

Operator Theory: Advances and
Applications
Vol. 168

Editor:
I. Gohberg

Editorial Office:
School of Mathematical
Sciences
Tel Aviv University
Ramat Aviv, Israel

Editorial Board:
D. Alpay (Beer-Sheva)
J. Arazy (Haifa)
A. Atzmon (Tel Aviv)
J. A. Ball (Blacksburg)
A. Ben-Artzi (Tel Aviv)
H. Bercovici (Bloomington)
A. Böttcher (Chemnitz)
K. Clancey (Athens, USA)
L. A. Coburn (Buffalo)
R. E. Curto (Iowa City)
K. R. Davidson (Waterloo, Ontario)
R. G. Douglas (College Station)
A. Dijksma (Groningen)
H. Dym (Rehovot)
P. A. Fuhrmann (Beer Sheva)
B. Gramsch (Mainz)
J. A. Helton (La Jolla)
M. A. Kaashoek (Amsterdam)
H. G. Kaper (Argonne)

S. T. Kuroda (Tokyo)
P. Lancaster (Calgary)
L. E. Lerer (Haifa)
B. Mityagin (Columbus)
V. Olshevsky (Storrs)
M. Putinar (Santa Barbara)
L. Rodman (Williamsburg)
J. Rovnyak (Charlottesville)
D. E. Sarason (Berkeley)
I. M. Spitkovsky (Williamsburg)
S. Treil (Providence)
H. Upmeyer (Marburg)
S. M. Verduyn Lunel (Leiden)
D. Voiculescu (Berkeley)
D. Xia (Nashville)
D. Yafaev (Rennes)

Honorary and Advisory
Editorial Board:
C. Foias (Bloomington)
P. R. Halmos (Santa Clara)
T. Kailath (Stanford)
H. Langer (Vienna)
P. D. Lax (New York)
M. S. Livsic (Beer Sheva)
H. Widom (Santa Cruz)

Partial Differential Equations and Functional Analysis

The Philippe Clément Festschrift

Erik Koelink
Jan van Neerven
Ben de Pagter
Guido Sweers
Editors

Birkhäuser Verlag
Basel · Boston · Berlin

Editors:

Frik Koelink, Jan van Neerven, Ben de Pagter and
Guido Sweers
Technische Universiteit Delft
DIAM
P.O. Box 5031
2600 GA Delft
The Netherlands
e-mail: H.T.Koelink@math.tudelft.nl
J.vanNeerven@math.tudelft.nl
B.dePagter@math.tudelft.nl
G.H.Sweers@math.tudelft.nl

Annemarie Luger
Harald Woracek
Institut für Analysis und Scientific Computing
Technische Universität Wien
Wiedner Hauptstrasse 8–10 / 101
1040 Wien
Austria
e-mail: aluger@mail.zserv.tuwien.ac.at
harald.woracek@tuwien.ac.at

20, 47B50; Secondary 34L05, 47A57, 47A75

2000 Mathematics Subject Classification 35xx, 45xx, 47Dxx

A CIP catalogue record for this book is available from the
Library of Congress, Washington D.C., USA

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in
the Internet at <<http://dnb.ddb.de>>.

ISBN 3-7643-7600-7 Birkhäuser Verlag, Basel – Boston – Berlin

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.

© 2006 Birkhäuser Verlag, P.O. Box 133, CH-4010 Basel, Switzerland
Part of Springer Science+Business Media

Printed on acid-free paper produced from chlorine-free pulp. TCF ∞

Cover design: Heinz Hiltbrunner, Basel

Printed in Germany

ISBN-10: 3-7643-7600-7

e-ISBN: 3-7643-7601-5

ISBN-13: 978-3-7643-7600-4

9 8 7 6 5 4 3 2 1

www.birkhauser.ch

Contents

| | |
|--|------|
| Preface | vii |
| Portrait of <i>Philippe Clément</i> | viii |
| <i>Philippe Clément</i> : Curriculum Vitae | ix |
| <i>Gabriella Caristi and Enzo Mitidieri</i> | |
| Harnack Inequality and Applications to Solutions of Biharmonic Equations | 1 |
| <i>Carsten Carstensen</i> | |
| Clément Interpolation and Its Role in Adaptive Finite Element Error Control | 27 |
| <i>Sandra Cerrai</i> | |
| Ergodic Properties of Reaction-diffusion Equations Perturbed by a Degenerate Multiplicative Noise | 45 |
| <i>Giuseppe Da Prato and Alessandra Lunardi</i> | |
| Kolmogorov Operators of Hamiltonian Systems Perturbed by Noise | 61 |
| <i>A.F.M. ter Elst, Derek W. Robinson, Adam Sikora and Yueping Zhu</i> | |
| Dirichlet Forms and Degenerate Elliptic Operators | 73 |
| <i>Onno van Gaans</i> | |
| On R-boundedness of Unions of Sets of Operators | 97 |
| <i>Matthias Geißert, Horst Heck and Matthias Hieber</i> | |
| On the Equation $\operatorname{div} u = g$ and Bogovskii's Operator in Sobolev Spaces of Negative Order | 113 |
| <i>F. den Hollander</i> | |
| Renormalization of Interacting Diffusions: A Program and Four Examples | 123 |
| <i>Tuomas P. Hytönen</i> | |
| Reduced Mihlin-Lizorkin Multiplier Theorem in Vector-valued L^p Spaces | 137 |

