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Inverse Problems in Quantum Scattering Theory **Scattering Theory: Some Old and New Problems** **The Inverse Problem of Scattering Theory** **Scattering Theory** **Qualitative Methods in Inverse Scattering Theory** **Inverse Problems in Quantum Scattering Theory** **Integral Equation Methods in Scattering Theory** **Scattering Theory of Classical and Quantum N-Particle Systems** **Lectures in Scattering Theory** *Scattering Theory of Waves and Particles* *Inverse Acoustic and Electromagnetic Scattering Theory* An Introduction to Inverse Scattering and Inverse Spectral Problems *Inverse Spectral and Scattering Theory* Variational Methods in Electron-Atom Scattering Theory **Quantum Scattering Theory for Several Particle Systems** **Mathematical Aspects of the Three-body Problem in the Quantum Scattering Theory** *An Introduction to Linear and Nonlinear Scattering Theory* Time-dependent Scattering Theory and the Few-particle Problem Principles of Quantum Scattering Theory *An Introduction to Linear and Nonlinear Scattering Theory* **Direct and Inverse Problems** Inverse Scattering Theory and Transmission Eigenvalues **A Qualitative Approach to Inverse Scattering Theory** **The Inverse Problem in the Quantum Theory of Scattering** **Scattering Theory for Transport Phenomena** Inverse Acoustic and Electromagnetic Scattering Theory **Aspects of the Inverse Problem of Scattering Theory** *The Inverse Scattering Problem for Perturbed Wave Equations* **Scattering Theory in Mathematical Physics** **Properties of the Inverse Problem in Scattering Theory** The Inverse Problem of Scattering Theory and Quantum Field Theory **Scattering Theory** *Energy Decay Problems in Scattering Theory* **Scattering, Two-Volume Set** **Inverse and Algebraic Quantum Scattering Theory** *Direct and Inverse Scattering for the Matrix Schrödinger Equation* Numerical Method for Solving the Inverse Problem of Quantum Scattering Theory **Dispersion Decay and Scattering Theory** **III: Scattering Theory** **Mathematical Physics**

This classic book provides a rigorous treatment of the Riesz?Fredholm theory of compact operators in dual systems, followed by a derivation of the jump relations and mapping properties of scalar and vector potentials in spaces of continuous and HÓlder continuous functions. These results are then used to study scattering problems for the Helmholtz and Maxwell equations. Readers will benefit from a full discussion of the mapping properties of scalar and vector potentials in spaces of continuous and HÓlder continuous functions, an in-depth treatment of the use of boundary integral equations to solve scattering problems for acoustic and electromagnetic waves, and an introduction to inverse scattering theory with an emphasis on the ill-posedness and nonlinearity of the inverse scattering problem. The aim of this book is to provide basic knowledge of the inverse problems arising in various areas in mathematics, physics, engineering, and medical science. These practical problems boil down to the mathematical question in which one tries to recover the operator (coefficients) or the domain (manifolds) from spectral data. The characteristic properties of the operators in question are often reduced to those of Schrödinger operators. We start from the 1-dimensional theory to observe the main features of inverse spectral problems and then proceed to multi-dimensions. The first milestone is the Borg–Levinson theorem in the inverse Dirichlet problem in a bounded domain elucidating basic motivation of the inverse problem as well as the difference between 1-dimension and multi-dimension. The main theme is the inverse scattering, in which the spectral data is Heisenberg's S-matrix defined through the observation of the asymptotic behavior at infinity of solutions. Significant progress has been made in the past 30 years by using the Faddeev–Green function or the complex geometrical optics solution by Sylvester and Uhlmann, which made it possible to reconstruct the potential from the S-matrix of one fixed energy. One can also prove the equivalence of the knowledge of S-matrix and that of the Dirichlet-to-Neumann map for boundary value problems in bounded domains. We apply this idea also to the Dirac equation, the Maxwell equation, and discrete Schrödinger operators on perturbed lattices. Our final topic is the boundary control method introduced by Belishev and Kurylev, which is for the moment the only systematic method for the reconstruction of the Riemannian metric from the boundary observation, which we apply to the inverse scattering on non-compact manifolds. We stress that this book focuses on the lucid exposition of these problems and mathematical backgrounds by explaining the basic knowledge of functional analysis and spectral theory, omitting the technical details in order to make the book accessible to graduate students as an introduction to partial differential equations (PDEs) and functional analysis. Inverse scattering theory has been a particularly active and