

# Complexities



## Women in Mathematics

Bettye Anne Case and Anne M. Leggett, Editors

ADVANCE PRAISE FOR **Complexities**

"The talented and amazing women featured in this book will serve as inspirational role models for all generations that follow. *Complexities* carefully documents the importance of role models in inspiring women to enter mathematics. It is a lesson that can be applied beyond this field to anywhere where women are underrepresented."

—Linda Babcock, author, with Sara Laschever,  
*of Women Don't Ask (Princeton)*

"A provocative and informative inside view of what it is like to be both a mathematician and a woman. The belief that mathematics is solely a male preserve is fast disappearing, and *Complexities* will speed it on its way."

—Ian Stewart, Mathematics Awareness Centre,  
*University of Warwick*

"This book contains a wealth of inspiration for women in the mathematical sciences, with real-life advice on how to weather the tough times, find joy in the good times, and at the same time experience excitement and love for the subject. For young women seeking their paths in this field, the personal stories provide valuable mentorship. Even for those of us who have a parent as mentor, this collection provides essential insight into a variety of experiences and career paths."

—Alison Marsden, *Stanford University* and Jerry Marsden,  
*California Institute of Technology*

"This astounding book provides a wealth of important information on women in mathematics over the ages, exploring how they entered the field, what excited them about it in their youth, what excites them now, and the many ways these women have advanced the frontiers of mathematics or have used mathematics to the benefit of society. Although not a mathematician myself, I have known many of the women mathematicians in this book and have shared with them my experiences as a physicist. How wonderful that this is all gathered in one volume of easy reading."

—Mildred Dresselhaus, *Massachusetts Institute of Technology*

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*Edited by*

BETTYE ANNE CASE

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PRINCETON UNIVERSITY PRESS

*Princeton and Oxford*

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Published by Princeton University Press, 41 William Street, Princeton,  
New Jersey 08540

In the United Kingdom: Princeton University Press, 3 Market Place,  
Woodstock, Oxfordshire OX20 1SY

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LIBRARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA

Complexities : women in mathematics / edited by Bettye Anne Case, Anne M. Leggett.  
p. cm.

Includes bibliographical references and index.

ISBN 0-691-11462-5 (cloth : acid-free paper)

1. Women in mathematics—United States—History. 2. Feminism and science—  
United States. 3. Women mathematicians—United States—Biography.

4. Mathematics—Vocational guidance—United States. I. Case, Bettye Anne.  
II. Leggett, Anne M.

QA27.5.C66 2005

510'82'0973—dc22 2004048843

British Library Cataloging-in-Publication Data is available

This book has been composed in Sabon and Swiss 721

Printed on acid-free paper. ∞

pup.princeton.edu

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1



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Sophie Germain taught herself mathematics by candlelight, huddled in her bedclothes. Ada Byron Lovelace anticipated aspects of general-purpose digital computing by more than a century. Cora Ratto de Sadosky advanced messages of tolerance and equality while sharing her mathematical talents with generations of students.

This captivating book gives voice to women mathematicians from the late eighteenth century through to the present day. It documents the complex nature of the conditions women around the world have faced—and continue to face—while pursuing their careers in mathematics. The stories of the three women above and those of many more appear here, each one enlightening and inspiring. The earlier parts of the book provide historical context and perspective, beginning with excursions into the lives of fifteen women born before 1920. Included are histories of collective efforts to improve women's opportunities in research mathematics. In addition, a photo essay puts a human face on the subject as it illustrates women's contributions in professional associations.

More than four score women from academe, government, and the private sector provide a rich *mélange* of insights and strategies for creating workable career paths while maintaining rewarding personal lives. The book discusses related social and cultural issues, and includes a summary of recent comparative data relating to women and men in mathematics and women from other sciences. First-person accounts provide explicit how-tos; many narratives demonstrate great determination and perseverance. Talented women vividly portray their pleasure in discovering new mathematics. The senior among them speak out candidly, interweaving their mathematics with autobiographical detail. At the beginning of a new century, women at all stages of their careers share their outlooks and experiences.

Clear, engaging, and meticulously researched, *Complexities* will inspire young women who are contemplating careers in mathematics and will speak to women in many fields of endeavor and walks of life.

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*To Jack and Gerry, always there*



## PREFACE

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On the cusp of the new century, we began a journey through time and place. Looking back showed how women before us fared in the world of mathematics; examining the present highlighted trends and directions for today's women mathematicians, leading to a vision of an ideal future where women are full participants in all intellectual ventures. Women's journey from the margins of the world of doctoral-level mathematics to a more central position in this particular universe has been long and difficult. The struggle has led to more satisfying lives, both professional and personal. This chronicle of some women who have chosen to be professional mathematicians is intended to facilitate the journey for our sisters who follow.

Thought-provoking perspectives of special interest to those concerned with gender issues appear in many of the articles, offering encouragement and support to women in different trenches—associates in law firms, medical residents—a whole generation of women finding their paths. More directly, the stories include points of reference and parallels for women in all academic fields, especially in those where the proportions of women researchers are low, as they are, for example, in the bench sciences, computer science, and engineering.

