BOOK REVIEW

G. B. Whitham

# LINEAR AND NONLINEAR WAVES*

Reviewed by V. P. Korobeinikov

Professor Whitham's book is of considerable interest because it covers an extensive range of topics in wave theory for various physical systems. It deals with a large variety of wave processes in the mechanics of continuous media, electrodynamics, and optics from the unified point of view.

A similar but older work is that by Jeffrey and Taniuti: Non-Linear Wave Propagation with Application to Physics and Magnetohydrodynamics, which appeared over 10 years ago [1]. A distinction of the present book is that it deals with comparatively new topics, particularly nonlinear waves with dispersion.

The volume consists of an introduction and two parts. The literature reference indicate that it covers results appearing up to 1973.

Part 1 deals with wave processes described by hyperbolic equations; this part contains 10 chapters. These deal with traditional topics such as the theory of characteristics, Riemann invariants, and weak discontinuities of the equations of gasdynamics; as well as the theory of shock waves, solution of the wave equations for various types of symmetry, and so on. Detailed analysis are presented for topics such as shock-wave propagation in inhomogeneous media, asymptotic damping laws for weak shock waves, the principles of interaction and diffraction for shock waves, and solutions to Burger's equations. Also, a study is made of the behavior of solutions to wave problems for a variety of particular cases, including transport fluxes, waves in shallow water, waves produced by supersonic aircraft, shock-wave cumulation, point explosions, and geometric optics.

The second part consists of 7 chapters. This part is not closely related to the first part, since it deals with relatively unfamiliar topics in wave propagation for dispersive media. In that case, the behavior is affected by the frequency parameters. The author does not give a general description of the type of equation system that results in dispersion, but discusses instead various particular cases that result in such dispersion. Two major topics are handled here: the construction of analytical solutions to the Korteweg–de Vries equation and development of variational methods for examining dispersion waves. Of the particular problems examined here we may note ones in crystal optics, waves in water involving dispersion, nonlinear beam self-focusing, interaction between nonlinear waves (solutions), and use of Schrödingers' equation in dispersion-wave research. The group-velocity concept is extensively applied to nonlinear waves, and examples are given of uses of variational methods.

The book is intended for students in final courses and graduate students specializing in physics, technology, and applied mathematics. The author has attempted to cover all the major topics and aspects in nonlinearity, while illustrating major applications and familiarizing the reader with the art of combining mathematics with intuitive or physical arguments in defining the most efficient means of solving problems. Although the book does not contain the traditional mathematical exposition of theorems for existence and uniqueness, it should be useful for specialists in mathematical physics as a source book for formulating new initial-value and boundary-value problems.

However, the book does have some disadvantages. For instance, the classification given for nonlinear waves (Chap. 1) is incomplete. Thermal waves and nonlinear diffusion waves have been completely omitted, while there is also no mention of phase-transition waves and combustion waves.

The following classification would appear to correspond more fully to the current state of the art:

a) hyperbolic waves

*Wiley-Interscience, New York–London–Sydney–Toronto (1974), 636 pp.

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b) dissipative diffusion waves

c) waves with dispersion

d) state-change waves (waves involving phase transitions, condensation, combustion, etc.)

e) combined waves.

Series expansion in terms of coordinates or parameters is used in various applications, but no proofs are given for convergence of such series in many instances, and sometimes there is even no discussion of convergence. Also, the required features in the initial functions are not always specified in formulating initial-value problems. Finally, the concept of a general solution for nonlinear equations is given too schematically.

Although the bibliography cites over 150 items, the list does not include famous items such as the monograph by Jeffrey and Taniuti, Rozhdestvenskii and Yanenko's book on quasilinear equations [2], and Karpman's book [3] on nonlinear waves in dispersive media.

Further, the book lacks almost entirely sections dealing with numerical methods in defining solutions for nonlinear waves. These methods have been discussed in [2].

In spite of these deficiencies, the book is extremely valuable for anyone concerned with the theory and applications of nonlinear waves.

## LITERATURE CITED


1. A. Jeffrey and T. Taniuti, Non-Linear Wave Propagation with Application to Physics and Magnetohydrodynamics, Academic Press, New York–London (1964), 369 pp.
2. B. L. Rozhdestvenskii and N. N. Yanenko, Systems of Quasilinear Equations [in Russian], Nauka, Moscow (1968).
3. V. I. Karpman, Nonlinear Waves in Dispersive Media [in Russian], Nauka, Moscow (1973).