

CONTEMPORARY MATHEMATICS

577

Multi-Scale and High-Contrast PDE: From Modelling, to Mathematical Analysis, to Inversion

Conference on Multi-Scale and High-Contrast PDE:
From Modelling, to Mathematical Analysis, to Inversion
June 28–July 1, 2011
University of Oxford, United Kingdom

Habib Ammari
Yves Capdeboscq
Hyeonbae Kang
Editors



American Mathematical Society

Multi-Scale and High-Contrast
PDE: From Modelling,
to Mathematical Analysis,
to Inversion

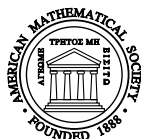
CONTEMPORARY MATHEMATICS

577

Multi-Scale and High-Contrast PDE: From Modelling, to Mathematical Analysis, to Inversion

Conference on Multi-Scale and High-Contrast PDE:
From Modelling, to Mathematical Analysis, to Inversion
June 28–July 1, 2011
University of Oxford, United Kingdom

Habib Ammari
Yves Capdeboscq
Hyeonbae Kang
Editors



American Mathematical Society
Providence, Rhode Island

EDITORIAL COMMITTEE

Dennis DeTurck, Managing Editor

Michael Loss Kailash Misra Martin J. Strauss

2010 *Mathematics Subject Classification*. Primary 35B30, 35J05, 35J25, 35K35, 35R30, 65M06, 76A15, 35L05, 93B05.

Library of Congress Cataloging-in-Publication Data

Conference on Multi-scale and High-contrast PDE: from Modelling, to Mathematical Analysis, to Inversion (2011 Oxford, England).

Multi-scale and high-contrast PDE: from modelling, to mathematical analysis, to inversion, June 28–July 1, 2011, University of Oxford, United Kingdom / Habib Ammari, Yves Capdeboscq, Hyeonbae Kang, editors.

p. cm. — (Contemporary mathematics ; v. 577)

Includes bibliographical references.

ISBN 978-0-8218-6929-1 (alk. paper)

1. Image processing—Mathematics—Congresses. 2. Multiscale modeling—Congresses. 3. Differential equations, Partial—Congresses. I. Ammari, Habib. II. Capdeboscq, Yves, 1971– III. Kang, Hyeonbae. IV. Title.

TA1637.C666 2010
515'.353—dc23

2012013127

Copying and reprinting. Material in this book may be reproduced by any means for educational and scientific purposes without fee or permission with the exception of reproduction by services that collect fees for delivery of documents and provided that the customary acknowledgment of the source is given. This consent does not extend to other kinds of copying for general distribution, for advertising or promotional purposes, or for resale. Requests for permission for commercial use of material should be addressed to the Acquisitions Department, American Mathematical Society, 201 Charles Street, Providence, Rhode Island 02904-2294, USA. Requests can also be made by e-mail to reprint-permission@ams.org.

Excluded from these provisions is material in articles for which the author holds copyright. In such cases, requests for permission to use or reprint should be addressed directly to the author(s). (Copyright ownership is indicated in the notice in the lower right-hand corner of the first page of each article.)

© 2012 by the American Mathematical Society. All rights reserved.

The American Mathematical Society retains all rights
except those granted to the United States Government.

Copyright of individual articles may revert to the public domain 28 years
after publication. Contact the AMS for copyright status of individual articles.

Printed in the United States of America.

∞ The paper used in this book is acid-free and falls within the guidelines
established to ensure permanence and durability.

