

sciences. (There are several typographical mistakes. The two most serious concern references to figures in New Global Tectonics: figure 14 on page 79 should be figure 15, and figure 1b on page 88 should be figure 16.)

Active Control of Vibration

▶ C. R. Fuller, S. J. Elliott and P. A. Nelson
Academic, San Diego, Calif., 1996. 332 pp. \$75.00 hc
ISBN 0-12-269440-6

Although the control of sound fields is applied on longitudinal waves, while mechanical waves, which are those most often subject to active control, are transverse waves, there are essential similarities in the physical aspects of the fields, optimization formulations of the controls, and electronic control theory and circuitry. It makes sense, then, to view *Active Control of Vibration* as a second volume of the book *Active Control of Sound* (Academic, 1992) written by Philip A. Nelson and Stephen J. Elliott, who are also coauthors with Christopher R. Fuller of *Active Control of Vibration*. Active control of sound and vibration emerged only recently as a distinct subfield of acoustics. The importance of the new book is strengthened by the fact that it is the first book written on its subject matter, as was *Active Control of Sound*, and that all the authors are well known for their distinguished research and journal publications.

Active control of sound or vibration is achieved by generating electronically controlled secondary fields that, by interference with the sound field of primary sources, result in substantial reduction of either the primary sound or vibrational field. Another application is the enhancement of the sound field in rooms to achieve optimal listening. The goal of active vibration control is always to reduce the vibrational amplitudes or vibration transmission on a structure as well as sound radiation from the structure. The essential task is to determine optimal locations of the secondary sound or vibrational sources to achieve the selected goals. Generally, there are no closed-form solutions to this task. Therefore, the understanding of physical fundamentals of sound radiation and sound-field configuration is essential for the use of computational techniques to determine the effectiveness of the secondary sources.

While the mutual topology of the primary and secondary sources determines the degree of achievable sound or vibrational field modifications, the

actual control in most systems is accomplished by adaptive electronics, which modifies the output of the secondary sources to minimize the field at predetermined sensor locations. Various adaptive algorithms, which are implemented by fast digital signal processing boards, perform this task.

Both the students and engineers involved in vibration control can benefit from reading *Active Control of Sound* first, in order to become familiar with several basic concepts of sound-field control, adaptive filtering and specialized matrix algebra. However, *Active Control of Vibration* contains—and systematically presents—all of the material needed to understand and design active vibration control systems.

Two introductory sections of the book summarize mechanical vibrations and waves on structures. The reader will find a good blend of physics and engineering descriptions of the structures. The emphasis on plate and cylindrical structures reflects the most important applications. Before the topic of active control can be addressed, the reader is exposed to two basic types of control: feedback and feedforward. In spite of stability and other problems, feedback controls are favored by many engineers who consider them to be fundamental for control implementation. Feedforward techniques, particularly the adaptive time-domain controllers, have been subject to intensive research and development, and the corresponding section of *Active Control of Vibration* provides very solid fundamentals for understanding the basic issues and algorithms for adaptive filter implementation.

An essential class of active control on structures is based on the modal control of plates and cylinders. This requires the sensing and actuation of individual modes. These topics are addressed in the section on distributed transducers for active control, which provides in-depth applications of piezoelectric sensors but also mentions the use of shape-memory alloys, actuators and sensors. The second half of the book is dedicated to the control techniques and strategies on actual structures. An introductory chapter on feedback and feedforward control of flexural waves is followed by an essential section on active vibration isolation. This latter section contains important engineering applications on automobile and airplane engine mounts and other sources that transmit vibrations to supporting structures. The rest of the book is dedicated to structural control of both plate systems and cylinder-like systems. These reflect the author's extensive experience in research and numerous applications.

The book is well balanced, as it covers the principles, applications, control systems and transducers for structural control. By blending the physics and engineering approaches, it qualifies as an excellent textbook, providing both the fundamental and engineering issues of active vibration control. It also complements the earlier *Active Control of Sound*, which I have been using successfully as a textbook for a graduate-level course.

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Nuclear Energy: Principles, Practices and Prospects

▶ David Bodansky
AIP, Woodbury, N.Y., 1996.
396 pp. \$65.00 hc
ISBN 1-56396-244-6

The early history of nuclear fission was shaped by the work of physicists and chemists. It is therefore desirable, and even important, for physicists and chemists to understand the technological revolutions, both good and bad, that they have wrought. In *Nuclear Energy*, David Bodansky is neither removed from the argument nor judgmental. Rather, he lays out the arguments that have been made and offers a background against which they can be assessed.

