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# **Nonlinear Waves in Elastic Crystals**

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GÉRARD A. MAUGIN



OXFORD SCIENCE PUBLICATIONS

# Nonlinear Waves In Elastic Crystals

**Jüri Engelbrecht**



## **Nonlinear Waves In Elastic Crystals:**

*Nonlinear Waves in Elastic Crystals* Gérard A. Maugin, 1999 The mathematical modelling of changing structures in materials is of increasing importance to industry where applications of the theory are found in subjects as diverse as aerospace and medicine This book deals with aspects of the nonlinear dynamics of deformable ordered solids known as elastic crystals where the nonlinear effects combine or compete with each other Physical and mathematical models are discussed and computational aspects are also included Different models are considered on discrete as well as continuum scales applying heat electricity or magnetism to the crystal structure and these are analysed using the equations of rational mechanics In this way the student is introduced to the important equations of nonlinear science that describe shock waves solitons and chaos and also the non exactly integrable systems or partial differential equations A large number of problems and examples are included many taken from recent research and involving both one dimensional and two dimensional problems as well as some coupled degrees of freedom

**Nonlinear Elastic Waves in Materials** Jeremiah J. Rushchitsky, 2014-04-23 The main goal of the book is a coherent treatment of the theory of propagation in materials of nonlinearly elastic waves of displacements which corresponds to one modern line of development of the nonlinear theory of elastic waves The book is divided on five basic parts the necessary information on waves and materials the necessary information on nonlinear theory of elasticity and elastic materials analysis of one dimensional nonlinear elastic waves of displacement longitudinal vertically and horizontally polarized transverse plane nonlinear elastic waves of displacement analysis of one dimensional nonlinear elastic waves of displacement cylindrical and torsional nonlinear elastic waves of displacement analysis of two dimensional nonlinear elastic waves of displacement Rayleigh and Love nonlinear elastic surface waves The book is addressed first of all to people working in solid mechanics from the students at an advanced undergraduate and graduate level to the scientists professionally interesting in waves But mechanics is understood in the broad sense when it includes mechanical and other engineering material science applied mathematics and physics and so forth The genesis of this book can be found in author's years of research and teaching while a head of department at SP Timoshenko Institute of Mechanics National Academy of Sciences of Ukraine a member of Center for Micro and Nanomechanics at Engineering School of University of Aberdeen Scotland and a professor at Physical Mathematical Faculty of National Technical University of Ukraine KPI The book comprises 11 chapters Each chapter is complemented by exercises which can be used for the next development of the theory of nonlinear waves

**Waves in Nonlinear Pre-Stressed Materials** M. Destrade, G. Saccomandi, 2007-11-08 The papers in this book provide a unique state of the art multidisciplinary overview on the subject of waves in pre stressed materials through the interaction of several topics ranging from the mathematical modelling of incremental material response elastic and inelastic to the analysis of the governing differential equations and boundary value problems and to computational methods for the solution to these problems with particular

reference to industrial geophysical and biomechanical applications A complete view on the title subject is proposed including The basic and fundamental theoretical issues mechanical modelling exact solutions asymptotic methods numerical treatment A unified introduction to wave propagation small on large and large on large A look toward classical such as geophysics and the mechanics of rubber like solids and emergent such as biomechanics applications **The interaction of complex harmonic elastic waves with periodically corrugated surfaces and with anisotropic viscoelastic and/or piezoelectric layered media.** Nico F. Declercq, 2005-05-12 Unabridged Ph D Thesis with thesis defense photos and presentation at the end **Proceedings, "WASCOM 2005"** Roberto Monaco, Giuseppe Mulone, Salvatore Rionero, Tommaso Ruggeri, 2006 The book contains recent contributions in the field of waves propagation and stability in continuous media In particular the contributions consider discontinuity and shock waves stability in fluid dynamics small parameter problems kinetic theories towards continuum models non equilibrium thermodynamics and numerical applications The volume is the fourth in a series published by World Scientific since 1999 The following distinguished authors contribute to the present book S Bianchini R Caflish C Cercignani Y Choquet Bruhat C Dafermos L Desvillettes V Giovangigli H Gouin I Muller D Parker B Straughan M Sugiyama and W Weiss *IUTAM Symposium on Computational Mechanics of Solid Materials at Large Strains* Christian Miehe, 2013-06-29 The steady increase in computational power induces an equally steady increase in the complexity of the engineering models and associated computer codes This particularly affects the modeling of the mechanical response of materials Material behavior is nowadays modeled in the strongly nonlinear range by taking into account finite strains complex hysteresis effects fracture phenomena and multiscale features Progress in this field is of fundamental importance for many engineering disciplines especially those concerned with material testing safety reliability and serviceability analyses of engineering structures In recent years many important achievements have been made in the field of the theoretical formulation the mathematical analysis and the numerical implementation of deformation processes in solids Computational methods and simulation techniques today play a central role in advancing the understanding of complex material behavior Research in the field of Computational Mechanics of Materials is concerned with the development of mathematical models and numerical solution techniques for the simulation of material response It is a very broad interdisciplinary field of science with inputs from traditional fields such as Applied Mechanics Applied Mathematics Materials Science Solid State Physics and Information Technology The intention of the IUTAM Symposium Computational Mechanics of Solid Materials at Large Strains held at the University of Stuttgart Germany from August 20-24 2001 was to give a state of the art and a survey about recent developments in this field and to create perspectives for future research trends **Modelling of Complex Signals in Nerves** Jüri Engelbrecht, Kert Tamm, Tanel Peets, 2021-05-11 This book describes fundamental physical principles together with their mathematical formulations for modelling the propagation of signals in nerve fibres Above all it focuses on the complex electro mechano thermal process that produces an ensemble of waves composed of several components besides the

