Special Issue

Mathematical Methods for Wave Phenomena

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Mathematical Methods For Wave Phenomena

William Edward Fitzgibbon

Mathematical Methods For Wave Phenomena:

   Mathematical Methods for Wave Phenomena Norman Bleistein,2012-12-02 Computer Science and Applied Mathematics Mathematical Methods for Wave Phenomena focuses on the methods of applied mathematics including equations wave fronts boundary value problems and scattering problems The publication initially ponders on first order partial differential equations Dirac delta function Fourier transforms asymptotics and second order partial differential equations Discussions focus on prototype second order equations asymptotic expansions asymptotic expansions of Fourier integrals with monotonic phase method of stationary phase propagation of wave fronts and variable index of refraction The text then examines wave equation in one space dimension as well as initial boundary value problems characteristics for the wave equation in one space dimension and asymptotic solution of the Klein Gordon equation The manuscript offers information on wave equation in two and three dimensions and Helmholtz equation and other elliptic equations Topics include energy integral domain of dependence and uniqueness scattering problems Green s functions and problems in unbounded domains and the Sommerfeld radiation condition The asymptotic techniques for direct scattering problems and the inverse methods for reflector imaging are also elaborated The text is a dependable reference for computer science experts and mathematicians pursuing studies on the mathematical methods of wave phenomena   **Mathematics of Wave Phenomena** Willy Dörfler,Marlis Hochbruck,Dirk Hundertmark,Wolfgang Reichel,Andreas Rieder,Roland Schnaubelt,Birgit Schörkhuber,2020-10-01 Wave phenomena are ubiquitous in nature Their mathematical modeling simulation and analysis lead to fascinating and challenging problems in both analysis and numerical mathematics These challenges and their impact on significant applications have inspired major results and methods about wave type equations in both fields of mathematics The Conference on Mathematics of Wave Phenomena 2018 held in Karlsruhe Germany was devoted to these topics and attracted internationally renowned experts from a broad range of fields These conference proceedings present new ideas results and techniques from this exciting research area   **Applied Wave Mathematics II** Arkadi Berezovski,Tarmo Soomere,2019-11-16 This book gathers contributions on various aspects of the theory and applications of linear and nonlinear waves and associated phenomena as well as approaches developed in a global partnership of researchers with the national Centre of Excellence in Nonlinear Studies CENS at the Department of Cybernetics of Tallinn University of Technology in Estonia The papers chiefly focus on the role of mathematics in the analysis of wave phenomena They highlight the complexity of related topics concerning wave generation propagation transformation and impact in solids gases fluids and human tissues while also sharing insights into selected mathematical methods for the analytical and numerical treatment of complex phenomena In addition the contributions derive advanced mathematical models share innovative ideas on computing and present novel applications for a number of research fields where both linear and nonlinear wave problems play an important role The papers are written in a tutorial style intended for non specialist researchers and students The

