Rydberg Atoms

T. F. Gallagher
Cambridge U. P., New York, 1994. 495 pp. $100.00 hc
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Ex Africa semper aliquid novi—There is always something new out of Africa. Had Pliny the Elder been a contemporary physicist, he might have expressed this sentiment about Rydberg atoms, atoms containing one and usually no more than two highly excited electrons. Now a noted researcher is presenting an overview of their properties and various ways of producing and analyzing them.

Much like the ancient continent whose constant stream of new marvels enthralled Pliny and his contemporaries, Rydberg atoms are still a source of much remarkable and fundamental physics. They owe this pride of place to a peculiar constitution that keeps their physical properties simple yet exaggerates them to the point where experiments unthinkable in most systems become feasible in these atoms. Today Rydberg atoms are atomic-scale laboratories in which, among other things, the quantum mechanics of nonlinear systems and the correspondence-principle limit of quantum mechanics are studied. Yet many decades ago Rydberg atoms were catalysts for the dawning of modern physics, and ultimately quantum mechanics itself, through Johann Jacob Balmer's research in line spectra and Niels Bohr's theory of planetary atoms.

The methods by which Rydberg atoms are studied have evolved, of course, since the days of Balmer, and they form the subject of this monograph. A third of *Rydberg Atoms* is devoted to collisions, and these chapters, with their detail and up-to-date references, are a must for those studying atomic collisions. I was also delighted to see the attention paid to interactions with electric fields, because most experiments on Rydberg atoms use field ionization for detection (a subject to which the author, Tom Gallagher, has made seminal contributions).

In a surprising recent development, pulsed field ionization of Rydberg molecules has become the method of choice for analyzing the vibration–rotation structure of molecules, through the so-called ZEKE technique; the book's coverage of this technique will provide valuable background as well as technical reading for photochemists. Other subjects include radiative interactions, microwave ionization, magnetic-field interactions, quantum defect theory, autoionization and double Rydberg states. In reviewing a book with such a wide scope, it is tempting to recount what is not covered: Cavity electrodynamics (a subject of frontline experimentation) is omitted, as are the semiclassical behavior of electronic motion and its broader implications for spectroscopy, chaos and wavepacket motion.

It would be a disservice to the author and the community not to give a taste of some of the directions described in *Rydberg Atoms*. Gallagher describes a set of experiments he performed on the interaction of Rydberg atoms with circularly polarized microwave fields. These experiments precipitated a flood of theoretical and experimental investigations, which have provided new insights into the effects of velocity-dependent Coriolis forces in the ionization of Rydberg atoms and molecules and, further, have revealed how such interactions might be used to produce harmonic-oscillator-like atomic coherent states, a longstanding Holy Grail of atomic physics.

This timely and beautifully produced book provides the background needed to delve into the recent literature in the area. Moreover, given the paradigmatic nature of Rydberg states in illustrating the interplay of classical and quantum mechanics, it also constitutes a rich source of experimentally realizable and elegant illustrations of basic physical principles.

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Statistical Physics of Macromolecules

Alexander Yu. Grosberg
and Alexei R. Khokhlov
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A major class of modern society's materials and several key elements in biological machinery are based on polymers. Spectacular technological advances are now possible due to our increasing knowledge of such systems. In support of the experimental studies, mechanisms from theoretical physics have been vital in achieving our current understanding, and new developments have been blooming in recent years. The goal of *Statistical Physics of Macromolecules* is to provide a comprehensive description of these theoretical tools.

There is a limited number of books on statistical mechanics in macromolecules, and this volume makes a nice new addition. No general knowledge