The readings for this time travel, an eclectic anthology in five parts, have varied origins. Many of the articles in parts I through III are based on material from the newsletters of the Association for Women in Mathematics (AWM, est. 1971). This volume serves as an archival source for those selected as well as for the information in parts III and IV about the Olga Taussky Todd Celebration of Careers for Women in Mathematics. The conversational flavor of the articles that were originally talks at mathematics meetings and conferences has been preserved in their written form. Throughout the book, supplementary information from many sources augments topics introduced in the main articles, providing context and balance. Finally, writings from this new century complement the earlier works, providing deeper insight into women's place in mathematics today.

*Complexities* sets the stage in part I by presenting biographies, autobiographies, mathematical histories, or vignettes from the lives of fifteen women born from 1776 to 1919. Obstacles that stood in their way, often solely because they were female, appear in story after story. Part II portrays the collective efforts of women to eliminate some of these barriers or to mitigate the difficulties involved in navigating them. The narratives about AWM yield multiple examples of women's accomplishments, both

as individuals and in groups. This theme is also explored in several articles illuminating women's place on the global mathematics stage.

In part III, practitioners describe multiple career paths open today to women mathematicians. The challenges explored range from how some valiant African-American women have dealt with discrimination on two fronts to how some young mothers have succeeded in doing mathematics while raising their children. Contributions from currently active women mathematicians appear throughout and form all of parts IV and V. Several of the authors in part IV describe a problem (in mathematics research or teaching), along with solutions to and perspectives on that problem. Part V is a tapestry of recent thinking from a spectrum of mathematical women—distinguished recipients of multiple honors to new doctorates—speaking freely on mathematics and life.

The book's attention to career issues parallels that of workshops held for beginning mathematicians and follows the theme of the Taussky Todd conference, which in turn took its cue from the extraordinarily varied career path of its namesake. The talks there featured not only mathematical results and descriptions of technical work but also interwoven observations on the themes of existence: overcoming the difficulties life has placed before women who want to be mathematicians, carving out a career path around the stumbling blocks, having a life and a career in today's complicated world, and working to make it easier for future generations of women to pursue mathematics.

One of our pleasures in working on this book has been noting similarities, regardless of the differences in circumstance, among the commentaries of these mathematical women. A vibrant thread links the earliest women to the most recent—the passion to do mathematics and to share it with others, despite the obstacles laid before them by lives and times. Please join our journey into the world of women mathematicians.

## ACKNOWLEDGMENTS

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As editors of a volume with over seventy contributors, we owe our gratitude to many individuals and organizations. We would like first of all to thank developmental editor Susan Gerstein, who provided valuable services and ideas as the manuscript began to take shape. Her sustained enthusiasm for the project encouraged us in turn. We are similarly indebted to the editorial advisors, Carolyn S. Gordon (Dartmouth College), Suzanne Lenhart (University of Tennessee), and Sylvia M. Wiegand (University of Nebraska), for volunteering their efforts whenever and for whatever we needed them. Lenhart, president of AWM during crucial phases of book production, was particularly generous.

We especially thank the volume's contributors for their responsiveness during the editing process. Many AWM members have given time to advance various stages of the editorial process—as contributors, referees, editorial advisors, and executive committee members. We owe a special debt to the organization's founders, past officers, and early newsletter editors. We have been informed and inspired by authors of earlier works that lend intellectual support for this volume, and by the comments of knowledgeable reviewers, which we have appreciated. We also thank the staff at Princeton University Press for all their efforts in producing this book.

Our colleagues at the Department of Mathematics of the Florida State University (FSU) and the Department of Mathematics and Statistics of Loyola University Chicago gave useful information and wise advice; we thank our students for their patience. We have appreciated support for project needs from our departments. The staff at AWM's Maryland office and at FSU Mathematics provided multiple types of in-kind assistance; staff members at the American Mathematical Society (AMS) and the Mathematical Association of America (MAA) provided information and advice.

A goal of the organizers and funding agencies of the 1999 Olga Taussky Todd Celebration of Careers in Mathematics for Women was the widest possible dissemination of the biographical, mathematical, and career information that was developed from that conference. Base funding for the conference and developmental stages of this volume was provided by the National Security Agency, with additional support from the Department of Energy, the Office of Naval Research, and the Mathematical Sciences Research Institute in Berkeley. "The Taussky Todd Conference," IV, lists many individuals whose work made that conference and, by extension, early efforts on this project possible. The editors gratefully acknowledge the

benefits to this volume of the direct and in-kind funding received by AWM over the years; a partial listing appears in "Activities and Awards," II.

