Mathias Fink William A. Kuperman
Jean-Paul Montagner Arnaud Tourin (Eds.)

Imaging of Complex Media with Acoustic and Seismic Waves

With 162 Figures

Springer

Prof. Mathias Fink
Lab. Ondes et Acoustiques ESPCI
Université Paris VII-Denis Diderot
10, rue Vauquelin
75231 Paris Cedex 05
France
mathias.fink@espci.fr

Prof. William A. Kuperman
Marine Physical Laboratory
University of California, San Diego
9500 Gilman Drive
92093 La Jolla, CA
USA

Prof. Jean-Paul Montagner
Departement de Sismologie
Institut de Physique du Globe
4, Place Jussieu
75252 Paris Cedex 05
France
jpm@ipgp.jussieu.fr

Prof. Arnaud Tourin
Lab. Ondes et Acoustiques ESPCI
Université Paris VII-Denis Diderot
10, rue Vauquelin
75231 Paris Cedex 05
France
arnaud.tourin@espci.fr

Library of Congress Cataloging-in-Publication Data

Imaging of complex media with acoustic and seismic waves / Mathias Fink ... [et al.].
p. cm. -- (Topics in applied physics ; v. 82)
Includes bibliographical references and index.
ISBN 3540416676 (alk. paper)
1. Acoustic imaging. I. Fink, Mathias, 1945- II. Series.

TA1770 .I43 2002
620.2'8--dc21

2001032277

Physics and Astronomy Classification Scheme (PACS):
43.30.+m, 81.70, 87.57.G, 91.30.-f, 02.30.Zz, 43.58.+z, 43.60.+d

ISSN print edition: 0303-4216
ISSN electronic edition: 1437-0859
ISBN 3-540-41667-6 Springer-Verlag Berlin Heidelberg New York

Springer-Verlag Berlin Heidelberg New York
a member of BertelsmannSpringer Science+Business Media GmbH

Printed in Germany

http://www.springer.de

Typesetting: DA-TEX Gerd Blumenstein, Leipzig
Cover design: *design & production* GmbH, Heidelberg

Printed on acid-free paper SPIN: 10749907 56/3141/mf 5 4 3 2 1 0

Preface

The objective of the workshop held in Cargèse from the 26 April to the 8 May 1999 was to bring together scientists of different communities that were interested in "acoustic and seismic wave imaging of complex media," a subject which covers many areas of applied research. Indeed, acoustic and elastic wave propagation is being investigated in media such as the ocean, the earth, biological tissues and solid materials. In these different areas, many specific techniques have been developed which differ by the wavelength (sound, ultrasound, seismic waves), polarization and the instrumentation used. The various communities have traditionally worked in an independent fashion, communicating only at specific and focused workshops, so that the interactions between underwater acousticians, geophysicists, medical scientists and researchers in nondestructive evaluation have been very limited up to now.

Today, improvements in multi-element sensor technology and computer capacity make possible the transfer of migration and tomography techniques used in seismics to medical imaging or nondestructive evaluation. The adaptive focalization techniques, first developed in optics, have also appeared in acoustics; such very various methods are open to comparison. Especially, the ultrasonic time-reversal mirror approach has some similarities but also significant differences with phase conjugation methods used in underwater acoustics. New, very promising fields such as anisotropic media studies (seismology and nondestructive testing) or imaging based on speckle correlation techniques (seismology and medical imaging) are developing quickly. Finally, medical imaging scientists have been interested for a few years by studies concerning low-frequency elastic wave propagation through the human body (elastography), and analogies with seismic problems become important.

Thus, it appeared that it had become necessary for physicists, geophysicists and engineers to gather at a meeting devoted to an interdisciplinary program. The different contributions of the lecturers are now gathered in this book.

Although four main fields of research are represented in this book, we did not organise it in four distinct parts, since some contributions actually cover several subjects. The book begins with five contributions dealing with the connections between time reversal, imaging and the inverse problem from both theoretical and practical points of view. Then, in the two next parts,

classical imaging and detection techniques are presented in the context of medical imaging and nondestructive testing. The last contributions concern more specifically the resolution of the inverse problem based on the study of elastic wave propagation. Despite the diversity of the propagation media (the human body, the earth or polycrystals) and of the wavelengths involved, the goal remains the same: determine the elastic parameters, velocities structures or even nature of the source in order to elaborate an elastic model of the tested medium as reliably as possible. More specifically, the role of polarization effects and anisotropy are discussed in both seismology and NDT. As for the medical imaging field, elastography techniques are elaborated upon which present great similarities with the ones used in seismics. This work was made possible by financial support from the Centre National de la Recherche Scientifique (CNRS), the Groupement de Recherches "Propagation et imagerie en milieu aléatoire" (GDR PRIMA), the Délégation Générale de l'Armement (DGA, Ministère de la Défense), the Collectivité Territoriale de Corse and finally the Organization of Naval Research (ONR), to whom we owe special thank. The personal of the "Institut d'Etudes Scientifiques de Gargése" has made our stay very enjoyable. We thank all of them.

Finally, we thank Dr. Elisabeth Dubois-Violette, Director of the Cargese Institute, where the ideas leading to this work originated.

Paris, November 2001

Mathias Fink
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Arnaud Tourin

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