



# **Operator Theory: Advances and Applications**

**Volume 213**

**Founded in 1979 by Israel Gohberg**

## **Editors:**

Joseph A. Ball (Blacksburg, VA, USA)  
Harry Dym (Rehovot, Israel)  
Marinus A. Kaashoek (Amsterdam, The Netherlands)  
Heinz Langer (Vienna, Austria)  
Christiane Tretter (Bern, Switzerland)

## **Associate Editors:**

Vadim Adamyan (Odessa, Ukraine)  
Albrecht Böttcher (Chemnitz, Germany)  
B. Malcolm Brown (Cardiff, UK)  
Raul Curto (Iowa, IA, USA)  
Fritz Gesztesy (Columbia, MO, USA)  
Pavel Kurasov (Lund, Sweden)  
Leonid E. Lerer (Haifa, Israel)  
Vern Paulsen (Houston, TX, USA)  
Mihai Putinar (Santa Barbara, CA, USA)  
Leiba Rodman (Williamsburg, VA, USA)  
Ilya M. Spitkovsky (Williamsburg, VA, USA)

## **Honorary and Advisory Editorial Board:**

Lewis A. Coburn (Buffalo, NY, USA)  
Ciprian Foias (College Station, TX, USA)  
J. William Helton (San Diego, CA, USA)  
Thomas Kailath (Stanford, CA, USA)  
Peter Lancaster (Calgary, Canada)  
Peter D. Lax (New York, NY, USA)  
Donald Sarason (Berkeley, CA, USA)  
Bernd Silbermann (Chemnitz, Germany)  
Harold Widom (Santa Cruz, CA, USA)

## **Subseries**

### **Linear Operators and Linear Systems**

#### **Subseries editors:**

Daniel Alpay (Beer Sheva, Israel)  
Birgit Jacob (Wuppertal, Germany)  
André C.M. Ran (Amsterdam, The Netherlands)

## **Subseries**

### **Advances in Partial Differential Equations**

#### **Subseries editors:**

Bert-Wolfgang Schulze (Potsdam, Germany)  
Michael Demuth (Clausthal, Germany)  
Jerome A. Goldstein (Memphis, TN, USA)  
Nobuyuki Tose (Yokohama, Japan)  
Ingo Witt (Göttingen, Germany)

# Pseudo-Differential Operators: Analysis, Applications and Computations

Luigi Rodino  
Man W. Wong  
Hongmei Zhu  
Editors

*Editors*

Luigi Rodino  
Dipartimento di Matematica  
Università di Torino  
Via Carlo Alberto, 10  
10123 Torino  
Italy  
[Luigi.Rodino@unito.it](mailto:Luigi.Rodino@unito.it)

M.W. Wong and Hongmei Zhu  
Department of Mathematics and Statistics  
York University  
4700 Keele Street  
Toronto, Ontario M3J 1P3  
Canada  
[mwwong@mathstat.yorku.ca](mailto:mwwong@mathstat.yorku.ca)  
[hmzhu@mathstat.yorku.ca](mailto:hmzhu@mathstat.yorku.ca)

2010 Mathematical Subject Classification: Primary: 22A10, 32A40, 32A45, 35A17, 35A22, 35B05, 35B40, 35B60, 35J70, 35K05, 35K65, 35L05, 35L40, 35S05, 35S15, 35S30, 43A77, 46F15, 47B10, 47B35, 47B37, 47G10, 47G30, 47L15, 58J35, 58J40, 58J50, 65R10, 92A55, 94A12; Secondary: 22C05, 30E25, 35G05, 35H10, 35J05, 42B10, 42B35, 47A10, 47A53, 47F05, 58J20, 65M60, 65T10, 94A12

ISBN 978-3-0348-0048-8                      e-ISBN 978-3-0348-0049-5  
DOI 10.1007/978-3-0348-0049-5

Library of Congress Control Number: 2011923066

© Springer Basel AG 2011

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in other ways, and storage in data banks. For any kind of use permission of the copyright owner must be obtained.

