CONTEMPORARY MATHEMATICS

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Control Methods in PDE-Dynamical Systems

AMS-IMS-SIAM Joint Summer Research Conference
July 3–7, 2005
Snowbird, Utah

Fabio Ancona
Irena Lasiecka
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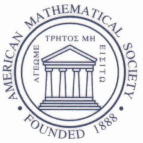
Editors



American Mathematical Society

http://dx.doi.org/10.1090/conm/426

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This volume contains the proceedings of an AMS-IMS-SIAM Joint Summer Research Conference on Control Methods in PDE-Dynamical Systems, held at the Snowbird Resort, Snowbird, UT, from July 3–7, 2005, with support from the National Science Foundation, grant DMS-9973450.

2000 *Mathematics Subject Classification.* Primary 35–XX, 49–XX, 93–XX.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Library of Congress Cataloging-in-Publication Data

AMS-IMS-SIAM Joint Summer Research Conference on Control Methods in PDE-Dynamical Systems (2005 : Snowbird, Utah)

Control methods in PDE-dynamical systems : AMS-IMS-SIAM Joint Summer Research Conference on Control Methods in PDE-Dynamical Systems, July 3–7, 2005, Snowbird, Utah / Fabio Ancona... [et al.], editors.

p. cm. — (Contemporary mathematics, ISSN 0271-4132 ; V. 426)

Includes bibliographical references.

ISBN-13: 978-0-8218-3766-5 (alk. paper)

ISBN-10: 0-8218-3766-4 (alk. paper)

1. Differential equations, Partial–Congresses. 2. Differentiable dynamical systems–Congresses. 3. Nonlinear difference equations–Congresses. 4. Control theory–Congresses. I. Ancona, Fabio, 1964– II. Title. III. Series: Contemporary mathematics (American Mathematical Society) ; v. 426.

QA377.A568 2005

515′.353—dc22 2006048032

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Preface

This volume contains selected papers that were presented at the AMS-IMS-SIAM Joint Summer Research Conference on "Control Methods in PDE-Dynamical Systems," held at the Snowbird Resort, Utah, July 3–7, 2005. This conference was conceived and proposed by the underwriters in February 2004, with one overriding aim: to remain rooted in the topic of controlled PDE systems while reaching out to an ostensibly distinct, yet scientifically related, research community in mathematics; namely, those researchers involved in the study of dynamical properties and asymptotic long-time behavior (in particular, stability) of PDE-mixed problems. It is this community of PDE-based dynamical system specialists that the conference sought to bring together with the community of PDE-control and optimization theorists. These two groups have been concentrated in (roughly) complementary research areas; both in terms of the types of PDEs under investigation and of the nature of the questions asked.

Indeed, the PDE control group—while not neglecting parabolic PDEs—has predominantly been focused on more challenging (non-smoothing) hyperbolic or hyperbolic-like (Petrowski-type) PDEs, typically endowed with low regularity properties. For these dynamics, this group has studied issues such as: (i) optimal (global) interior and boundary (trace) regularity of mixed (initial and boundary value) problems (that is, the issue of well-posedness); (ii) global exact controllability and, equivalently, by duality, corresponding continuous observability estimates (of inverse-type); (iii) uniform stabilization of original conservative (energy preserving) problems: global in the linear case, or local and global in the nonlinear case, either by the insertion of suitable damping or dissipation, or else through the introduction of optimization theory; (iv) well-posedness, regularity, or blow-up of *finite energy* solutions, corresponding to feedback *controlled* nonlinear problems. Here, feedback dissipative mechanisms that are effective in securing good stability of hyperbolic dynamics are typically "rough" or "unbounded." Therefore, the analysis of the resulting nonlinear feedback problem is typically outside the realm of perturbation theory and requires very special considerations rooted in nonlinear PDE theory (e.g., weak convergence methods, compensated compactness, etc.); (v) control-theoretic properties of controllability, asymptotic behaviour and optimality for weak solutions of (hyperbolic) conservation laws and balance laws.

The second, dynamical system, group has dealt mostly with the asymptotic question of long-time behavior of PDEs (non-necessarily dissipative) of smoothing and regularizing parabolic PDEs; and the consequent issues concerning existence of global attractors, their geometric, topological, and structural properties, as well as their dimension (when this is finite).

While pursuing separate interests in their respective range of action with a different focus, and often with a different array of technical tools, the two communities do share, however, a substantial body of common knowledge and background in evolution equations. Thus, it was the organizers' firm conviction that the time was ripe and the momentum propitious to bring them together at a joint conference, to mutually stimulate each other and to share recent advances and breakthroughs in their respective disciplines. These would then serve as springboards for new progress through their combination. This conviction was further buttressed by recent discoveries that certain nontrivial energy methods, initially devised for control-theoretic *a-priori* estimates, once combined with dynamical systems techniques, yield entirely new asymptotic results on well-established, nonlinear PDE systems, particularly hyperbolic and Petrowski-type PDEs.

These expectations are now particularly well reflected in the contributions to this volume. They involve nonlinear parabolic, as well as hyperbolic, equations and their attractors, aeroelasticity, elastic systems, Euler-Korteweg models, thin-film equations, Schrödinger equations, beam equations, variational principles, etc. In addition, the static topics of Helmholtz equations, and Morrey potentials are also prominently featured. A special component of the present volume focuses on hyperbolic conservation laws where, thanks to recent, major theoretical advances, a general mathematical theory is now in place. This is also suitable for the analysis of boundary or distributed control problems, such as they are motivated by various applications including traffic flow models, gas dynamics, etc.

In all of these areas, the reader will find state-of-the-art accounts as stimulating starting points for further research.

The organizers are grateful to all participants for their contributions to the Conference, either by lecturing, by publishing in the present *Proceedings*, or by actively taking part in the intellectual debate at the Conference.

Very warm thanks are extended to the AMS staff; in particular, to Ms. Donna Salter and Ms. Lori Melucci, whose much appreciated efforts and smooth, professional coordination of a large variety of activities were essential to the success of the Conference.

Finally, we wish to thank Ms. Christine Thivierge from the AMS Publication Office, for precious help in connection with the publication of the present volume.

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While rooted in controlled PDE systems, this 2005 AMS-IMS-SIAM Summer Research Conference sought to reach out to a rather distinct, yet scientifically related, research community in mathematics interested in PDE-based dynamical systems. Indeed, this community is also involved in the study of dynamical properties and asymptotic long-time behavior (in particular, stability) of PDE-mixed problems. It was the editors' conviction that the time had become ripe and the circumstances propitious for these two mathematical communities—that of PDE control and optimization theorists and that of dynamical specialists—to come together in order to share recent advances and breakthroughs in their respective disciplines. This conviction was further buttressed by recent discoveries that certain energy methods, initially devised for control-theoretic a-priori estimates, once combined with dynamical systems techniques, yield wholly new asymptotic results on well-established, nonlinear PDE systems, particularly hyperbolic and Petrowski-type PDEs.

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ISBN 978-0-8218-3766-5

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CONM/426