

Scattering of Electromagnetic Waves

Numerical Simulations

Leung Tsang
Jun Au Kong
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Wiley Series in Remote Sensing, Jin Au Kong, Series Editor

Scattering Of Electromagnetic Waves Numerical Simulations

**Michael I. Mishchenko, Larry D.
Travis, Andrew A. Lacis**



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Scattering of Electromagnetic Waves Leung Tsang, Jin Au Kong, Kung-Hau Ding, Chi On Ao, 2004-03-24 A timely and authoritative guide to the state of the art of wave scattering Scattering of Electromagnetic Waves offers in three volumes a complete and up to date treatment of wave scattering by random discrete scatterers and rough surfaces Written by leading scientists who have made important contributions to wave scattering over three decades this new work explains the principles methods and applications of this rapidly expanding interdisciplinary field It covers both introductory and advanced material and provides students and researchers in remote sensing as well as imaging optics and electromagnetic theory with a one stop reference to a wealth of current research results Plus Scattering of Electromagnetic Waves contains detailed discussions of both analytical and numerical methods including cutting edge techniques for the recovery of earth land parametric information The three volumes are entitled respectively Theories and Applications Numerical Simulation and Advanced Topics In the second volume Numerical Simulations Leung Tsang University of Washington Jin Au Kong MIT Kung Hau Ding Air Force Research Lab and Chi On Ao MIT cover Layered media simulations Rough surface and volume scattering simulations Dense media models and simulations Electromagnetic scattering by discrete scatterers and a buried object Scattering by vertical cylinders above a surface Electromagnetic waves scattering by vegetation Computational methods and programs used for performing various simulations

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rough surfaces Written by leading scientists who have made important contributions to wave scattering over three decades this new work explains the principles methods and applications of this rapidly expanding interdisciplinary field It covers both introductory and advanced material and provides students and researchers in remote sensing as well as imaging optics and electromagnetic theory with a one stop reference to a wealth of current research results Plus Scattering of Electromagnetic Waves contains detailed discussions of both analytical and numerical methods including cutting edge techniques for the recovery of earth land parametric information The three volumes are entitled respectively Theories and Applications Numerical Simulation and Advanced Topics In the second volume Numerical Simulations Leung Tsang University of Washington Jin Au Kong MIT Kung Hau Ding Air Force Research Lab and Chi On Ao MIT cover Layered media simulations Rough surface and volume scattering simulations Dense media models and simulations Electromagnetic scattering by discrete scatterers and a buried object Scattering by vertical cylinders above a surface Electromagnetic waves scattering by vegetation Computational methods and programs used for performing various simulations *Scattering of Electromagnetic Waves* Leung Tsang, Jin Au Kong, 2004-03-24 A timely and authoritative guide to the state of the art of wave scattering Scattering of Electromagnetic Waves offers in three volumes a complete and up to date treatment of wave scattering by random discrete scatterers and rough surfaces Written by leading scientists who have made important contributions to wave scattering over three decades this new work explains the principles methods and applications of this rapidly expanding interdisciplinary field It covers both introductory and advanced material and provides students and researchers in remote sensing as well as imaging optics and electromagnetic theory with a one stop reference to a wealth of current research results Plus Scattering of Electromagnetic Waves contains detailed discussions of both analytical and numerical methods including cutting edge techniques for the recovery of earth land parametric information The three volumes are entitled respectively Theories and Applications Numerical Simulation and Advanced Topics In the third volume Advanced Topics Leung Tsang University of Washington and Jin Au Kong MIT cover Two dimensional random rough surface scattering Kirchhoff and related methods for rough surface scattering Analytic theory of volume scattering based on cascading of layers Analytic wave theory for medium with permittivity fluctuations Multiple scattering theory for discrete scatterers Quasicrystalline approximation in dense media scattering Dense media scattering Backscattering enhancement

