



# **Nonlinear Waves in Solid State Physics**

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# Nonlinear Waves In Solid State Physics

**Kartikeya Dutta**



## **Nonlinear Waves In Solid State Physics:**

Nonlinear Waves in Solid State Physics A.D. Boardman, M. Bertolotti, T. Twardowski, 2012-12-06 This book is based on the contributions to the 17th International School of Materials Science and Technology entitled Nonlinear Waves in Solid State Physics This was held as a NATO Advanced Study Institute at the Ettore Majorana Centre in Erice Sicily between the st th 1 and 15 July 1989 and attracted almost 100 participants from over 20 different countries The book covers the fundamental properties of nonlinear waves in solid state materials dealing with both theory and experiment The aim is to emphasise the methods underpinning the important new developments in this area The material is organised into subject areas that can broadly be classified into the following groups the theory of nonlinear surface and guided waves in self focusing magnetic and non magnetic materials nonlinear effects at interfaces nonlinear acoustoelectronic and surface acoustic waves Lagrangian and Hamiltonian formulations of nonlinear problems nonlinear effects in optical fibres resonance phenomena and nonlinear integrated optics The chapters have been grouped together according to these classifications as closely as possible but it should be borne in mind that although there is much overlap of ideas each chapter is essentially independent of the others We would like to acknowledge the sponsorship of the NATO Scientific Affairs Division the European Physical Society the National Science Foundation of the USA the European Research Office the Italian Ministry of Education the Italian Ministry of Scientific and Technological Research the Sicilian Regional Government and the Ugo Bordoni Foundation

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

Nonlinear Waves in Solid State Physics A.D. Boardman, M. Bertolotti, T. Twardowski, 1991-02-28 This book is based on the contributions to the 17th International School of Materials Science and Technology entitled Nonlinear Waves in Solid State Physics This was held as a NATO Advanced Study Institute at the Ettore Majorana Centre in Erice Sicily between the st th 1 and 15 July 1989 and attracted almost 100 participants from over 20 different countries The book covers the fundamental properties of nonlinear waves in solid state materials dealing with both theory and experiment The aim is to emphasise the methods underpinning the important new developments in this area The material is organised into subject areas that can broadly be classified into the following groups the theory of nonlinear surface and guided waves in self focusing magnetic

and non magnetic materials nonlinear effects at interfaces nonlinear acoustoelectronic and surface acoustic waves Lagrangian and Hamiltonian formulations of nonlinear problems nonlinear effects in optical fibres resonance phenomena and nonlinear integrated optics The chapters have been grouped together according to these classifications as closely as possible but it should be borne in mind that although there is much overlap of ideas each chapter is essentially independent of the others We would like to acknowledge the sponsorship of the NATO Scientific Affairs Division the European Physical Society the National Science Foundation of the USA the European Research Office the Italian Ministry of Education the Italian Ministry of Scientific and Technological Research the Sicilian Regional Government and the Ugo Bordoni Foundation

**Nonlinear Waves: Classical and Quantum Aspects** Fatkhulla Abdullaev, Vladimir V. Konotop, 2006-03-02 Leading scientists discuss the most recent physical and experimental results in the physics of Bose Einstein condensate theory the theory of nonlinear lattices including quantum and nonlinear lattices and nonlinear optics and photonics Classical and quantum aspects of the dynamics of nonlinear waves are considered The contributions focus on the Gross Pitaevskii equation and on the quantum nonlinear Schrödinger equation Recent experimental results on atomic condensates and hydrogen bonded systems are reviewed Particular attention is given to nonlinear matter waves in periodic potential *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 **Linear and Nonlinear Waves in Microstructured Solids** Igor V. Andrianov, Jan Awrejcewicz, Vladyslav Danishevskyy, 2021-04-22 This book uses asymptotic methods to obtain simple approximate analytic solutions to various problems within mechanics notably wave processes in heterogeneous materials Presenting original solutions to common issues within mechanics this book builds upon years of research to demonstrate the benefits of implementing asymptotic techniques within mechanical engineering and material science Focusing on linear and nonlinear wave phenomena in complex micro structured solids the book determines their global characteristics through analysis of their internal structure using homogenization and asymptotic procedures in line with the latest thinking within the field The book's cutting edge methodology can be applied to optimal design non destructive control and in deep seismic sounding