successful field in applied mathematics and engineering for the past twenty years. The increasing demands of imaging and target identification require new powerful and flexible techniques besides the existing weak scattering approximation or nonlinear optimization methods. One class of such methods comes under the general description of qualitative methods in inverse scattering theory. This textbook is an easily-accessible "class-tested" introduction to the field. It is accessible also to readers who are not professional mathematicians, thus making these new mathematical ideas in inverse scattering theory available to the wider scientific and engineering community. Scattering theory is the study of an interacting system on a scale of time and/or distance which is large compared to the scale of the interaction itself. As such, it is the most effective means, sometimes the only means, to study microscopic nature. To understand the importance of scattering theory, consider the variety of ways in which it arises. First, there are various phenomena in nature (like the blue of the sky) which are the result of scattering. In order to understand the phenomenon (and to identify it as the result of scattering) one must understand the underlying dynamics and its scattering theory. Second, one often wants to use the scattering of waves or particles whose dynamics on knows to determine the structure and position of small or inaccessible objects. For example, in x-ray crystallography (which led to the discovery of DNA), tomography, and the detection of underwater objects by sonar, the underlying dynamics is well understood. What one would like to construct are correspondences that link, via the dynamics, the position, shape, and internal structure of the object to the scattering data. Ideally, the correspondence should be an explicit formula which allows one to reconstruct, at least approximately, the object from the scattering data. The main test of any proposed particle dynamics is whether one can construct for the dynamics a scattering theory that predicts the observed experimental data. Scattering theory was not always so central the physics. Even thought the Coulomb cross section could have been computed by Newton, had he bothered to ask the right question, its calculation is generally attributed to Rutherford more than two hundred years later. Of course, Rutherford's calculation was in connection with the first experiment in nuclear physics. The investigation of scattering phenomena is a major theme of modern physics. A scattered particle provides a dynamical probe of the target system. The practical problem of interest here is the scattering of a low energy electron by an N-electron atom. It has been difficult in this area of study to achieve theoretical results that are even qualitatively correct, yet quantitative accuracy is often needed as an adjunct to experiment. The present book describes a quantitative theoretical method, or class of methods, that has been applied effectively to this problem. Quantum mechanical theory relevant to the scattering of an electron by an N-electron atom, which may gain or lose energy in the process, is summarized in Chapter 1. The variational theory itself is presented in Chapter 2, both as currently used and in forms that may facilitate future applications. The theory of multichannel resonance and threshold effects, which provide a rich structure to observed electron-atom scattering data, is presented in Chapter 3. Practical details of the computational implementation of the variational theory are given in Chapter 4. Chapters 5 and 6 summarize recent appli cations of the variational theory to problems of experimental interest, with many examples of the successful interpretation of complex structural fea tures observed in scattering experiments, and of the quantitative prediction of details of electron-atom scattering phenomena. This monograph by two Soviet experts in mathematical physics was a major contribution to inverse scattering theory. The two-part treatment examines the boundary-value problem with and without singularities. 1963 edition. This volume crosses the boundaries of physics' traditional subdivisions to treat scattering theory within the context of classical electromagnetic radiation, classical particle mechanics, and quantum mechanics. Includes updates on developments in three-particle collisions, scattering by noncentral potentials, and inverse scattering problems. 