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Calvin H. Wilcox

# Sound Propagation in Stratified Fluids



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# Sound Propagation In Stratified Fluids

**Martin Brokate, Jürgen Sprekels**



## Sound Propagation In Stratified Fluids:

**Sound Propagation in Stratified Fluids** Calvin H Wilcox, 1984-04-01 *Sound Propagation in Stratified Fluids* Calvin Hayden Wilcox, 1984 Spectral Analysis of Sound Propagation in Stratified Fluids Calvin H. Wilcox, 1980 This paper presents a spectral analysis of the acoustic fields in stationary plane stratified fluids whose densities and sound speeds are functions of the depth The analysis is based on families of normal mode fields that have simple physical interpretations The acoustic field in such a fluid may be described by an acoustic potential or by the excess pressure *Transient Acoustic Wave Propagation in Stratified Fluids* Calvin H. Wilcox, UTAH UNIV SALT LAKE CITY DEPT OF MATHEMATICS., 1981 Transient acoustic wave propagation is analyzed for the case of plane stratified fluids having density  $\rho(y)$  and sound speed  $c(y)$  at depth  $y$  For infinite fluids it is assumed that the in general discontinuous functions  $\rho(y)$  and  $c(y)$  are uniformly positive and bounded and satisfy  $\lim_{y \rightarrow \pm\infty} \rho(y) = \rho_0$  or  $C$  or  $y$  to the  $\alpha$  power  $\lim_{y \rightarrow \pm\infty} c(y) = c_0$  or  $C$  or  $y$  to the  $\alpha$  power for  $0 < \alpha < 3/2$  Semi infinite and finite layers are also treated The acoustic potential is a solution of the wave equation  $\Delta u = -\frac{1}{c^2} \frac{\partial}{\partial t} \left( \frac{1}{\rho} \frac{\partial u}{\partial t} \right)$  where  $x_1, x_2$  are horizontal coordinates and  $f(t, x)$  characterizes the wave sources The principal results of the analysis show that  $u$  is the sum of a free component which behaves like a diverging spherical wave for large  $t$  and a guided component which is approximately localized in regions  $0 < y < y_0$

**Manipulation of Sound Properties by Acoustic Metasurface and Metastructure** Jiajun Zhao, 2016-08-06 This thesis focuses on the manipulation of sound properties by artificial materials It elaborates on the fundamental design of acoustic metasurfaces and metastructures as the extension of metamaterials and their functionality in the manipulation of sound properties A broad and comprehensive guideline of designing acoustic metasurfaces and metastructures is also provided Based on the proposed subwavelength metasurfaces and the metastructures with a simplified layout multiple potential applications are demonstrated This thesis will appeal to acoustic engineers and researchers who are interested in designing acoustic artificial structures

**Acoustic and Electromagnetic Equations** Jean-Claude Nedelec, 2001-03-30 Acoustic and electromagnetic waves underlie a range of modern technology from sonar radio and television to microwave heating and electromagnetic compatibility analysis This book written by an international researcher presents some of the research in a complete way It is useful for graduate students in mathematics physics and engineering

*Hysteresis and Phase Transitions* Martin Brokate, Jürgen Sprekels, 2012-12-06 Hysteresis is an exciting and mathematically challenging phenomenon that occurs in rather different situations it can be a byproduct of fundamental physical mechanisms such as phase transitions or the consequence of a degradation or imperfection like the play in a mechanical system or it is built deliberately into a system in order to monitor its behaviour as in the case of the heat control via thermostats The delicate interplay between memory effects and the occurrence of hysteresis loops has the effect that hysteresis is a genuinely nonlinear phenomenon which is usually non smooth and thus not easy to treat mathematically

