

# CONTEMPORARY MATHEMATICS

218

## Domain Decomposition Methods 10

The Tenth International Conference  
on Domain Decomposition Methods  
August 10–14, 1997  
Boulder, CO

Jan Mandel  
Charbel Farhat  
Xiao-Chuan Cai  
Editors



## Selected Titles in This Series

- 218 **Jan Mandel, Charbel Farhat, and Xiao-Chuan Cai, Editors**, Domain decomposition methods 10, 1998
- 217 **Eric Carlen, Evans M. Harrell, and Michael Loss, Editors**, Advances in differential equations and mathematical physics, 1998
- 216 **Akram Aldroubi and EnBing Lin, Editors**, Wavelets, multiwavelets, and their applications, 1998
- 215 **M. G. Nerurkar, D. P. Dokken, and D. B. Ellis, Editors**, Topological dynamics and applications, 1998
- 214 **Lewis A. Coburn and Marc A. Rieffel, Editors**, Perspectives on quantization, 1998
- 213 **Farhad Jafari, Barbara D. MacCluer, Carl C. Cowen, and A. Duane Porter, Editors**, Studies on composition operators, 1998
- 212 **E. Ramírez de Arellano, N. Salinas, M. V. Shapiro, and N. L. Vasilevski, Editors**, Operator theory for complex and hypercomplex analysis, 1998
- 211 **Józef Dodziuk and Linda Keen, Editors**, Lipa's legacy: Proceedings from the Bers Colloquium, 1997
- 210 **V. Kumar Murty and Michel Waldschmidt, Editors**, Number theory, 1998
- 209 **Steven Cox and Irena Lasiecka, Editors**, Optimization methods in partial differential equations, 1997
- 208 **Michel L. Lapidus, Lawrence H. Harper, and Adolfo J. Rumbos, Editors**, Harmonic analysis and nonlinear differential equations: A volume in honor of Victor L. Shapiro, 1997
- 207 **Yujiro Kawamata and Vyacheslav V. Shokurov, Editors**, Birational algebraic geometry: A conference on algebraic geometry in memory of Wei-Liang Chow (1911–1995), 1997
- 206 **Adam Korányi, Editor**, Harmonic functions on trees and buildings, 1997
- 205 **Paulo D. Cordaro and Howard Jacobowitz, Editors**, Multidimensional complex analysis and partial differential equations: A collection of papers in honor of François Trèves, 1997
- 204 **Yair Censor and Simeon Reich, Editors**, Recent developments in optimization theory and nonlinear analysis, 1997
- 203 **Hanna Nencka and Jean-Pierre Bourguignon, Editors**, Geometry and nature: In memory of W. K. Clifford, 1997
- 202 **Jean-Louis Loday, James D. Stasheff, and Alexander A. Voronov, Editors**, Operads: Proceedings of Renaissance Conferences, 1997
- 201 **J. R. Quine and Peter Sarnak, Editors**, Extremal Riemann surfaces, 1997
- 200 **F. Dias, J.-M. Ghidaglia, and J.-C. Saut, Editors**, Mathematical problems in the theory of water waves, 1996
- 199 **G. Banaszak, W. Gajda, and P. Krasoń, Editors**, Algebraic  $K$ -theory, 1996
- 198 **Donald G. Saari and Zhihong Xia, Editors**, Hamiltonian dynamics and celestial mechanics, 1996
- 197 **J. E. Bonin, J. G. Oxley, and B. Servatius, Editors**, Matroid theory, 1996
- 196 **David Bao, Shiing-shen Chern, and Zhongmin Shen, Editors**, Finsler geometry, 1996
- 195 **Warren Dicks and Enric Ventura**, The group fixed by a family of injective endomorphisms of a free group, 1996
- 194 **Seok-Jin Kang, Myung-Hwan Kim, and Insok Lee, Editors**, Lie algebras and their representations, 1996
- 193 **Chongying Dong and Geoffrey Mason, Editors**, Moonshine, the Monster, and related topics, 1996
- 192 **Tomek Bartoszyński and Marion Scheepers, Editors**, Set theory, 1995

*(Continued in the back of this publication)*



# Domain Decomposition Methods 10

# CONTEMPORARY MATHEMATICS

---

218

## Domain Decomposition Methods 10

The Tenth International Conference  
on Domain Decomposition Methods  
August 10–14, 1997  
Boulder, CO

