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Avner Friedman Robert Gulliver

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George Papanicolaou
Editor

Wave Propagation in Complex Media

With 68 Illustrations

Springer

George Papanicolaou
Department of Mathematics
Stanford University
Stanford CA 94305, USA

Series Editors:
Avner Friedman
Robert Gulliver
Institute for Mathematics and its
Applications
University of Minnesota
Minneapolis, MN 55455 USA

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FOREWORD

This IMA Volume in Mathematics and its Applications

WAVE PROPAGATION IN COMPLEX MEDIA

is based on the proceedings of two workshops:

- Wavelets, multigrid and other fast algorithms (multipole, FFT) and their use in wave propagation and
- Waves in random and other complex media.

Both workshops were integral parts of the 1994–1995 IMA program on "Waves and Scattering." We would like to thank Gregory Beylkin, Robert Burridge, Ingrid Daubechies, Leonid Pastur, and George Papanicolaou for their excellent work as organizers of these meetings.

We also take this opportunity to thank the National Science Foundation (NSF), the Army Research Office (ARO, and the Office of Naval Research (ONR), whose financial support made these workshops possible.

Avner Friedman

Robert Gulliver

PREFACE

During the last few years the numerical techniques for the solution of elliptic problems, in potential theory for example, have been drastically improved. Several so-called fast methods have been developed which reduce the required computing time many orders of magnitude over that of classical algorithms. The new methods include multigrid, fast Fourier transforms, multipole methods and wavelet techniques. Wavelets have recently been developed into a very useful tool in signal processing, the solution of integral equation, etc. Wavelet techniques should be quite useful in many wave propagation problems, especially in inhomogeneous and nonlinear media where special features of the solution such as singularities might be tracked efficiently.

Waves propagation in random and other complex media exhibit effects of inhomogeneities that are challenging both theoretically and computationally. Areas of interest include long wave propagation in periodic and random media, effective media theory and homogenization, nonlinear wave propagation, localization in strongly inhomogeneous media, geometrical optics (short waves) in randomly inhomogeneous media, multiple scattering by discrete scatterers, transport theory for waves in random media, dispersion and randomness in long wave transmission, and reflection and transmission of waves by nonlinear random media. Applications include optical fibers, radio wave propagation in the atmosphere, sound propagation in the ocean, and seismic waves propagation in the earth.

During the Fall of 1994 the Institute for Mathematics and its Applications held two workshops; one devoted to wavelets, multigrid and other fast algorithms (multipole, FFT) and their use in wave propagation, and another devoted to waves in random waves and other complex media.

Both workshops focused on applications to problems in wave propagation. The first workshop dealt primarily with fast numerical methods, whereas the second workshop concentrated on the effects of inhomogeneities on wave propagation.

Most of the articles in this volume deal with the effects of inhomogeneities of wave propagation both theoretically and computationally. They include topics such as waves in random media, coherent effects in scattering for random systems with discrete spectrum, interaction of microwaves with sea ice, scattering in magnetic field, surface waves, seismograms envelopes, backscattering, polarization mode dispersions, and spatio-temporal distribution of seismic power. Several articles describes numerical methods, such as fast algorithm for solving electromagnetic scattering problems, and the panel clustering methods in 3-d BEM.

George Papanicolaou

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