action potential These components include mechanical waves in the biomembrane and axoplasm together with the temperature change Pursuing a step by step approach the content moves from physics and mathematics to describing the physiological effects and finally to modelling the coupling effects The assumptions and hypotheses used for modelling as well as selected helpful concepts from continuum mechanics are systematically explained and the modelling is illustrated using the outcomes of numerical simulation The book is chiefly intended for researchers and graduate students providing them with a detailed description of how to model the complex physiological processes in nerve fibres

Mechanics of Microstructured Solids J.-F. Ganghoffer, Franco Pastrone, 2009-05-14 This is a compendium of reviewed articles presented at the 11th EUROMECH MECAMAT conference entitled Mechanics of microstructured solids cellular materials fibre reinforced solids and soft tissues It provides all the latest information in the field

Mechanics of Material Forces Paul Steinmann, Gérard A. Maugin, 2006-01-20 The notion dealt with in this volume of proceedings is often traced back to the late 19th century writings of a rather obscure scientist C V Burton A probable reason for this is that the painstaking deciphering of this author's paper in the Philosophical Magazine Vol 33 pp 191-204 1891 seems to reveal a notion that was introduced in mathematical form much later that of local structural rearrangement This notion obviously takes place on the material manifold of modern continuum mechanics It is more or less clear that seemingly different phenomena phase transition local destruction of matter in the form of the loss of local ordering such as in the appearance of structural defects or of the loss of cohesion by the appearance of damage or the extension of cracks plasticity material growth in the bulk or at the surface by accretion wear and the production of debris should enter a common framework where by pure logic the material manifold has to play a prominent role Finding the mathematical formulation for this was one of the great achievements of J D Eshelby He was led to consider the apparent but true motion or displacement of embedded material inhomogeneities and thus he began to investigate the driving force causing this motion or displacement something any good mechanician would naturally introduce through the duality inherent in mechanics since J L d'Alembert

Variational and Extremum Principles in Macroscopic Systems Stanislaw Sieniutycz, Henrik Farkas, 2010-07-07 Recent years have seen a growing trend to derive models of macroscopic phenomena encountered in the fields of engineering physics chemistry ecology self organisation theory and econophysics from various variational or extremum principles Through the link between the integral extremum of a functional and the local extremum of a function explicit for example in the Pontryagin's maximum principle variational and extremum principles are mutually related Thus it makes sense to consider them within a common context The main goal of Variational and Extremum Principles in Macroscopic Systems is to collect various mathematical formulations and examples of physical reasoning that involve both basic theoretical aspects and applications of variational and extremum approaches to systems of the macroscopic world The first part of the book is focused on the theory whereas the second focuses on applications The unifying variational approach is used to derive the balance or conservation equations phenomenological

equations linking fluxes and forces equations of change for processes with coupled transfer of energy and substance and optimal conditions for energy management A unique multidisciplinary synthesis of variational and extremum principles in theory and application A comprehensive review of current and past achievements in variational formulations for macroscopic processes Uses Lagrangian and Hamiltonian formalisms as a basis for the exposition of novel approaches to transfer and conversion of thermal solar and chemical energy

**Proceedings of the Estonian Academy of Sciences, Physics and Mathematics**, 1999-09 Vibration Problems ICOVP 2011 Jiří Náprstek, Jaromír Horáček, Miloslav Okrouhlík, Bohdana

Marvalová, Ferdinand Verhulst, Jerzy T. Sawicki, 2011-08-26 This volume presents the Proceedings of the 10th International Conference on Vibration Problems 2011 Prague Czech Republic ICOVP 2011 brings together again scientists from different backgrounds who are actively working on vibration related problems of engineering both in theoretical and applied fields thus facilitating a lively exchange of ideas methods and results between the many different research areas The aim is that reciprocal intellectual fertilization will take place and ensure a broad interdisciplinary research field The topics indeed cover a wide variety of vibration related subjects from wave problems in solid mechanics to vibration problems related to biomechanics The first ICOVP conference was held in 1990 at A C College Jalpaiguri India under the co chairmanship of Professor M M Banerjee and Professor P Biswas Since then it has been held every 2 years at various venues across the World