Hence it was only in the early seventies that the group of Russian scientists around M A Krasnoselskii initiated a systematic mathematical investigation of the phenomenon of hysteresis which culminated in the fundamental monograph Krasnoselskii Pokrovskii 1983 In the meantime many mathematicians have contributed to the mathematical theory and the important monographs of I Mayergoyz 1991 and A Visintin 1994a have appeared We came into contact with the notion of hysteresis around the year 1980 Matched Asymptotic Expansions P.A. Lagerstrom, 2013-03-09 Content and Aims of this Book Earlier drafts of the manuscript of this book James A. Boya was then coauthor contained discussions of many methods and examples of singular perturbation problems The ambitious plans of covering a large number of topics were later abandoned in favor of the present goal a thorough discussion of selected ideas and techniques used in the method of matched asymptotic expansions Thus many problems and methods are not covered here the method of averaging and the related method of multiple scales are mentioned mainly to give reasons why they are not discussed further Examples which required too sophisticated and involved calculations or advanced knowledge of a special field are not treated for instance to the author's regret some very interesting applications to fluid mechanics had to be omitted for this reason Artificial mathematical examples introduced to show some exotic or unexpected behavior are omitted except when they are analytically simple and are needed to illustrate mathematical phenomena important for realistic problems Problems of numerical analysis are not discussed

Invariant Manifolds and Fibrations for Perturbed Nonlinear Schrödinger Equations Charles Li, Stephen Wiggins, 2012-12-06 This book presents a development of invariant manifold theory for a specific canonical nonlinear wave system the perturbed nonlinear Schrödinger equation The main results fall into two parts The first part is concerned with the persistence and smoothness of locally invariant manifolds The second part is concerned with fibrations of the stable and unstable manifolds of inflowing and overflowing invariant manifolds The central technique for proving these results is Hadamard's graph transform method generalized to an infinite dimensional setting However our setting is somewhat different than other approaches to infinite dimensional invariant manifolds since for conservative wave equations many of the interesting invariant manifolds are infinite dimensional and noncompact The style of the book is that of providing very detailed proofs of theorems for a specific infinite dimensional dynamical system the perturbed nonlinear Schrödinger equation The book is organized as follows Chapter one gives an introduction which surveys the state of the art of invariant manifold theory for infinite dimensional dynamical systems Chapter two develops the general setup for the perturbed nonlinear Schrödinger equation Chapter three gives the proofs of the main results on persistence and smoothness of invariant manifolds Chapter four gives the proofs of the main results on persistence and smoothness of fibrations of invariant manifolds This book is an outgrowth of our work over the past nine years concerning homoclinic chaos in the perturbed nonlinear Schrödinger equation The theorems in this book provide key building blocks for much of that work An Introduction to the Mathematical Theory of Inverse Problems Andreas Kirsch, 1996-09-26 Following Keller 119 we call two

problems inverse to each other if the formulation of each of them requires full or partial knowledge of the other. By this definition it is obviously arbitrary which of the two problems we call the direct and which we call the inverse problem. But usually one of the problems has been studied earlier and perhaps in more detail. This one is usually called the direct problem whereas the other is the inverse problem. However there is often another more important difference between these two problems. Hadamard [91] introduced the concept of a well posed problem originating from the philosophy that the mathematical model of a physical problem has to have the properties of uniqueness, existence and stability of the solution. If one of the properties fails to hold he called the problem ill posed. It turns out that many interesting and important inverse problems in science lead to ill posed problems while the corresponding direct problems are well posed. Often existence and uniqueness can be forced by enlarging or reducing the solution space, the space of models. For restoring stability however one has to change the topology of the spaces which is in many cases impossible because of the presence of measurement errors. At first glance it seems to be impossible to compute the solution of a problem numerically if the solution of the problem does not depend continuously on the data, i.e. for the case of ill posed problems.