Visit the AMS home page at <http://www.ams.org/>

10 9 8 7 6 5 4 3 2 1 17 16 15 14 13 12

Contents

Preface	vii
Enhancement of near-cloaking. Part III: Numerical simulations, statistical stability, and related questions H. AMMARI, J. GARNIER, V. JUGNON, H. KANG, H. LEE, AND M. LIM	1
Looking at the world through liquid crystal glasses O. D. LAVRETOVICH	25
A remark on the observability of conservative linear systems E. ZUAZUA	47
On the scattered field generated by a ball inhomogeneity of constant index in dimension three Y. CAPDEBOSQ, G. LEADBETTER, AND A. PARKER	61
Pointwise bounds on the gradient and the spectrum of the Neumann-Poincaré operator: The case of 2 discs E. BONNETIER AND F. TRIKI	81
A high-contrast fourth-order PDE from imaging: numerical solution by ADI splitting B. DÜRING AND C.-B. SCHÖNLIEB	93
Imaging with noise blending M. DE HOOP, E. FEDRIZZI, J. GARNIER, AND K. SØLNA	105
Correlations of heterogeneous wave fields propagating in homogeneous media G. BAL AND O. PINAUD	125

Preface

The mathematical analysis of PDE modelling materials, or tissues, presenting multiple scales have been an active area of research for more than 40 years. The study of the corresponding imaging, or reconstruction, problem is a more recent one. If the material parameters of the PDE present high contrast ratio, then the solution to the PDE becomes particularly challenging to analyze, or compute. Similar difficulties occur in time dependent equations in high frequency regimes. On the other hand, high frequency regimes, or very contrasted materials, were considered first in imaging, as well-differentiated areas are, at first sight, simpler to locate by ad-hoc methods. Over the last decade the analysis of the inversion problem at moderate frequencies, the rigorous derivation of asymptotics at high frequencies, and the regularity properties of solutions of elliptic PDE in highly heterogeneous media have received a lot of attention.

The focus of this volume is on recent progress towards a complete understanding of the direct problem with high contrast or high frequencies, and unified approaches to the inverse and imaging problems for both small and large contrast or frequencies.

The volume includes contributions on the inverse problem, both on its analysis and on numerical reconstructions. It offers the reader a good overview of current research and direction for further pursuit on multiscale problems, both in PDE and in signal processing, and in the analysis of the equations or the computation of their solutions. Finally, a special attention is devoted to new models and problems coming from physics leading to innovative imaging methods.

The tremendous success of the workshop was only possible due to the enthusiastic participation of wonderful speakers and authors of this volume. We are thankful to all of them. We also acknowledge with gratitude the generous support from the Engineering and Physical Sciences Research Council, the Oxford Centre for Nonlinear PDE, the Oxford Centre for Collaborative Applied Mathematics, the National Research Foundation of Korea, and the European Research Council Project MULTIMOD. We would also like to thank the Mathematical Institute of the University of Oxford.

Habib Ammari, Yves Capdeboscq, and Hyeonbae Kang

This volume contains the proceedings of the conference “Multi-Scale and High-Contrast PDE: From Modelling, to Mathematical Analysis, to Inversion”, held June 28–July 1, 2011, at the University of Oxford.

The mathematical analysis of PDE modelling materials, or tissues, presenting multiple scales has been an active area of research for more than 40 years. The study of the corresponding imaging, or reconstruction, problem is a more recent one. If the material parameters of the PDE present high contrast ratio, then the solution to the PDE becomes particularly challenging to analyze, or compute. Similar difficulties occur in time dependent equations in high frequency regimes. Over the last decade the analysis of the inversion problem at moderate frequencies, the rigorous derivation of asymptotics at high frequencies, and the regularity properties of solutions of elliptic PDE in highly heterogeneous media have received a lot of attention.

The focus of this volume is on recent progress towards a complete understanding of the direct problem with high contrast or high frequencies, and unified approaches to the inverse and imaging problems for both small and large contrast or frequencies. The volume also includes contributions on the inverse problem, both on its analysis and on numerical reconstructions. It offers the reader a good overview of current research and direction for further pursuit on multiscale problems, both in PDE and in signal processing, and in the analysis of the equations or the computation of their solutions. Special attention is devoted to new models and problems coming from physics leading to innovative imaging methods.

ISBN 978-0-8218-6929-1



9 780821 869291

CONM/577

AMS on the Web
www.ams.org