*Proceedings of the Estonian Academy of Sciences, Physics and Mathematics*, 2003-03 Proceedings of the Estonian Academy of Sciences, Physics and Mathematics, 2003-03 **Local Gradient Theory for Dielectrics** Olha Hrytsyna, Vasyl Kondrat, 2019-11-22 This book is devoted to the development of the local gradient theory of dielectrics It presents a brief description of the known approaches to the construction of generalized integral and gradient type continuous theories of dielectrics It describes a new continuum thermodynamic approach to the construction of nonlinear high order gradient theory of thermoelastic non ferromagnetic polarized media This approach is based on accounting for non diffusive and non convective mass fluxes associated with the changes in the material microstructure Within the linear approximation the theory has been applied to study transition modes of the formation of near surface inhomogeneity of coupled fields in solids disjoining pressure in thin films etc The theory describes a number of observable phenomena including the surface size flexoelectric pyroelectric and thermopolarization effects in centrosymmetric crystals the Meads anomaly the high frequency dispersion of elastic waves etc that cannot be explained within the framework of the classical theory of dielectrics IUTAM

Symposium on Recent Advances of Acoustic Waves in Solids Tsung-Tsong Wu, Chien-Ching Ma, 2010-09-08 Rapid growth of the mobile communication market has triggered extensive research on the bulk as well as surface acoustic wave devices in the last decade Quite a few important results on the modeling and simulation of Film Bulk Acoustic Resonator FBAR and Layered SAW devices were reported recently The other recent advance of acoustic waves in solids is the so called phononic crystals or phononic band gap materials Analogous to the band gap of light in photonic crystals acoustic waves in periodic

elastic structures also exhibit band gap Important applications of phononic band gap materials can potentially be found with creating a vibration free environment in microstructures and design of advanced acoustic frequency filter etc In addition to the wave electronics and phononic crystals to facilitate the emerging needs in the quantitative nondestructive evaluation of materials waves in anisotropic solids and or electro magneto interaction problems also regained much attention recently Topics treated include Waves in piezoelectric crystals Simulation of advanced BAW and SAW devices Analysis of band gaps in phononic structures Experimental investigation of phononic structures Waves in multilayered media Waves in anisotropic solids and or electro magneto interaction problems      Nonlinear Waves in Solids A. Jeffrey,J. Engelbrecht,2014-05-04

Travelling wave processes and wave motion are of great importance in many areas of mechanics and nonlinearity also plays a decisive role there The basic mathematical models in this area involve nonlinear partial differential equations and predictability of behaviour of wave phenomena is of great importance Beside fluid dynamics and gas dynamics which have long been the traditional nonlinear sciences solid mechanics is now taking an ever increasing account of nonlinear effects Apart from plasticity and fracture mechanics nonlinear elastic waves have been shown to be of great importance in many areas such as the study of impact nondestructive testing and seismology These lectures offer a thorough account of the fundamental theory of nonlinear deformation waves and in the process offer an up to date account of the current state of research in the theory and practice of nonlinear waves in solids      *Questions About Elastic Waves* Jüri

Engelbrecht,2015-03-05 This book addresses the modelling of mechanical waves by asking the right questions about them and trying to find suitable answers The questions follow the analytical sequence from elementary understandings to complicated cases following a step by step path towards increased knowledge The focus is on waves in elastic solids although some examples also concern non conservative cases for the sake of completeness Special attention is paid to the understanding of the influence of microstructure nonlinearity and internal variables in continua With the help of many mathematical models for describing waves physical phenomena concerning wave dispersion nonlinear effects emergence of solitary waves scales and hierarchies of waves as well as the governing physical parameters are analysed Also the energy balance in waves and non conservative models with energy influx are discussed Finally all answers are interwoven into the canvas of complexity      *Mathematical and Numerical Aspects of Wave Propagation WAVES 2003* Gary Cohen,Erkki

Heikkola,Patrick Joly,Pekka Neittaanmäki,2012-12-06 This volume includes articles on the mathematical modeling and numerical simulation of various wave phenomena For many years Waves 2003 and its five prior conferences have been an important forum for discussions on wave propagation The topic is equally important for fundamental sciences engineering mathematics and in particular for industrial applications Areas of specific interest are acoustics electromagnetics elasticity and related inverse and optimization problems This book gives an extensive overview of recent developments in a very active field of scientific computing      **Recent Developments in the Theory of Shells** Holm Altenbach,Jacek

Chróścielewski, Victor A. Eremeyev, Krzysztof Wiśniewski, 2019-09-25 This book commemorates the 80th birthday of Prof W Pietraszkiewicz a prominent specialist in the field of general shell theory Reflecting Prof Pietraszkiewicz's focus the respective papers address a range of current problems in the theory of shells In addition they present other structural mechanics problems involving dimension reduced models Lastly several applications are discussed including material models for such dimension reduced structures



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