Numerical Simulations Lutz Angermann, 2011-01-30 This book will interest researchers scientists engineers and graduate students in many disciplines who make use of mathematical modeling and computer simulation Although it represents only a small sample of the research activity on numerical simulations the book will certainly serve as a valuable tool for researchers interested in getting involved in this multidisciplinary field It will be useful to encourage further experimental and theoretical researches in the above mentioned areas of numerical simulation **Electromagnetic Scattering: A Remote Sensing Perspective** Yang Du, 2017-03-08 Remote sensing is a fast growing field with many

important applications as demonstrated in the numerous scientific missions of the Earth Observation System EOS worldwide. Given the interdisciplinary nature of remote sensing technologies, the fulfillment of these scientific goals calls for, among other things, a fundamental understanding of the complex interaction between electromagnetic waves and the targets of interest. Using a systematic treatment, *Electromagnetic Scattering: A Remote Sensing Perspective* presents some of the recently advanced methods in electromagnetic scattering as well as updates on the current progress on several important aspects of such an interaction. The book covers topics including scattering from random rough surfaces of both terranean and oceanic natures, scattering from typical man-made targets or important canonical constituents of natural scenes such as a dielectric finite cylinder or dielectric thin disk, the characterization of a natural scene as a whole represented as a random medium, and the extraction of target features with a polarimetric radar.

Wave Propagation, Scattering And Emission In Complex Media Ya-qiu Jin, 2005-01-26. This book contains review papers presented at the International Workshop on Wave Propagation, Scattering and Emission on Theory, Experiment, Simulation and Inversion (WPSE). The papers are of high quality, covering broad areas: a new mechanism of interaction of electromagnetic waves with complex media, remote sensing information, computational electromagnetics, etc. This book summarizes the most significant progress in wave propagation encompassing theory, experiment, simulation, and inversion. It will also serve as a good reference for scientists in future research.

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Monte Carlo Methods for Electromagnetics Matthew N.O. Sadiku, 2018-10-03. Until now, novices had to painstakingly dig through the literature to discover how to use Monte Carlo techniques for solving electromagnetic problems. Written by one of the foremost researchers in the field, *Monte Carlo Methods for Electromagnetics* provides a solid understanding of these methods and their applications in electromagnetic computation. Including much of his own work, the author brings together essential information from several different publications. Using a simple, clear writing style, the author begins with a historical background and review of electromagnetic theory. After addressing probability and statistics, he introduces the finite difference method as well as the fixed and floating random walk Monte Carlo methods. The text then applies the Exodus method to Laplace's and Poisson's equations and presents Monte Carlo techniques for handling Neumann problems. It also deals with whole-field computation using the Markov chain, applies Monte Carlo methods to time-varying

diffusion problems and explores wave scattering due to random rough surfaces The final chapter covers multidimensional integration Although numerical techniques have become the standard tools for solving practical complex electromagnetic problems there is no book currently available that focuses exclusively on Monte Carlo techniques for electromagnetics Alleviating this problem this book describes Monte Carlo methods as they are used in the field of electromagnetics

Advances in Heat Transfer James P. Hartnett, 2003-10-09 Advances in Heat Transfer presents review articles on topics of current interest Each contribution starts from widely understood principles and brings the reader up to the forefront of the topic being addressed The favorable response by the international scientific and engineering community to the 37 volumes published to date is an indication of the success of our authors in fulfilling this purpose This is recommended reading for all mechanical engineers and researchers Provides an overview of review articles on topics of current interest Bridges the gap between academic researchers and practitioners in industry A long running and prestigious series *Mathematical Analysis of Deterministic and Stochastic Problems in Complex Media Electromagnetics* G. F. Roach, I. G. Stratis, A. N.

Yannacopoulos, 2012-03-04 Electromagnetic complex media are artificial materials that affect the propagation of electromagnetic waves in surprising ways not usually seen in nature Because of their wide range of important applications these materials have been intensely studied over the past twenty five years mainly from the perspectives of physics and engineering But a body of rigorous mathematical theory has also gradually developed and this is the first book to present that theory Designed for researchers and advanced graduate students in applied mathematics electrical engineering and physics this book introduces the electromagnetics of complex media through a systematic state of the art account of their mathematical theory The book combines the study of well posedness homogenization and controllability of Maxwell equations complemented with constitutive relations describing complex media The book treats deterministic and stochastic problems both in the frequency and time domains It also covers computational aspects and scattering problems among other important topics Detailed appendices make the book self contained in terms of mathematical prerequisites and accessible to engineers and physicists as well as mathematicians *Multiple Scattering of Light by Particles* Michael I. Mishchenko, Larry D.