1982 edition. It has now been almost ten years since our first book on scattering theory ap peared [32]. At that time we claimed that "in recent years the development of integral equation methods for the direct scattering problem seems to be nearing completion, whereas the use of such an approach to study the inverse scattering problem has progressed to an extent that a 'state of the art' survey appears highly desirable". Since we wrote these words, the inverse scattering problem for acoustic and electromagnetic waves has grown from being a few theoreti cal considerations with limited numerical implementations to a weH developed mathematical theory with tested numerical algorithms. This maturing of the field of inverse scattering theory has been based on the realization that such problems are in general not only nonlinear but also improperly posed in the sense that the solution does not depend continuously on the measured data. This was emphasized in [32] and treated with the ideas and tools available at that time. Now, almost ten years later, these initial ideas have developed to the extent that a monograph summarizing the mathematical basis of the field seems appropriate. This book is oUf attempt to write such a monograph. The inverse scattering problem for acoustic and electromagnetic waves can broadly be divided into two classes, the inverse obstacle problem and the inverse medium problem. Inverse scattering theory is an important area of applied mathematics due to its central role in such areas as medical imaging , nondestructive testing and geophysical exploration. Until recently all existing algorithms for solving inverse scattering problems were based on using either a weak scattering assumption or on the use of nonlinear optimization techniques. The limitations of these methods have led in recent years to an alternative approach to the inverse scattering problem which avoids the incorrect model assumptions inherent in the use of weak scattering approximations as well as the strong a priori information needed in order to implement nonlinear optimization techniques. These new methods come under the general title of qualitative methods in inverse scattering theory and seek to determine an approximation to the shape of the scattering object as well as estimates on its material properties without making any weak scattering assumption and using essentially no a priori information on the nature of the scattering object. This book is designed to be an introduction to this new approach in inverse scattering theory focusing on the use of sampling methods and transmission eigenvalues. In order to aid the reader coming from a discipline outside of mathematics we have included background material on functional analysis, Sobolev spaces, the theory of ill posed problems and certain topics in in the theory of entire functions of a complex variable. This book is an updated and expanded version of an earlier book by the authors published by Springer titled Qualitative Methods in Inverse Scattering Theory Review of Qualitative Methods in Inverse Scattering Theory All in all, the authors do exceptionally well in combining such a wide variety of mathematical material and in presenting it in a well-organized and easy-to-follow fashion. This text certainly complements the growing body of work in inverse scattering and should well suit both new researchers to the field as well as those who could benefit from such a nice codified collection of profitable results combined in one bound volume. SIAM Review, 2006 This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it. This work is in the public domain in the United States of America, and possibly other nations. Within the United States, you may freely copy and distribute this work, as no entity (individual or corporate) has a copyright on the body of the work. Scholars believe, and we concur, that this work is important enough to be preserved, reproduced, and made generally available to the public. To ensure a quality reading experience, this work has been proofread and republished using a format that seamlessly blends the original graphical elements with text in an easy-to-read typeface. We appreciate your support of the preservation process, and thank you for being an important part of keeping this knowledge alive and relevant. This monograph has two main purposes, first to act as a companion volume to more advanced texts by gathering together the principal mathematical topics commonly used in developing scattering theories and, in so doing, provide a reasonable, self-contained introduction to linear and nonlinear scattering theory for those who might wish to begin working in the area. Secondly, to indicate how these various aspects might be applied to problems in mathematical physics and the applied sciences. Of particular interest will be the influence of boundary conditions. A simplified, yet rigorous treatment of scattering theorymethods and their applications Dispersion Decay and Scattering Theory provides thorough,easy-to-understand guidance on the application of scattering theorymethods to modern problems in mathematics, quantum physics, andmathematical physics. Introducing spectral methods withapplications to dispersion time-decay and scattering theory, thisbook presents, for the first time, the Agmon-Jensen-Kato spectraltheory for the Schr?dinger equation, extending the theory to theKlein-Gordon equation. The dispersion decay plays a crucial role inthe modern application to asymptotic stability of solitons ofnonlinear Schr?dinger and Klein-Gordon equations. The authors clearly explain the fundamental concepts andformulas of the Schr?dinger