counterparts for the assignments and interpretations of the rotation–vibration spectra of specific molecules. The case is well made that algebraic theory reproduces observed spectra at least as well as or better than does the more conventional Dunham expansion and with somewhat fewer parameters. (I hope we shall see more experimental papers in which the interpreters of molecular spectra use the algebraic method to analyze their results.)

Some sections of the book would have been clearer and probably more persuasive to experimenters if the authors had expanded their discussion and given fuller physical interpretations to the formal material. To cite a few examples: In their discussion on page 34 of the double well, about reducing the symmetry from U(2) to O(2), the authors could have discussed the role of tunneling and how algebraic theory incorporates it. For spectroscopists, some discussion would have been valuable in chapter 4 of Coriolis interaction and centrifugal distortion and how they appear in algebraic theory. More discussion of the physics of the position-dependent mass in chapter 7 would have been both interesting and enlightening to me. Overall, this chapter is less didactic than the earlier chapters; I found the discussion of new directions of research particularly stimulating.

One other minor carping criticism that I have is the occasional "hard-sell" rhetoric, which I found unnecessary and a bit embarrassing. The work is quite strong enough to stand on its own merit, and many of us will simply have to learn and use it.

R. Stephen Berry
University of Chicago
Chicago, Illinois

Spectra of Atoms and Molecules

Peter F. Bernath
Oxford U. P., New York, 1995. 400 pp. $49.95 hc
ISBN 0-19-507598-6

Atomic and molecular spectroscopy is a vast subject with applications ranging from the detection of fluctuations in the cosmic background radiation to the identification of molecular species in biochemical analyses. Spectroscopic techniques have been used recently in the creation and detection of Bose–Einstein condensation in weakly interacting atoms (PHYSICS TODAY, August 1995, page 17). Spectroscopy permits the determination of the potential energy curves of diatomic molecules and the structures of complex polyatomic molecules. The extraordinary resolution that can be achieved is exploited in tests of the fundamental laws of physics and provides the experimental support for quantum electrodynamics.

Because spectroscopic data offer a specific identification of the emitting or absorbing species, they are used to learn the compositions of gases and plasmas and are of unique value in the study of remote objects. Spectroscopic data can be acquired at wavelengths across the electromagnetic spectra from x rays to radio waves, and they reflect the properties of materials at temperatures from near zero to a hundred million degrees Kelvin. Spectroscopic line intensities yield information on energy-level populations of atoms and molecules, from which inferences can be drawn about the temperature, the density and the radiation environment; if magnetic fields are present, their strengths can also be derived.

The diversity of the applications, the variety of experimental techniques, the complexity of the theoretical framework and the sheer vastness of the data base would require many volumes to give a comprehensive accounting of the material. For any one book on the subject, therefore, stringent choices must be made. In *Spectra of Atoms and Molecules*, Peter Bernath emphasizes the development of the theoretical basis of spectroscopy, and the spectroscopic data presented are largely to illustrate the theoretical concepts.

The title refers to atoms and molecules, but the attention given to atoms is limited. In discussing line theory absorption and emission spectroscopy, Bernath gives a conventional account of semiclassical radiation theory, but he incorporates instructive discussions of the responses of a two-level system driven by laser radiation and of line shapes and line-broadening mechanisms. A brief description of the energy-level structure of the hydrogen atom, derived from the Schrödinger equation and the empirical addition of electron spin, serves as an introduction to the independent-particle model of many-electron atoms. The coupling of angular momenta and the construction of the terms of a configuration are illustrated, and formulas are written down for the effects of spin–orbit interactions in fine structure and hyperfine structure and for the Zeeman effect. The formal apparatus of angular momentum theory is avoided. Selection rules are explored but only for electric dipole transitions, and no mention is made of forbidden transitions.

The substance of the book is molecules, diatomic and polyatomic. For polyatomic molecules, group theory is mandatory, and it is provided here at an accessible level with a clear description of molecular symmetries. The heart of the book is an extensive discussion of the classical and quantum mechanics of rotational and vibrational motion in diatomic and polyatomic molecules in ground and excited electronic states. The presentation is coherent and well-organized, and the difficulties and subtleties are elucidated. The examples are of interest mostly to chemists. The utility of spectroscopic data in deriving the structure of polyatomic molecules is made apparent.

Spectra of Atoms and Molecules continues with a brief chapter on rotation–vibration Raman spectroscopy and concludes with an important and extensive presentation of the spectroscopy and the rotational and vibrational structure of excited electronic states of diatomic and polyatomic molecules. The different angular momentum coupling schemes for diatomic molecules represented by the different Hund's coupling cases are described. For polyatomic systems, an account is given of the Herzberg–Teller, Jahn–Teller and Renner–Teller effects. The chapters contain a very clear exposition of parity in molecular eigenfunctions.

Spectra of Atoms and Molecules is a textbook. Its value as such is enhanced by a careful selection of problems in which stimulating questions are asked. The book is written in a lucid, explanatory style at a level that should be accessible to readers having some minimal knowledge of quantum mechanics, and it will serve as an excellent introduction to the spectra of diatomic and polyatomic molecules.

Alexander Dalgarno
Harvard-Smithsonian Center for Astrophysics
Cambridge, Massachusetts

Advances in Photochemistry

Edited by D. C. Neckers, D. H. Volman and G. von Bünau
Wiley, New York, 1995. Vol. 19: 325 pp, $129.95 hc ISBN 0-471-04912-3; Vol. 20: 297 pp. $95.00 hc ISBN 0-471-11469-3

Volumes 19 and 20 of *Advances in Photochemistry* are the lastest contributions to the longest continuing series of reviews of recent developments in photochemistry. The editorial policy articulated in the initial volume (edited by J. N. Pitts, G. S. Hammond and W. A. Noyes in 1963) was "to explore the frontiers of photochemistry through the medium of chapters written by pioneers who are experts." By and large the series—roughly one volume a year—has maintained a quality