Permission to use material printed in other sources and to reproduce photographs has been graciously provided by AMS, AWM, Boston University, British Society for the History of Mathematics *Newsletter*, Computing Research Association *Newsletter*, European Women in Mathematics, Pamela Davis Kivelson, Kovalevskaja Fund *Newsletter*, Suzanne Lenhart, Deborah Lockhart, MAA, Constance Reid, Springer-Verlag Inc., St. Joseph's University, Elaine Terry, John Todd, University of Texas, Dawn Wheeler, and Sylvia Wiegand.

In addition to the above, the list of individuals that follows includes many of those who have helped or inspired this work. We apologize in advance for any omissions. The editors thank Robin Aguiar, Jean Berry, Phil Bowers, Mickey Boyd, Mimi Burbank, Barbara Deuink, Muriel Daley, Chandler Davis, Esther Diaguila, Wayne Drady, Susan Ecklund, John Ewing, Etta Falconer, Sergei Gelfand, Grace Godfrey-Brock, Mary Gray, Judy Green, Gloria Hewitt, Johnny L. Houston, Sam Huckaba, Joan Hutchinson, Allyn Jackson, Lise Jacobson, Linda Jarvis, Alison Kalett, Tanja Kazan, Beth Kegler, Pat Kenschaft, Cathy Kessel, Susan Leggett, Lee Lorch, Jim Maxwell, Joe Mayne, Susan Minnerly, Calvin Moore, Joe Mott, Dianne O'Leary, Kendra Remick Priestly, Sam Rankin, Judy Roitman, Colleen Rose, Donna Salter, Diane Saxe, Alice Schafer, Hans Schneider, Pam Schnitter, Martha Siegel, Vickie Magoon Sims, Wilma Slight, Elaine Smith, Jackie Smith, Melissa Smith, Tina Straley, Rebekka Struik, De Witt Sumners, Jean Taylor, Laura Tedeschini-Lalli, Christine Thivierge, Priscilla Travis, and Miao Ye.

Our families have been wonderful, especially in their understanding when we have been overly busy; we thank Jack Quine and Gerry McDonald for their support and sage counsel. Finally, we give special thanks to senior editor Vickie Kearn and production editor Gail Schmitt at Princeton University Press, without whose enthusiasm, encouragement, and commitment this book would not exist. Gail cheerfully dealt with the myriad questions and changes we threw her way. For more than two years, Vickie helped us stay on target and, much more important, was our collaborator with suggestions that vastly improved the original concept. When she said, "You'll look back and say this extra work was worth it," she was always right.

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## NOTE TO READERS

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All bylined papers that have not previously appeared in print were refereed. Reprints have been excerpted or modified from their earlier published form. Known factual errors in reprints have been corrected, but statistics and time signifiers reflect the date of original writing. In some cases, footnotes and references have been added to provide new information. Bracketed numbers in the text indicate references at the end of the paper in which they appear.

Many of the websites in the list of abbreviations have information and bibliographies on topics discussed in this book as well as on related issues (e.g., gender issues in precollege education). There is also a website for this volume, <http://www.pup.princeton.edu/titles/7915.html> where additional references and updates to book material are provided. Readers are encouraged to inform us of additional relevant sources, corrections, and so forth.

The editors are coauthors of introductions and other text that is not attributed to another source.





## ABBREVIATIONS

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AAAS: American Association for the Advancement of Science; <http://www.aaas.org/>

AAUW: American Association of University Women; <http://www.aauw.org/>

ACM: Association for Computing Machinery; <http://www.acm.org/>

AIM: American Institute of Mathematics; <http://www.aimath.org/>

AMS: American Mathematical Society; <http://www.ams.org/>

AMUCWMA: African Mathematical Union Commission on Women in Mathematics in Africa; <http://www.math.buffalo.edu/mad/AMU/amucwma.html>

ASEE: American Society for Engineering Education; <http://www.asee.org/>

AWC: Association for Women in Computing; <http://www.awc-hq.org/>

AWIS: Association for Women in Science; <http://www.awis.org/>

AWM: Association for Women in Mathematics; <http://www.awm-math.org/>

BMSA: Board on Mathematical Sciences and Their Applications, formerly Board on Mathematical Science; <http://www7.nationalacademies.org/bms/>

CBMS: Conference Board of the Mathematical Sciences; <http://www.cbmsweb.org/>

CWS: Caucus for Women in Statistics; <http://www.geocities.com/ResearchTriangle/System/2290/>

EWM: European Women in Mathematics; <http://www.math.helsinki.fi/EWM/>

EYH™: Expanding Your Horizons, the flagship program of the Math/Science Network; <http://www.expandingyourhorizons.org/>

Femmes et Mathématiques; <http://www.femmes-et-maths.fr.fm/>

IAS: Institute for Advanced Study; <http://www.ias.edu/>

ICIAM: International Congress of Industrial and Applied Mathematicians; held every four years under the auspices of the International Council for Industrial and Applied Mathematicians; [http://www.iciam.org/council/council\\_tf.html](http://www.iciam.org/council/council_tf.html)

ICM: International Congress of Mathematicians; held every four years under the auspices of the International Mathematical Union; <http://www.mathunion.org/ICM/index.html>