providing a valuable alternative to widely used numerical methods Using case studies the book covers topics such as elastic waves in nonhomogeneous materials regular and chaotic dynamics based on continualisation and discretization and vibration localization in 1D Linear and Nonlinear lattices The book will be of interest to students research engineers and professionals specialising in mathematics and physics as well as mechanical and civil engineering

*Surface Waves in Geomechanics: Direct and Inverse Modelling for Soils and Rocks* Carlo G. Lai, Krzysztof Wilmanski, 2007-03-23 Theories of surface waves develop since the end of XIX century and many fundamental problems like existence phase and group velocities attenuation quality factor mode conversion etc have been in part successfully solved within the framework of such simple models as ideal fluids or linear elasticity However a sufficiently complete presentation of this subject particularly for solids is still missing in the literature The sole exception is the book of I A Viktorov which contains an extensive discussion of fundamental properties of surface waves in homogeneous and stratified linear elastic solids with particular emphasis on contributions of Russian scientists Unfortunately the book has never been translated to English and its Russian version is also hardly available Practical applications of surface waves develop intensively since a much shorter period of time than theories even though the motivation of discoverers of surface waves such as Lord Rayleigh stems from their appearance in geophysics and seismology Nowadays the growing interest in practical applications of surface waves stem from the following two main factors surface waves are ideal for developing relatively cheap and convenient methods of nondestructive testing of various systems spanning from nanomaterials e g

**Non-Equilibrium Dynamics of Semiconductors and Nanostructures** Kong-Thon Tsen, 2018-10-03 The advent of the femto second laser has enabled us to observe phenomena at the atomic timescale One area to reap enormous benefits from this ability is ultrafast dynamics Collecting the works of leading experts from around the globe Non Equilibrium Dynamics of Semiconductors and Nanostructures surveys recent developments in a variety of areas in ultrafast dynamics In eight authoritative chapters illustrated by more than 150 figures this book spans a broad range of new techniques and advances It begins with a review of spin dynamics in a high mobility two dimensional electron gas followed by the generation propagation and nonlinear properties of high amplitude ultrashort strain solitons in solids The discussion then turns to nonlinear optical properties of nanoscale artificial dielectrics optical properties of GaN self assembled quantum dots and optical studies of carrier dynamics and non equilibrium optical phonons in nitride based semiconductors Rounding out the presentation the book examines ultrafast non equilibrium electron dynamics in metal nanoparticles monochromatic acoustic phonons in GaAs and electromagnetically induced transparency in semiconductor quantum wells With its pedagogical approach and practical up to date coverage Non Equilibrium Dynamics of Semiconductors and Nanostructures allows you to easily put the material into practice whether you are a seasoned researcher or new to the field

**Nonlinear Optical Waves** A.I. Maimistov, A.M. Basharov, 2013-03-09 A non linear wave is one of the fundamental objects of nature They are inherent to aerodynamics and hydrodynamics solid state physics and plasma physics optics and field theory chemistry

reaction kinetics and population dynamics nuclear physics and gravity All non linear waves can be divided into two parts dispersive waves and dissipative ones The history of investigation of these waves has been lasting about two centuries In 1834 J S Russell discovered the extraordinary type of waves without the dispersive broadening In 1965 N J Zabusky and M D Kruskal found that the Korteweg de Vries equation has solutions of the solitary wave form This solitary wave demonstrates the particle like properties i e stability under propagation and the elastic interaction under collision of the solitary waves These waves were named solitons In succeeding years there has been a great deal of progress in understanding of soliton nature Now solitons have become the primary components in many important problems of nonlinear wave dynamics It should be noted that non linear optics is the field where all soliton features are exhibited to a great extent This book had been designed as the tutorial to the theory of non linear waves in optics The first version was projected as the book covering all the problems in this field both analytical and numerical methods and results as well However it became evident in the process of work that this was not a real task