operators, discuss the basic propertiesof the Schr?dinger equation, and offer in-depth coverage ofAgmon-Jensen-Kato theory of the dispersion decay in the weightedSobolev norms. The book also details the application of dispersiondecay to scattering and spectral theories, the scattering crosssection, and the weighted energy decay for 3D Klein-Gordon and waveequations. Complete streamlined proofs for key areas of theAgmon-Jensen-Kato approach, such as the high-energy decay of theresolvent and the limiting absorption principle are alsoincluded. Dispersion Decay and Scattering Theory is a suitable bookfor courses on scattering theory, partial differential equations,and functional analysis at the graduate level. The book also servesas an excellent resource for researchers, professionals, andacademics in the fields of mathematics, mathematical physics, andquantum physics who would like to better understand scatteringtheory and partial differential equations and gain problem-solvingskills in diverse areas, from high-energy physics to wavepropagation and hydrodynamics. This monograph has two main purposes, first to act as a companion volume to more advanced texts by gathering together the principal mathematical topics commonly used in developing scattering theories and, in so doing, provide a reasonable, self-contained introduction to linear and nonlinear scattering theory for those who might wish to begin working in the area. Secondly, to indicate how these various aspects might be applied to problems in mathematical physics and the applied sciences. Of particular interest will be the influence of boundary conditions. Lectures in Scattering Theory discusses problems in quantum mechanics and the principles of the non-relativistic theory of potential scattering. This book describes in detail the properties of the scattering matrix and its connection with physically observable quantities. This text presents a stationary formulation of the scattering problem and the wave functions of a particle found in an external field. This book also examines the analytic properties of the scattering matrix, dispersion relations, complex angular moments, as well as the separable representation of the scattering amplitude. The text also explains the method of factorizing the potential and the two-particle scattering amplitude, based on the Hilbert-Schmidt theorem for symmetric integral equations. In investigating the problem of scattering in a three-particle system, this book notes that the inapplicability of the Lippman-Schwinger equations can be fixed by appropriately re-arranging the equations. Faddeev equations are the new equations formed after such re-arrangements. This book also cites, as an example, the scattering of a spin-1/2 particle by a spinless particle (such as the scattering of a nucleon by a spinless nucleus). This text is suitable for students and professors dealing with quantum mechanics, theoretical nuclear physics, or other fields of advanced physics. Rapid progress in quantum theory brings us new important results which are often not immediately clear to all who need them. But fortunately, this is also followed by simplifications and unifications of our previous concepts. The inverse problem method ("The most beautiful idea of the XX-th century" - Zakharov et aI., 1980) has just both these aspects. It is rather astonishing that it took 50 years after the foundation of quantum mechanics for the creation of the "pictures" showing the direct connection of obser vables with interactions. Recently, illustrations of this type began to appear in the literature (e. g., how potentials are deformed with thc shift of one energy level or change of some resonance reduced width). Although they are transparent to those studying the quantum world and can be included within the necessary elements of quantum literacy, they are still largely unknown even to many specialists. For the first time, the most interesting of these pictures enriching our quantum intuition are col lected here and placed at your disposal. The readers of this monograph have the advantage of getting the latest information which became available after the publication of the Russian edition. It has been incor porated here in the simplest presentation possible. For example, new sections con cerning exactly solvable models, including the multi-channel, multi-dimensional ones and with time dependent potentials have been added. The first attempts in solving the three-body inverse problem are also mentioned. The inverse scattering problem is central to many areas of science and technology such as radar and sonar, medical imaging, geophysical exploration and nondestructive testing. This book is devoted to the mathematical and numerical analysis of the inverse scattering problem for acoustic and electromagnetic waves. In this third edition, new sections have been added on the linear sampling and factorization methods for solving the inverse scattering problem as well as expanded treatments of iteration methods and uniqueness theorems for the inverse