Bodansky describes the sources of radiation (mostly natural) to which people are exposed as well as the known biological effects of radiation upon people. Then he touches a number of controversial issues: The linearity—at low doses—of cancer induction with dose is a "hypothesis" that, Bodansky notes, is useful for setting standards for radiation protection. Some scientists believe, however, that they have evidence for another hypothesis—that radiation at low doses is beneficial. I would have appreciated a brief discussion of the data against which to judge the hypotheses. Although Bodansky discusses the principle of keeping exposures "as low as reasonably achievable" (ALARA) and notes that the Nuclear Regulatory Commission promulgated the rule (in RM-30-2) that radiation exposure should be reduced if it can be done for \$1000 per Man Rem, (about \$4 million per life), an independent study showed that radwaste regulations require the spending of over a billion dollars per life—240 times the ALARA guideline.

The chapter on nuclear reactor safety includes a discussion of the landmark Reactor Safety Study (RSS),

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chaired by Norman Rasmussen, that began the probabilistic safety assessment (PSA) procedure. Bodansky endorses the notion that the study's main value lies in the insights that are obtained in the process of analysis, rather than in any final answers it produced. I agree with Bodansky that, in retrospect, "the average estimates of core melt probabilities given in the RSS were too low" at the time, although not now. I also agree that the use of PSA studies by the Nuclear Regulatory Commission "in regulatory decisions appears to be in a state of flux."

The chapter on nuclear accidents includes an excellent discussion of Chernobyl. This would have been an opportunity to stress the importance of delayed neutrons in reactor safety. It is important to ensure that no changes in reactivity are made that exceed this fraction of delayed neutrons or the reactor becomes uncontrollable—as was the Chernobyl reactor. The list (Bodansky's table 12.2) of the amounts of radionuclides released at Chernobyl is probably close to correct (the amounts are larger than the initial Soviet estimates), but a better source would be the papers by Alexander Sich in *Nuclear Safety* (January–June 1994).

Dixy Lee Ray, thinking of technical problems, not political ones, when she was head of the Atomic Energy Commission commented that "nuclear waste is the biggest nonproblem that we have got." Physicists should be among the first to tell the public whether or not a technical problem exists. The chapter "Issues in Nuclear Waste Disposal" and two other chapters on waste are therefore important. In them, Bodansky discusses the Environmental Protection Agency's regulations regarding high-level waste disposal and their overturn by the Court of Appeals in 1987—but not the damning descriptions of the regulations and their bases by several EPA review committees.

Bodansky notes, in chapter 14, that "most observers believe that the most profound problem with using nuclear energy for electricity generation is the connection between nuclear power and nuclear weapons." He discusses here a matter of great topical interest: the permanent destruction or disposal of plutonium declared excess to military needs. Although a National Academy of Sciences committee declared in 1994 that the existence of this material is "a clear and present danger" to the United States, the US government has moved with glacial speed on the matter.

Chapter 15, on the costs of nuclear electricity, is important, but it is a somewhat weak chapter in an otherwise very strong book. I would have

liked to see a comparison of costs in different countries and a clear statement that the costs have risen dramatically since 1973, as well as a more systematic discussion of the possible reasons for these increases.

Although there are these many things I would like to have seen done differently, this is by far the best book I have seen on nuclear energy for the interested scientist. Every physics professor and physics library should have a copy. I hope that eager young scientists will read the book and lead the country toward a sounder and more broadly based program of nuclear energy than we have had heretofore.

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An Introduction to Modern Astrophysics

Bradley W. Carroll

and Dale A. Ostlie

Addison-Wesley, Reading, Mass.,

1996. 1327 pp. \$76.95 hc

ISBN 0-201-54730-9

Modern astrophysics is continually expanding its tent, and the breadth of its coverage is immediately clear from a perusal of the table of contents of Bradley W. Carroll and Dale A. Ostlie's *An Introduction to Modern Astrophysics*. Within the 1.3 kilopages of this impressive book there are brief introductory reviews of traditional mechanics and optics, followed by the basics of special relativity, radiation and telescopes. The determination of stellar masses, using observations of binaries, is nicely set out and, thus armed, the student can explore stellar classification and internal structure, formation and evolution through to exotic objects of current interest such as neutron stars and black holes. The Solar System is reviewed in four chapters. The text then proceeds to ever-larger scales: from binaries to galaxies and the structure and evolution of our universe. Those of us who have written introductory texts or who teach the typical freshman astronomy courses must pause to recognize the authors' achievement in writing a text of such broad scope and judicious detail.

This volume has been designed to "open the entire field of modern astrophysics . . . using only the basic tools of physics" and is aimed at junior-year undergraduates who have already completed the typical introductory calculus-based physics course. Accordingly, this volume can probe topics that the freshman surveys cannot approach. So, for example, Carroll and