

Zurich Lectures in Advanced Mathematics

Edited by

Habib Ammari, Alexander Gorodnik (Managing Editor), Urs Lang (Managing Editor), Michael Struwe

Mathematics in Zurich has a long and distinguished tradition, in which the writing of lecture notes volumes and research monographs plays a prominent part. The *Zurich Lectures in Advanced Mathematics* series aims to make some of these publications better known to a wider audience. The series has three main constituents: lecture notes on advanced topics given by internationally renowned experts, in particular lecture notes of "Nachdiplomvorlesungen", organized jointly by the Department of Mathematics and the Institute for Research in Mathematics (FIM) at ETH, graduate text books designed for the joint graduate program in Mathematics of the ETH and the University of Zürich, as well as contributions from researchers in residence. Moderately priced, concise and lively in style, the volumes of this series will appeal to researchers and students alike, who seek an informed introduction to important areas of current research.

Previously published in this series:

Yakov B. Pesin, Lectures on partial hyperbolicity and stable ergodicity

Sun-Yung Alice Chang, Non-linear Elliptic Equations in Conformal Geometry

Sergei B. Kuksin, Randomly forced nonlinear PDEs and statistical hydrodynamics in 2 space dimensions

Pavel Etingof, Calogero–Moser systems and representation theory

Guus Balkema and Paul Embrechts, High Risk Scenarios and Extremes – A geometric approach

Demetrios Christodoulou, Mathematical Problems of General Relativity I

Camillo De Lellis, Rectifiable Sets, Densities and Tangent Measures

Paul Seidel, Fukaya Categories and Picard–Lefschetz Theory

Alexander H. W. Schmitt, Geometric Invariant Theory and Decorated Principal Bundles

Michael Farber, Invitation to Topological Robotics

Alexander Barvinok, Integer Points in Polyhedra

Christian Lubich, From Quantum to Classical Molecular Dynamics: Reduced Models and Numerical Analysis

Shmuel Onn, Nonlinear Discrete Optimization – An Algorithmic Theory

Kenji Nakanishi and Wilhelm Schlag, Invariant Manifolds and Dispersive Hamiltonian Evolution Equations

Erwan Faou, Geometric Numerical Integration and Schrödinger Equations

Alain-Sol Sznitman, Topics in Occupation Times and Gaussian Free Fields

François Labourie, Lectures on Representations of Surface Groups

Isabelle Gallagher, Laure Saint-Raymond and Benjamin Texier, From Newton to Boltzmann: Hard Spheres and Short-range Potentials

Robert J. Marsh, Lecture Notes on Cluster Algebras

Emmanuel Hebey, Compactness and Stability for Nonlinear Elliptic Equations

Sylvia Serfaty, Coulomb Gases and Ginzburg-Landau Vortices

Alessio Figalli, The Monge–Ampère Equation and Its Applications

Walter Schachermayer, Asymptotic Theory of Transaction Costs

Anne Thomas, Geometric and Topological Aspects of Coxeter Groups and Buildings

Todd Fisher and Boris Hasseblatt, Hyperbolic Flows

Sebastian Baader Geometry and Topology of Surfaces



Author:

Sebastian Baader Mathematisches Institut Universität Bern Sidlerstrasse 5 3012 Bern, Switzerland

E-mail: sebastian.baader@math.unibe.ch

2020 Mathematics Subject Classification: 57K20

Key words: mapping class group, Dehn twist, pseudo-Anosov diffeomorphism, hyperbolic surface, Basmajian identity, measured foliation, Teichmüller theory, Thurston classification

ISBN 978-3-98547-000-6

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.

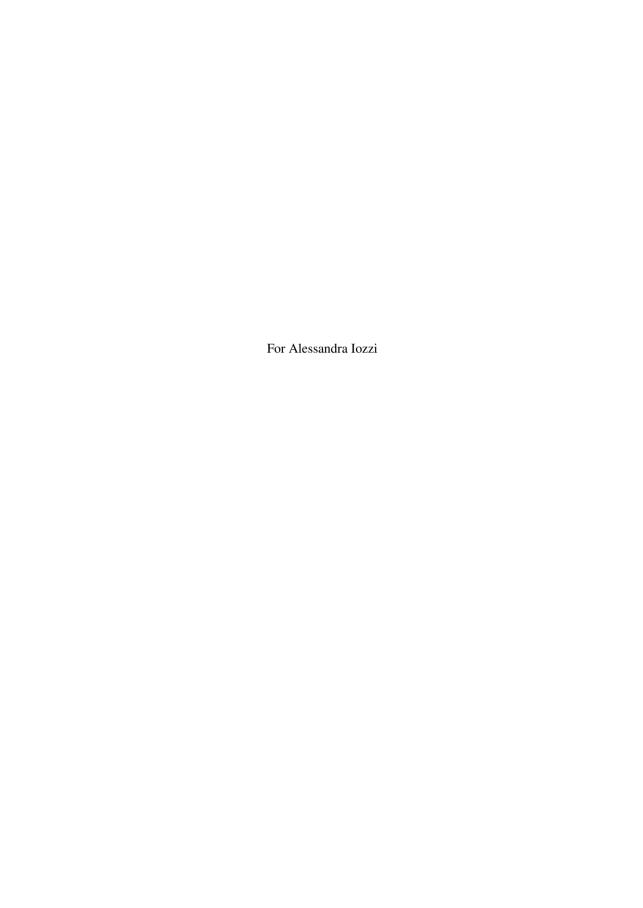
Published by EMS Press, an imprint of the

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

https://ems.press

© 2021 European Mathematical Society

Typeset using the author's tex files: WisSat Publishing + Consulting GmbH, Fürstenwalde, Germany Printing and binding: Beltz Bad Langensalza GmbH, Bad Langensalza, Germany ∞ Printed on acid free paper 9 8 7 6 5 4 3 2 1



Acknowledgments

First and foremost, I would like to thank the Department of Mathematics of ETH Zurich and the director of the Institute for Mathematical Research, Tristan Rivière, for inviting me to give a graduate course at ETH on a topic of my choice.

I had a fantastic audience that kept me motivated throughout these lectures, very demanding at times, spotting errors, correcting and simplifying proofs. Special thanks go to Alessandra Iozzi, Emmanuel Kowalski and Merlin Incerti-Medici from the front row, Marc Burger, Peter Feller and Alessandro Sisto from the back row, and Matthew Cordes, Yannick Krifka, Jean-Claude Picaud from the middle row. Jean-Claude read the entire manuscript, helped fixing it in several places, served me wine and cheese, and got me excited about stretch factors of pseudo-Anosov maps. Altogether, his support with this project was enormous.

All the figures in these notes, forty in number, were produced by Raphael Appenzeller. I thank him for the enormous amount of time and effort he put into this. In fact, even the notes are not entirely new: in 2011, I gave a similar course at EPFL. I thank Livio Liechti for sharing his excellent notes with me, as well as for proving interesting results that found their way into this manuscript.

The chapter on the Basmajian identity may come as a surprise, and would not exist without Hugo Parlier, who explained it to me last summer in Les Diablerets. Thank you for that, Hugo.

These notes are dedicated to Alessandra Iozzi, in honor of her 60th birthday, and in appreciation of her support and inspiration. Thank you so much, Alessandra!