

**EM**  
**S** ■  
**PRESS**

## IRMA Lectures in Mathematics and Theoretical Physics

Edited by Olivier Guichard (IRMA, Strasbourg)

This series is devoted to the publication of research monographs, lecture notes, and other material arising from programs of the *Institut de Recherche Mathématique Avancée* (IRMA). The goal is to promote recent advances in mathematics and theoretical physics and to make them accessible to wide circles of mathematicians, physicists, and students of these disciplines.

Institut de Recherche Mathématique Avancée  
CNRS et Université de Strasbourg  
7 rue René Descartes  
67084 Strasbourg Cedex, France

Previously published in this series:

- 8 AdS/CFT Correspondence: Einstein Metrics and Their Conformal Boundaries, *O. Biquard (Ed.)*
- 9 Differential Equations and Quantum Groups, *D. Bertrand, B. Enriquez, C. Mitschi, C. Sabbah, R. Schäfke (Eds.)*
- 10 Physics and Number Theory, *L. Nyssen (Ed.)*
- 11 Handbook of Teichmüller Theory, Vol. I, *A. Papadopoulos (Ed.)*
- 12 Quantum Groups, *B. Enriquez (Ed.)*
- 13 Handbook of Teichmüller Theory, Vol. II, *A. Papadopoulos (Ed.)*
- 14 *M. Weber*, Dynamical Systems and Processes
- 15 Renormalization and Galois Theory, *A. Connes, F. Fauvet, J.-P. Ramis (Eds.)*
- 16 Handbook of Pseudo-Riemannian Geometry and Supersymmetry, *V. Cortés (Ed.)*
- 17 Handbook of Teichmüller Theory, Vol. III, *A. Papadopoulos (Ed.)*
- 18 Strasbourg Master Class on Geometry, *A. Papadopoulos (Ed.)*
- 19 Handbook of Teichmüller Theory, Vol. IV, *A. Papadopoulos (Ed.)*
- 20 Singularities in Geometry and Topology, *V. Blanloeil, T. Ohmoto (Eds.)*
- 21 Faà di Bruno Hopf Algebras, Dyson–Schwinger Equations, and Lie–Butcher Series, *K. Ebrahimi-Fard, F. Fauvet (Eds.)*
- 22 Handbook of Hilbert Geometry, *A. Papadopoulos, M. Troyanov (Eds.)*
- 23 Sophus Lie and Felix Klein: The Erlangen Program and Its Impact in Mathematics and Physics, *L. Ji, A. Papadopoulos (Eds.)*
- 24 Free Loop Spaces in Geometry and Topology, *J. Latschev, A. Oancea (Eds.)*
- 25 *T. Shioya*, Metric Measure Geometry. Gromov’s Theory of Convergence and Concentration of Metrics and Measures
- 26 Handbook of Teichmüller Theory, Vol. V, *A. Papadopoulos (Ed.)*
- 27 Handbook of Teichmüller Theory, Vol. VI, *A. Papadopoulos (Ed.)*
- 28 *Y. Bugeaud*, Linear Forms in Logarithms and Applications
- 29 Eighteen Essays in Non-Euclidean Geometry, *V. Alberge, A. Papadopoulos (Eds.)*
- 30 Handbook of Teichmüller Theory, Vol. VII, *A. Papadopoulos (Ed.)*
- 31 Algebraic Combinatorics, Resurgence, Moulds and Applications (CARMA), Vol. 1, *F. Chapoton, F. Fauvet, C. Malvenuto, J.-Y. Thibon (Eds.)*
- 32 Algebraic Combinatorics, Resurgence, Moulds and Applications (CARMA), Vol. 2, *F. Chapoton, F. Fauvet, C. Malvenuto, J.-Y. Thibon (Eds.)*
- 33 Topology and Geometry, A Collection of Essays Dedicated to Vladimir G. Turaev, *A. Papadopoulos (Ed.)*



# Essays in Geometry

Dedicated to Norbert A'Campo

Edited by  
Athanasios Papadopoulos



## Editor

Athanase Papadopoulos  
Institut de Recherche Mathématique Avancée  
Université de Strasbourg et CNRS  
7 rue René Descartes  
67084 Strasbourg Cedex, France  
E-mail: papadop@math.unistra.fr

**2020 Mathematics Subject Classification:** 00B15, 01-02, 01-06, 01A70, 14B05, 34M35, 57K20, 57R45, 32S05, 32S55, 57K12, 57R17, 57K45, 57K30, 57K45, 00A30, 57K10, 57K16, 58K30, 51M15, 53C70

**Keywords:** hyperbolic geometry, super hyperbolic geometry, 3-manifolds, singularities, dynamical systems, metric geometry, mapping class groups, linear groups, Riemann surfaces, Teichmüller space, high-dimensional complex geometry, differential topology, symplectic geometry, number theory, algebraic geometry, mathematical physics, philosophy of mathematics

ISBN 978-3-98547-024-2, eISBN 978-3-98547-524-7, DOI 10.4171/IRMA/34

### Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.dnb.de>.

Published by EMS Press, an imprint of the

European Mathematical Society – EMS – Publishing House GmbH  
Institut für Mathematik  
Technische Universität Berlin  
Straße des 17. Juni 136  
10623 Berlin, Germany

<https://ems.press>

© 2023 EMS Press

Typesetting: Tamás Bori, Nagyszékely, Hungary and Katalin Fried, Budapest, Hungary

Printed in Germany

© Printed on acid free paper