authors first describe the basics of a problem that is currently of interest in the scientific community discuss the state of the art in related research and then share their own experiences in tackling the problem Each chapter highlights the importance of applied mathematics for central issues in the study of waves and associated complex phenomena in different media The topics range from basic principles of wave mechanics up to the mathematics of Planet Earth in the broadest sense including contemporary challenges in the mathematics of society In turn the areas of application range from classic ocean wave mathematics to material science and to human nerves and tissues All contributions describe the approaches in a straightforward manner making them ideal material for educational purposes e g for courses master class lectures or seminar presentations   **Handbook of Mathematical Methods in Imaging** Otmar Scherzer,2010-11-23 The Handbook of Mathematical Methods in Imaging provides a comprehensive treatment of the mathematical techniques used in imaging science The material is grouped into two central themes namely Inverse Problems Algorithmic Reconstruction and Signal and Image Processing Each section within the themes covers applications modeling mathematics numerical methods using a case example and open questions Written by experts in the area the presentation is mathematically rigorous The entries are cross referenced for easy navigation through connected topics Available in both print and electronic forms the handbook is enhanced by more than 150 illustrations and an extended bibliography It will benefit students scientists and researchers in applied mathematics Engineers and computer scientists working in imaging will also find this handbook useful   *Wave Propagation in Electromagnetic Media* Julian L. Davis,2012-12-06 This is the second work of a set of two volumes on the phenomena of wave propagation in nonreacting and reacting media The first entitled Wave Propagation in Solids and Fluids published by Springer Verlag in 1988 deals with wave phenomena in nonreacting media solids and fluids This book is concerned with wave propagation in reacting media specifically in electro magnetic materials Since these volumes were designed to be relatively self contained we have taken the liberty of adapting some of the pertinent material especially in the theory of hyperbolic partial differential equations concerned with electromagnetic wave propagation variational methods and Hamilton Jacobi theory to the phenomena of electromagnetic waves The purpose of this volume is similar to that of the first except that here we are dealing with electromagnetic waves We attempt to present a clear and systematic account of the mathematical methods of wave phenomena in electromagnetic materials that will be readily accessible to physicists and engineers The emphasis is on developing the necessary mathematical tech niques and on showing how these methods of mathematical physics can be effective in unifying the physics of wave propagation in electromagnetic media Chapter 1 presents the theory of time varying electromagnetic fields which involves a discussion of Faraday s laws Maxwell s equations and their appli cations to electromagnetic wave propagation under a variety of conditions   *Mathematics of Multidimensional Seismic Imaging, Migration, and Inversion* N. Bleistein,J.K. Cohen,John W. Jr. Stockwell,2013-11-22 In the last 40 years geophysicists have found that it is possible to construct images and even determine important physical

characteristics of rocks that can yield information about oil and gas bearing structures in the earth To make these images and extract this information requires the application of an advanced understanding of the mathematical physics of wave propagation The oil and gas industry labels a major collection of the necessary seismic data processing methods by the name seismic migration This text ist the first to treat many kinds of migration in a unified mahtematical way The audience is mathematically oriented geophysicists or applied mathematicians working in the field of inverse scattering imaging The text can serve as a bridge between the applied math and geophysics community by presenting geophysicists with a practical introduction to advanced engineering mathematics while presenting mathematicians with a window into the world of the mathematically sophistiated geophysicist *Mathematical and Computational Methods in Seismic Exploration and Reservoir Modeling* William Edward Fitzgibbon,1986-01-01 <u>Wave Phenomena</u> Lui Lam,Hedley C. Morris,2012-12-06 IJ 1 June of 1987 the Center for Applied Mathematics and Computer Science at San Jose State University received a bequest of over half a million dollars from the estate of Mrs Marie Woodward In the opening article of this collection of papers Jane Day the founder of the Center describes the background that led to this gift In recognition of the bequest it was decided that a series of Woodward Conferences be established The First Woodward Conference took place at San Jose State University on June 2 3 1988 The themes of the conference were the Theoretical Computational and Practical Aspects of Wave Phenomena and these same themes have been used to divide the contributions to this volume Part I is concerned with papers on theoretical aspects This section includes papers on pseudo differential operator techniques inverse problems and the mathematical foundations of wave propagation in random media Part II consists of papers that involve significant amounts of computation Included are papers on the Fast Hartley Transform computational algorithms for electromagnetic scattering problems and nonlinear wave interaction problems in fluid mechanics vi Part III contains papers with a genuine physics flavor This final section illustrates the widespread importance of wave phenomena in physics Among the phenomena considered are waves in the atmosphere viscous fingering in liquid crystals solitons and wave localization **The Theory of Elastic Waves and Waveguides** J. Miklowitz,2012-12-02 The primary objective of this book is to give the reader a basic understanding of waves and their propagation in a linear elastic continuum The studies of elastodynamic theory and its application to fundamental value problems should prepare the reader to tackle many physical problems of general interest in engineering and geophysics and of particular interest in mechanics and seismology **Geophysical Electromagnetic Theory and Methods** Michael S. Zhdanov,2009-06-12 In this book the author presents the state of the art electromagnetic EM theories and methods employed in EM geophysical exploration The book brings together the fundamental theory of EM fields and the practicalaspects of EM exploration for mineral and energy resources This text is unique in its breadth and completeness in providing anoverview of EM geophysical exploration technology The book is divided into four parts covering the foundations of EMfield theory and its applications and emerging geophysical methods Part I is an introduction to the field theory required for