**Integral Manifolds and Inertial Manifolds for Dissipative Partial Differential Equations** P. Constantin, C. Foias, B. Nicolaenko, R. Temam, 2012-12-06. This work was initiated in the summer of 1985 while all of the authors were at the Center of Nonlinear Studies of the Los Alamos National Laboratory; it was then continued and polished while the authors were at Indiana University at the University of Paris Sud Orsay and again at Los Alamos in 1986 and 1987. Our aim was to present a direct geometric approach in the theory of inertial manifolds, global analogs of the unstable center manifolds for dissipative partial differential equations. This approach based on Cauchy integral manifolds for which the solutions of the partial differential equations are the generating characteristic curves has the advantage that it provides a sound basis for numerical Galerkin schemes obtained by approximating the inertial manifold. The work is self contained and the prerequisites are at the level of a graduate student. The theoretical part of the work is developed in Chapters 2-14 while in Chapters 15-19 we apply the theory to several remarkable partial differential equations.

Inverse Problems for Partial Differential Equations Victor Isakov, 2013-06-29. This book describes the contemporary state of the theory and some numerical aspects of inverse problems in partial differential equations. The topic is of substantial and growing interest for many scientists and engineers and accordingly to graduate students in these areas. Mathematically these problems are relatively new and quite challenging due to the lack of conventional stability and to nonlinearity and nonconvexity. Applications include recovery of inclusions from anomalies of their gravitational fields, reconstruction of the interior of the human body from exterior electrical, ultrasonic and magnetic measurements, recovery of interior structural parameters of detail of machines and of the underground from similar data, non destructive evaluation and locating flying or navigated objects from their acoustic or electromagnetic fields. Currently there are hundreds of publications containing new and interesting results. A purpose of the book is to collect and present many of them in a readable and

informative form Rigorous proofs are presented whenever they are relatively short and can be demonstrated by quite general mathematical techniques Also we prefer to present results that from our point of view contain fresh and promising ideas In some cases there is no complete mathematical theory so we give only available results We do not assume that a reader possesses an enormous mathematical technique In fact a moderate knowledge of partial differential equations of the Fourier transform and of basic functional analysis will suffice

**Probability Approximations via the Poisson Clumping Heuristic** David Aldous,2013-03-09 If you place a large number of points randomly in the unit square what is the distribution of the radius of the largest circle containing no points Of the smallest circle containing 4 points Why do Brownian sample paths have local maxima but not points of increase and how nearly do they have points of increase Given two long strings of letters drawn i i d from a finite alphabet how long is the longest consecutive resp non consecutive substring appearing in both strings If an imaginary particle performs a simple random walk on the vertices of a high dimensional cube how long does it take to visit every vertex If a particle moves under the influence of a potential field and random perturbations of velocity how long does it take to escape from a deep potential well If cars on a freeway move with constant speed random from car to car what is the longest stretch of empty road you will see during a long journey If you take a large i i d sample from a 2 dimensional rotationally invariant distribution what is the maximum over all half spaces of the deviation between the empirical and true distributions These questions cover a wide cross section of theoretical and applied probability The common theme is that they all deal with maxima or minima in some sense

**Technical Abstract Bulletin** ,1980  
*Lectures on Viscoelasticity Theory* A.C. Pipkin,2012-12-06 This book contains notes for a one semester course on viscoelasticity given in the Division of Applied Mathematics at Brown University The course serves as an introduction to viscoelasticity and as a workout in the use of various standard mathematical methods The reader will soon find that he needs to do some work on the side to fill in details that are omitted from the text These are notes not a completely detailed explanation Furthermore much of the content of the course is in the problems assigned for solution by the student The reader who does not at least try to solve a good many of the problems is likely to miss most of the point Much that is known about viscoelasticity is not discussed in these notes and references to original sources are usually not give so it will be difficult or impossible to use this book as a reference for looking things up Readers wanting something more like a treatise should see Ferry s *Viscoelastic Properties of Polymers* Lodge s *Elastic Liquids* the volumes edited by Eirich on Rheology or any issue of the *Transactions of the Society of Rheology* These works emphasize physical aspects of the subject On the mathematical side Gurtin and Sternberg s long paper *On the Linear Theory of Viscoelasticity* ARMA II 291 1962 remains the best reference for proofs of theorems