obstacle problem. These additions have in turn required an expanded presentation of both transmission eigenvalues and boundary integral equations in Sobolev spaces. As in the previous editions, emphasis has been given to simplicity over generality thus providing the reader with an accessible introduction to the field of inverse scattering theory. Review of earlier editions: “Colton and Kress have written a scholarly, state of the art account of their view of direct and inverse scattering. The book is a pleasure to read as a graduate text or to dip into at leisure. It suggests a number of open problems and will be a source of inspiration for many years to come.” SIAM Review, September 1994 “This book should be on the desk of any researcher, any student, any teacher interested in scattering theory.” Mathematical Intelligencer, June 1994 Authored by two experts in the field who have been long-time collaborators, this monograph treats the scattering and inverse scattering problems for the matrix Schrödinger equation on the half line with the general selfadjoint boundary condition. The existence, uniqueness, construction, and characterization aspects are treated with mathematical rigor, and physical insight is provided to make the material accessible to mathematicians, physicists, engineers, and applied scientists with an interest in scattering and inverse scattering. The material presented is expected to be useful to beginners as well as experts in the field. The subject matter covered is expected to be interesting to a wide range of researchers including those working in quantum graphs and scattering on graphs. The theory presented is illustrated with various explicit examples to improve the understanding of scattering and inverse scattering problems. The monograph introduces a specific class of input data sets consisting of a potential and a boundary condition and a specific class of scattering data sets consisting of a scattering matrix and bound-state information. The important problem of the characterization is solved by establishing a one-to-one correspondence between the two aforementioned classes. The characterization result is formulated in various equivalent forms, providing insight and allowing a comparison of different techniques used to solve the inverse scattering problem. The past literature treated the type of boundary condition as a part of the scattering data used as input to recover the potential. This monograph provides a proper formulation of the inverse scattering problem where the type of boundary condition is no longer a part of the scattering data set, but rather both the potential and the type of boundary condition are recovered from the scattering data set. Here is a clearly written introduction to three central areas of inverse problems: inverse problems in electromagnetic scattering theory, inverse spectral theory, and inverse problems in quantum scattering theory. Inverse problems, one of the most attractive parts of applied mathematics, attempt to obtain information about structures by nondestructive measurements. Based on a series of lectures presented by three of the authors, all experts in the field, the book provides a quick and easy way for readers to become familiar with the area through a survey of recent developments in inverse spectral and inverse scattering problems. An introduction to the important areas of mathematical physics, this volume starts with basic ideas and proceeds (sometimes rapidly) to a more sophisticated level, often to the context of current research. All of the necessary functional analysis and differential geometry is included, along with basic calculus of variations and partial differential equations (linear and nonlinear). An introduction to classical and quantum mechanics is given with topics in Feynman integrals, gauge fields, geometric quantization, attractors for PDE, Ginzburg-Landau Equations in superconductivity, Navier-Stokes equations, soliton theory, inverse problems and ill-posed problems, scattering theory, convex analysis, variational inequalities, nonlinear semigroups, etc. Contents: 1. Classical Ideas and Problems. Introduction. Some Preliminary Variational Ideas. Various Differential Equations and Their Origins. Linear Second Order PDE. Further Topics in the Calculus of Variations. Spectral Theory for Ordinary Differential Operators, Transmutation, and Inverse Problems. Introduction to Classical Mechanics. Introduction to Quantum Mechanics. Weak Problems in PDE. Some Nonlinear PDE. Ill-Posed Problems and Regularization. 2. Scattering Theory and Solitons. Introduction. Scattering Theory I (Operator Theory). Scattering Theory II (3-D). Scattering Theory III (A Medley of Themes). Scattering Theory IV (Spectral Methods in 3-D). Systems and Half Line Problems. Relations between Potentials and Spectral Data. Introduction to Soliton Theory. Solitons via AKNS Systems. Soliton Theory (Hamiltonian Structure). Some Topics in Integrable Systems. 