

# Low Dimensional Topology

AMERICAN MATHEMATICAL SOCIETY



## CONTEMPORARY MATHEMATICS

### **Titles in this Series**

VOLUME 1	<b>Markov random fields and their applications</b> Ross Kindermann and J. Laurie Snell
VOLUME 2	<b>Proceedings of the conference on integration,</b> <b>topology, and geometry in linear spaces</b> William H. Graves, Editor
VOLUME 3	<b>The closed graph and P-closed graph</b> <b>properties in general topology</b> T. R. Hamlett and L. L. Herrington
VOLUME 4	<b>Problems of elastic stability and vibrations</b> Vadim Komkov, Editor
VOLUME 5	<b>Rational constructions of modules for simple Lie algebras</b> George B. Seligman
VOLUME 6	<b>Umbral calculus and Hopf algebras</b> Robert Morris, Editor
VOLUME 7	<b>Complex contour integral representation of cardinal spline functions</b> Walter Schempp
VOLUME 8	<b>Ordered fields and real algebraic geometry</b> D. W. Dubois and T. Recio, Editors
VOLUME 9	<b>Papers in algebra, analysis and statistics</b> R. Lidl, Editor
VOLUME 10	<b>Operator algebras and K-theory</b> Ronald G. Douglas and Claude Schochet, Editors
VOLUME 11	Plane ellipticity and related problems Robert P. Gilbert, Editor
VOLUME 12	<b>Symposium on algebraic topology in honor of José Adem</b> Samuel Gitler, Editor

VOLUME 13	<b>Algebraists' homage: Papers in ring theory</b> <b>and related topics</b> Edited by S. A. Amitsur, D. J. Saltman and G. B. Seligman
VOLUME 14	<b>Lectures on Nielsen fixed point theory</b> Boju Jiang
VOLUME 15	<b>Advanced analytic number theory.</b> <b>Part I: Ramification theoretic methods</b> Carlos J. Moreno
VOLUME 16	<b>Complex representations of GL(2, K)</b> <b>for finite fields K</b> Ilya Piatetski-Shapiro
VOLUME 17	<b>Nonlinear partial differential equations</b> Joel A. Smoller, Editor
VOLUME 18	<b>Fixed points and nonexpansive mappings</b> Robert C. Sine, Editor
VOLUME 19	<b>Proceedings of the Northwestern</b> <b>homotopy theory conference</b> Haynes R. Miller and Stewart B. Priddy, Editors
VOLUME 20	<b>Low dimensional topology</b> Samuel J. Lomonaco, Jr., Editor

# CONTEMPORARY MATHEMATICS Volume 20

## Low Dimensional Topology

Samuel J. Lomonaco, Jr., Editor

AMERICAN MATHEMATICAL SOCIETY Providence - Rhode Island

### PROCEEDINGS OF THE SPECIAL SESSION ON LOW DIMENSIONAL TOPOLOGY 87TH ANNUAL MEETING OF THE AMERICAN MATHEMATICAL SOCIETY

HELD IN SAN FRANCISCO, CALIFORNIA JANUARY 7-11, 1981

1980 Mathematics Subject Classification. Primary 57-06, 57Mxx, 55-06.

ISBN 0-8218-5016-4

Library of Congress Cataloging in Publication Data Main entry under title: Low dimensional topology. (Contemporary mathematics, ISSN 0271-4132; v. 20) Papers presented at the AMS Special Session held in San Francisco, Calif., 1981. Bibliography: p. 1. Low-dimensional topology—Congresses. I. Lomonaco, Samuel J., Jr. II. American Mathematical Society. III. Series: Contemporary mathematics (American Mathematical Society); v. 20. QA612.14.L68 1983 514<sup>'</sup>.2 83-10022

**Copying and reprinting.** Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews provided the customary acknowledgement of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

The appearance of the code on the first page of an article in this volume indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law, provided that the fee of \$1.00 plus \$.25 per page for each copy be paid directly to Copyright Clearance Center, Inc. 21 Congress Street, Salem, Massachusetts 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotion purposes, for creating new collective works or for resale.

Copyright © 1983 by the American Mathematical Society Printed in the United States of America All rights reserved except those granted to the United States Government This volume was printed directly from author prepared copy.

