# Preface

Wave processes are observed in any field, where matter moves: in electrodynamics, plasma physics, optics, acoustics, fluid dynamics, complex two-phase media such as “gas-drip system”, soils of various types, solids with pores filled with liquid, etc.

During wave propagation in various continuous media, the physical properties of matter play a very important role. The most important properties, which are present in majority of cases, are nonlinearity, dissipation, dispersion, diffraction, and heterogeneity.

Linear and nonlinear wave processes are also of special interest for their applications in various practical problems.

It is interesting to note that despite the difference in the physical nature of wave processes (acoustic, electromagnetic), they are described by similar equations. One of the powerful methods of mathematical study (especially, for nonlinear waves) is the method of evolution equation (or short-wavelengths) and the method of non-linear modulation equation, the latter equation is often referred to as a non-linear Schrödinger equation. There are two questions in this aspect: the first one is how to derive evolution equations from various complex systems of equations describing wave motion in a medium and the nature of the waves; and the second one is how to examine the obtained equations that in each case have different types of modification (different coefficients, order of equations, etc.).

For investigation of wave processes it is important to identify the laws of linear and nonlinear dispersion, to reveal types of modulation (amplitude, frequency, etc.), to study problems of stability (instability) of modulation and other types of waves, in particular, solitons. If wave beam propagation is studied, the important problems facing the researchers are focusing problems: it is necessary to determine the distance of focus formation, focal spots, the existence of self-focusing (defocusing), laws of variation of the beam radius in space and time.

In this monograph the original results are used and developed, which have been obtained by the authors in their research activity at the Mechanical Engineering Research Institute of the Russian Academy of Sciences (Nizhny Novgorod, Russia) and at the Institute of Mechanics of the National Academy of Sciences of Armenia

(Yerevan, Armenia), as well as in their joint research. Study of the self-modulation effects of elastic waves in media with complex physical and mechanical properties (interaction of deformation fields with electromagnetic fields, fields of defects, etc.) is also of great interest.

Features of propagation and interaction of nonlinear strain waves in mechanical systems are being intensively investigated for the last three decades in many countries. This is explained, as already mentioned, by numerous physical, technical and technological applications of such systems. Some monographs on nonlinear waves in continuous media have been published (e.g., [24, 65, 83, 112, 133, 165, 166, 192, 193, 203, 214, 225, 237, 250, 281, 327, 331, 363, 378, 392, 400]).

This monograph is devoted, in the first place, to the study of wave processes in media, where interaction of deformation fields with fields of the physical nature is significant. The content of this monograph does not duplicate the content of the existing books, but is intended to supplement them, finding its "niche" in this research field.

The book is based on [9, 17, 18, 25–61, 108, 113, 115–128, 267–276, 286–300, 330–340, 388, 389, 398, 406, 407]. In one way or another, we could represent the results of our colleagues—"wave-researchers" belonging to different scientific schools of the former Soviet Union [2, 3, 6, 8, 10–14, 20–23, 62–65, 67–69, 71, 75–77, 80–84, 87–89, 92, 95, 98–101, 103, 107, 130–135, 143, 145, 147, 152–155, 162–164, 176–178, 181–185, 192–194, 196–202, 204, 208–210, 213, 215, 216, 218, 220, 221, 224, 227, 228, 230, 231, 233, 234, 239, 245, 246, 252, 277, 278, 282, 349, 361, 383, 402].

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Bagdoev, A.G.; Erofeev, V.I.; Shekoyan, A.V.

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