheim, FRG, 1985); and *Surface Crystallography: An Introduction to Low Energy Electron Diffraction* by L. J. Clarke (Wiley, New York, 1985; reviewed in PHYSICS TODAY, April 1987, page 83). The present book by D. P. Woodruff and T. A. Delchar offers a balanced treatment of the various electron and ion spectroscopies, including LEED, Auger electron spectroscopy and photoelectron spectroscopy, which in this book is still artificially separated into ultraviolet and x-ray photoelectron spectroscopy, but has been blurred into a single technique by the widespread use of synchrotron radiation.

Thus Woodruff and Delchar's book will not be all things to all people working in surface science. But it does provide a solid explanation of the physics inherent in the various measurement techniques that it treats. One can certainly find a clearer and more detailed exposition of each of these techniques in other sources; an example is Clarke's book cited above, which treats LEED in great detail. However, it is difficult to find a better *concise* exposition of the array of the most commonly used uhv surface techniques than these authors discuss. I found the summary on LEED in *Modern Techniques* to be quite useful for some of my own recent studies of stepped surfaces; the discussion of electron analyzers also is extremely good for its length. Other areas that are well done include sputter-depth profiling by Auger and secondary ion emission techniques as well as electron-stimulated desorption. In each case, the authors place their emphasis on the fundamental physics inherent in the measurement process rather than on a recipe for a particular measurement. Thus *Modern Techniques of Surface Science* is well suited to a course on the principles of the measurements, such as an advanced undergraduate or beginning graduate physics lab course. For a course that emphasizes the rules and methodology of surface analysis and is aimed at thin-film materials scientists, the book by Feldman and Mayer is perhaps more suitable.

Perhaps the book that comes closest to Woodruff and Delchar's is the volume by Ertl and Küppers, which is already in its second edition. This book treats LEED and XPS on a level nearly equal to that of Woodruff and Delchar, but is somewhat superior in its treatment of electron energy loss spectroscopy and UPS, at the expense of a nearly complete neglect of the important techniques of ion scattering and molecular beam methods. Woodruff and Delchar's book is the better choice for a university course on a variety of the important techniques, while that by Ertl and Küppers is probably the better choice for a somewhat more specialized use involving mainly electron methods, such as the short courses now offered in conjunction with many scientific meetings. The strongest recommendation that I can think to give *Modern Techniques of Surface Science* is that I would use it as the text of a course on surface science methods such as the one I taught at AT&T Bell Labs about ten years ago.

J. E. ROWE
AT&T Bell Laboratories
Murray Hill, New Jersey

Laser Handbook, Volume 4

Edited by Malcolm L. Stitch and Michael Bass
North Holland, New York, 1985. 594 pp. $141.50 hc
ISBN 0-444-86927-1

Laser Handbook, Volume 5

Edited by Michael Bass and Malcolm L. Stitch
North Holland, New York, 1985. 692 pp. $161.00 hc
ISBN 0-444-86934-4

As with previous volumes of the *Laser Handbook*, volumes 4 and 5 include authoritative articles on lasers and key laser-related technologies. (See PHYSICS TODAY, December 1980, page 59, for a review of volume 3.) Although both volumes have 1985 publishing dates, their articles present information and concepts that remain timeless. The handbooks provide a unique introduction to the field for the beginner, along with a clear presentation of the scientific and technological context and a comprehensive list of references. Every serious researcher in quantum electronics should have access to these books.

The editors have consistently obtained qualified authors who have carefully written chapters that are well researched and documented. Volume 4 covers free-electron lasers, color center lasers, the ring laser gyro, optical phase conjugation and optical bistability. Volume 5 contains articles on uv lasers and tunable solid-state lasers as well as on the uses of lasers in high-resolution spectroscopy, microfabrication and thermonuclear plasma diagnostics.

Picking up volume 4, I read with fascination the entire 142-page chapter on free-electron lasers by G. Dattoli and A. Revieri. These Italian authors have superbly described both the theory and experiments under way with free-electron lasers. From this article the basics of operation are accessible to all physicists, but it also outlines considerably more detailed theory for those planning to enter the field.

L. F. Mollenauer is a name synonymous with color center lasers; that he has authored the section on these lasers is indicative of the high editorial standards of the handbook. The article ranges through the basic physics of color centers and the design of commercial lasers, ending with a description of mode locking and the soliton laser.

D. M. Pepper has written an excellent article outlining optical phase conjugation and its applications. He introduces the concepts and theory of three- and four-wave mixing in Kerr, resonantly enhanced and photorefractive media. His discussion of experimental demonstrations includes aberration compensation and polarization effects as well as phase conjugation in waveguides, and intracavity and self-pumped conjugation. Exciting applications such as real-time adaptive optics, image processing, phase conjugate resonators and temporal signal shaping and analysis are described.