Jan Mandel  
Charbel Farhat  
Xiao-Chuan Cai  
Editors



---

American Mathematical Society  
Providence, Rhode Island

## Editorial Board

Dennis DeTurck, managing editor

Andy R. Magid

Michael Vogelius

Clark Robinson

Peter M. Winkler

This volume contains the proceedings of the Tenth International Conference on Domain Decomposition Methods for Partial Differential Equations, which took place at the University of Colorado at Boulder, August 10–August 14, 1997. The focus of the conference was on realistic applications in structural mechanics, structural dynamics, computational fluid dynamics, and heat transfer. The volume is divided into four parts: the first part contains invited papers; the rest of the volume contains minisymposia and contributed presentations, further divided into Algorithms, Theory, and Applications.

Support was provided by the National Science Foundation, ANSYS, Inc., the Sandia National Laboratories, the Colorado School of Mines, the University of Colorado at Boulder, and the University of Colorado at Denver.

1991 *Mathematics Subject Classification*. Primary 65–06;  
Secondary 65N55, 65M55, 65Y05, 73–06, 76–06.

---

### Library of Congress Cataloging-in-Publication Data

International Conference on Domain Decomposition Methods for Partial Differential Equations (1997 : Boulder, Colo.)

Domain decomposition methods 10 : the Tenth International Conference on Domain Decomposition Methods, August 10–14, 1997, Boulder, Colorado, USA / Jan Mandel, Charbel Farhat, Xiao-Chuan Cai, editors.

p. cm. — (Contemporary mathematics, ISSN 0271-4132 ; 218)

Includes bibliographical references.

ISBN 0-8218-0988-1 (pbk. : alk. paper)

1. Decomposition method—Congresses. 2. Differential equations, Partial—Congresses. I. Mandel, Jan. II. Farhat, Charbel. III. Cai, Xiao-Chuan, 1962–. IV. Title. V. Series: Contemporary mathematics (American Mathematical Society) ; v. 218.

QA402.2.I57 1997

515'.353—dc21

98-15580

CIP

---

**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 Assistant to the Publisher, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940-6248. Requests can also be made by e-mail to [reprint-permission@ams.org](mailto: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.)

© 1998 by the American Mathematical Society. All rights reserved.

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

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 URL: <http://www.ams.org/>

10 9 8 7 6 5 4 3 2 1 03 02 01 00 99 98

# Contents

|  |          |
|--|----------|
| Preface  | xi       |
| <b>Part 1. Invited Presentations</b>   | <b>1</b> |
| Nonmatching Grids for Fluids<br>YVES ACHDOU, GASSAN ABDOULAEV, JEAN-CLAUDE HONTAND, YURI<br>A. KUZNETSOV, OLIVIER PIRONNEAU, AND CHRISTOPHE PRUD'HOMME   | 3        |
| A Parallel Non-Overlapping Domain-Decomposition Algorithm for<br>Compressible Fluid Flow Problems on Triangulated Domains<br>TIMOTHY J. BARTH, TONY F. CHAN, AND WEI-PAI TANG                                      | 23       |
| A Non-Overlapping Domain Decomposition Method for the Exterior Helmholtz<br>Problem<br>ARMEL DE LA BOURDONNAYE, CHARBEL FARHAT, ANTONINI MACEDO,<br>FRÉDÉRIC MAGOULÈS, AND FRANÇOIS-XAVIER ROUX                    | 42       |
| An Agglomeration Multigrid Method for Unstructured Grids<br>TONY F. CHAN, JINCHAO XU, AND LUDMIL ZIKATANOV   | 67       |
| Solution of Coercive and Semicoercive Contact Problems by FETI Domain<br>Decomposition<br>ZDENĚK DOSTÁL, ANA FRIEDLANDER, AND SANDRA A. SANTOS   | 82       |
| An Iterative Substructuring Method for Elliptic Mortar Finite Element<br>Problems with Discontinuous Coefficients<br>MAKSYMILIAN DRYJA   | 94       |
| Domain Decomposition Methods for Flow in Heterogeneous Porous Media<br>MAGNE S. ESPEDAL, KARL J. HERSVIK, AND BRIT G. ERSLAND  | 104      |
| A Fictitious Domain Method with Distributed Lagrange Multipliers for the<br>Numerical Simulation of Particulate Flow<br>ROLAND GLOWINSKI, TSORNG-WHAY PAN, TODD I. HESLA, DANIEL<br>D. JOSEPH, AND JACQUES PERIAUX | 121      |
| Domain Decomposition Algorithms for Saddle Point Problems<br>LUCA F. PAVARINO  | 138      |
| Parallel Implementation of Direct Solution Strategies for the Coarse Grid<br>Solvers in 2-level FETI Method<br>FRANÇOIS-XAVIER ROUX AND CHARBEL FARHAT   | 158      |
| Domain Decomposition and Multi-Level Type Techniques for General Sparse<br>Linear Systems<br>YOUSEF SAAD, MARIA SOSONKINA, AND JUN ZHANG   | 174      |