### TABLE OF CONTENTS

Preface	vii
List of Participants	ix
Knotted periodic orbits in dynamical system II: Knot holders for fibered knots JOAN S. BIRMAN AND R. F. WILLIAMS	1
Doubly prime knots STEVEN A. BLEILER	61
On J. H. C. Whitehead's aspherical question II JOE BRANDENBURG, MICHEAL DYER, AND RALPH STREBEL	65
Geometric cohomology theory ROGER FENN AND DENIS SJERVE	79
Seifert fibered 3-manifolds and nonorientable 4-manifolds RONALD FINTUSHEL AND RONALD J. STERN	103
A conservative Dehn's lemma MICHAEL H. FREEDMAN	12 1
The Murasugi sum is a natural geometric operation DAVID GABAI	131
Manifolds and their special spines DAVID GILLMAN AND DALE ROLFSEN	145
Realizing units as Whitehead torsions in low dimension SUSHIL JAJODIA AND BRUCE MAGURN	153
A survey of the Torelli group DENNIS JOHNSON	165
Combinatorics and knot theory LOUIS H. KAUFFMAN	181

TABLE OF CONTENTS

Dehn twists and handlebodies of genus two R. KRAMER	201
Localization of link modules J. P. LEVINE	213
Alexander modules of plane algebraic curves A.LIBGOBER	231
Five dimensional knot theory S. J. LOMONACO, JR.	249
Covering linkage invariants and Fox's problem 13 TORU MAEDA AND KUNIO MURASUGI	271
Numeric invariants in 3-manifolds RICHARD MANDELBAUM AND BORIS MOISHEZON	285
Polyhedra representation of link complements WILLIAM W. MENASCO	305
A fibered knot in a homology 3-sphere whose group is nonclassical JOHN G. RATCLIFFE	327
Automorphisms of the free group of rank two without finite orbits MARTIN SCHARLEMANN AND CRAIG SQUIER	341

٧i

#### PREFACE

This volume arose from a special session on Low Dimensional Topology that I organized and conducted at the American Mathematical Society meeting held in San Francisco, California, January 7-11, 1981. To my surprise, the response to this special session exceeded my most ambitious expectations. My only disappointment was that there were not enough available slots to accept all of the outstanding papers submitted to the session.

I would like to thank all of the special session participants and attendees for making this special session a resounding success. Special thanks are due Ron Stern for his help in the preparation of this volume. I would also like to express my gratitude to the Science and Technology Division of the Institute for Defense Analyses for providing a congenial atmosphere in which this manuscript could be completed. Finally, my thanks to the L-O-O-P Fund(\*) for its partial support.

> Samuel J. Lomonaco, Jr.<sup>†</sup> Science and Technology Division Institute for Defense Analyses Alexandria, Virginia October, 1982

<sup>(\*)</sup>L-0-0-P Fund No. 1981SFCA

<sup>&</sup>lt;sup>†</sup>Current address: Harry Diamond Laboratories, 2800 Powder Mill Road, Adelphi, MD 20783.

### LIST OF PARTICIPANTS AMS SPECIAL SESSION ON LOW DIMENSIONAL TOPOLOGY SAN FRANCISCO, CALIFORNIA JANURARY 7-11, 1981

Joan S. Birman Steven A. Bleiler Joe E. Brandenburg Andrew J. Casson William D. Dunbar Micheal N. Dver Roger A. Fenn H. Clay Fickle Ronald A. Fintushel Michael H. Freedman David Gabai David S. Gillman Cameron McA. Gordon Sushil Jajodia Dennis Johnson Louis H. Kauffman Robert J. Kramer Jerome P. Levine Anatoly S. Libgober Samuel J. Lomonaco, Jr. Toru Maeda Bruce A. Magurn Richard Mandelbaum William Wyatt Menasco Robert Meyerhoff Boris Moishezon Kunio Murasugi Robert Myers Lee P. Neuwirth Steven P. Plotnick John G. Ratcliffe Dale Rolfsen Martin G. Scharlemann Allan J. Sieradski Denis Sjerve Craig Squier Ronald J. Stern Ralph Strebel James M. Van Buskirk Robert F. Williams

ix

