

# CONTEMPORARY MATHEMATICS

## The Lefschetz Centennial Conference

### Proceedings on Differential Equations

Proceedings of The Lefschetz  
Centennial Conference held  
December 10–14, 1984

AMERICAN MATHEMATICAL SOCIETY

**VOLUME 58**

**Part III**

## Titles in This Series

---

### Volume

- 1 **Markov random fields and their applications**, Ross Kindermann and J. Laurie Snell
- 2 **Proceedings of the conference on integration, topology, and geometry in linear spaces**, William H. Graves, Editor
- 3 **The closed graph and P-closed graph properties in general topology**, T. R. Hamlett and L. L. Herrington
- 4 **Problems of elastic stability and vibrations**, Vadim Komkov, Editor
- 5 **Rational constructions of modules for simple Lie algebras**, George B. Seligman
- 6 **Umbral calculus and Hopf algebras**, Robert Morris, Editor
- 7 **Complex contour integral representation of cardinal spline functions**, Walter Schempp
- 8 **Ordered fields and real algebraic geometry**, D. W. Dubois and T. Recio, Editors
- 9 **Papers in algebra, analysis and statistics**, R. Lidl, Editor
- 10 **Operator algebras and K-theory**, Ronald G. Douglas and Claude Schochet, Editors
- 11 **Plane ellipticity and related problems**, Robert P. Gilbert, Editor
- 12 **Symposium on algebraic topology in honor of José Adem**, Samuel Gitler, Editor
- 13 **Algebraists' homage: Papers in ring theory and related topics**, S. A. Amitsur, D. J. Saltman, and G. B. Seligman, Editors
- 14 **Lectures on Nielsen fixed point theory**, Boju Jiang
- 15 **Advanced analytic number theory. Part I: Ramification theoretic methods**, Carlos J. Moreno
- 16 **Complex representations of  $GL(2, K)$  for finite fields  $K$** , Ilya Piatetski-Shapiro
- 17 **Nonlinear partial differential equations**, Joel A. Smoller, Editor
- 18 **Fixed points and nonexpansive mappings**, Robert C. Sine, Editor
- 19 **Proceedings of the Northwestern homotopy theory conference**, Haynes R. Miller and Stewart B. Priddy, Editors
- 20 **Low dimensional topology**, Samuel J. Lomonaco, Jr., Editor
- 21 **Topological methods in nonlinear functional analysis**, S. P. Singh, S. Thomeier, and B. Watson, Editors
- 22 **Factorizations of  $b^n \pm 1$ ,  $b = 2, 3, 5, 6, 7, 10, 11, 12$  up to high powers**, John Brillhart, D. H. Lehmer, J. L. Selfridge, Bryant Tuckerman, and S. S. Wagstaff, Jr.
- 23 **Chapter 9 of Ramanujan's second notebook—Infinite series identities, transformations, and evaluations**, Bruce C. Berndt and Padmini T. Joshi
- 24 **Central extensions, Galois groups, and ideal class groups of number fields**, A. Fröhlich
- 25 **Value distribution theory and its applications**, Chung-Chun Yang, Editor
- 26 **Conference in modern analysis and probability**, Richard Beals, Anatole Beck, Alexandra Bellow, and Arshag Hajian, Editors
- 27 **Microlocal analysis**, M. Salah Baouendi, Richard Beals, and Linda Preiss Rothschild, Editors
- 28 **Fluids and plasmas: geometry and dynamics**, Jerrold E. Marsden, Editor
- 29 **Automated theorem proving**, W. W. Bledsoe and Donald Loveland, Editors
- 30 **Mathematical applications of category theory**, J. W. Gray, Editor
- 31 **Axiomatic set theory**, James E. Baumgartner, Donald A. Martin, and Saharon Shelah, Editors
- 32 **Proceedings of the conference on Banach algebras and several complex variables**, F. Greenleaf and D. Gulick, Editors
- 33 **Contributions to group theory**, Kenneth I. Appel, John G. Ratcliffe, and Paul E. Schupp, Editors
- 34 **Combinatorics and algebra**, Curtis Greene, Editor
- 35 **Four-manifold theory**, Cameron Gordon and Robion Kirby, Editors
- 36 **Group actions on manifolds**, Reinhard Schultz, Editor
- 37 **Conference on algebraic topology in honor of Peter Hilton**, Renzo Piccinini and Denis Sjerve, Editors