The Numerical Solution of a Nonlinear Wave Equation from Solid State Physics Sandra K. Hiesser,1993

**Seismic Resistant Design and Technology** Dentcho Ivanov,2015-06-26 An earthquake is a powerful surface acoustic wave SAW generated by a seismic event such as a volcano or motion of the Earth s layers that propagates on the Earth s surface This book explains the design of earthquake resistant structures using SAW techniques that offer a variety of experimental setups and theoretical models Designs of protecti

**Surface Waves in Anisotropic and Laminated Bodies and Defects Detection** Robert V. Goldstein,Gérard A. Maugin,2006-02-21 Among the variety of wave motions one can single out surface wave pr agation since these surface waves often adjust the features of the energy transfer in the continuum system its deformation and fracture Predicted by Rayleigh in 1885 surface waves represent waves localized in the vicinity ofextendedboundaries surfaces of uidsorelasticmedia Intheidealcase of an isotropic elastic half space while the Rayleigh waves propagate along the surface the wave amplitude displacement in the transverse direction exponentially decays with increasing distance away from the surface As a resulttheenergyofsurfaceperturbationsislocalizedbytheRayleighwaves within a relatively narrow layer beneath the surface It is this property of the surface waves that leads to the resonance phenomena that accompany the motion of the perturbation sources like surface loads with velocities close to the Rayleigh one see e g R V Goldstein Rayleigh waves and resonance phenomena in elastic bodies Journal of Applied Mathematics and Mechanics PMM 1965 v 29 N 3 pp 608 619 It is essential to note that resonance phenomena are also inherent to the elastic medium in the case where initially there are no free unloaded surfaces However they occur as a result of an external action accompanied by the violation of the continuity of certain physical quantities e g by crack nucleation and dynamic propagation Note that the aforementioned resonance phenomena are related to the nature of the surface waves as homogeneous solutions eigenfunctions of the dynamic elasticity equations for a half space i e nonzero solutions at vanishing boundary conditions

**II International Symposium on Surface Waves in**

**Solids and Layered Structures and IV International Scientific Technical Conference, Acoustoelectronics '89, September 14-19, 1989, Varna, Bulgaria** Milko Borisov, 1990      **Partial Differential Equations** Kartikeya

Dutta, 2025-02-20 Partial Differential Equations A Detailed Exploration is a comprehensive textbook designed for undergraduate students offering an in depth study of Partial Differential Equations PDEs We blend accessibility with academic rigor making it suitable for students in mathematics physics and engineering disciplines Our book starts with a strong foundation in mathematical modeling and analysis tailored to meet the needs of undergraduate learners We provide a balanced approach combining theoretical underpinnings with practical applications Each chapter includes clear explanations illustrative examples and thought provoking exercises to foster active engagement and skill development This journey equips students with essential tools to solve real world problems and instills a deep appreciation for the elegance of PDE theory Whether exploring heat conduction wave propagation or fluid dynamics readers will immerse themselves in the rich tapestry of mathematical methods designed to unravel the secrets of nature Partial Differential Equations A Detailed Exploration invites undergraduates to transform mathematical challenges into triumphs laying the groundwork for a deeper understanding of PDEs      *Wave Turbulence Under Parametric Excitation* Victor S. L'vov, 2012-12-06