3. Some Nonlinear Analysis: Some Geometric Formalism. Introduction. Nonlinear Analysis. Monotone Operators. Topological Methods. Convex Analysis. Nonlinear Semigroups and Monotone Sets. Variational Inequalities. Quantum Field Theory. Gauge Fields (Physics). Gauge Fields (Mathematics) and Geometric Quantization. Appendices: Introduction to Linear Functional Analysis. Selected Topics in Functional Analysis. Introduction to Differential Geometry. References. Index. Inverse scattering theory is a major theme of applied mathematics, and it has applications to such diverse areas as medical imaging, geophysical exploration, and nondestructive testing. The inverse scattering problem is both nonlinear and ill-posed, thus presenting particular problems in the development of efficient inversion algorithms. Although linearized models continue to play an important role in many applications, an increased need to focus on problems in which multiple scattering effects cannot be ignored has led to a central role for nonlinearity, and the possibility of collecting large amounts of data over limited regions of space means that the ill-posed nature of the inverse scattering problem has become a problem of central importance.? Initial efforts to address the nonlinear and the ill-posed nature of the inverse scattering problem focused on nonlinear optimization methods. While efficient in many situations, strong a priori information is necessary for their implementation. This problem led to a qualitative approach to inverse scattering theory in which the amount of a priori information is drastically reduced, although at the expense of only obtaining limited information about the values of the constitutive parameters. This qualitative approach (the linear sampling method, the factorization method, the theory of transmission eigenvalues, etc.) is the theme of Inverse Scattering Theory and Transmission Eigenvalues.? The authors begin with a basic introduction to the theory, then proceed to more recent developments, including a detailed discussion of the transmission eigenvalue problem; present the new generalized linear sampling method in addition to the well-known linear sampling and factorization methods; and in order to achieve clarification of presentation, focus on the inverse scattering problem for scalar homogeneous media.? Scattering is one of the most powerful methods used to study the structure of matter, and many of the most important breakthroughs in physics have been made by means of scattering. Nearly a century has passed since the first investigations in this field, and the work undertaken since then has resulted in a rich literature encompassing both experimental and theoretical results. In scattering, one customarily studies collisions among nuclear, sub-nuclear, atomic or molecular particles, and as these are intrinsically quantum systems, it is logical that quantum mechanics is used as the basis for modern scattering theory. In Principles of Quantum Scattering Theory, the author judiciously combines physical intuition and mathematical rigour to present various selected principles of quantum scattering theory. As always in physics, experiment should be used to ultimately validate physical and mathematical modelling, and the author presents a number of exemplary illustrations, comparing theoretical and experimental cross sections in a selection of major inelastic ion-atom collisions at high non-relativistic energies. Quantum scattering theory, one of the most beautiful theories in physics, is also very rich in mathematics. Principles of Quantum Scattering Theory is intended primarily for graduate physics students, but also for non-specialist physicists for whom the clarity of exposition should aid comprehension of these mathematical complexities. The last decade witnessed an increasing interest of mathematicians in prob lems originated in mathematical physics. As a result of this effort, the scope of traditional mathematical physics changed considerably. New problems es pecially those connected with quantum physics make use of new ideas and methods. Together with classical and functional analysis, methods from dif ferential geometry and Lie algebras, the theory of group representation, and even topology and algebraic geometry became efficient tools of mathematical physics. On the other hand, the problems tackled in mathematical physics helped to formulate new, purely mathematical, theorems. This important development must obviously influence the contemporary mathematical literature, especially the review articles and monographs. A considerable number of books and articles appeared, reflecting to some extend this trend. In our view, however, an adequate language and appropriate methodology has not been developed yet. Nowadays, the current literature includes either mathematical monographs occasionally using physical terms, or books on theoretical physics focused on the mathematical apparatus. We hold the opinion that the traditional mathematical language of lem mas and theorems is not appropriate for the contemporary writing on mathe matical physics. In such literature, in contrast to the standard