Stig-Olof Londen

- Interpolation Spaces for Initial Values of
Abstract Fractional Differential Equations 153

Noboru Okazawa

- Semilinear Elliptic Problems Associated with
the Complex Ginzburg-Landau Equation 169

Jan Prüss and Gieri Simonett

- Operator-valued Symbols for Elliptic and
Parabolic Problems on Wedges 189

Jan Prüss and Mathias Wilke

- Maximal L_p -regularity and Long-time Behavior
of the Non-isothermal Cahn-Hilliard Equation
with Dynamic Boundary Conditions 209

Jacques Rappaz

- Numerical Approximation of PDEs and Clément's Interpolation 237

Erik G.F. Thomas

- On Prohorov's Criterion for Projective Limits 251

Lutz Weis

- The H^∞ Holomorphic Functional Calculus
for Sectorial Operators – a Survey 263

Preface

The present volume is dedicated to Philippe Clément on the occasion of his retirement in December 2004. It has its origin in the workshop “Partial Differential Equations and Functional Analysis” (Delft, November 29–December 1, 2004) which was held to celebrate Philippe’s profound contributions in various areas of Mathematical Analysis.

The articles presented here offer a panorama of current developments in the theory of partial differential equations as well as applications to such diverse areas as numerical analysis of PDEs, Volterra equations, evolution equations, H^∞ -calculus, elliptic systems, mathematical physics, and stochastic analysis. They reflect Philippe’s interests very well and indeed several of the authors have collaborated with him in the course of his career.

The editors gratefully acknowledge the financial support of the Royal Netherlands Academy of Arts and Sciences, the Netherlands Organization for Scientific Research, and the Thomas Stieltjes Institute for organizing the workshop. They also thank Thomas Hempfling for the pleasant collaboration during the preparation of this volume.

Last but not least the editors, all members of his former group, thank Philippe for his constant inspiration and for sharing his enthusiasm in mathematics with them.

The Editors



This volume is dedicated to *Philippe Clément*
on the occasion of his retirement.

Philippe Clément: Curriculum Vitae

Philippe Clément, born on 9 January 1943 in Billens, Switzerland, started his study in Physics at the Ecole Polytechnique de l' Université de Lausanne (now EPFL) in 1962 and obtained the degree of Physicist-Engineer in 1967. During that period he discovered that his true interest was much more in Mathematics and he obtained the License des Sciences Mathématiques in 1968 from the University of Lausanne. Hereafter he started to work on his Ph.D. thesis in the area of Numerical Analysis at the EPFL with J. Descloux as supervisor. He defended his thesis, "*Méthode des éléments finis appliquée à des problèmes variationnels de type indéfini*", in February 1974. Some of the results were published in his seminal paper "*Approximation by finite element functions using local regularization*" (Rev. Française Automat. Informat. Recherche Opérationnelle, RAIRO Analyse Numérique 9, 1975, R-2, 77–84). In this paper he introduced what is nowadays known in the literature as *the Clément-type interpolation operators*, which play a key role in the analysis of adaptive finite element methods.

In the period 1972–74 Philippe was First Assistant at the Department of Mathematics of the EPFL and under the influence of B. Zwohlen he became interested in Nonlinear Analysis. It was a very stimulating and inspiring time and environment for him, in particular, he met at various workshops Amann, Aubin, Da Prato, Grisvard, Tartar and others. The years 1974–77 Philippe continued his mathematical work, supported by the Swiss National Foundation for Scientific Research, in Madison (USA), first as Honorary Fellow at the Mathematics Department, later as a Research Staff Member at the Mathematics Research Center, of the University of Wisconsin. In that period he came into contact with Crandall and Rabinowitz and worked on nonlinear elliptic problems. Together with Nohel and Londen, he started to be involved in nonlinear Volterra equations.

In 1977 Philippe moved to the University of Technology in Delft, where he was appointed as Associate Professor. In 1980 he became full professor and in 1985 he obtained the Chair in Functional Analysis in Delft. His main areas of interest and research were (and still are) the theory of evolution equations, operator semigroups as well as the Volterra equations and elliptic problems mentioned before. In particular, he was involved in problems concerning maximal regularity and problems related to functional calculus. Philippe is widely recognized for his important contributions in these areas. The very stimulating seminars in Delft on the theory of semigroups have resulted in the book "*One-Parameter Semigroups*" (Clément, Heijmans et al.). In recent years his interests also include stochastic integral equations.