

The Earth: A laboratory for wave propagation

Wave Propagation

I. Tolstoy

466 pp. McGraw-Hill, New York, 1973. \$18.50

Reviewed by A. O. Williams Jr

This excellent book is intended as a text for graduate students of geophysics. However, the physical information it contains and its clarity of analysis suggest a wider audience.

Geophysics—here generalized to embrace the ocean, atmosphere, ionosphere and extraterrestrial planets—is a fast-growing subject with an even faster growth of complexity. Wave propagation is an omnipresent geophysical phenomenon, as well as a major tool for measurements. Ivan Tolstoy is thoroughly qualified to expound upon this subject. He has written many papers covering a wide range of geophysics and underwater sound issues and, with C. S. Clay, he is co-author of *Ocean Acoustics* (McGraw-Hill, 1966).

The author argues that propagation of linear classical waves is so important as to warrant a unified treatment, that dissipation and nonlinearities can be left until later, and hence, that waves are "fundamentally conservative phenomena . . . nature's mechanism for transporting energy without degradation and without transporting matter."

The structure of the chosen foundation, Hamilton's Principle, is presented briefly. Each topic starts from there: the Lagrangian density is computed from Newton's and Maxwell's laws and linear elastic theory; the Euler-Lagrange equations lead to the pertinent wave equation, and the rest follows from carefully explored methods of analysis.

A strength of the book is its early and continuing recognition of complexities—media that are stratified, bounded, moving, porous or plasmas, and the interacting effects of elasticity, gravity, buoyancy and electromagnetism. Nevertheless, the novice need not be overwhelmed. At first, only plane waves are used (with warning of consequent paradoxes). Analytical methods, including stationary-phase and WKB approximations, are expanded



This seismic reflection record from a deep-water survey reveals the probable existence of a salt dome (bottom of record).

gradually. Important but distracting material is relegated to appendices. Difficulties at the research level are avoided by careful exposition of limiting cases. Eventually, Tolstoy introduces Green's functions, normal modes and normal coordinates allowing his treatment of nonplanar waves and diffraction.

In two final chapters, aspects deferred earlier are discussed briefly, but with the same attention to clarity: scattering, dissipation, noise (and filter theory), propagation on a spherical planet, and some nonlinear topics, including Lighthill's treatment of sound generation by turbulence. It is demonstrated that linear conservative theory still continues as a valid approximation.

Stress Wave Propagation in Solids

R. J. Wasley

279 pp. Marcel Dekker, N.Y., 1973. \$17.75

Reviewed by Julius Miklowitz

In the preface R. J. Wasley states that his book is intended to "set the stage" for the continued study of the propagation of relatively short-duration, high-intensity, principally nonelastic, mechanical stress disturbances in solids, with the application of certain relevant aspects of elasticity. There is no doubt that research of this specific type, and more generally in elastic and nonelastic stress-wave propagation, finds ever increasing importance in our understanding of high-speed processes and their involvement in modern technological problems. There are numerous examples of these problem areas. Since World War II, in mechanics, materials science and engineering, there has been much activity devoted to understanding the response of materials and structures subjected to sharp loadings. Modern examples are structures subject to strong motion earthquakes and nuclear blasts. Other interests relate to ultrasonic devices for studying material flaws and for use as delay lines. Needless to say, a major interest lies in seismology, which through the years has produced much basic and applied information on waves in solids.

To accomplish his task Wasley has partitioned his book into two parts, the first on "concepts of elasticity," and the second on "extension of applications of elastic concepts." Essentially the first part presents an introduction to linear elastodynamics (governing equations), wave propagation in the unbounded medium, reflection and refraction of time-harmonic waves at an interface, time-harmonic waves in a circular cylindrical rod and a final section on selected static and dynamic applications of elastic concepts, for example, resonance and pulse ultrasonic techniques.

The second part of the book is concerned with nonelastic wave propagation in solids. The experiment is prime, but some analytical discussions

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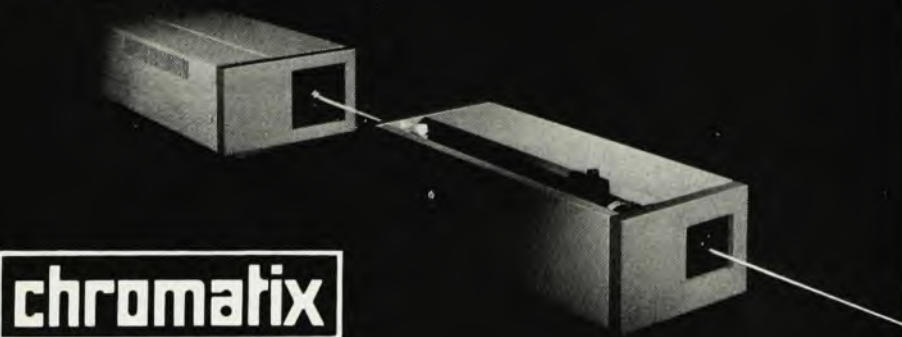
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are given. In essence this part first includes a discussion of nonelastic material behavior, and then experimental investigations of one-dimensional stress-wave propagation and one-dimensional shock strain-wave propagation. In the latter a supersonic disturbance propagates, which, for example, can be created at a point of a concave upward stress-strain curve where the slope is greater than the elastic modulus.

