

SPRINGER PROCEEDINGS IN PHYSICS

Please view available titles in *Springer Proceedings in Physics* on series homepage
<http://www.springer.com/series/361/>

Stefano Bellucci

Editor

The Attractor Mechanism

Proceedings

of the INFN-Laboratori Nazionali di Frascati
School 2007

With 52 Figures



Springer

Editor

Professor Stefano Bellucci
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati
via E. Fermi 40, 00044 Frascati Roma, Italy
E-mail: bellucci@lnf.infn.it

Springer Proceedings in Physics ISSN 0930-8989
ISBN 978-3-642-10735-1 e-ISBN 978-3-642-10736-8
DOI 10.1007/978-3-642-10736-8
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2010930787

© Springer-Verlag Berlin Heidelberg 2010

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: eStudio Calamar Steinen

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

This book is based upon the lectures delivered from 18 to 22 June 2007 at the INFN-Laboratori Nazionali di Frascati School on Attractor Mechanism, directed by Stefano Bellucci, with the participation of prestigious lecturers, including S. Ferrara, M. Gaiardin, P. LeVay, T. Mohaupt, and A. Zichichi. All lectures were given at a pedagogical, introductory level, a feature which is reflected in the specific “flavor” of this volume, which has also benefited much from the extensive discussions and related reworking of the various contributions.

This is the fourth volume in a series of books on the general topics of supersymmetry, supergravity, black holes, and the attractor mechanism. Indeed, based on previous meetings, three volumes have already been published:

BELLUCCI S. (2006). *Supersymmetric Mechanics – Vol. 1: Supersymmetry, Noncommutativity and Matrix Models.* (vol. 698, pp. 1–229). ISBN: 3-540-33313-4. Berlin, Heidelberg: Springer Verlag (Germany). Springer Lecture Notes in Physics Vol. 698.

BELLUCCI S., S. FERRARA, A. MARRANI. (2006). *Supersymmetric Mechanics – Vol. 2: The Attractor Mechanism and Space Time Singularities.* (vol. 701, pp. 1–242). ISBN-13: 9783540341567. Berlin, Heidelberg: Springer Verlag (Germany). Springer Lecture Notes in Physics Vol. 701.

BELLUCCI S. (2008). *Supersymmetric Mechanics – Vol. 3: Attractors and Black Holes in Supersymmetric Gravity.* (vol. 755, pp. 1–373). ISBN-13: 9783540795223. Berlin, Heidelberg: Springer Verlag (Germany). Springer Lecture Notes in Physics 755.

In this volume, we have included two contributions originating from short presentations of recent original results given by participants, i.e., Wei Li and Filipe Moura.

I thank all the lecturers and participants for contributing to the success of the School, which prompted the publication of this volume. I also thank Mrs. Silvia Colasanti for her generous efforts in the secretarial work and in various organizational aspects. My gratitude goes to INFN and in particular to Mario Calvetti for supporting the School. At this special time for me and my family, with the birth

of our longed for daughter Maristella recently and happily occurred, my thoughts go to my wife Gloria and our beloved Costanza, Eleonora, Annalisa, and Erica for supporting and encouraging me every day: their love gave me strength to complete this volume.

April 2010

Stefano Bellucci

Contents

1 SAM Lectures on Extremal Black Holes in $d = 4$ Extended Supergravity	1
Stefano Bellucci, Sergio Ferrara, Murat Günaydin, and Alessio Marrani	
2 Lectures on Spectrum Generating Symmetries and U-Duality in Supergravity, Extremal Black Holes, Quantum Attractors and Harmonic Superspace	31
Murat Günaydin	
3 Attractors, Black Holes and Multiqubit Entanglement	85
Péter Lévy	
4 From Special Geometry to Black Hole Partition Functions	165
Thomas Mohaupt	
5 Complexity at the Fundamental Level	243
Antonino Zichichi	
6 Non-supersymmetric Attractors in Symmetric Coset Spaces	289
Wei Li	
7 Higher-Order String Effective Actions and Off-Shell $d = 4$ Supergravity	317
Filipe Moura	

Contributors

Stefano Bellucci INFN – Laboratori Nazionali di Frascati, Via Enrico Fermi 40, 00044 Frascati, Italy, bellucci@lnf.infn.it

Sergio Ferrara Physics Department, Theory Unit, CERN, CH 1211, Geneva 23, Switzerland, sergio.ferrara@cern.ch

and

INFN – Laboratori Nazionali di Frascati, Via Enrico Fermi 40, 00044 Frascati, Italy
and

Department of Physics and Astronomy, University of California, Los Angeles, CA, USA

Murat Günaydin Department of Physics, Institute for Gravitation and the Cosmos, Penn State University, University Park, PA 16802, USA, murat@phys.psu.edu

Péter Lévy Department of Theoretical Physics, Institute of Physics, Budapest University of Technology and Economics Budafoki út 8. H1111 Budapest, Hungary, levay@neumann.phy.bme.hu

Wei Li Jefferson Physical Laboratory, Harvard University, Cambridge MA 02138, USA, weili@fas.harvard.edu

Alessio Marrani Department of Physics, Stanford Institute for Theoretical Physics, Stanford University, 382 Via Pueblo Mall, Varian Lab, Stanford, CA 94305-4060, USA, marrani@lnf.infn.it

Thomas Mohaupt Department of Mathematical Sciences, University of Liverpool, Peach Street, Liverpool L69 7ZL, UK, Thomas.Mohaupt@liv.ac.uk

Filipe Moura Security and Quantum Information Group, Instituto de Telecomunicações, Instituto Superior Técnico, Departamento de Matemática, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

and

Centro de Matemática da Universidade do Minho, Escola de Ciências, Campus de Gualtar, 4710-057 Braga, Portugal, fmoura@math.ist.utl.pt

Antonino Zichichi CERN, Geneva, Switzerland

and

Enrico Fermi Centre, Rome, Italy

and

INFN, Frascati, Italy

and

University of Bologna, Bologna, Italy, Antonino.Zichichi@cern.ch