

# Scattering of Electromagnetic Waves

*Advanced Topics*

Leung Tsang  
Jin Au Kong

*Wiley Series in Remote Sensing, Jin Au Kong, Series Editor*

# Scattering Of Electromagnetic Waves Vol 1 Advanced Topics

**Vitaliy Zhurbenko**



## **Scattering Of Electromagnetic Waves Vol 1 Advanced Topics:**

**Scattering of Electromagnetic Waves**, 2001      *Electromagnetic Wave Scattering from Random Rough Surfaces*

Nicolas Pinel, Christophe Boulrier, 2013-12-02 Electromagnetic wave scattering from random rough surfaces is an active interdisciplinary area of research with myriad practical applications in fields such as optics acoustics geoscience and remote sensing Focusing on the case of random rough surfaces this book presents classical asymptotic models used to describe electromagnetic wave scattering The authors begin by outlining the basic concepts relevant to the topic before moving on to look at the derivation of the scattered field under asymptotic models based on the Kirchhoff tangent plane in order to calculate both the scattered field and the statistical average intensity More elaborated asymptotic models are also described for dealing with specific cases and numerical results are presented to illustrate these models Comparisons with a reference numerical method are made to confirm and refine the theoretical validity domains The final chapter derives the expressions of the scattering intensities of random rough surfaces under the asymptotic models Its expressions are given for their incoherent contributions from statistical calculations These results are then compared with numerical computations using a Monte Carlo process as well as with experimental models for sea surface backscattering Contents 1 Electromagnetic Wave Scattering from Random Rough Surfaces Basics 2 Derivation of the Scattered Field under Asymptotic Models 3 Derivation of the Normalized Radar Cross Section under Asymptotic Models APPENDIX 1 Far Field Scattered Fields under the Method of Stationary Phase APPENDIX 2 Calculation of the Scattering Coefficients under the GO for 3D Problems About the Authors Nicolas Pinel worked as a Research Engineer at the IETR Institut d Electronique et de T l communications de Rennes laboratory at Polytech Nantes University of Nantes France before joining Alyotech Technologies in Rennes France in July 2013 His research interests are in the areas of radar and optical remote sensing scattering and propagation In particular he works on asymptotic methods of electromagnetic wave scattering from random rough surfaces and layers Christophe Bourlier works at the IETR Institut d Electronique et de T l communications de Rennes laboratory at Polytech Nantes University of Nantes France and is also a Researcher at the French National Center for Scientific Research CNRS on electromagnetic wave scattering from rough surfaces and objects for remote sensing applications and radar signatures He is the author of more than 160 journal articles and conference papers      *Scattering of Electromagnetic Waves* Leung Tsang, Jin Au Kong, Kung-Hau Ding, 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 first volume Theories and Applications Leung Tsang University of Washington Jin Au Kong MIT and Kung Hau Ding Air Force Research Lab cover Basic theory of electromagnetic scattering Fundamentals of random scattering Characteristics of discrete scatterers and rough surfaces Scattering and emission by layered media Single scattering and applications Radiative transfer theory and solution techniques One dimensional random rough surface scattering     Scattering, Natural Surfaces, and Fractals Giorgio Franceschetti, Daniele Riccio, 2006-12-08 Scattering Natural Surfaces and Fractals provides a comprehensive overview of electromagnetic scattering from natural surfaces ranging from the classical to the more recent fractal approach As remote sensing applications become increasingly important this text provides readers with a solid background in interpretation classification and thematization of microwave images The scattering problem is discussed in detail with emphasis on its application to electromagnetic wave propagation remote sensing radar detection and electromagnetic diagnostics Natural surface and fractals complete this treatise focusing on how the fractal model represents our natural environment and other planets in our solar system most recently as used to research the planet Venus and Titan one of the moons of Saturn An example of how scattering fractals and natural surfaces are of great importance is the following Natural oil slicks in the ocean have been found to be fractal while man made ones generated by illegal washing of oil carrying ships are not Processing of an ocean image from space may detect the latter by means of a fractal analysis An elegant and clear treatment of a rigorous topic with informative prose and realistic illustrations of scattering Provides readers with a solid background in interpretation classification and thematization of microwave images The only book available on fractal models and their application to scattering     Microwave Remote Sensing of Land Surfaces Nicolas Baghdadi, Mehrez Zribi, 2016-11-08 Microwave Remote Sensing of Land Surface Techniques and Methods brings essential coverage of the space techniques of observation on continental surfaces The authors explore major applications and provide detailed chapters on physical principles physics of measurement and data processing for each technique bringing readers up to date descriptions of techniques used by leading scientists in the field of remote sensing and Earth observation Presents clear and concise descriptions of modern methods Explores current remote sensing techniques that include physical aspects of measurement theory and their applications Provides physical principles measurement and data processing chapters that are included for each technique described