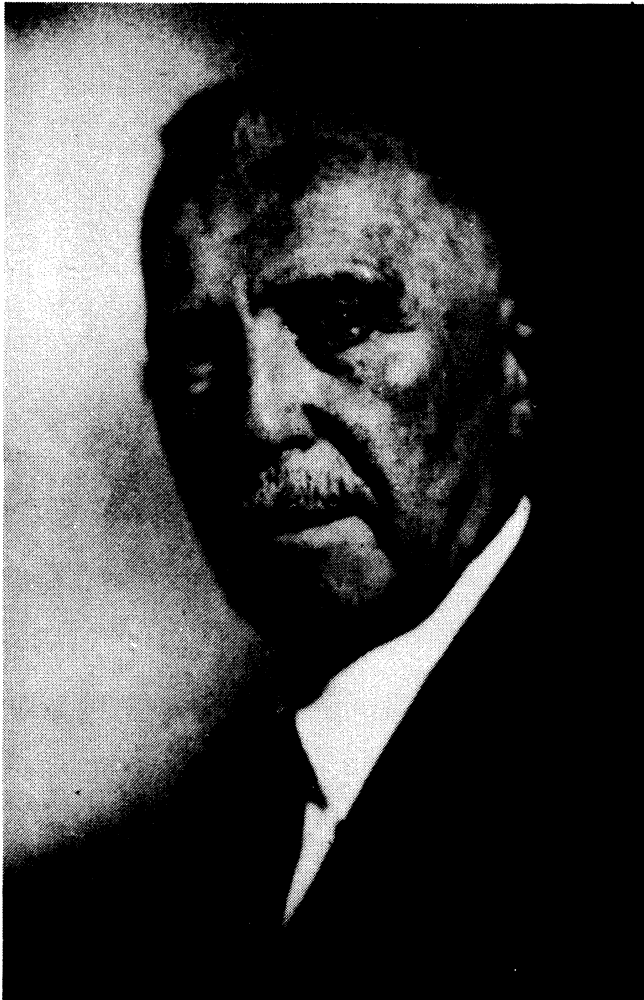
# Titles in This Series

---

## Volume

- 38 Topics in complex analysis**, Dorothy Browne Shaffer, Editor
- 39 Errett Bishop: Reflections on him and his research**, Murray Rosenblatt, Editor
- 40 Integral bases for affine Lie algebras and their universal enveloping algebras**, David Mitzman
- 41 Particle systems, random media and large deviations**, Richard Durrett, Editor
- 42 Classical real analysis**, Daniel Waterman, Editor
- 43 Group actions on rings**, Susan Montgomery, Editor
- 44 Combinatorial methods in topology and algebraic geometry**, John R. Harper and Richard Mandelbaum, Editors
- 45 Finite groups—coming of age**, John McKay, Editor
- 46 Structure of the standard modules for the affine Lie algebra  $A_1^{(1)}$** , James Lepowsky and Mirko Primc
- 47 Linear algebra and its role in systems theory**, Richard A. Brualdi, David H. Carlson, Biswa Nath Datta, Charles R. Johnson, and Robert J. Plemmons, Editors
- 48 Analytic functions of one complex variable**, Chung-chun Yang and Chi-tai Chuang, Editors
- 49 Complex differential geometry and nonlinear differential equations**, Yum-Tong Siu, Editor
- 50 Random matrices and their applications**, Joel E. Cohen, Harry Kesten, and Charles M. Newman, Editors
- 51 Nonlinear problems in geometry**, Dennis M. DeTurck, Editor
- 52 Geometry of normed linear spaces**, R. G. Bartle, N. T. Peck, A. L. Peressini, and J. J. Uhl, Editors
- 53 The Selberg trace formula and related topics**, Dennis A. Hejhal, Peter Sarnak, and Audrey Anne Terras, Editors
- 54 Differential analysis and infinite dimensional spaces**, Kondagunta Sundaresan and Srinivasa Swaminathan, Editors
- 55 Applications of algebraic K-theory to algebraic geometry and number theory**, Spencer J. Bloch, R. Keith Dennis, Eric M. Friedlander, and Michael R. Stein, Editors
- 56 Multiparameter bifurcation theory**, Martin Golubitsky and John Guckenheimer, Editors
- 57 Combinatorics and ordered sets**, Ivan Rival, Editor
- 58 The Lefschetz centennial conference. Part I: Proceedings on algebraic geometry**, D. Sundaraman, Editor
- 58.II The Lefschetz centennial conference. Part II: Proceedings on algebraic topology**, S. Gitler, Editor
- 58.III The Lefschetz centennial conference. Part III: Proceedings on differential equations**, A. Verjovsky, Editor
- 59 Function estimates**, J. S. Marron, Editor
- 60 Nonstrictly hyperbolic conservation laws**, Barbara Lee Keyfitz and Herbert C. Kranzer, Editors
- 61 Residues and traces of differential forms via Hochschild homology**, Joseph Lipman
- 62 Operator algebras and mathematical physics**, Palle E. T. Jorgensen and Paul S. Muhly, Editors
- 63 Integral geometry**, Robert L. Bryant, Victor Guillemin, Sigurdur Helgason, and R. O. Wells, Jr., Editors
- 64 The Legacy of Sonya Kovalevskaya**, Linda Keen, Editor
- 65 Logic and combinatorics**, Stephen G. Simpson, Editor
- 66 Free group rings**, Narian Gupta, Editor

**The Lefschetz  
Centennial Conference  
Proceedings on  
Differential Equations**



**SOLOMON LEFSCHETZ**

# **CONTEMPORARY MATHEMATICS**

**Volume 58.III**

## **The Lefschetz Centennial Conference**

### **Proceedings on Differential Equations**

**Proceedings of The Lefschetz  
Centennial Conference held  
December 10-14, 1984**

**A. Verjovsky, Editor**

**AMERICAN MATHEMATICAL SOCIETY**

**Providence • Rhode Island**

## EDITORIAL BOARD

Irwin Kra, managing editor	David Eisenbud W. H. Jaco
Thomas F. Banchoff	Gerald J. Janusz
M. Salah Baouendi	Jan Mycielski
Daniel M. Burns	Alan D. Weinstein

The Proceedings of The Lefschetz Centennial Conference on Algebraic Geometry, Algebraic Topology and Differential Equations was held at the Centro de Investigación y de Estudios Avanzados, in Mexico City, Mexico, December 10-14, 1984.