Travis, Andrew A. Lacis, 2006-04-27 This monograph on multiple scattering of light by small particles is an ideal resource for science professionals engineers and graduate students **Light Scattering and Nanoscale Surface Roughness** Alexei A.

Maradudin, 2010-05-10 All real surfaces both those occurring naturally and those fabricated artificially and with great care are rough to some degree It is therefore of interest and often of importance to know the extent to which this roughness affects physical processes occurring at a surface A particularly interesting class of physical processes occurring at a rough surface is the scattering of electromagnetic waves from it or their transmission through it In this case the degree of the surface roughness is referred to the wavelength of the waves incident on it The study of the scattering of electromagnetic waves from rough surfaces has been actively carried out for more than a century now since Rayleigh's investigations of the

scattering of a monochromatic plane wave incident normally on a sinusoidal interface between two different media The first theoretical treatment of the scattering of an electromagnetic wave from a randomly rough surface was due to Mandelstam in the context of the scattering of light from a liquid's surface In these pioneering studies the angular dependence of the intensity of the scattered field was calculated by perturbation theory as an expansion in powers of the surface profile function though the first nonzero term a single scattering approximation

Advances in SAR Remote Sensing of Oceans Xiaofeng Li, Huadong Guo, Kun-Shan Chen, Xiaofeng Yang, 2018-10-12 The oceans cover approximately 71% of Earth's surface 90% of the biosphere and contains 97% of Earth's water Since the first launch of SEASAT satellite in 1978 an increasing number of SAR satellites have or will become available such as the European Space Agency's ERS 1 2 ENVISAT and Sentinel 1 series the Canadian RADARSAT 1 2 and the upcoming RADARSAT Constellation Mission series satellites the Italian COSMO SkyMed satellites the German TERRASAR X and TANDEM X and the Chinese GAOFEN 3 SAR among others Recently European Space Agency has launched a new generation of SAR satellites Sentinel 1A in 2014 and Sentinel 1B in 2016 These SAR satellites provide researchers with free and open SAR images necessary to carry out their research on the global oceans The scope of *Advances in SAR Remote Sensing of Oceans* is to demonstrate the types of information that can be obtained from SAR images of the oceans and the cutting edge methods needed for analysing SAR images Written by leading experts in the field and divided into four sections the book presents the basic principles of radar backscattering from the ocean surface introduces the recent progresses in SAR remote sensing of dynamic coastal environment and management discusses the state of the art methods to monitor parameters or phenomena related to the dynamic ocean environment and deals specifically with new techniques and findings of marine atmospheric boundary layer observations *Advances in SAR Remote Sensing of Oceans* is a very comprehensive and up to date reference intended for use by graduate students researchers practitioners and R D engineers working in the vibrant field of oceans interested to understand how SAR remote sensing can support oceanography research and applications

Wave Propagation Concepts for Near-Future

Telecommunication Systems Sandra Costanzo, 2017-05-03 *Wave Propagation Concepts for Near Future Telecommunication Systems* is an edited book discussing recent researches for the development of innovative telecommunication systems with particular focus on the propagation aspects and radiating systems design It is divided into two sections Section 1 devoted to the illustration of advanced results in terms of microwave propagation at high operating frequencies and Section 2 illustrating new electromagnetic concepts and applications

Terahertz Spectroscopy and Imaging Kai-Erik Peiponen, Axel Zeitler, Makoto Kuwata-Gonokami, 2012-10-04 This book presents the state of the art of Terahertz spectroscopy It is a modern source for a beginners and researcher interested in THz spectroscopy The basics and physical background of THz spectroscopy and technology are explained and important applications are described The book presents the highlights of scientific research in the field of THz science and provides an excellent overview of the field and

future directions of research Over the last decade the field of terahertz spectroscopy has developed into one of the most rapidly growing fields of spectroscopy with large impact across a wide range of scientific disciplines Due to substantial advances in femtosecond laser technology terahertz time domain spectroscopy THz TDS has established itself as the dominant spectroscopic technique for experimental scientists interested in measurements in this frequency range In solids and liquids terahertz radiation is at resonance with both phonon modes and hydrogen bonding modes which makes it an ideal tool to study the interaction between molecules in a unique way thus opening a wealth of opportunities for research in physics chemistry biology materials science and pharmaceuticals This book provides an easy access to scientists engineers and students alike who want to understand the theory and applications of modern terahertz spectroscopy

