Controlling the behaviour of the solutions to Einstein’s field equations on large scales is still the most important technical task in classical general relativity. The long standing problem of ‘cosmic censorship’ will not be resolved without a sufficiently general and deep understanding of the solutions. The unexpected emergence of the Bartnik-McKinnon solutions and Choptuik’s disclosure of critical collapse phenomena show us that Einstein’s theory still has surprises in store.

The last two discoveries also demonstrate clearly the important role of numerical techniques in the analysis of specific solutions and in the study of the manifold of solutions. The interplay of analytical with numerical methods is bound to become the most important strategy in exploring the content of the theory.

Moreover, since various projected gravitational wave antennae will soon become operational, templates with gravitational waves forms will urgently be needed for analysing the recorded data. This makes the interaction between analytical and numerical techniques a most exciting and important project, because it may help open new vistas of our universe. The fact that the calculation of the form of gravitational waves generated by astrophysical processes turned out so much more difficult than expected hints at a lack of insight into the analytical basis of the theory or at an insufficient exploitation of the present analytical knowledge.

Any general analysis of asymptotically flat space-times in the large needs to take into account the causal and the underlying null cone or conformal structure of the field. These structures should thus also be critical in the semi-global or global numerical calculation of space-times. Not surprisingly, the two numerical techniques presently used to perform such calculations, the characteristic method and the method based on the conformal field equations, employ basic features of the conformal structure in the definition of their procedures.

The analytical and the numerical methods both offer possibilities not accessible to the other one, and each of them asks questions and poses problems likely to initiate interesting research with the other method. For researchers in the fields to get an insight into the potential and the problems of the other field, we therefore organized a workshop on analytical, geometrical, and numerical studies which make explicit use of conformal or related structures. This book contains extended versions of the contributions to this workshop.
Following the suggestion of the publisher we tried to avoid the traditional style of proceedings and aimed at a book which will help a newcomer find access to the field, which offers new results to the experienced researcher, and which provides a comprehensive source of references. In particular, one of us (H.F.) wrote an extensive introductory chapter in which he tries to introduce the newcomer to the field and to provide a general perspective by pointing out the relations to the other studies represented here. Because this perspective may be clouded by the author’s ignorance and personal taste, however, we do urge the reader to understand these references as an encouragement to carefully study those articles themselves. The intricate net of relations between the different parts of the work discussed in this book will then become evident. A complete picture of the present situation can only be obtained by trying to understand the full scope of those articles and the specific views of their author’s. Were different opinions occur the reader is invited to search for solutions of the corresponding open problems.

While we have tried to maintain to some extent the division of this area of research into the three subfields indicated in the title of this book, it is clear that the assignment of a single article to any of these subfields is not sharply defined. This fact should be seen as a virtue since it was the expressed purpose of the workshop to have researchers in different areas interact with each other and see how they can profit by viewing their subject from different perspectives.

There remains the pleasant task to thank the speakers and the participants for helping create an inspiring atmosphere at the workshop and the contributors of these proceedings for helping create a picture of the present situation of the field which illustrates its richness and its potential.

We also thank the Deutsche Forschungsgemeinschaft and the ‘Unibund’ of the University of Tübingen for their financial support. It is a pleasure to thank Prof. Hanns Ruder for his support and Heike and Bettina Fricke for their help in administrative matters during and after the workshop. Finally, we acknowledge help from T. Müller, A. King and M. King during the preparation of this book.

Tübingen and Golm, 
June 2002

Jörg Frauendiener
Helmut Friedrich
List of Contributors

Lars Andersson
Department of Mathematics
University of Miami
Coral Gables, FL 33124
USA
larsa@math.miami.edu

Robert Bartnik
School of Mathematics and Statistics
University of Canberra,
ACT 2601, Australia
bartnik@ise.canberra.edu.au

Adrian Butscher
MPI f"ur Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
butscher@aei-potsdam.mpg.de

Piotr Chru´sciel
D´epartement de Math´ematiques
Facult´e des Sciences
F 37200 Tours
France
piotr@gargan.math.univ-tours.fr

Sergio Dain
MPI f"ur Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
dain@aei-potsdam.mpg.de

Jos´e A. Font
Dep. de Astronom´ıa y Astrof´ısica
Universidad de Valencia
46100 Burjassot (Valencia)
Spain
j.antonio.font@uv.es

Jörg Frauendiener
Institut f¨ur Theoretische Astrophysik
Universit¨at T¨ubingen
72076 T¨ubingen
Germany
joergf@tat.physik.uni-tuebingen.de

Helmut Friedrich
MPI f¨ur Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
hef@aei-potsdam.mpg.de

Simonetta Frittelli
Physics Department
Duquesne University
Pittsburgh, PA 15282
USA
simo@mayu.physics.duq.edu

Greg Galloway
University of Miami
Coral Gables
FL 33124
USA
galloway@math.miami.edu

David Garfinkle
Department of Physics
Oakland University
Rochester, Michigan 48309
USA
garfinkl@vela.acs.oakland.edu
List of Contributors

Sascha Husa
MPI für Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
shusa@aei-potsdam.mpg.de

Niky Kamran
Mathematics Department
McGill University
Montreal
Canada

Heinz-Otto Kreiss
Department of Mathematics
University of California
Los Angeles, CA 90095
USA
kreiss@math.ucla.edu

Juan Valiente Kroon
MPI für Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
jav@aei-potsdam.mpg.de

Luis Lehner
Department of Physics and Astronomy
The University of British Columbia
Vancouver, BC V6T 1Z1
Canada
luisl@sgil.physics.ubc.ca

Ezra T. Newman
Department of Physics and Astronomy
University of Pittsburgh
Pittsburgh PA 15260
USA
newman@phyast.pitt.edu

Andrew Norton
School of Mathematics and Statistics
University of Canberra,
ACT 2601, Australia

Omar E. Ortiz
Universidad Nacional de Córdoba
Facultad de Matemática,
Astronomía y Física,
(5000) Córdoba
Argentina
ortiz@fis.uncor.edu

Roger Penrose
Mathematical Institute
University of Oxford
24–29 St. Giles’
Oxford OX1 3LB
England

Bernd G. Schmidt
MPI für Gravitationsphysik
Albert-Einstein-Institut
14476 Golm
Germany
bernd@aei-potsdam.mpg.de

Walter Simon
Institut für theoretische Physik
der Universität Wien
Boltzmanngasse 5
A-1090 Wien
Austria
simon@ap.univie.ac.at

K. P. Tod
Mathematical Institute
University of Oxford
24–29 St. Giles’
Oxford OX1 3LB
England
tod@maths.ox.ac.uk
The Conformal Structure of Space-Times
Geometry, Analysis, Numerics
Frauendiener, J.; Friedrich, H. (Eds.)
2002, XIV, 374 p., Hardcover
ISBN: 978-3-540-44280-6