|   |            |
|---|------------|
| Spectral/ <i>hp</i> Methods for Elliptic Problems on Hybrid Grids<br>SPENCER J. SHERWIN, TIMOTHY C.E. WARBURTON, AND GEORGE EM<br>KARNIADAKIS   | 191        |
| Physical and Computational Domain Decompositions for Modeling Subsurface<br>Flows<br>MARY F. WHEELER AND IVAN YOTOV   | 217        |
| <b>Part 2. Algorithms</b>   | <b>229</b> |
| Nonoverlapping Domain Decomposition Algorithms for the $p$ -version Finite<br>Element Method for Elliptic Problems<br>ION BICĂ  | 231        |
| A 2-level and Mixed Domain Decomposition Approach for Structural Analysis<br>DAVID DUREISSEIX AND PIERRE LADEVÈZE   | 238        |
| Iso-P2 P1/P1/P1 Domain-Decomposition/Finite-Element Method for the<br>Navier-Stokes Equations<br>SHOICHI FUJIMA   | 246        |
| Overlapping Nonmatching Grids Method: Some Preliminary Studies<br>SERGE GOOSSENS, XIAO-CHUAN CAI, AND DIRK ROOSE  | 254        |
| Nonconforming Grids for the Simulation of Fluid-Structure Interaction<br>CÉLINE GRANDMONT AND YVON MADAY  | 262        |
| Hash-Storage Techniques for Adaptive Multilevel Solvers and Their Domain<br>Decomposition Parallelization<br>MICHAEL GRIEBEL AND GERHARD ZUMBUSCH   | 271        |
| Extension of a Coarse Grid Preconditioner to Non-symmetric Problems<br>CAROLINE JAPHET, FRÉDÉRIC NATAF, AND FRANÇOIS-XAVIER ROUX  | 279        |
| On the Interaction of Architecture and Algorithm in the Domain-based<br>Parallelization of an Unstructured-grid Incompressible Flow Code<br>DINESH K. KAUSHIK, DAVID E. KEYES, AND BARRY F. SMITH       | 287        |
| Additive Domain Decomposition Algorithms for a Class of Mixed Finite<br>Element Methods<br>AXEL KLAWONN   | 296        |
| Non-conforming Domain Decomposition Method for Plate and Shell Problems<br>CATHERINE LACOUR   | 304        |
| Solutions of Boundary Element Equations by a Flexible Elimination Process<br>CHOI-HONG LAI AND KE CHEN  | 311        |
| An Efficient FETI Implementation on Distributed Shared Memory Machines<br>with Independent Numbers of Subdomains and Processors<br>MICHEL LESOINNE AND KENDALL PIERSON                                  | 318        |
| Additive Schwarz Methods with Nonreflecting Boundary Conditions for the<br>Parallel Computation of Helmholtz Problems<br>LOIS C. MCINNES, ROMEO F. SUSAN-RESIGA, DAVID E. KEYES, AND<br>HAFIZ M. ATASSI | 325        |