J. A. Goldstone describes the optical bistability that occurs in nonlinear Fabry–Perot and ring interferometers as well as in hybrid electrical–optical devices. Optical bistability interests physicists in part because of the similarity between lasers and nonlinear interferometers. Many have focused on Maxwell–Bloch equations, investigating instabilities and optical chaos, atomic cooperativity, χ_3 processes (third-order linearities) and two-level atoms. Engineers are excited by the possibilities of nonlinear optical switching, signal processing and computing. This article takes the physics approach, with a heavy stress on the unique dynamic response of these devices. While demonstrations of optical bistability are referenced, there is no detailed description of experiments. The hybrid electrical–optical device is given emphasis because of its simplicity and ability to demonstrate theoretical results in a simple experimental fashion. Of all the areas covered in the handbook, optical bistability has perhaps had the most rapid engineering development since the manuscript was originally completed in 1983. Thus, this article serves as a basic introduction to the concepts but does not include the newest results. Furthermore, the lack of organization in the additional references seriously reduces their usefulness.

The multioscillator ring laser gyroscope, a particular second-generation design to replace the commercially available basic RLGs, is described in volume 4 by H. Statz, T. A. Dorschner, M. Holtz and I. W. Smith. This seems like an overly sophisticated development to discuss in a general laser handbook. A broader discussion of simpler RLGs, a brief description of the multioscillator RLG and an introduction to fiber gyros, along with a comparison of all three, would have held the most interest. There is undoubtedly serious commercial interest in the multioscillator RLG, and the article contains some fascinating discussions of out-of-plane resonators and magnetic mirrors. However, I doubt that this technology will have the general impact on quantum electronics that the other subjects in the volume will have.

Volume 5 contains an exciting discussion of uv and vacuum uv sources, including lasers and nonlinear processes such as harmonics and stimulated Raman scattering, by John F. Reintjes, a world-renowned specialist in short-wavelength generation by frequency conversion. Tables detail uv wavelengths available from atomic–ion, molecular, rare gas excimer, halide and dye lasers. Descriptions include operating powers, efficiencies, spectral characteristics and schematic diagrams of laser system designs, but no theoretical background. By contrast, the use of nonlinear processes to obtain uv is fully supported by basic theory. The theoretical introduction to frequency doubling and tripling, phase matching and the optics of relevant crystals is of interest not just for uv generation, but more generally. The theoretical discussion continues into important practical limitations such as saturation and incomplete phase matching. This discussion is followed by an enumeration of recent experimental results.

P. F. Moulton describes the use of transition metals and rare earths in crystals such as sapphire, ruby, alexandrite, emerald and gadolinium gallium garnet. This article takes the reader through the physical background of ions in crystals to an understanding of the performance of specific lasers. Moulton has spent considerable time studying these systems and includes previously unpublished data. A minor criticism is the difficulty in understanding that alexandrite and emerald lasers both use Cr ions—a fact missing from the tables and hidden in the text.

The survey of methods to obtain supernarrow optical resonances by V. P. Chebotayev includes saturated absorption, two-photon resonances and the methods of separated fields. Laser lines are now so narrow that one can investigate new effects caused by particle collisions, finite transit time, recoil and particle flight in the resonance. This paper suffers from stilted English, but the physics is superb. It is a welcome addition to the handbook to have a paper from the Soviet Union, complete with Russian references.

Laser photochemical and thermal processing for microlithography is described briefly by J. T. Yardley. Finally, an extended article by N. C. Luhmann Jr and W. A. Peebles on laser diagnostics of plasmas includes an important but esoteric description of laser interferometry, polarimetry, Thompson scattering and fluorescence spectroscopy as applied to plasma research. I wonder if this specialized application is of sufficiently general interest to fill almost 200 pages of a handbook. Two articles, one on far-infrared lasers and one on light scattering processes in plasmas, might have been of greater value.

In conclusion, these handbooks are a valuable resource for the quantum electronics community. They are strongly recommended for every library and research group. I look forward to additional volumes in the series.

Elsa Garmire
Center for Laser Studies
University of Southern California

Elements of Quantum Mechanics of Infinite Systems

Franco Strocchi

World Scientific, Singapore (Teaneck, N. J.), 1985. 179 pp. $33.00 hc ISBN 9971-978-91-1; $21.00 pb ISBN 9971-978-92-X

There is a dramatic difference between the quantum mechanical behaviors of a finite system and of an asymptotically infinite system. The difference appears in such behaviors as collective phenomena and symmetry breaking that play a crucial role in theoretical physics and have no counterpart in the quantum mechanics of finite systems. Historically many have viewed these phenomena as the origin of numerous difficulties