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.

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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.

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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

consistent with this goal.

During the last three decades, however, the enormous success of photochemistry as a discipline adopted by organic chemists, physical chemists, biochemists, material scientists and others has made the subject matter for the series more diverse. Any potential purchaser will need to pay specific attention to the topics selected. However, the overall quality of the series and the timeliness of selections and authors warrant continuation of the series by any library wishing to maintain a first-rate reference series to the photochemical literature.

Volume 19 contains four articles. The first, by Helmut Gorner and Hans Jochen Kuhn, is entitled "*cis–trans* Photoisomerization of Stilbenes and Stilbene-Like Molecules." This is an excellent, comprehensive review of the mechanistic features of the *cis–trans* isomerization of stilbenes. A historical perspective is also included.

The second article, by Gerd Kaupp, is "AFM and STM in Photochemistry, Including Photon Tunneling." The author has been a pioneer in the use of AFM and STM to study photoreactions. The focus is on organic photochemistry with suggestions of the eventual application of AFM and STM to biological photochemistry.

The third article, by Ying Wang, is "Photophysical and Photochemical Processes of Semiconductor Nanoclusters." Like the previous article, this one can be considered a review of material science photochemistry, in this case the photochemistry of small semiconductor particles and the use of photochemically produced electrons and (positive) holes to drive reactions. Of particular note is a very readable account of the effect of the particle size on the photochemistry.

The final article, by Julian A. Davies, David L. Boucher and Jimmie G. Edwards, is "The Question of Artificial Photosynthesis of Ammonia on Heterogeneous Catalysts." This article focuses somewhat on what might appear to be a topic with a minor photochemical component. There is, however, a certain connection to the previous article in that the use of photochemical excitation of semiconductors to drive artificial photosynthesis is discussed.

Volume 20 contains five articles exploring a range of topics. The first, by Tatsuo Arai and Katsumi Tokumaru, is "Present Status of the Photoisomerization About Ethylenic Bonds." This article focuses on a phenomenon, termed "one way photoisomerization," that Tokumaru's group has investigated extensively. This phenomenon typically refers to systems for which *cis* to *trans* isomerization is unaccompanied by the reverse *trans* to *cis* isomerization.

The second article, by Christoph Zander and Karl H. Drexhage, entitled "Cooling of a Dye Solution By Anti-Stokes Fluorescence," focuses on the possiblity of cooling a dye solution by anti-Stokes fluorescence, and describes in detail an experiment that makes a quantitative investigation of anti-Stokes cooling possible.

The third article, by Joseph S. Francisco and M. Matti Maricq, is "Atmospheric Photochemistry of Alternative Halocarbons." This is a timely topic, given that the 1995 Nobel Prize in Chemistry was awarded to pioneers who investigated the environmental effect of pollutants such as halocarbons. The offending chlorofluorocarbons are being systematically replaced by hydrofluorocarbons with the expectation that the chlorine-mediated photochemistry of CFCs responsible for damaging the ozone layer will abate when HFCs rather than CFCs are released in the atmosphere. This article is an excellent point of reference for information on atmospheric photochemistry in general and atmospheric halocarbon photochemistry in particular.

The fourth article, by Horst Weller and Alexander Eychmuller, is "Photochemistry and Photoelectrochemistry of Quantized Matter: Properties of Semiconductor Nanoparticles in Solution and Thin-Film Electrodes." The article is closely related to that by Wang in Volume 19, but it focuses on models for photoinduced fluorescence in semiconductors and how fluorescence can be employed in surface chemistry.

The final article, in Volume 20, by Itamar Wilner and Bilha Wilner, is "Artificial Photosynthetic Transformations Through Biocatalysis and Biomimetic Systems." It provides a compact review of a wide range of material involving two general approaches for modeling photosynthesis: the mimicking of the functions of the photosynthetic reaction center by synthesis analogs and the mimicking of photosynthesis by integrated assemblies that duplicate the functions of the natural process to the extent that light is converted to stored energy of products.

Overall the nine articles in these two volumes should be quite readable by scientists with an interest and background in photochemistry. Instructors who teach advanced courses that include photochemistry should be aware of the articles, which can serve to bring students rapidly up to date on the areas covered.

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