|  |     |
|--|-----|
| On the Reuse of Ritz Vectors for the Solution to Nonlinear Elasticity Problems<br>by Domain Decomposition Methods<br>FRANCK RISLER AND CHRISTIAN REY             | 334 |
| Dual Schur Complement Method for Semi-Definite Problems<br>DANIEL J. RIXEN   | 341 |
| Two-level Algebraic Multigrid for the Helmholtz Problem<br>PETR VANĚK, JAN MANDEL, AND MARIAN BREZINA  | 349 |
| A Comparison of Scalability of Different Parallel Iterative Methods for Shallow<br>Water Equations<br>ARNT H. VEENSTRA, HAI XIANG LIN, AND EDWIN A.H. VOLLEBREGT | 357 |
| A Nonoverlapping Subdomain Algorithm with Lagrange Multipliers and Its<br>Object Oriented Implementation for Interface Problems<br>DAOQI YANG                    | 365 |
| <b>Part 3. Theory</b>  | 375 |
| A Robin-Robin Preconditioner for an Advection-Diffusion Problem<br>YVES ACHDOU AND FRÉDÉRIC NATAF  | 377 |
| A Semi-dual Mode Synthesis Method for Plate Bending Vibrations<br>FRÉDÉRIC BOURQUIN AND RABAH NAMAR  | 384 |
| Overlapping Schwarz Algorithms for Solving Helmholtz's Equation<br>XIAO-CHUAN CAI, MARIO A. CASARIN, FRANK W. ELLIOTT, JR., AND<br>OLOF B. WIDLUND               | 391 |
| Symmetrized Method with Optimized Second-Order Conditions for the<br>Helmholtz Equation<br>PHILIPPE CHEVALIER AND FRÉDÉRIC NATAF                                 | 400 |
| Non-overlapping Schwarz Method for Systems of First Order Equations<br>SÉBASTIEN CLERC   | 408 |
| Interface Conditions and Non-overlapping Domain Decomposition Methods<br>for a Fluid-Solid Interaction Problem<br>XIAOBING FENG                                  | 417 |
| Overlapping Schwarz Waveform Relaxation for Parabolic Problems<br>MARTIN J. GANDER   | 425 |
| Domain Decomposition, Operator Trigonometry, Robin Condition<br>KARL GUSTAFSON   | 432 |
| On Orthogonal Polynomial Bases for Triangles and Tetrahedra Invariant under<br>the Symmetric Group<br>GARY MAN-KWONG HUI AND HOWARD SWANN                        | 438 |
| On Schwarz Alternating Methods for Nonlinear Elliptic Problems<br>SHIU HONG LUI  | 447 |
| Convergence Results for Non-Conforming $hp$ Methods: The Mortar Finite<br>Element Method<br>PADMANABHAN SESHAIYER AND MANIL SURI                                 | 453 |

|   |     |
|---|-----|
| Intergrid Transfer Operators for Biharmonic Problems Using Nonconforming Plate Elements on Nonnested Meshes<br>ZHONGCI SHI AND ZHENGHUI XIE   | 460 |
| Additive Schwarz Methods for Hyperbolic Equations<br>YUNHAI WU, XIAO-CHUAN CAI, AND DAVID E. KEYES  | 468 |
| <b>Part 4. Applications</b>   | 477 |
| A Minimum Overlap Restricted Additive Schwarz Preconditioner and Applications in 3D Flow Simulations<br>XIAO-CHUAN CAI, CHARBEL FARHAT, AND MARCUS SARKIS                               | 479 |
| Time Domain Decomposition for European Options in Financial Modelling<br>DIANE CRANN, ALAN J. DAVIES, CHOI-HONG LAI, AND SWEE H. LEONG  | 486 |
| Parallel Modal Synthesis Methods in Structural Dynamics<br>JEAN-MICHEL CROS   | 492 |
| Efficient Computation of Aerodynamic Noise<br>GEORGI S. DJAMBAZOV, CHOI-HONG LAI, AND KOULIS A. PERICLEOUS  | 500 |
| Non-overlapping Domain Decomposition Applied to Incompressible Flow Problems<br>FRANK-CHRISTIAN OTTO AND GERT LUBE  | 507 |
| A Domain Decomposition Based Algorithm for Non-linear 2D Inverse Heat Conduction Problems<br>CHARAKA J. PALANSURIYA, CHOI-HONG LAI, CONSTANTINOS S. IEROTHEOU, AND KOULIS A. PERICLEOUS | 515 |
| Overlapping Domain Decomposition and Multigrid Methods for Inverse Problems<br>XUE-CHENG TAI, JOHNNY FRØYEN, MAGNE S. ESPEDAL, AND TONY F. CHAN   | 523 |
| Some Results on Schwarz Methods for a Low-Frequency Approximation of Time-Dependent Maxwell's Equations in Conductive Media<br>ANDREA TOSELLI   | 530 |
| Parallel Computing for Reacting Flows Using Adaptive Grid Refinement<br>ROBBERT L. VERWEIJ, ARIS TWERDA, AND TIM W.J. PEETERS   | 538 |
| The Coupling of Mixed and Conforming Finite Element Discretizations<br>CHRISTIAN WIENERS AND BARBARA I. WOHLMUTH  | 547 |

## Preface

The annual International Conference on Domain Decomposition Methods for Partial Differential Equations has been a major event in Applied Mathematics and Engineering for the last ten years. The proceedings of the Conferences have become a standard reference in the field, publishing seminal papers as well as the latest theoretical results and reports on practical applications.