approaches of theoretical physics, the mathematical ideology must be utmost emphasized and the reference to physical ideas must be supported by appropriate mathe matical statements. Of special importance are the results and methods that have been developed in this way for the first time. Part 1: SCATTERING OF WAVES BY MACROSCOPIC TARGET -- Interdisciplinary aspects of wave scattering -- Acoustic scattering -- Acoustic scattering: approximate methods -- Electromagnetic wave scattering: theory -- Electromagnetic wave scattering: approximate and numerical methods -- Electromagnetic wave scattering: applications -- Elastodynamic wave scattering: theory -- Elastodynamic wave scattering: Applications -- Scattering in Oceans -- Part 2: SCATTERING IN MICROSCOPIC PHYSICS AND CHEMICAL PHYSICS -- Introduction to direct potential scattering -- Introduction to Inverse Potential Scattering -- Visible and Near-visible Light Scattering -- Practical Aspects of Visible and Near-visible Light Scattering -- Nonlinear Light Scattering -- Atomic and Molecular Scattering: Introduction to Scattering in Chemical -- X-ray Scattering -- Neutron Scattering -- Electron Diffraction and Scattering -- Part 3: SCATTERING IN NUCLEAR PHYSICS -- Nuclear Physics -- Part 4: PARTICLE SCATTERING -- State of the Art of Peturbative Methods -- Scattering Through Electro-weak Interactions (the Fermi Scale) -- Scattering Through Strong Interactions (the Hadronic or QCD Scale) -- Part 5: SCATTERING AT EXTREME PHYSICAL SCALES -- Scattering at Extreme Physical Scales -- Part 6: SCATTERING IN MATHEMATICS AND NON-PHYSICAL SCIENCES -- Relations with Other Mathematical Theories -- Inverse Scattering Transform and Non-linear Partial Differenttial Equations -- Scattering of Mathematical Objects. These proceedings contain lectures given at the N.A.T.O. Advanced Study Institute entitled "Scattering Theory in Mathematics and Physics" held in Denver, Colorado, June 11-29, 1973. We have assembled the main series of lectures and some presented by other participants that seemed naturally to complement them. Unfortunately the size of this volume does not allow for a full account of all the contributions made at the Conference; however, all present were pleased by the number and breadth of those topics covered in the informal afternoon sessions. The purpose of the meeting, as reflected in its title, was to examine the single topic of scattering theory in as many of its manifestations as possible, i.e. as a hub of concepts and techniques from both mathematics and physics. The format of all the topics presented here is mathematical. The physical content embraces classical and quantum mechanical scattering, N-body systems and quantum field theoretical models. Left out are such subjects as the so-called analytic S-matrix theory and phenomeno logical models for high energy scattering. We would like to thank the main lecturers for their excellent presentations and written summaries. They provided a focus for the exceptionally strong interaction among the participants and we hope that some of the coherence achieved is reflected in these published notes. We have made no attempt to unify notation. This monograph addresses researchers and students. It is a modern presentation of time-dependent methods for studying problems of scattering theory in the classical and quantum mechanics of N-particle systems. Particular attention is paid to long-range potentials. For a large class of interactions the existence of the asymptotic velocity and the asymptotic completeness of the wave operators is shown. The book is self-contained and explains in detail concepts that deepen the understanding. As a special feature of the book, the beautiful analogy between classical and quantum scattering theory (e.g., for N-body Hamiltonians) is presented with deep insight into the physical and mathematical problems. The normal business of physicists may be schematically thought of as predic ting the motions of particles on the basis of known forces, or the propagation of radiation on the basis of a known constitution of matter. The inverse problem is to conclude what the forces or constitutions are on the basis of the observed motion. A large part of our sensory contact with the world around us depends on an intuitive solution of such an inverse problem: We infer the shape, size, and surface texture of external objects from their scattering and absorption of light as detected by our eyes. When we use scattering experiments to learn the size or shape of particles, or the forces they exert upon each other, the nature of the problem is similar, if more refined. The kinematics, the equations of motion, are usually assumed to be known. It is the forces that are sought, and how they vary from point to point. As with so many other physical ideas, the first one we know of to have touched upon the kind of inverse problem discussed in this book was Lord Rayleigh (1877). In the course of describing the vibrations of strings of variable density he briefly discusses the possibility of inferring the density