

with several homework problems, which typically involve short derivations and the plugging of numbers into results obtained in the text. The student will also need to work through the derivations in the text to become proficient at the material. The level of detail in the derivations is uneven, and much is frequently left for the student (or instructor) to fill in. There are a number of places in the book where the student would have been better served with a few extra words of explanation rather than a phrase such as "It is obvious that. . ."

The book's greatest strength is in its demonstration of the derivation of specific results from the various approximate transport equations (such as MHD, Fokker-Planck, and Navier-Stokes) and, ultimately, the Boltzmann equation. Many sections begin with a clear description of the equations, assumptions, and approximations that lead to a particular result. This is especially useful to a reader who will eventually be pursuing more extensive analytic or numeric computations.

The author is not always careful to explain or provide supporting material. The normalization of the axes on two plots of the Maxwellian distribution function is not explained, even though it is important to a discussion in the text. Another figure shows the decrease of stratospheric ozone in Dobson units, but Dobson units are not defined in the text. A section on particle acceleration leaves the incorrect impression that only two mechanisms, second-order Fermi acceleration and shock acceleration, are important in the Solar System, and that an exponential particle energy distribution implies second-order Fermi acceleration while a power-law energy distribution implies shock acceleration. The author's decision to cite directly only certain journal articles and books in the text, and to place other books in a general bibliography, often leaves the reader uncertain of a topic's heritage and where to find additional information.

It would be unfortunate if Gombosi's text were a student's only exposure to solar-terrestrial physics. A good advanced undergraduate prelude to *Physics of the Space Environment* would be Thomas F. Tascione's *Introduction to the Space Environment* (Krieger, 1994, 2nd edition). Tascione's text requires less mathematical sophistication and has chapters on atmospheric and solar physics. And although it was not intended to be a textbook, Kenneth R. Lang's *Sun, Earth, and Sky* (Springer, 1995) presents an excellent non-mathematical introduction to the Sun-Earth connection for any reader. For the advanced reader, however, *Physics*

of the Space Environment is a welcome addition to the space physics literature.

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Molecular Symmetry and Spectroscopy

Philip R. Bunker and Per Jensen
NRC Research, Ottawa, Canada,
1998. 2nd edition. 747 pp.
\$64.96 hc ISBN 0-660-17519-3

Molecular spectroscopy is sometimes perceived as a mature domain of science offering few genuine surprises. Yet some fascinating discoveries have been made recently in the field. (That of carbon-60, the so-called Buckminsterfullerene molecule, is a prime example.)

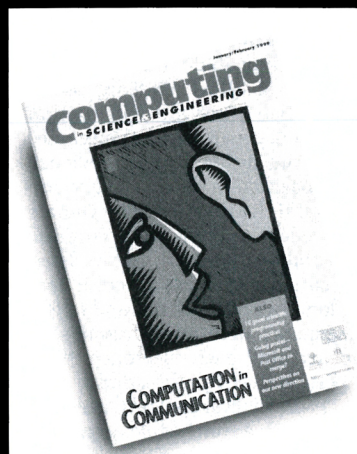
Philip Bunker and Per Jensen have written *Molecular Symmetry and Spectroscopy* for everyday use by molecular spectroscopists faced with the typical problems of this field: how to classify the quantum energy levels arising from the complex motions of the electrons and nuclei in a molecule and how to predict the frequencies and intensities of optical transitions taking place between those levels, by which molecular systems are usually detected and identified.

Generations of molecular scientists have been trained through intense use of the late Gerhard Herzberg's famous *Molecular Spectra and Molecular Structure* (Van Nostrand), the three volumes of which appeared in 1939, 1945, and 1966, respectively. (They were reedited at the beginning of this decade by Herzberg himself (Krieger, Malabar, 1989 and 1991)). These classics present an overview of the field of molecular spectroscopy as it existed at the time they were written.

Bunker, a renowned theoretical spectroscopist, has been associated for many years with the institute founded by Herzberg in Ottawa, Canada. Jensen, based at Wuppertal in Germany, is known for his contributions to the theory of large amplitude vibrations in floppy systems (non-rigid molecules). As reflected by its title, the scope of the first edition of their book (Academic Press, 1979) was more limited than Herzberg's, concentrating on group theory and its application to spectroscopic problems. However, the vastly expanded second edition (the first edition had 424 pages) has grown into a quite-complete compendium of modern-day spectroscopy, which, if it does not fully replace Herzberg's textbooks, represents a welcome and necessary update and complement.

The interested reader will find detailed chapters on, for example, normal

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vibrations and rigid rotors; large amplitude nuclear motions occurring in floppy systems; the Born–Oppenheimer separation of the motions of heavy and light particles (nuclei and electrons, respectively) and its breakdown in some instances; and the Jahn–Teller effect and its relation to the Berry geometrical phase. The authors also give a brief and clear account of quantum chemical structure calculations (explaining the physics behind some of the mysterious acronyms circulating among quantum chemists), and even a glimpse of collision theory as applied to states with spatially diffuse electron clouds, the so-called Rydberg states. Fragmentation processes and continuous spectra in general are not discussed.

While the authors were obviously not in a position to discuss every subject in equal depth, they have complemented each chapter with carefully written bibliographical notes. These notes contain references to other textbooks, key historical papers, and related recent papers reflecting the present state of the art, and each reference is put into perspective by thoughtful comments. These bibliographical notes alone make the book a worthwhile acquisition for anyone active in spectroscopy.

Molecular symmetry is still given prominence in the present edition. The authors discuss the use of the molecular symmetry group introduced by Christopher Longuet-Higgins and Jon Hougen. The elements of the molecular symmetry group consist of permutations of identical particles, particularly nuclei. Most older textbooks had been based on the use of point groups consisting of the symmetry operations of molecules having specific structural symmetries like reflection planes and symmetry axes. As the authors point out, the molecular symmetry group is more fundamental, because it is based on the fact that identical particles are indistinguishable, and it does not require a molecule to possess a specific geometry at any given time. This approach turns out to be particularly fruitful, even vital, for the novel developments of modern spectroscopy, where studies are made of loose assemblies of atoms or molecules (weakly bound cluster molecules), which execute large amplitude vibrational motions with continuously changing structural geometry.

Bunker and Jensen have made a considerable pedagogical effort to make their reputedly difficult subject accessible to the reader. Each chapter contains problems inserted in the text, followed immediately by the solution. The formal developments are carried through in great detail, with many intermediate steps fully written out. This makes it easy for the newcomer

to see how things are done, although I felt that sometimes it was overdone, making it more difficult to follow the main thread of the argument.

The book is written in an easy, modern style that lets us see not only what is done but also why, for example, a particular route is followed instead of another and what difficulties are encountered along the way. Each chapter opens with an abstract and closes with a summary. The numerous cross-references are very helpful. The index includes, in addition to the usual material, important symbols as well as references to many individual molecules.

In conclusion I would say that this is an impressive book and an important contribution to a field that suffers from a lack of modern textbooks treating their subject in depth. Like Herzberg's volumes, this book will be most useful for everyday, practical purposes; it will also serve as an introductory text for the seriously interested newcomer to the field.

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