The Tenth Conference on Domain Decomposition Methods took place at the University of Colorado at Boulder from August 10 to August 14, 1997. It was organized by Charbel Farhat, Department of Aerospace Engineering Science, Xiao-Chuan Cai, Department of Computer Science, both at the University of Colorado at Boulder, and Jan Mandel, Department of Mathematics at the University of Colorado at Denver.

Driven by the availability of powerful parallel processors, the field of Domain Decomposition has matured during the past ten years. The focus of new methods has been shifting from positive definite elliptic problems to complicated applications, nonlinear problems, systems, and problems with non-elliptic numerical behavior, such as wave propagation and the Helmholtz equation. At the same time, the advent of practical massively parallel computers poses new challenges for elliptic equations, especially on arbitrary, nonuniform meshes. These Proceedings contain contributions from all these areas. The focus of the Conference, as reflected in the selection of invited speakers, was on realistic applications in structural mechanics, structural dynamics, computational fluid dynamics, and heat transfer.

The Conference had 171 registered participants. There were 16 invited plenary lectures and 113 mini-symposia and plenary presentations. These proceedings contain 13 invited and 41 mini-symposia and contributed papers. All papers have been refereed. The Proceedings are divided into four parts. The first part contains invited papers. The rest of the volume contains mini-symposia and contributed presentations, further divided into Algorithms, Theory, and Applications.

Previous proceedings of the International Conferences on Domain Decomposition were published by SIAM, AMS, and John Wiley & Sons. We welcome the return of the Proceedings to AMS. We would like to acknowledge the help of the AMS staff in deciding the format and preparing the Proceedings. We would like to thank particularly Dr. Sergei Gelfand for encouraging us to abolish the page limit for invited presentations.

We wish to thank the members of the International Scientific Committee, and in particular the Chair, Petter Bjørstad, for their help in setting the scientific direction of the Conference. We are also grateful to the organizers of the mini-symposia for attracting high-quality presentations.



Timely production of these Proceedings would not have been possible without the cooperation of the authors and the anonymous referees. We would like to thank them all for their graceful and timely response to our various demands.

The organizers of the Conference would like to acknowledge the sponsors of the Conference, namely the National Science Foundation, ANSYS, Inc., the Sandia National Laboratories, the Colorado School of Mines, the University of Colorado at Boulder, and the University of Colorado at Denver. Their generous support made the Conference possible and, among other things, allowed the organizers to fund the participation of graduate students.

Finally, we would like to express our appreciation to Ms. Cathy Moser, the Secretary of the Conference, who made all organizational details run smoothly, and Dr. Radek Tezaur, the Technical Editor of these Proceedings, who finalized the formatting of the papers in AMS- $\LaTeX$  and prepared the whole book for printing.

The complete program of the Conference is available at the Conference Web site <http://www-math.cudenver.edu/dd10>. More related information, including links to other Domain Decomposition conferences and books, can be found at the Official Domain Decomposition Web site at <http://www.ddm.org>. The purchaser of this volume is entitled to the online edition of this book by AMS. To gain access, follow the instructions given on the form found in the back of this volume.