WAVE TURBULENCE is a state of a system of many simultaneously excited and interacting waves characterized by an energy distribution which is not in any sense close to thermodynamic equilibrium Such situations in a choppy sea in a hot plasma in dielectrics under arise for example a powerful laser beam in magnets placed in a strong microwave field etc Among the great variety of physical situations in which wave turbulence arises it is possible to select two large limiting groups which allow a detailed analysis The first is fully developed wave turbulence arising when energy pumping and dissipation have essentially different space scales In this case there is a wide power spectrum of turbulence This type of turbulence is described in detail e g in Zakharov et al 1 In the second limiting case the scales in which energy pumping and dissipation occur are the same As a rule in this case a narrow almost singular spectrum of turbulence appears which is concentrated near surfaces curves or even points in  $k$  space One of the most important widely investigated and instructive examples of this kind of turbulence is parametric wave turbulence appearing as a result of the evolution of a parametric instability of waves in media under strong external periodic modulation laser beam microwave electromagnetic field etc The present book deals with parametric wave turbulence      *Understanding the Discrete Element Method* Hans-Georg Matuttis, Jian Chen, 2014-06-23 Gives readers a more thorough understanding of DEM and equips researchers for independent work and an ability to judge methods related to simulation of polygonal particles Introduces DEM from the fundamental concepts theoretical mechanics and solidstate physics with 2D and 3D simulation methods for polygonal particles Provides the fundamentals of coding discrete element method DEM requiring little advance knowledge of granular matter or numerical simulation Highlights the numerical tricks and pitfalls that are usually only realized after years of experience with relevant simple experiments as applications Presents

a logical approach starting with the mechanical and physical bases followed by a description of the techniques and finally their applications. Written by a key author presenting ideas on how to model the dynamics of angular particles using polygons and polyhedral. Accompanying website includes MATLAB Programs providing the simulation code for two dimensional polygons. Recommended for researchers and graduate students who deal with particle models in areas such as fluid dynamics, multi body engineering, finite element methods, the geosciences and multi scale physics.

**Scientific and Technical Aerospace Reports**, 1994. Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.

*Structural Modeling of Metamaterials* Vladimir I. Erofeev, Igor S. Pavlov, 2020-11-13. This book discusses the theoretical foundations of the structural modeling method applied to metamaterials. This method takes into account the parameters of the crystal lattice, the size of the medium particles as well as their shape and constants of force interactions between them. It provides mathematical models of metamaterials that offer insights into the qualitative influence of the local structure on the effective elastic moduli of the considered medium and into performing theoretical estimations of these quantities. This book is useful for researchers working in the fields of solid mechanics, physical acoustics and condensed matter physics as well as for graduate and postgraduate students studying mathematical modeling methods.

**Strain Solitons in Solids and How to Construct Them** Alexander M. Samsonov, 2001-01-18. Although the theory behind solitary waves of strain shows that they hold significant promise in nondestructive testing and a variety of other applications, an enigma has long persisted: the absence of observable elastic solitary waves in practice. Inspired by this apparent contradiction, *Strain Solitons in Solids and How to Construct Them* refines the theory.

*Fluctuations and Non-Linear Wave Interactions in Plasmas* A. G. Sitenko, 2016-09-20. *Fluctuations and Non linear Wave Interactions in Plasmas* talks about a theory of fluctuations in a homogenous plasma. The title takes into consideration non linear wave interactions. The text first presents the statistical description of plasma and then proceeds to covering non linear electrodynamic equations. Next, the selection deals with the electrodynamic properties of magnetized active plasma and waves in plasma. The text also tackles non linear wave interactions along with fluctuations in plasmas. The next chapter talks about the effect of non linear wave interaction on fluctuations in a plasma. Chapter 8 details fluctuation dissipation theorem while Chapter 9 discusses kinetic equations. The tenth chapter covers the scattering and radiation of waves and the last chapter tackles wave interaction in semi bounded plasma. The book will be of great use to scientists and professionals who deal with plasmas.



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### **Nonlinear Waves In Solid State Physics Introduction**

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