*Scientific Computing in Electrical Engineering SCEE 2010* Bastiaan Michielsen, Jean-René Poirier, 2012-01-06 Selected from papers presented at the 8th Scientific Computation in Electrical Engineering conference in Toulouse in 2010 the contributions to this volume cover every angle of numerically modelling electronic and electrical systems including computational electromagnetics circuit theory and simulation and device modelling On computational electromagnetics the

chapters examine cutting edge material ranging from low frequency electrical machine modelling problems to issues in high frequency scattering Regarding circuit theory and simulation the book details the most advanced techniques for modelling networks with many thousands of components Modelling devices at microscopic levels is covered by a number of fundamental mathematical physics papers while numerous papers on model order reduction help engineers and systems designers to bring their modelling of industrial scale systems within the reach of present day computational power Complementing these more specific papers the volume also contains a selection of mathematical methods which can be used in any application domain

**Electromagnetic Waves** Vitaliy Zhurbenko,2011-06-21 This book is dedicated to various aspects of electromagnetic wave theory and its applications in science and technology The covered topics include the fundamental physics of electromagnetic waves theory of electromagnetic wave propagation and scattering methods of computational analysis material characterization electromagnetic properties of plasma analysis and applications of periodic structures and waveguide components and finally the biological effects and medical applications of electromagnetic fields

**Introduction to Dual Polarization Weather Radar** V. Chandrasekar,Robert M. Beauchamp,Renzo Bechini,2023-08-17 An interdisciplinary easy to understand introduction covering fundamental theory and practical applications Featuring numerous operational examples and interpretation of radar observations this is a perfect resource for scientists and engineers working on or with radars as well as senior undergraduate and graduate students

Remote Sensing of the Cryosphere Marco Tedesco,2015-01-27 The cryosphere that region of the world where water is temporarily or permanently frozen plays a crucial role on our planet Recent developments in remote sensing techniques and the acquisition of new data sets have resulted in significant advances in our understanding of all components of the cryosphere and its processes This book based on contributions from 40 leading experts offers a comprehensive and authoritative overview of the methods techniques and recent advances in applications of remote sensing of the cryosphere Examples of the topics covered include snow extent depth grain size and impurities surface and subsurface melting glaciers accumulation over the Greenland and Antarctica ice sheets ice thickness and velocities gravimetric measurements from space sea lake and river ice frozen ground and permafrost fieldwork activities recent and future cryosphere oriented missions and experiments All figures are in color and provide an excellent visual accompaniment to the technical and scientific aspect of the book Readership Senior undergraduates Masters and PhD Students PostDocs and Researchers in cryosphere science and remote sensing Remote Sensing of the Cryosphere is the significant first volume in the new Cryosphere Science Series This new series comprises volumes that are at the cutting edge of new research or provide focussed interdisciplinary reviews of key aspects of the science

Remote Sensing of Environmental Changes in Cold Regions Jinyang Du,Jennifer D.Watts,Hui Lu,Lingmei Jiang,Paolo Tarolli,2019-11-14 This Special Issue gathers papers reporting recent advances in the remote sensing of cold regions It includes contributions presenting improvements in modeling microwave emissions from snow assessment of

satellite based sea ice concentration products satellite monitoring of ice jam and glacier lake outburst floods satellite mapping of snow depth and soil freeze thaw states near nadir interferometric imaging of surface water bodies and remote sensing based assessment of high arctic lake environment and vegetation recovery from wildfire disturbances in Alaska A comprehensive review is presented to summarize the achievements challenges and opportunities of cold land remote sensing

