

# **Progress in Nonlinear Differential Equations and Their Applications**

## ***Editor***

Haim Brezis  
Département de Mathématiques  
Université P. et M. Curie  
4, Place Jussieu  
75252 Paris Cedex 05  
France

*and*

Department of Mathematics  
Rutgers University  
Piscataway, NJ 08854-8019  
U.S.A.

*Progress in Nonlinear Differential Equations and Their Applications* is a book series that lies at the interface of pure and applied mathematics. Many differential equations are motivated by problems arising in such diversified fields as Mechanics, Physics, Differential Geometry, Engineering, Control Theory, Biology, and Economics. This series is open to both the theoretical and applied aspects, hopefully stimulating a fruitful interaction between the two sides. It will publish monographs, polished notes arising from lectures and seminars, graduate level texts, and proceedings of focused and refereed conferences.

We encourage preparation of manuscripts in some form of T<sub>E</sub>X for delivery in camera-ready copy, which leads to rapid publication, or in electronic form for interfacing with laser printers or typesetters.

Proposals should be sent directly to the editor or to: Birkhäuser Boston, 675 Massachusetts Avenue, Cambridge, MA 02139

- PNLDE 1 Partial Differential Equations and the Calculus of Variations, Volume I:  
Essays in Honor of Ennio De Giorgi  
*F. Colombini, A. Marino, L. Modica, and S. Spagnolo, editors*
  
- PNLDE 2 Partial Differential Equations and the Calculus of Variations, Volume II:  
Essays in Honor of Ennio De Giorgi  
*F. Colombini, A. Marino, L. Modica, and S. Spagnolo, editors*
  
- PNLDE 3 Propagation and Interaction of Singularities in Nonlinear Hyperbolic Problems  
*Michael Beals*
  
- PNLDE 4 Variational Methods  
*Henri Berestycki, Jean-Michel Coron, and Ivar Ekeland, editors*
  
- PNLDE 5 Composite Media and Homogenization Theory  
*Gianni Dal Maso and Gian Fausto Dell'Antonio, editors*

- PNLDE 6 Infinite Dimensional Morse Theory and Multiple Solution Problems  
*Kung-ching Chang*
- PNLDE 7 Nonlinear Differential Equations and their Equilibrium States, 3  
*N.G. Lloyd, W.M. Ni, L.A. Peletier, J. Serrin, editors*
- PNLDE 8 Introduction to  $\Gamma$ -Convergence  
*Gianni Dal Maso*
- PNLDE 9 Differential Inclusions in Nonsmooth  
Mechanical Problems: Shocks and Dry Frictions  
*Manuel D. P. Monteiro Marques*
- PNLDE 10 Periodic Solutions of Singular Lagrangian Systems  
*Antonio Ambrosetti and Vittorio Coti Zelati*
- PNLDE 11 Nonlinear Waves and Weak Turbulence:  
With Applications in Oceanography and  
Condensed Matter Physics  
*N. Fitzmaurice, D. Gurarie, F. McCaughan,  
and W. A. Woyczynski, editors*
- PNLDE 12 Seminar on Dynamical Systems: Euler  
International Math Institute, St. Petersburg, 1991  
*S. Kuksin, V. Lazutkin, and J. Pöschel, editors*
- PNLDE 13 Ginzburg–Landau Vortices  
*F. Bethuel, H. Brezis, and F. Hélein*
- PNLDE 14 Variational Methods for Image Segmentation  
*Jean-Michel Morel and Sergio Solomini*
- PNLDE 15 Topological Nonlinear Analysis: Degree,  
Singularity, and Variations  
*Michele Matzeu and Alfonso Vignoli, editors*
- PNLDE 16 Analytic Semigroups and Optimal Regularity  
in Parabolic Problems  
*A. Lunardi*
- PNLDE 17 Blowup for Nonlinear Hyperbolic Equations  
*Serge Alinhac*
- PNLDE 18 The Heat Kernel Lefschetz Fixed Point Formula  
for the Spin-c Dirac Operator  
*J. Duistermaat*