1980 *Mathematics Subject Classification*. Primary 58-06, 34-06, 35-06, 53-06.

Organizing committee: J. Adem, S. Gitler, J. J. Kohn, E. Ramirez de Arellano, D. Sundararaman, A. Verjovsky.

Editorial Committee of the Proceedings: A. Verjovsky, J. Adem, E. Ramirez de Arellano, S. Gitler, D. Sundararaman.

---

### Library of Congress Cataloging-in-Publication Data (Revised for part II)

Lefschetz Centennial Conference (1984: Mexico City, Mexico). The Lefschetz Centennial Conference.

(Contemporary mathematics, ISSN 0271-4132; v. 58)

Includes bibliographies.

Contents: pt. 1. Proceedings on algebraic geometry, D. Sundararaman, editor — pt. 2. Proceedings on algebraic topology / S. Gitler — pt. 3. Proceedings on differential equations / A. Verjovsky.

1. Algebraic geometry—Congresses. 2. Algebraic topology—Congresses. 3. Differential equations—Congresses. I. Lefschetz, Solomon, 1884-1972. II. Sundararaman, D. III. Gitler, Samuel. IV. Verjovsky A. V. Series: Contemporary mathematics (American Mathematical Society); v. 58.

QA564.L43 1984

512'.33

86-14040

ISBN 0-8218-5064-4 (pt. III)

ISBN 0-8218-5065-2 (set)

---

Copyright ©1987 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.

Information on copying and reprinting can be found at the back of this volume.

This volume was printed directly from author-prepared copy.

The paper used in this book is acid-free and falls within the guidelines established to ensure permanence and durability. ∞

## TABLE OF CONTENTS

PREFACE	ix
Perturbation results on the long run behavior of nonlinear dynamical systems	1
H. CARRILLO C.	
Harmonic maps and minimal surface coboundaries	11
K.-C. CHANG AND J. EELLS	
Lefschetz formulas for flows	19
D. FRIED	
Phase locking and higher order averaging	71
C. GARCIA AND A. MINZONI	
Groupes D'homeomorphismes du cercle et cohomologie bornée	81
E. GHYS	
Harmonic maps of Riemann surfaces to quaternionic projective spaces and grassmannians	107
J. GLAZEBROOK	
Foliations by curves of complex analytic spaces	123
X. GOMEZ-MONT	
Renormalization of one dimensional mappings and strange attractors	143
J. GUCKENHEIMER	
Orbits and harmonic maps	161
M. GUEST	
Some examples of infinite dimensional systems	173
J. HALE	
E. Cartan's generalized spaces and connections	183
M. KURANISHI	



Infinity manifolds for positive energy in celestial mechanics E. LACOMBA	193
Homoclinic orbits, hyperbolic dynamics and dimension of cantor sets J. PALIS	203
On the estimate of number of solutions for the nonlinear boundary values problem V. SCHUCHMAN	217
The index of a vector field on a complex analytic surface with singularities J. SEADE	225
A uniformization theorem for holomorphic foliations A. VERJOVSKY	233

## PREFACE

The Solomon Lefschetz Centennial Conference was held in the Centro de Investigación y de Estudios Avanzados in Mexico City from 10 to 14, December 1984. The topics of the conference were Algebraic Geometry, Algebraic Topology and Differential Equations, the three areas in which the late S. Lefschetz had made original contributions. Experts from many countries, as well as mathematicians from Mexico, participated actively and enthusiastically resulting in a very successful conference.

This volume contains the proceedings of the conference corresponding to the general area of Differential Equations.

Financial support to the conference came from CONACyT, SEP and CINVESTAV del IPN of Mexico, and the NSF of U.S.A. cosponsored and supported the conference through their Cooperative Science Programs with Latin America and the Caribbean.

The Organizing Committee of the Conference and the Editorial Committee of the Proceedings would like to thank all the participants in the conference and all the contributors to this volume.

A. Verjovsky.

CINVESTAV, Mexico City, November 1986.

**Copying and reprinting.** Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews provided the customary acknowledgement of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

The appearance of the code on the first page of an article in this volume indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U. S. Copyright Law, provided that the fee of \$1.00 plus \$.25 per page for each copy be paid directly to Copyright Clearance Center, Inc., 21 Congress Street, Salem, Massachusetts 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotion purposes, for creating new collective works or for resale.