distribution from the frequencies of vibration. This passage may be regarded as a precursor of the mathematical study of the inverse spectral problem some seventy years later. The scattering theory for transport phenomena was initiated by P. Lax and R. Phillips in 1967. Since then, great progress has been made in the field and the work has been ongoing for more than half a century. This book shows part of that progress. The book is divided into 7 chapters, the first of which deals with preliminaries of the theory of semigroups and C*-algebra, different types of semigroups, Schatten–von Neuman classes of operators, and facts about ultraweak operator topology, with examples using wavelet theory. Chapter 2 goes into abstract scattering theory in a general Banach space. The wave and scattering operators and their basic properties are defined. Some abstract methods such as smooth perturbation and the limiting absorption principle are also presented. Chapter 3 is devoted to the transport or linearized Boltzmann equation, and in Chapter 4 the Lax and Phillips formalism is introduced in scattering theory for the transport equation. In their seminal book, Lax and Phillips introduced the incoming and outgoing subspaces, which verify their representation theorem for a dissipative hyperbolic system initially and also matches for the transport problem. By means of these subspaces, the Lax and Phillips semigroup is defined and it is proved that this semigroup is eventually compact, hence hyperbolic. Balanced equations give rise to two transport equations, one of which can satisfy an advection equation and one of which will be nonautonomous. For generating, the Howland semigroup and Howland's formalism must be used, as shown in Chapter 5. Chapter 6 is the highlight of the book, in which it is explained how the scattering operator for the transport problem by using the albedo operator can lead to recovery of the functionality of computerized tomography in medical science. The final chapter introduces the Wigner function, which connects the Schrödinger equation to statistical physics and the Husimi distribution function. Here, the relationship between the Wigner function and the quantum dynamical semigroup (QDS) can be seen. Scattering theory is, roughly speaking, perturbation theory of self-adjoint operators on the (absolutely) continuous spectrum. It has its origin in mathematical problems of quantum mechanics and is intimately related to the theory of partial differential equations. Some recently solved problems, such as asymptotic completeness for the Schrödinger operator with long-range and multiparticle potentials, as well as open problems, are discussed. Potentials for which asymptotic completeness is violated are also constructed. This corresponds to a new class of asymptotic solutions of the time-dependent Schrödinger equation. Special attention is paid to the properties of the scattering matrix, which is the main observable of the theory. The book is addressed to readers interested in a deeper study of the subject. This volume contains three interrelated, beautiful, and useful topics of quantum scattering theory: inverse scattering theory, algebraic scattering theory and supersymmetrical quantum mechanics. The contributions cover such issues as coupled-channel inversions at fixed energy, inversion of pion-nucleon scattering cross-sections into potentials, inversions in neutron and x-ray reflection, 3-dimensional fixed-energy inversion, inversion of electron scattering data affected by dipole polarization, nucleon-nucleon potentials by inversion versus meson-exchange theory, potential reversal and reflectionless impurities in periodic structures, quantum design in spectral, scattering, and decay control, solution hierarchy of Toda lattices, etc. This graduate-level text is intended for any student of physics who requires a thorough grounding in the quantum theory of nonrelativistic scattering. It is designed for readers who are already familiar with the general principles of quantum mechanics and who have some small acquaintance with scattering theory. Study of this text will allow students of atomic or nuclear physics to begin reading the literature and tackling real problems, with a complete grasp of the underlying principles. For students of high-energy physics, it provides the necessary background for later study of relativistic problems. Topics are presented in terms of the simplest relevant example, so that scattering theory can be learned by becoming familiar with all of the basic concepts — the S operator, cross sections, the T matrix, and so forth — in their simplest context. The time-dependent approach to the subject is emphasized, starting with the use of time-dependent formalism to define all of the basic concepts and the subsequent introduction of the time-independent theory as a tool for computation and for establishing certain general properties. Problems at the end of each chapter improve and supplement readers' grasp of the material.

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