Taking into account the stated purpose of the book, I feel the first part on linear-elastic waves is much too long (three-quarters of the book) for what it accomplishes: laying the groundwork for potential researchers in nonelastic waves. Further, the treatment is not novel and, in fact, nearly omits certain important topics (very little information is provided on transient waves in one and two-dimensions, except for references with practically no discussion of their content). On the other hand the second part of the book has merit. It offers a look at a complicated topic in a reasonable way. In addition to text references, the book has a list of references for collateral reading. According to the author the book is intended for people in nonacademic fields (national laboratories and private research groups), but could be used in an introductory course on waves in solids. Perhaps it can be useful for these purposes.

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The book is efficiently organized as a text. Each chapter has an expository preamble, some four main sections with individual summaries, a brief annotated bibliography for further study and several meaningful problems (explanatory comments are appended). Numerous displays of experimental results illustrate the theoretical development.

A few minor flaws exist. A number of misprints or similar slips were noted, mainly not distracting. Superior dots (for time differentiation) occasionally are confusingly close to the main symbol. Brevity and clarity are sought through much use of reference to earlier equation numbers, but sometimes an explanatory word might have obviated the back search.

Both author and publisher deserve much credit for a new and useful book

that is well planned, well written and well produced.

* * *

Julius Miklowitz is a professor of Applied Mechanics at the California Institute of Technology. During the last 15 years he has published 35 papers in the area of waves in solids.

Cosmic Rays at Ground Level

A. W. Wolfendale, ed.

233 pp. Institute of Physics, London,
1973. \$12.00

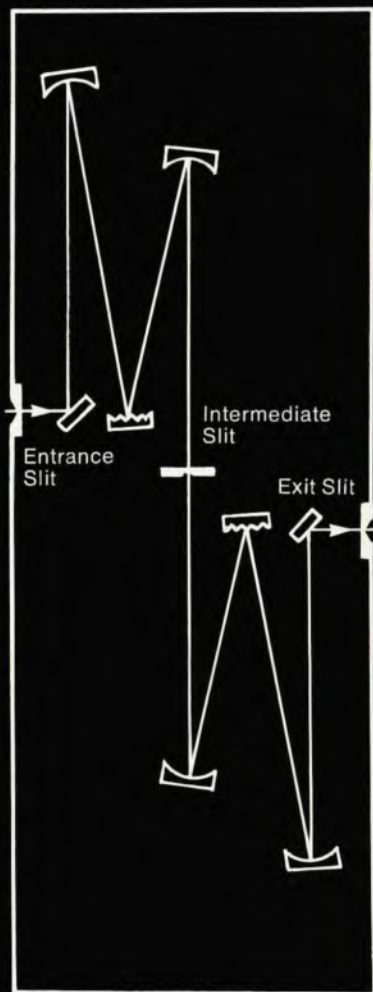
Arnold W. Wolfendale, for many years a leader in research to determine the precise momentum spectrum of energetic cosmic-ray muons deep in the atmosphere, has organized a very useful "festschrift" in honor of George D. Rochester, FRS, whose retirement occurred this year. The shock is that Rochester has been retired, a victim of an indiscriminating system that dictates age 65 as the most probable end of academic capability. One can only hope that he now will have more time to enjoy his research and continue to contribute to advancement of understanding of the ultrahigh energy radiation provided by nature. Rochester's discovery in 1947 (in collaboration with Clifford C. Butler) of the first "strange" particles—the so-called V-particles that were the unstable heavies among cosmic-ray shower secondaries—certainly gave rise to the succeeding great revolution in elementary-particle physics and a large number of Nobel Prizes connected with it.

Wolfendale and many of his colleagues presently (or lately) at the Universities of Leeds and Durham, including several former students of Rochester, have compiled a series of reviews and reports covering the nature of the primary cosmic radiation, the composition and spectrum of the sea-level particle radiation, muon and electron-neutrino physics, searches for quarks, magnetic monopoles and tachyons, extensive air showers (much of the shower work being done at Haverah Park in Yorkshire, an observatory that Rochester helped to create) and some details of special observational techniques developed to a high degree of precision at Durham (including magnetic cloud-chamber spectrometers and neon flash-tube detector arrays).

As is unavoidable in the case of such a compendium, the style and coverage are uneven, but the level of performance is generally good throughout. The authors have mostly succeeded in giving a broad and nonparochial view of their various topics; most of the ref-

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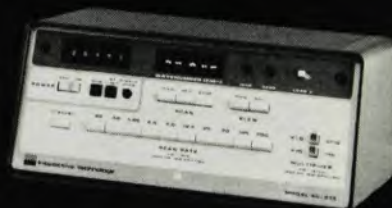
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