- PNLDE 19 Nonlinear Dynamical Systems and Chaos  
*H.W. Broer, S.A. van Gils, I. Hoveijn, F. Takens, editors*
- PNLDE 20 Topics in Geometry: Honoring the Memory  
of Joseph D'Atri  
*Simon Gindikin, editor*
- PNLDE 21 Partial Differential Equations and Mathematical  
Physics: The Danish-Swedish Analysis Seminar, 1995  
*Lars Hörmander and Anders Melin, editors*
- PNLDE 22 Partial Differential Equations and Functional  
Analysis: In Memory of Pierre Grisvard  
*J. Cea, D. Chenais, G. Geymonat, and  
J.-L. Lions, editors*
- PNLDE 23 Geometry of Harmonic Maps  
*Yuanlong Xin*
- PNLDE 24 Minimax Theorems  
*Michel Willem*
- PNLDE 25 Variational Methods for Discontinuous Structures  
*Raul Serapioni and Franco Tomarelli*
- PNLDE 26 Algebraic Aspects of Integrable Systems: In Memory  
of Irene Dorfman  
*A. S. Fokas and I. M. Gelfand, editors*
- PNLDE 27 Topological Nonlinear Analysis II:  
Degree, Singularity, and Variations  
*Michele Matzeu and Alfonso Vignoli, editors*
- PNLDE 28 Models of Phase Transitions  
*Augusto Visintin*
- PNLDE 29 Nonlinear Partial Differential Equations in Geometry  
and Physics: The 1995 Barrett Lectures  
*Garth Baker and Alexandre Freire, editors*
- PNLDE 30 Parametrized Measures and Variational Principles  
*Pablo Pedregal*
- PNLDE 31 Topics in Mathematical Modelling of Composite Materials  
*Andrej Cherkaev and Robert Kohn, editors*

- PNLDE 32 Geometrical Optics and Related Topics  
*Ferruccio Colombini and Nicolas Lerner, editors*
- PNLDE 33 Entire Solutions of Semilinear Elliptic Equations  
*I. Kuzin and S. Pohozaev*
- PNLDE 34 Stability of Functional Equations in Several Variables  
*Donald H. Hyers, George Isac and Themistocles M. Rassias*
- PNLDE 35 Topics in Nonlinear Analysis: The Herbert Amann Anniversary Volume  
*Joachim Escher and Gieri Simonett, editors*
- PNLDE 36 Variational Problems with Concentration  
*Martin Flucher*
- PNLDE 37 Implicit Partial Differential Equations  
*Bernard Dacorogna and Paolo Marcellini*
- PNLDE 38 Systems of Conservation Laws: Two-Dimensional Riemann Problems  
*Yuxi Zheng*
- PNLDE 39 Linear and Nonlinear Aspects of Vortices: The Ginzburg–Landau Model  
*Frank Pacard and Tristan Rivière*
- PNLDE 40 Recent Trends in Nonlinear Analysis: Festschrift Dedicated to Alfonso Vignoli on the Occasion of his Sixtieth Birthday  
*Jürgen Appell, editor*
- PNLDE 41 Quasi-hydrodynamic Semiconductor Equations  
*Ansgar Jüngel*
- PNLDE 42 Semigroups of Operators: Theory and Applications  
*A.V. Balakrishnan, editor*
- PNLDE 43 Nonlinear Analysis and its Applications to Differential Equations  
*M.R. Grosshino, M. Ramos, C. Rebelo, and L. Sanchez, editors*
- PNLDE 44 The Monge–Ampère Equation  
*Cristian E. Gutiérrez*
- PNLDE 45 Spatial Patterns: Higher Order Models in Physics and Mechanics  
*L.A. Peletier and W.C. Troy*
- PNLDE 46 Carleman Estimates and Applications to Uniqueness and Control Theory  
*Ferruccio Colombini and Claude Zuily, editors*

- PNLDE 47 Recent Advances in the Theory of Shock Waves  
*Heinrich Freistühler and Anders Szepessy, editors*
- PNLDE 48 Energy Methods for Free Boundary Problems: Applications to  
Nonlinear PDEs and Fluid Mechanics  
*S.N. Antontsev, J.I. Díaz, and S. Shmarev*
- PNLDE 49 Variational and Topological Methods in the Study of Nonlinear Phenomena  
*V. Benci, G. Cerami, M. Degiovanni, D. Fortunato, F. Giannoni, and  
A. M. Micheletti, editors*