baselineunderstanding Part II is an overview of all the basic elements ofgeophysical EM theory from Maxwell s fundamental equations to modernmethods of modeling the EM field in complex 3 D geoelectrical formations Part III deals with the regularized solution of ill posedinverse electromagnetic problems the multidimensional migration and imaging ofelectromagnetic data and general interpretation techniques Part IV describes major geophysical electromagnetic methods direct current DC induced polarization IP magnetotelluric MT and controlled source electromagnetic CSEM methods and covers different applications of EM methods in exploration geophysics includingminerals and HC exploration environmental study and crustal study Presents theoretical and methodological findings as well as examples of applications of recently developed algorithms and software in solving practical problems Describes the practical importance of electromagnetic data through enabling discussions on a construction of a closed technological cycle processing analysis and three dimensional interpretation Updates current findings in the field especially with MT magnetovariational and seismo electrical methods and the practice of 3D interpretations **Wave Phenomena** Willy Dörfler,Marlis Hochbruck,Jonas Köhler,Andreas Rieder,Roland Schnaubelt,Christian Wieners,2023-03-30 This book presents the notes from the seminar on wave phenomena given in 2019 at the Mathematical Research Center in Oberwolfach The research on wave type problems is a fascinating and emerging field in mathematical research with many challenging applications in sciences and engineering Profound investigations on waves require a strong interaction of several mathematical disciplines including functional analysis partial differential equations mathematical modeling mathematical physics numerical analysis and scientific computing The goal of this book is to present a comprehensive introduction to the research on wave phenomena Starting with basic models for acoustic elastic and electro magnetic waves topics such as the existence of solutions for linear and some nonlinear material laws efficient discretizations and solution methods in space and time and the application to inverse parameter identification problems are covered The aim of this book is to intertwine analysis and numerical mathematics for wave type problems promoting thus cooperative research projects in this field **Fundamentals of Seismic Wave Propagation** Chris Chapman,2004-07-29 Fundamentals of Seismic Wave Propagation published in 2004 presents a comprehensive introduction to the propagation of high frequency body waves in elastodynamics The theory of seismic wave propagation in acoustic elastic and anisotropic media is developed to allow seismic waves to be modelled in complex realistic three dimensional Earth models This book provides a consistent and thorough development of modelling methods widely used in elastic wave propagation ranging from the whole Earth through regional and crustal seismology exploration seismics to borehole seismics sonics and ultrasonics Particular emphasis is placed on developing a consistent notation and approach throughout which highlights similarities and allows more complicated methods and extensions to be developed without difficulty This book is intended as a text for graduate courses in theoretical seismology and as a reference for all academic and industrial seismologists using numerical modelling methods Exercises and suggestions for further reading are included in each chapter