Optical Remote Sensing of Ocean Hydrodynamics Victor Raizer, 2019-03-04 Optical Remote Sensing is one of the main technologies used in sea surface monitoring Optical Remote Sensing of Ocean Hydrodynamics investigates and demonstrates capabilities of optical remote sensing technology for enhanced observations and detection of ocean environments It provides extensive knowledge of physical principles and capabilities of optical observations of the oceans at high spatial resolution 1 4m and on the observations of surface wave hydrodynamic processes It also describes the implementation of spectral statistical and fusion algorithms for analyses of multispectral optical databases and establishes physics based criteria for detection of complex wave phenomena and hydrodynamic disturbances including assessment and management of optical databases This book explains the physical principles of high resolution optical imagery of the ocean surface discusses for the first time the capabilities of observing hydrodynamic processes and events and emphasizes the integration of optical measurements and enhanced data analysis It also covers both the assessment and the interpretation of dynamic multispectral optical databases and includes applications for advanced studies and nonacoustic detection This book is an invaluable resource for researches industry professionals engineers and students working on cross disciplinary problems in ocean hydrodynamics optical remote sensing of the ocean and sea surface remote sensing Readers in the fields of geosciences and remote sensing applied physics oceanography satellite observation technology and optical engineering will learn the theory and practice of optical interactions with the ocean

*Quick Finite Elements for Electromagnetic Waves* Giuseppe Pelosi, Roberto Coccioli, Stefano Selleri, 2009 The classic 1998 Artech House book *Quick Finite Elements for Electromagnetic Waves* has now been revised and expanded to bring you up to date with the latest developments in the Field You find brand new discussions on finite elements in 3D 3D resonant cavities and 3D waveguide devices Moreover the second edition supplies you with MATLAB code making this resource easier to comprehend and use for your projects in the field This practical book and accompanying software enables you to quickly and easily work out challenging microwave engineering and high frequency electromagnetic problems using the finite element method FEM Using clear concise text and dozens of real world application examples the book provides a detailed description of FEM implementation while the software provides the code and tools needed to solve the three major types of EM problems guided propagation scattering and radiation With this unique book and software set in hand you can compute the dispersion diagram of arbitrarily shaped inhomogeneous isotropic lossless or lossy guiding structures analyze E and H plane waveguide discontinuities and devices and understand the reflection from and transmission through simple 2D and 3D inhomogeneous periodic structures CD ROM Included Easy

to use finite element software contains ready made MATLAB and FORTRAN source code that you can use immediately to solve a wide range of microwave and EM problems The package is fully compatible with Internet freeware so you can perform advanced engineering functions without having to purchase expensive pre and post processing tools *Technical Abstract Bulletin* , Remote Sensing of Turbulence Victor Raizer,2021-10-04 This book offers a unique multidisciplinary integration of the physics of turbulence and remote sensing technology Remote Sensing of Turbulence provides a new vision on the research of turbulence and summarizes the current and future challenges of monitoring turbulence remotely The book emphasizes sophisticated geophysical applications detection and recognition of complex turbulent flows in oceans and the atmosphere Through several techniques based on microwave and optical IR observations the text explores the technological capabilities and tools for the detection of turbulence their signatures and variability FEATURES Covers the fundamental aspects of turbulence problems with a broad geophysical scope for a wide audience of readers Provides a complete description of remote sensing capabilities for observing turbulence in the earth s environment Establishes the state of the art remote sensing techniques and methods of data analysis for turbulence detection Investigates and evaluates turbulence detection signatures their properties and variability Provides cutting edge remote sensing applications for space based monitoring and forecasts of turbulence in oceans and the atmosphere This book is a great resource for applied physicists the professional remote sensing community ecologists geophysicists and earth scientists **Radio Science** ,2003

