

Nonlinear Water Waves

- Fully nonlinear 3D water waves
- Primary unknowns: φ, η
- Parallelization based on an existing sequential Diffpack simulator

$$\nabla^2 \varphi = 0 \text{ in water volume}$$

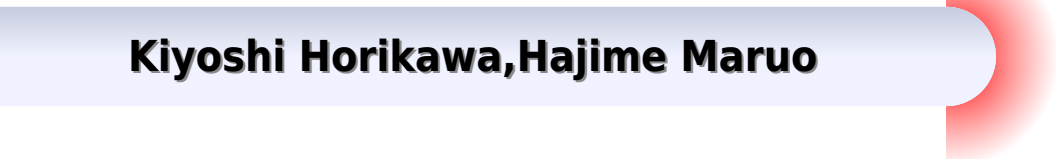
$$\eta_t + \varphi_x \eta_x + \varphi_y \eta_y - \varphi_{\bar{z}} = 0 \text{ on water surface}$$

$$\varphi_t + (\varphi_x^2 + \varphi_y^2 + \varphi_{\bar{z}}^2)/2 + g\eta = 0 \text{ on water surface}$$

$$\frac{\partial \varphi}{\partial n} = 0 \text{ on solid walls}$$

Nonlinear Water Waves

Kiyoshi Horikawa, Hajime Maruo



Nonlinear Water Waves:

Nonlinear Water Waves Lokenath Debnath, 1994-03-29 Wave motion in water is one of the most striking observable phenomena in nature Throughout the twentieth century development of the linearized theory of wave motion in fluids and hydrodynamic stability has been steady and significant In the last three decades there have been remarkable developments in nonlinear dispersive waves in general nonlinear water waves in particular and nonlinear instability phenomena New solutions are now available for waves modulated in both space and time which exhibit new phenomena as diverse as solitons resonant interactions side band instability and wave breaking Other achievements include the discovery of soliton interactions and the Inverse Scattering Transform method for finding the explicit exact solution for several canonical nonlinear partial differential equations This monograph is the first to summarize the research on nonlinear wave phenomena over the past three decades and it also presents numerous applications in physics geophysics and engineering *Nonlinear Water Waves with Applications to Wave-Current Interactions and Tsunamis* Adrian Constantin, 2011-12-01 This overview of some of the main results and recent developments in nonlinear water waves presents fundamental aspects of the field and discusses several important topics of current research interest It contains selected information about water wave motion for which advanced mathematical study can be pursued enabling readers to derive conclusions that explain observed phenomena to the greatest extent possible The author discusses the underlying physical factors of such waves and explores the physical relevance of the mathematical results that are presented The book is intended for mathematicians physicists and engineers interested in the interplay between physical concepts and insights and the mathematical ideas and methods that are relevant to specific water wave phenomena The material is an expanded version of the author's lectures delivered at the NSF CBMS Regional Research Conference in the Mathematical Sciences organized by the Mathematics Department of the University of Texas Pan American in 2010 **Nonlinear Water Waves** David Henry, Konstantinos Kalimeris, Emilian I. Părau, Jean-Marc Vanden-Broeck, Erik Wahlén, 2019-11-27 The motion of water is governed by a set of mathematical equations which are extremely complicated and intractable This is not surprising when one considers the highly diverse and intricate physical phenomena which may be exhibited by a given body of water Recent mathematical advances have enabled researchers to make major progress in this field reflected in the topics featured in this volume Cutting edge techniques and tools from mathematical analysis have generated strong rigorous results concerning the qualitative and quantitative physical properties of solutions of the governing equations Furthermore accurate numerical computations of fully nonlinear steady and unsteady water waves in two and three dimensions have contributed to the discovery of new types of waves Model equations have been derived in the long wave and modulational regime using Hamiltonian formulations and solved numerically This book brings together interdisciplinary researchers working in the field of nonlinear water waves whose contributions range from survey articles to new research results which address a variety of aspects in nonlinear water waves It is motivated by a

workshop which was organised at the Erwin Schrödinger International Institute for Mathematics and Physics in Vienna November 27 December 7 2017 The key aim of the workshop was to describe and foster new approaches to research in this field This is reflected in the contents of this book which is aimed to stimulate both experienced researchers and students alike