Reciprocity in Elastodynamics J. D. Achenbach,2003 The reciprocity theorem has been used for over 100 years to establish interesting and useful relations between different loading states of a body This book discusses current and novel uses of reciprocity relations for the determination of elastodynamic fields The author who is internationally distinguished for his contributions to theoretical and applied mechanics presents a novel method to solve for wave fields shedding new light on the use of reciprocity relations for dynamic fields in an elastic body The material presented in the book is relevant to several fields in engineering and applied physics Examples are ultrasonics for medical imaging and non destructive evaluation acoustic microscopy seismology exploratory geophysics structural acoustics and the response of structures to high rate loads and the determination of material properties by ultrasonic techniques   Selected Topics in Nonlinear Wave Mechanics C.I. Christov,Arde Guran,2012-12-06 This book gives an overview ofthe current state of nonlinear wave mechanics with emphasis on strong discontinuities shock waves and localized self preserving shapes solitons in both elastic and fluid media The exposition is intentionallyat a detailed mathematical and physical level our expectation being that the reader will enjoy coming to grips in a concrete manner with advances in this fascinating subject Historically modern research in nonlinear wave mechanics began with the famous 1858 piston problem paper of Riemann on shock waves and con tinued into the early part of the last century with the work of Hadamard Rankine and Hugoniot After WWII research into nonlinear propagation of dispersive waves rapidly accelerated with the advent of computers Works of particular importance in the immediate post war years include those of von Neumann Fermi and Lax Later additional contributions were made by Lighthill Glimm Strauss Wendroff and Bishop Dispersion alone leads to shock fronts of the propagating waves That the nonlinearity can com pensate for the dispersion leading to propagation with a stable wave having constant velocity and shape solitons came as a surprise A solitary wave was first discussed by J Scott Russell in 1845 in Report of British Asso ciations for the Advancement of Science He had while horseback riding observed a solitary wave travelling along a water channel and followed its unbroken progress for over a mile   Seismic Waves and Rays in Elastic Media Michael A. Slawinski,2003 This book seeks to explore seismic phenomena in elastic media and emphasizes the interdependence of mathematical formulation and physical meaning The purpose of this title which is intended for senior undergraduate and graduate students as well as scientists interested in quantitative seismology is to use aspects of continuum mechanics wave theory and ray theory to describe phenomena resulting from the propagation of waves The book is divided into three parts Elastic continua Waves and rays and Variational formulation of rays In Part I continuum mechanics are used to describe the material through which seismic waves propagate and to formulate a system of equations to study the behaviour of such material In Part II these equations are used to identify the types of body waves propagating in elastic continua as well as to express their velocities and displacements in terms of the properties of these continua To solve the equations of motion in anisotropic inhomogeneous continua the high frequency approximation is used and establishes the concept of a ray In Part III it is shown that in elastic continua a ray is tantamount

to a trajectory along which a seismic signal propagates in accordance with the variational principle of stationary travel time

Inverse Acoustic and Electromagnetic Scattering Theory David Colton,Rainer Kress,2013-03-09 In the five years since the first edition of this book appeared the field of in verse scattering theory has continued to grow and flourish Hence when the opportunity for a second edition presented itself we were pleased to have the possibility of updating our monograph to take into account recent developments in the area As in the first edition we have been motivated by our own view of inverse scattering and have not attempted to include all of the many new directions in the field However we feel that this new edition represents a state of the art overview of the basic elements of the mathematical theory of acoustic and electromagnetic inverse scattering In addition to making minor corrections and additional comments in the text and updating the references we have added new sections on Newton s method for solving the inverse obstacle problem Section 5 3 the spectral theory of the far field operator Section 8 4 a proof of the uniqueness of the solution to the inverse medium problem for acoustic waves Section 10 2 and a method for determining the support of an inhomogeneous medium from far field data by solving a linear integral equation of the first kind Section 10 7 We hope that this second edition will attract new readers to the beautiful and intriguing field of inverse scattering   Wave Propagation in Solids and Fluids Julian L. Davis,2012-12-06 The purpose of this volume is to present a clear and systematic account of the mathematical methods of wave phenomena in solids gases and water that will be readily accessible to physicists and engineers The emphasis is on developing the necessary mathematical techniques and on showing how these mathematical concepts can be effective in unifying the physics of wave propagation in a variety of physical settings sound and shock waves in gases water waves and stress waves in solids Nonlinear effects and asymptotic phenomena will be discussed Wave propagation in continuous media solid liquid or gas has as its foundation the three basic conservation laws of physics conservation of mass momentum and energy which will be described in various sections of the book in their proper physical setting These conservation laws are expressed either in the Lagrangian or the Eulerian representation depending on whether the boundaries are relatively fixed or moving In any case these laws of physics allow us to derive the field equations which are expressed as systems of partial differential equations For wave propagation phenomena these equations are said to be hyperbolic and in general nonlinear in the sense of being quasi linear We therefore attempt to determine the properties of a system of quasi linear hyperbolic partial differential equations which will allow us to calculate the displacement velocity fields etc   Diffuse Waves in Complex Media Jean-Pierre Fouque,2012-12-06 The NATO Advanced Study Institute on Diffuse Waves in Complex Media was held at the Centre de Physique des Houches in France from March 17 to 27 1998 The Schools scientific content wave propagation in heterogeneous me dia has covered many areas of fundamental and applied research On the one hand the understanding of wave propagation has considerably improved during the last thirty years New developments and concepts such as speckle correlations weak and strong localization time reversal near field propagation are under active research On the other hand