*Cover design:* deblik, Berlin

Printed on acid-free paper

Springer Basel AG is part of Springer Science+Business Media

[www.birkhauser-science.com](http://www.birkhauser-science.com)

# Contents

Preface .....	vii
<i>Q. Guo and M.W. Wong</i> Adaptive Wavelet Computations for Inverses of Pseudo-Differential Operators .....	1
<i>M. Pirhayati</i> Spectral Theory of Pseudo-Differential Operators on $\mathbb{S}^1$ .....	15
<i>S. Molahajloo</i> A Characterization of Compact Pseudo-Differential Operators on $\mathbb{S}^1$ .....	25
<i>B.-W. Schulze and M.W. Wong</i> Mellin Operators with Asymptotics on Manifolds with Corners .....	31
<i>B.-W. Schulze</i> The Iterative Structure of the Corner Calculus .....	79
<i>V.B. Vasilyev</i> Elliptic Equations and Boundary Value Problems in Non-Smooth Domains .....	105
<i>C. Iwasaki</i> Calculus of Pseudo-Differential Operators and a Local Index of Dirac Operators .....	123
<i>J. Delgado</i> $L^p$ Bounds for a Class of Fractional Powers of Subelliptic Operators ..	137
<i>V. Catană</i> The Heat Kernel and Green Function of the Generalized Hermite Operator, and the Abstract Cauchy Problem for the Abstract Hermite Operator .....	155
<i>V.S. Rabinovich</i> Local Exponential Estimates for $h$ -Pseudo-Differential Operators with Operator-Valued Symbols .....	173

<i>R. DeLeo, T. Gramchev and A. Kirilov</i>	
Global Solvability in Functional Spaces for Smooth Nonsingular Vector Fields in the Plane .....	191
<i>Y. Chiba</i>	
Fuchsian Mild Microfunctions with Fractional Order and their Applications to Hyperbolic Equations .....	211
<i>W. Ichinose</i>	
The Continuity of Solutions with Respect to a Parameter to Symmetric Hyperbolic Systems .....	219
<i>K. Benmeriem and C. Bouzar</i>	
Generalized Gevrey Ultradistributions and their Microlocal Analysis .....	235
<i>L. Cohen</i>	
Weyl Rule and Pseudo-Differential Operators for Arbitrary Operators .....	251
<i>L. Galleani</i>	
Time-Frequency Characterization of Stochastic Differential Equations .....	265
<i>P. Boggiatto, E. Carypis and A. Oliaro</i>	
Wigner Representations Associated with Linear Transformations of the Time-Frequency Plane .....	275
<i>E. Cordero and F. Nicola</i>	
Some Remarks on Localization Operators .....	289

# Preface

The ISAAC Group in Pseudo-Differential Operators (IGPDO) met again on July 13–18, 2009 at Imperial College London in England on the occasion of the Seventh Congress of the International Society for Analysis, its Applications and Computations (ISAAC). The special session for IGPDO turned out to be the largest session with over forty speakers filling out the entire schedule completely. Talks presented at the IGPDO session reflected the diversity of topics cutting across disciplines in the Analysis, Applications and Computations of Pseudo-Differential Operators.

This volume contains eighteen peer-reviewed papers related to the talks given at the IGPDO session. Chapters 1–3 feature a chapter on the adaptive wavelet computations of inverses of pseudo-differential operators (Q. Guo and M.W. Wong) and two chapters on the pseudo-differential operators on the unit circle (M. Pirhayati; S. Molahajloo). The latter two chapters pave the way towards the discretization and numerical computations of pseudo-differential operators. Chapters 4–7 are on pseudo-differential operators and boundary value problems on manifolds with singularities, non-smooth domains and Riemannian manifolds (B.-W. Schulze and M.W. Wong; B.-W. Schulze; V.B. Vasilyev; C. Iwasaki). Chapters 8–11 are devoted to concrete partial differential equations that are of interest in physics and geometry (J. Delgado; V. Catană; V.S. Rabinovich; R. DeLeo, T. Gramchev and A. Kirilov). Chapters 12–14 consist of chapters on microlocal analysis, hyperbolic equations and systems (Y. Chiba; W. Ichinose; K. Benmeriem and C. Bouzar). Chapters 15–18 are on topics related to Wigner transforms, Weyl transforms and localization operators (L. Cohen; L. Galleani; P. Boggiatto, E. Carypis and A. Oliaro; E. Cordero and F. Nicola).

In an era of interdisciplinary studies in academia fuelled by research and development for societal and global needs, the role of pseudo-differential operators in the mathematical, physical, biological, atmospherical, geological and medical sciences is vital. Underpinning novel *applications* are deep understanding in the *analysis* and efficient numerical *computations*. It is expected that new developments in Analysis, Applications and Computations of Pseudo-Differential Operators will deepen our understanding of science in general and hence improve the knowledge-based well-being of the world. Future developments of IGPDO are geared in the direction of interdisciplinarity.