**Scientific and Technical Aerospace Reports** ,1991

**Finite Element Analysis of Acoustic Scattering** Frank Ihlenburg,2006-03-29 A cognitive journey towards the reliable simulation of scattering problems using finite element methods with the pre asymptotic analysis of Galerkin FEM for the Helmholtz equation with moderate and large

wave number forming the core of this book Starting from the basic physical assumptions the author methodically develops both the strong and weak forms of the governing equations while the main chapter on finite element analysis is preceded by a systematic treatment of Galerkin methods for indefinite sesquilinear forms In the final chapter three dimensional computational simulations are presented and compared with experimental data The author also includes broad reference material on numerical methods for the Helmholtz equation in unbounded domains including Dirichlet to Neumann methods absorbing boundary conditions infinite elements and the perfectly matched layer A self contained and easily readable work

**Wave Packets and Their Bifurcations in Geophysical Fluid Dynamics** Huijun Yang, 2013-06-29 The material in this book is based predominantly on my recent work It is the first monograph on the subject though some support material may overlap other monographs The investigation of wave packets and their bifurcations is very interesting and useful theoretically and in practice not only in geophysical fluid dynamics which is the field to which the theory is being applied here but also in other fields in mathematics and the natural sciences I hope that the applied mathematician will find reading this book worthwhile especially the material on the behavior of highly nonlinear dynamic systems However it is my belief that applying the concepts and methods developed here to other fields will be both interesting and constructive since there are numerous phenomena in other areas of physics that share the characteristics of those in geophysical fluid dynamics The theory developed here provides an effective tool to investigate the structure and the structural changes of dynamic systems in physics Applications of the theory in geophysical fluid dynamics are an example of its usefulness and effectiveness Some of the results presented here give us more insight into the nature of geophysical fluids Moreover the material is presented systematically and developmentally Necessary basic knowledge is provided to make the book more readable for graduate students and researchers in such fields as applied mathematics geophysical fluid dynamics atmospheric sciences and physical oceanography

*Fluid Dynamics of Viscoelastic Liquids* Daniel D. Joseph, 2013-11-27 This book is about two special topics in rheological fluid mechanics the elasticity of liquids and asymptotic theories of constitutive models The major emphasis of the book is on the mathematical and physical consequences of the elasticity of liquids seventeen of twenty chapters are devoted to this Constitutive models which are instantaneously elastic can lead to some hyperbolicity in the dynamics of flow waves of vorticity into rest known as shear waves to shock waves of vorticity or velocity to steady flows of transonic type or to short wave instabilities which lead to ill posed problems Other kinds of models with small Newtonian viscosities give rise to perturbed instantaneous elasticity associated with smoothing of discontinuities as in gas dynamics There is no doubt that liquids will respond like elastic solids to impulses which are very rapid compared to the time it takes for the molecular order associated with short range forces in the liquid to relax After this all liquids look viscous with signals propagating by diffusion rather than by waves For small molecules this time of relaxation is estimated as  $10^{-13}$  to  $10^{-10}$  seconds depending on the fluids Waves associated with such liquids move with speeds of  $10^3$  cm/s or even faster For

engineering applications the instantaneous elasticity of these fluids is of little interest the practical dynamics is governed by diffusion say by the Navier Stokes equations On the other hand there are other liquids which are known to have much longer times of relaxation

*Scattering Theory for Hyperbolic Operators* V. Petkov, 1989-11-20

Scattering Theory for dissipative and time dependent systems has been intensively studied in the last fifteen years The results in this field based on various tools and techniques may be found in many published papers This monograph presents an approach which can be applied to spaces of both even and odd dimension The ideas on which the approach is based are connected with the RAGE type theorem with Enss decomposition of the phase space and with a time dependent proof of the existence of the operator  $W$  which exploits the decay of the local energy of the perturbed and free systems Some inverse scattering problems for time dependent potentials and moving obstacles with an arbitrary geometry are also treated in the book



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