

such as the author's account of the Australian bushfires that destroyed the Mount Stromlo Observatory in 2003 or her description of what it is like to spend weeks on end on a remote mountaintop observing the night skies. Readers of PHYSICS TODAY should have no problem with the physical concepts that feature in the chapters describing the various nucleosynthetic burning stages in a star's life or the neutron-capture processes that are responsible for the synthesis of elements heavier than iron. But readers less versed in basic physics and astronomy will find those chapters challenging and may find themselves flipping among chapters to weave a comprehensive picture.

Frebel's delightful blend of science and personal stories has plenty to offer for readers ranging from nonscientists to professional astronomers. In addition, by highlighting the important role of women astronomers in the development of stellar spectroscopy, Frebel clearly strives to motivate and inspire future generations of female scientists. Laden with passion and excitement, *Searching for the Oldest Stars* accomplishes what it

sets out to do—engage readers and provide insights into stellar archaeology and the motivations that propel scientists in their quest to answer fundamental questions.

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Atomic and Molecular Spectroscopy

Basic Concepts and Applications

Rita Kakkar

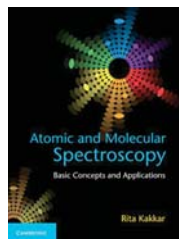
Cambridge U. Press, 2015. \$75.00 (415 pp.).
ISBN 978-1-107-06388-4

In her preface to *Atomic and Molecular Spectroscopy: Basic Concepts and Applications*, Rita Kakkar writes that the book is primarily intended for graduate and advanced undergraduate students who have already taken a course in quantum mechanics and know how to apply

elementary molecular point-group representation theory. Her text covers the basics of light-matter interactions; electronic spectroscopy of atoms; and rotational, vibrational, and electronic spectroscopies of diatomic and small polyatomic molecules. Raman spectroscopy, vibrational and rotational, receives its own chapter. That separation is common, but I prefer to integrate Raman with other absorption and emission spectroscopies. The book does not consider magnetic resonance spectroscopies or even the influence of nuclear moments on spectra.

The most attractive features of *Atomic and Molecular Spectroscopy* are that each chapter has many fully worked-out problems and each concludes with numerous exercises; the book includes 257 exercises in total. Mathematical derivations are presented in great detail, so even the weakest students should be able to follow them.

The cost of those features, however, is that the book treats most topics at a lower level of

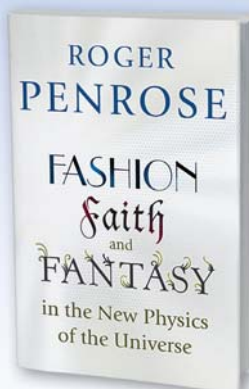


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detail than comparable texts, such as Peter Bernath's *Spectra of Atoms and Molecules* (3rd edition, Oxford University Press, 2015). The organization and range of topics in the Kakkar and Bernath books are similar, but Kakkar's is less thorough and quantitative. For example, the Kakkar text does not present a mathematical statement of the Born–Oppenheimer approximation, the most important principle in molecular spectroscopy; in fact, its qualitative statement of the principle is potentially misleading. Furthermore, the book does not cover the traditional effective model used to justify a single term for spin–orbit coupling, nor does it explain why the coupling grows rapidly with atomic number. The discussion of rotational spectroscopy does not quantitatively treat asymmetric top molecules, in which all three principal moments of inertia differ.

Atomic and Molecular Spectroscopy covers only traditional, well-established topics. I did not find a single subject that has not been presented in texts more than 50 years old. Completely absent are coherent spectroscopies, the optical Bloch equations, nonlinear optics and multiphoton spectroscopies, multiresonance and time-resolved spectroscopies, studies of intramolecular and intermolecular dynamics, ions and radicals, spectroscopy of weakly bound complexes, and almost all the other topics that feature in modern molecular-spectroscopy research. I recognize from my own teaching that only a small number of such topics can be shoehorned into a one-semester course, but I believe ignoring all modern research is a great disservice. Most spectroscopy papers these days include a comparison of experimental results with predictions from quantum chemistry, but Kakkar's text includes no such comparisons.

Unfortunately, the book has several other weaknesses. First, it frequently compares quantities that have different units or talks about dimensional quantities being large or small with no explicit reference. Second, it contains many false statements. Some of those could be typographical errors or oversimplifications, but most cannot be so readily dismissed. Third, although the book includes a two-page bibliography, it does not include in-text references, an omission that blocks the path of the curious student eager to learn more. In addition, the text is poorly

copyedited, and it includes many low-quality graphs and figures, several of which are copied from Colin N. Banwell's *Fundamentals of Molecular Spectroscopy* (McGraw-Hill, 1983).

I cannot recommend *Atomic and Molecular Spectroscopy*, on its own, to anyone, though it could be useful as a companion text for weaker students taking a course that is using a higher-level primary text such as Bernath's. More's the pity, as students would benefit from a truly modern molecular spectroscopy textbook that prepares them to read the current literature and work on modern research projects. At the moment, no such book exists.

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