Advances In Numerical Simulation Of Nonlinear Water Waves Qingwei Ma, 2010-04-15 Most of the Earth's surface is covered by water Many aspects of our everyday lives and activities may be affected by water waves in some way Sometimes the waves can cause disaster One of the examples was the tsunami that occurred in the Indian Ocean on 26 December 2004 This indicates how important it is for us to fully understand water waves in particular the very large ones One way to do so is to perform numerical simulation based on the nonlinear theory Considerable research advances have been made in this area over the past decade by developing various numerical methods and applying them to emerging problems however until now there has been no comprehensive book to reflect these advances This unique volume aims to bridge this gap This book contains 18 self contained chapters written by more than 50 authors from 12 different countries many of whom are world leading experts in the field Each chapter is based mainly on the pioneering work of the authors and their research teams over the past decades The chapters altogether deal with almost all numerical methods that have been employed so far to simulate nonlinear water waves and cover many important and very interesting applications such as overturning waves breaking waves waves generated by landslides freak waves solitary waves tsunamis sloshing waves interaction of extreme waves with beaches interaction with fixed structures and interaction with free response floating structures Therefore this book provides a comprehensive overview of the state of the art research and key achievements in numerical modeling of nonlinear water waves and serves as a unique reference for postgraduates researchers and senior engineers working in industry

Nonlinear Water Waves Kiyoshi Horikawa, Hajime Maruo, 2012-12-06 Non linear behaviour of water waves has recently drawn much attention of scientists and engineers in the fields of oceanography applied mathematics coastal engineering ocean engineering naval architecture and others The IUTAM Symposium on Non linear Water Waves was organized with the aim of bringing together researchers who are actively studying non linear water waves from various viewpoints The papers contained in this book are related to the generation and deformation of non linear water waves and the non linear interaction between waves and bodies That is various types of non linear water waves were analyzed on the basis of various well known equations experimental studies on breaking waves were presented and numerical studies of calculating second order non linear wave body interaction were proposed

Nonlinear Water Waves with Shear Baumstein Anatoly I., P. G. Saffman, California Institute of Technology. Division of Engineering and Applied Science, 1997

Nonlinear Ocean Waves and the Inverse Scattering Transform Alfred Osborne, 2010-04-07 For more than 200 years the Fourier Transform has been one of the most important mathematical tools for understanding the dynamics of linear wave trains Nonlinear Ocean Waves and the Inverse Scattering Transform presents the development of the nonlinear

Fourier analysis of measured space and time series which can be found in a wide variety of physical settings including surface water waves internal waves and equatorial Rossby waves This revolutionary development will allow hyperfast numerical modelling of nonlinear waves greatly advancing our understanding of oceanic surface and internal waves Nonlinear Fourier analysis is based upon a generalization of linear Fourier analysis referred to as the inverse scattering transform the fundamental building block of which is a generalized Fourier series called the Riemann theta function Elucidating the art and science of implementing these functions in the context of physical and time series analysis is the goal of this book Presents techniques and methods of the inverse scattering transform for data analysis Geared toward both the introductory and advanced reader venturing further into mathematical and numerical analysis Suitable for classroom teaching as well as research

Nonlinear Water Waves in a Channel M. C. Shen, WISCONSIN UNIV-MADISON MATHEMATICS RESEARCH CENTER., 1983

Nonlinear Water Waves Adrian Constantin, Joachim Escher, Robin Stanley Johnson, Gabriele Villari, 2016-06-28 This volume brings together four lecture courses on modern aspects of water waves The intention through the lectures is to present quite a range of mathematical ideas primarily to show what is possible and what currently is of particular interest Water waves of large amplitude can only be fully understood in terms of nonlinear effects linear theory being not adequate for their description Taking advantage of insights from physical observation experimental evidence and numerical simulations classical and modern mathematical approaches can be used to gain insight into their dynamics The book presents several avenues and offers a wide range of material of current interest The lectures provide a useful source for those who want to begin to investigate how mathematics can be used to improve our understanding of water wave phenomena In addition some of the material can be used by those who are already familiar with one branch of the study of water waves to learn more about other areas

Nonlinear Water Waves Royal Society, 2012

Nonlinear Waves Lokenath Debnath, 2009-01-08 The outcome of a conference held in East Carolina University in June 1982 this book provides an account of developments in the theory and application of nonlinear waves in both fluids and plasmas Twenty two contributors from eight countries here cover all the main fields of research including nonlinear water waves KdV equations solitons and inverse scattering transforms stability of solitary waves resonant wave interactions nonlinear evolution equations nonlinear wave phenomena in plasmas recurrence phenomena in nonlinear wave systems and the structure and dynamics of envelope solitons in plasmas