Jan Mandel  
Charbel Farhat  
Xiao-Chuan Cai

## Selected Titles in This Series

(Continued from the front of this publication)

- 191 **Tuong Ton-That, Kenneth I. Gross, Donald St. P. Richards, and Paul J. Sally, Jr., Editors**, Representation theory and harmonic analysis, 1995
- 190 **Mourad E. H. Ismail, M. Zuhair Nashed, Ahmed I. Zayed, and Ahmed F. Ghaleb, Editors**, Mathematical analysis, wavelets, and signal processing, 1995
- 189 **S. A. M. Marcantognini, G. A. Mendoza, M. D. Morán, A. Octavio, and W. O. Urbina, Editors**, Harmonic analysis and operator theory, 1995
- 188 **Alejandro Adem, R. James Milgram, and Douglas C. Ravenel, Editors**, Homotopy theory and its applications, 1995
- 187 **G. W. Brumfiel and H. M. Hilden**,  $SL(2)$  representations of finitely presented groups, 1995
- 186 **Shreeram S. Abhyankar, Walter Feit, Michael D. Fried, Yasutaka Ihara, and Helmut Voelklein, Editors**, Recent developments in the inverse Galois problem, 1995
- 185 **Raúl E. Curto, Ronald G. Douglas, Joel D. Pincus, and Norberto Salinas, Editors**, Multivariable operator theory, 1995
- 184 **L. A. Bokut', A. I. Kostrikin, and S. S. Kutateladze, Editors**, Second International Conference on Algebra, 1995
- 183 **William C. Connett, Marc-Olivier Gebuhrer, and Alan L. Schwartz, Editors**, Applications of hypergroups and related measure algebras, 1995
- 182 **Selman Akbulut, Editor**, Real algebraic geometry and topology, 1995
- 181 **Mila Cenk and Haynes Miller, Editors**, The Čech Centennial, 1995
- 180 **David E. Keyes and Jinchao Xu, Editors**, Domain decomposition methods in scientific and engineering computing, 1994
- 179 **Yoshiaki Maeda, Hideki Omoro, and Alan Weinstein, Editors**, Symplectic geometry and quantization, 1994
- 178 **Hélène Barcelo and Gil Kalai, Editors**, Jerusalem Combinatorics '93, 1994
- 177 **Simon Gindikin, Roe Goodman, Frederick P. Greenleaf, and Paul J. Sally, Jr., Editors**, Representation theory and analysis on homogeneous spaces, 1994
- 176 **David Ballard**, Foundational aspects of “non”standard mathematics, 1994
- 175 **Paul J. Sally, Jr., Moshe Flato, James Lepowsky, Nicolai Reshetikhin, and Gregg J. Zuckerman, Editors**, Mathematical aspects of conformal and topological field theories and quantum groups, 1994
- 174 **Nancy Childress and John W. Jones, Editors**, Arithmetic geometry, 1994
- 173 **Robert Brooks, Carolyn Gordon, and Peter Perry, Editors**, Geometry of the spectrum, 1994
- 172 **Peter E. Kloeden and Kenneth J. Palmer, Editors**, Chaotic numerics, 1994
- 171 **Rüdiger Göbel, Paul Hill, and Wolfgang Liebert, Editors**, Abelian group theory and related topics, 1994
- 170 **John K. Beem and Krishan L. Duggal, Editors**, Differential geometry and mathematical physics, 1994
- 169 **William Abikoff, Joan S. Birman, and Kathryn Kuiken, Editors**, The mathematical legacy of Wilhelm Magnus, 1994
- 168 **Gary L. Mullen and Peter Jau-Shyong Shiue, Editors**, Finite fields: Theory, applications, and algorithms, 1994
- 167 **Robert S. Doran, Editor**,  $C^*$ -algebras: 1943–1993, 1994
- 166 **George E. Andrews, David M. Bressoud, and L. Alayne Parson, Editors**, The Rademacher legacy to mathematics, 1994
- 165 **Barry Mazur and Glenn Stevens, Editors**,  $p$ -adic monodromy and the Birch and Swinnerton-Dyer conjecture, 1994

(See the AMS catalog for earlier titles)

## **Domain Decomposition Methods 10**

Jan Mandel, Charbel Farhat, and Xiao-Chuan Cai, Editors

This volume contains the proceedings of the Tenth International Conference on Domain Decomposition Methods, which focused on the latest developments in realistic applications in structural mechanics, structural dynamics, computational fluid dynamics, and heat transfer. The proceedings of these conferences have become standard references in the field and contain seminal papers as well as the latest theoretical results and reports on practical applications.

This volume is divided into four parts: the first part contains invited papers (some of which survey developments over the past decade), and the other parts gather material from mini-symposia and contributed presentations under three headings: Algorithms, Theory, and Applications.

**ISBN 0-8218-0988-1**



9 780821 809884

*AMS on the Web*  
**www.ams.org**