Differential Geometry and Mathematical Physics

AMS–CMS Special Session
on Geometric Methods in Mathematical Physics
August 15–19, 1993
Vancouver, British Columbia, Canada

John K. Beem
Krishan L. Duggal
Editors
Recent Titles in This Series

170  John K. Beem and Krishan L. Duggal, Editors,  Differential geometry and mathematical physics, 1994
168  Gary L. Mullen and Peter Jau-Shyong Shiue, Editors,  Finite fields: Theory, applications, and algorithms, 1994
165  Barry Mazur and Glenn Stevens, Editors,  $p$-adic monodromy and the Birch and Swinnerton-Dyer conjecture, 1994
164  Cameron Gordon, Yoav Moriah, and Bronislaw Wajnryb, Editors,  Geometric topology, 1994
163  Zhong-Ci Shi and Chung-Chun Yang, Editors,  Computational mathematics in China, 1994
162  Ciro Ciliberto, E. Laura Livorni, and Andrew J. Sommese, Editors,  Classification of algebraic varieties, 1994
161  Paul A. Schweitzer, S. J., Steven Hurder, Nathan Moreira dos Santos, and José Luis Arraut, Editors,  Differential topology, foliations, and group actions, 1994
160  Niky Kamran and Peter J. Olver, Editors,  Lie algebras, cohomology, and new applications to quantum mechanics, 1994
159  William J. Heinzer, Craig L. Huneke, and Judith D. Sally, Editors,  Commutative algebra: Syzygies, multiplicities, and birational algebra, 1994
158  Eric M. Friedlander and Mark E. Mahowald, Editors,  Topology and representation theory, 1994
157  Alfio Quarteroni, Jacques Periaux, Yuri A. Kuznetsov, and Olaf B. Widlund, Editors,  Domain decomposition methods in science and engineering, 1994
156  Steven R. Givant, The structure of relation algebras generated by relativizations, 1994
155  William B. Jacob, Tsit-Yuen Lam, and Robert O. Robson, Editors,  Recent advances in real algebraic geometry and quadratic forms, 1994
154  Michael Eastwood, Joseph Wolf, and Roger Zierau, Editors,  The Penrose transform and analytic cohomology in representation theory, 1993
153  Richard S. Elman, Murray M. Schacher, and V. S. Varadarajan, Editors,  Linear algebraic groups and their representations, 1993
152  Christopher K. McCord, Editor,  Nielsen theory and dynamical systems, 1993
151  Matatyahu Rubin, The reconstruction of trees from their automorphism groups, 1993
150  Carl-Friedrich Bödigheimer and Richard M. Hain, Editors,  Mapping class groups and moduli spaces of Riemann surfaces, 1993
149  Harry Cohn, Editor,  Doeblin and modern probability, 1993
148  Jeffrey Fox and Peter Haskell, Editors,  Index theory and operator algebras, 1993
147  Neil Robertson and Paul Seymour, Editors,  Graph structure theory, 1993
146  Martin C. Tangora, Editor,  Algebraic topology, 1993
145  Jeffrey Adams, Rebecca Herb, Stephen Kudla, Jian-Shu Li, Ron Lipsman, and Jonathan Rosenberg, Editors,  Representation theory of groups and algebras, 1993
144  Bor-Luh Lin and William B. Johnson, Editors,  Banach spaces, 1993
143  Marvin Knopp and Mark Sheingorn, Editors,  A tribute to Emil Grosswald: Number theory and related analysis, 1993
142  Chung-Chun Yang and Sheng Gong, Editors,  Several complex variables in China, 1993
141  A. Y. Cheer and C. P. van Dam, Editors,  Fluid dynamics in biology, 1993
Differential Geometry and Mathematical Physics

AMS–CMS Special Session
on Geometric Methods in Mathematical Physics
August 15–19, 1993
Vancouver, British Columbia, Canada

John K. Beem
Krishan L. Duggal
Editors
Contents

Preface vii

Stability of geodesic incompleteness
JOHN K. BEEM 1

Numerical simulation of two-polarization Gowdy $T^3$ cosmology
BEVERLY K. BERGER, DAVID GARFINKLE, VINCENT MONCRIEF, AND CARRIE SWIFT 13

“No hair” theorems—Folklore, conjectures, results
PIOTR T. CHRUSCIEL 23

Spacetime geometry of CR-structures
KRISHAN L. DUGGAL AND AUREL BEJANCU 51

From the Riccati inequality to the Raychaudhuri equation
PAUL E. EHRLICH AND SEON-BU KIM 65

Invariance properties of boundary sets of open embeddings of manifolds
and their application to the abstract boundary
CHRISTOPHER J. FAMA AND SUSAN M. SCOTT 79

Least area tori, black holes and topological censorship
GREGORY J. GALLOWAY 113

The method of timelike 2-surfaces
STEVEN G. HARRIS 125

Conjugate points and higher Arnol’d-Maslov classes
ADAM D. HELFER 135

Manifolds with a circle action and the Einstein constraint equations
JAMES ISENBERG AND VINCENT MONCRIEF 149

The internal geometry of black holes
WERNER ISRAEL 155

Einstein-Yang-Mills fields with spherical symmetry
H. P. KÜNZLE 167

Quasi-periodic motions of planar liquid drops
DEBRA LEWIS 185
CONTENTS

Compatible metrics on fiber bundles
   PHILLIP E. PARKER 201

Dynamic feedback for classical geometries
   WILLIAM F. SHADWICK AND WILLEM M. SLUIS 207

Ricci curvature inheriting symmetries of semi-Riemannian manifolds
   RAMESH SHARMA AND KRISHAN L. DUGGAL 215
Preface

In August 1993, the American Mathematical Society and the Canadian Mathematical Society held an international joint conference in Vancouver, British Columbia. This volume is the proceedings of a special session on “Geometric Methods in Mathematical Physics” organized at that conference.

The subject of differential geometry has substantial applications in mathematics and physics, with the stimulus from general relativity. This volume contains latest information on some of such applications. The major themes dealt with include studies involving black holes, singularities, censorship, the Einstein field equations, geodesics, index theory, submanifolds, CR-structures, and space-time symmetries. Also, there are papers on Yang-Mills fields, geometric techniques in control theory, and equilibria.

We are grateful to the American Mathematical Society for their support in publishing this volume. We would especially like to express our gratitude to Ms. Donna Harmon for her efforts. Finally, the editors are thankful to all the participants and the contributors whose interest and work made the publication of these proceedings possible.
Differential Geometry and Mathematical Physics
John K. Beem and Krishan L. Duggal, Editors

This book contains the proceedings of the Special Session, Geometric Methods in Mathematical Physics, held at the joint AMS-CMS meeting in Vancouver in August 1993. The papers collected here contain a number of new results in differential geometry and its applications to physics. The major themes include black holes, singularities, censorship, the Einstein field equations, geodesics, index theory, submanifolds, CR-structures, and space-time symmetries. In addition, there are papers on Yang-Mills fields, geometric techniques in control theory, and equilibria. Containing new results by established researchers in the field, the book provides a look at developments in this exciting area of research.