Optical Thin Films and Coatings Angela Piegari, François Flory, 2018-06-19 Optical Thin Films and Coatings From Materials to Applications Second Edition provides an overview of thin film materials and their properties design and manufacture across a wide variety of application areas Sections explore their design and manufacture and their unconventional features including the scattering properties of random structures in thin films optical properties at short wavelengths thermal properties and color effects Other chapters focus on novel materials including organic optical coatings surface multiplasmonics optical thin films containing quantum dots and optical coatings including laser components solar cells displays and lighting and architectural and automotive glass The book presents a technical resource for researchers and engineers working with optical thin films and coatings It is also ideal for professionals in the security automotive space and other industries who need an understanding of the topic Provides thorough review of applications of optical coatings including laser components solar cells glazing displays and lighting One stop reference that addresses deposition techniques properties and applications of optical thin films and coatings Novel methods suggestions for analysis and applications makes this a valuable resource for experts in the field as well

Electromagnetic Heterostructures Christian Brosseau, 2025-01-21 Electromagnetic Properties of Heterostructures Background and Calculation Methods covers the fundamental aspects of the electromagnetic properties of heterostructures and the theoretical knowledge of the computational techniques needed to understand dielectric phenomena in quantitative and physical terms The book re-establishes the conceptual foundations of the physics associated with numerical simulation tools of the Laplace or the Poisson equations and shows their immediate implementation It is relevant for all practicing engineers and materials scientists who develop composite materials that are capable of handling specified technological requirements by utilizing their electromagnetic properties Explains the basic concepts of the dielectric behavior of heterostructures and discusses how they relate to existing computational methods Covers the most widely used and efficient computational approaches including effective medium and percolation theory Fills the gap between theoretical knowledge learned in the classroom and practical knowledge gleaned through extensive work in the lab

Quantitative Remote Sensing of Land Surfaces Shunlin Liang, 2005-02-25 Processing the vast amounts of data on the Earth's land

surface environment generated by NASA's and other international satellite programs is a significant challenge. Filling a gap between the theoretical physically based modelling and specific applications, this in-depth study presents practical quantitative algorithms for estimating various land surface variables from remotely sensed observations. A concise review of the basic principles of optical remote sensing as well as practical algorithms for estimating land surface variables quantitatively from remotely sensed observations. Emphasizes both the basic principles of optical remote sensing and practical algorithms for estimating land surface variables quantitatively from remotely sensed observations. Presents the current physical understanding of remote sensing as a system with a focus on radiative transfer modelling of the atmosphere, canopy, soil, and snow. Gathers the state-of-the-art quantitative algorithms for sensor calibration, atmospheric and topographic correction, estimation of a variety of biophysical and geophysical variables, and four-dimensional data assimilation.

Physics of Negative Refraction and Negative Index Materials Clifford M. Krowne, Yong Zhang, 2007-08-14 This book deals with the subject of optical and electronic negative refraction (NR) and negative index materials (NIM). Diverse approaches for achieving NR and NIM are covered, such as using photonic crystals, phononic crystals, split ring resonators (SRRs), and continuous media focusing of waves, guided wave behavior, and nonlinear effects. It is perhaps the most comprehensive book on the new class of negative refraction materials, covering all aspects of negative refraction and negative index materials.

Optics of the Moon Yuriy Shkuratov, Gordon Videen, Vadym Kaydash, 2025-01-16 *Optics of the Moon* offers a modern approach to lunar remote sensing. It presents methods for interpreting optics of surfaces with complicated structures, in particular the lunar regolith. For example, this book illustrates how phase ratio techniques can lead to the detection of surface structure anomalies and describes polarimetric studies of the lunar surface and their use. This book addresses many questions related to the surfaces of the Moon, such as why the Moon looks like a ball at a large phase angle and like a disk in full moon, why the lunar surface has slight color variations, and why at large phase angles its polarization degree closely correlates with albedo. Including historical perspectives, case studies, maps, and figures to enhance the understanding of both theory and techniques, *Optics of the Moon* is a valuable resource for researchers and students in lunar and planetary science and remote sensing. Includes case studies, maps, and color figures to illustrate concepts clearly, with a specific application to the Moon. Presents theories alongside experimental and observational data to support and describe modern techniques. Communicates new approaches and methods related to the optics of lunar surfaces.

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