Research in Nonlinear Water Waves P. G. Saffman, CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL., 1991 Work during the quarter concentrated on the effect of a thin shear layer on the generation of waves by wind The case of no shear layer i.e the Miles mechanism has been re examined and it was found as mentioned in an earlier letter that the method of solution adopted by Miles and later justified physically by Lighthill is not very accurate both qualitatively and quantitatively The discrepancy is not as large as preliminary calculations indicated but it is still significant A search of the literature is now in progress to see if the more accurate calculations give

results which agree better with observation and the work is being prepared for publication

New Approaches to Nonlinear Waves Elena Tobisch, 2015-08-19 The book details a few of the novel methods developed in the last few years for studying various aspects of nonlinear wave systems The introductory chapter provides a general overview thematically linking the objects described in the book Two chapters are devoted to wave systems possessing resonances with linear frequencies Chapter 2 and with nonlinear frequencies Chapter 3 In the next two chapters modulation instability in the KdV type of equations is studied using rigorous mathematical methods Chapter 4 and its possible connection to freak waves is investigated Chapter 5 The book goes on to demonstrate how the choice of the Hamiltonian Chapter 6 or the Lagrangian Chapter 7 framework allows us to gain a deeper insight into the properties of a specific wave system The final chapter discusses problems encountered when attempting to verify the theoretical predictions using numerical or laboratory experiments All the chapters are illustrated by ample constructive examples demonstrating the applicability of these novel methods and approaches to a wide class of evolutionary dispersive PDEs e g equations from Benjamin Oro Boussinesq Hasegawa Mima KdV type Klein Gordon NLS type Serre Shamel Whitham and Zakharov This makes the book interesting for professionals in the fields of nonlinear physics applied mathematics and fluid mechanics as well as students who are studying these subjects The book can also be used as a basis for a one semester lecture course in applied mathematics or mathematical physics

Linear and Nonlinear Waves G. B. Whitham, 2011-10-18 Now in an accessible paperback edition this classic work is just as relevant as when it first appeared in 1974 due to the increased use of nonlinear waves It covers the behavior of waves in two parts with the first part addressing hyperbolic waves and the second addressing dispersive waves The mathematical principles are presented along with examples of specific cases in communications and specific physical fields including flood waves in rivers waves in glaciers traffic flow sonic booms blast waves and ocean waves from storms

Steady and Unsteady Nonlinear Water Waves Edward Davis Cokelet, University of Cambridge. Department of Applied Mathematics and Theoretical Physics, 1975

Higher Approximations to Nonlinear Water Waves Edmund Victor Laitone, 1962

Numerical Study of Fully Nonlinear Water Waves in Three Dimensions Hongbo Xü, 1992

Nonlinear Water Waves at a Submerged Obstacle Or Bottom Topography John Grue, 1991

A Unified Model for the Evolution of Nonlinear Water Waves James M. Witting, NAVAL RESEARCH LAB WASHINGTON DC., Naval Research Laboratory (U.S.), 1982 This paper gives details of a new model of water waves that describes wave propagation over long distances accurately at low cost and for a wide variety of physical situations The analysis and numerical methods selected for computer solution are given in some detail The model uses exact prognostic equations and a high order expansion to relate variables at each time step The accuracy of the model is demonstrated most completely for solitary wave propagation where model results are compared to exact results It is found that the model results are much more accurate for high solitary waves than are earlier Boussinesq type theories and give good results for waves so high that they are almost breaking The

capability of the model to treat a variety of situations is demonstrated for colliding solitary waves nonlinear dispersive wave trains waves in channels of varying breadth and undular bores Formally the model incorporates nonlinear long wave theory exactly incorporates enough dispersion to describe linear waves with fourth order precision so that both shallow water waves and deep water waves are included and describes accurately waves for which dispersive and nonlinear effects are both important The factors that have made this development possible include use of a new theoretical conservation of velocity law and associated formalism that reduces the dimensionality of the calculations by one while retaining nonlinear and dispersive effects to high order Accurate simulations of high waves can now be carried out roughly two orders of magnitude longer for the same computational investment than is possible with previous methods of comparable accuracy Conversely the model is considerably more accurate and able to treat a wider range of physical conditions than models that run as fast **Progress**

in Wave-current Interactions Adrian Constantin,2009

Nonlinear Water Waves Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has are more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is truly remarkable. This extraordinary book, aptly titled "**Nonlinear Water Waves**," written by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound affect our existence. Throughout this critique, we shall delve to the book is central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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