*Encyclopedia of Snow, Ice and Glaciers* Vijay P. Singh,Pratap Singh,Umesh K. Haritashya,2011-07-01 The earth s cryosphere which includes snow glaciers ice caps ice sheets ice shelves sea ice river and lake ice and permafrost contains about 75% of the earth s fresh water It exists at almost all latitudes from the tropics to the poles and plays a vital role in controlling the global climate system It also provides direct visible evidence of the effect of climate change and therefore requires proper understanding of its complex dynamics This encyclopedia mainly focuses on the various aspects of snow ice and glaciers but also covers other cryospheric branches and provides up to date information and basic concepts on relevant topics It includes alphabetically arranged and professionally written comprehensive and authoritative academic articles by well known international experts in individual fields The encyclopedia contains a broad spectrum of topics ranging from the atmospheric processes responsible for snow formation transformation of snow to ice and changes in their properties classification of ice and glaciers and their worldwide distribution glaciation and ice ages glacier dynamics glacier surface and subsurface characteristics geomorphic processes and landscape formation hydrology and sedimentary systems permafrost degradation hazards caused by cryospheric changes and trends of glacier retreat on the global scale along with the impact of climate change This book can serve as a source of reference at the undergraduate and graduate level and help to better understand snow ice and glaciers It will also be an indispensable tool containing specialized literature for geologists geographers climatologists hydrologists and water resources engineers as well as for those who are engaged in the practice

of agricultural and civil engineering earth sciences environmental sciences and engineering ecosystem management and other relevant subjects      Optical Thin Films and Coatings Angela Piegari, François Flory, 2013-08-31 Optical coatings including mirrors anti reflection coatings beam splitters and filters are an integral part of most modern optical systems Optical thin films and coatings provides an overview of thin film materials the properties design and manufacture of optical coatings and their use across a variety of application areas Part one explores the design and manufacture of optical coatings Part two highlights unconventional features of optical thin films including scattering properties of random structures in thin films optical properties of thin film materials at short wavelengths thermal properties and colour effects Part three focusses on novel materials for optical thin films and coatings and includes chapters on organic optical coatings surface multiplasmonics and optical thin films containing quantum dots Finally applications of optical coatings including laser components solar cells displays and lighting and architectural and automotive glass are reviewed in part four Optical thin films and coatings is a technical resource for researchers and engineers working with optical thin films and coatings professionals in the security automotive space and other industries requiring an understanding of these topics and academics interested in the field An overview of the materials properties design and manufacture of thin films Special attention is given to the unconventional features and novel materials of optical thin films Reviews applications of optical coatings including laser components solar cells glazing displays and lighting      **Tenth International Conference on Nonlinear Optics of Liquid and Photorefractive Crystals** Gertruda V. Klimusheva, Andrey G. Iljin, Sergey Kostyukevych, 2005 Proceedings of SPIE present the original research papers presented at SPIE conferences and other high quality conferences in the broad ranging fields of optics and photonics These books provide prompt access to the latest innovations in research and technology in their respective fields Proceedings of SPIE are among the most cited references in patent literature      *Sea Ice Analysis and Forecasting* Tom Carrieres, Mark Buehner, Jean-François Lemieux, Leif Toudal Pedersen, 2017-10-05 This book provides an advanced introduction to the science behind automated prediction systems focusing on sea ice analysis and forecasting Starting from basic principles fundamental concepts in sea ice physics remote sensing numerical methods and statistics are explained at an accessible level Existing operational automated prediction systems are described and their impacts on information providers and end clients are discussed The book also provides insight into the likely future development of sea ice services and how they will evolve from mainly manual processes to increasing automation with a consequent increase in the diversity and information content of new ice products With contributions from world leading experts in the fields of sea ice remote sensing data assimilation numerical modelling and verification and operational prediction this comprehensive reference is ideal for students sea ice analysts and researchers as well as decision makers and professionals working in the ice service industry      Photonic Crystals Kuon Inoue, Kazuo Ohtaka, 2013-11-11 Photonic Crystals details recent progress in the study of photonic crystals ranging from fundamental aspects to up to date applications



in one unified treatment It covers most of the worldwide frontier fields in photonic crystals including up to date fabrication techniques recent and future technological applications and our basic understanding of the various optical properties of photonic crystals Brand new theoretical and experimental data are also presented The book is intended for graduate course students and specialists actively working in this field but it will also be useful for newcomers especially the extensive chapter dealing with fundamental aspects of photonic crystals which paves the way to a full appreciation of the other topics addressed

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