wave propagation in random media is now being investigated in many different fields such as applied mathematics acoustics optics atomic physics geo physics or medical sciences Each community often uses its own langage to describe the same phenomena The aim of the School was to gather worldwide specialists to illuminate various aspects of wave propagation in random media This volume presents fourteen expository articles corresponding to courses and seminars given during the School They are arranged as follows The first three articles deal with the phenomena of localization of waves B van Tiggelen p 1 gives a critical review of the physics of localization J Lacroix p 61 presents the mathematical theory and A Klein p 73 describes recent results for randomized periodic media **Wave Fields in Real Media** José M. Carcione,2007-01-24 Wave Fields in Real Media examines the differences between an ideal and a real description of wave propagation where ideal means an elastic lossless isotropic and single phase medium and real means an anelastic anisotropic and multi phase medium The analysis starts by introducing the relevant stress strain relation This relation and the equations of momentum conservation are combined to give the equation of motion The differential formulation is written in terms of memory variables and Biot s theory is used to describe wave propagation in porous media For each rheology a plane wave analysis is performed in order to understand the physics of wave propagation The book contains a review of the main direct numerical methods for solving the equation of motion in the time and space domains The emphasis is on geophysical applications for seismic exploration but researchers in the fields of earthquake seismology rock acoustics and material science including many branches of acoustics of fluids and solids may also find this text useful Presents the fundamentals of wave propagation in anisotropic anelastic and porus media Contains a new chapter on the analogy between acoustic and electromagnetic waves incorporating the subject of electromagnetic waves Emphasizes geophysics particularly seismic exploration for hydrocarbon reservoirs which is essential for exploration and production of oil *Geophysical Inverse Theory and Regularization Problems* Michael S. Zhdanov,2002-04-24 This book presents state of the art geophysical inverse theory developed in modern mathematical terminology The book brings together fundamental results developed by the Russian mathematical school in regularization theory and combines them with the related research in geophysical inversion carried out in the West It presents a detailed exposition of the methods of regularized solution of inverse problems based on the ideas of Tikhonov regularization and shows the different forms of their applications in both linear and nonlinear methods of geophysical inversion This text is the first to treat many kinds of inversion and imaging techniques in a unified mathematical manner The book is divided in five parts covering the foundations of the inversion theory and its applications to the solution of different geophysical inverse problems including potential field electromagnetic and seismic methods The first part is an introduction to inversion theory The second part contains a description of the basic methods of solution of the linear and nonlinear inverse problems using regularization The following parts treat the application of regularization methods in gravity and magnetic electromagnetic and seismic inverse problems The key connecting idea of these applied parts of the book is the analogy

between the solutions of the forward and inverse problems in different geophysical methods The book also includes chapters related to the modern technology of geophysical imaging based on seismic and electromagnetic migration This volume is unique in its focus on providing a link between the methods used in gravity electromagnetic and seismic imaging and inversion and represents an exhaustive treatise on inversion theory

Unveiling the Power of Verbal Beauty: An Mental Sojourn through **Mathematical Methods For Wave Phenomena**

In some sort of inundated with displays and the cacophony of immediate communication, the profound power and psychological resonance of verbal artistry usually diminish into obscurity, eclipsed by the continuous barrage of sound and distractions. Yet, located within the musical pages of **Mathematical Methods For Wave Phenomena**, a interesting function of literary splendor that impulses with fresh thoughts, lies an unforgettable trip waiting to be embarked upon. Published by a virtuoso wordsmith, that interesting opus instructions readers on a psychological odyssey, softly exposing the latent potential and profound affect embedded within the intricate internet of language. Within the heart-wrenching expanse with this evocative evaluation, we can embark upon an introspective exploration of the book is key styles, dissect their captivating publishing fashion, and immerse ourselves in the indelible effect it leaves upon the depths of readers souls.

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