FRONTIERS IN THE STUDY OF CHAOTIC DYNAMICAL SYSTEMS WITH OPEN PROBLEMS

FRONTIERS IN THE STUDY OF CHAOTIC DYNAMICAL SYSTEMS WITH OPEN PROBLEMS

edited by

Elhadj Zeraouia

University of Tébessa, Algeria

Julien Clinton Sprott

University of Wisconsin, Madison, USA

WORLD SCIENTIFIC SERIES ON NONLINEAR SCIENCE

Editor: Leon O. Chua
University of California, Berkeley

Series B. SPECIAL THEME ISSUES AND PROCEEDINGS

- Volume 1: Chua's Circuit: A Paradigm for Chaos
Edited by *R. N. Madan*
- Volume 2: Complexity and Chaos
Edited by *N. B. Abraham, A. M. Albano, A. Passamante, P. E. Rapp, and R. Gilmore*
- Volume 3: New Trends in Pattern Formation in Active Nonlinear Media
Edited by *V. Perez-Villar, V. Perez-Munuzuri, C. Perez Garcia, and V. I. Krinsky*
- Volume 4: Chaos and Nonlinear Mechanics
Edited by *T. Kapitaniak and J. Brindley*
- Volume 5: Fluid Physics — Lecture Notes of Summer Schools
Edited by *M. G. Velarde and C. I. Christov*
- Volume 6: Dynamics of Nonlinear and Disordered Systems
Edited by *G. Martínez-Mekler and T. H. Seligman*
- Volume 7: Chaos in Mesoscopic Systems
Edited by *H. A. Cerdeira and G. Casati*
- Volume 8: Thirty Years After Sharkovskii's Theorem: New Perspectives
Edited by *L. Alsedà, F. Balibrea, J. Llibre, and M. Misiurewicz*
- Volume 9: Discretely-Coupled Dynamical Systems
Edited by *V. Pérez-Muñuzuri, V. Pérez-Villar, L. O. Chua, and M. Markus*
- Volume 10: Nonlinear Dynamics & Chaos
Edited by *S. Kim, R. P. Behringer, H.-T. Moon, and Y. Kuramoto*
- Volume 11: Chaos in Circuits and Systems
Edited by *G. Chen and T. Ueta*
- Volume 12: Dynamics and Bifurcation of Patterns in Dissipative Systems
Edited by *G. Dangelmayr and I. Oprea*
- Volume 13: Modeling and Computations in Dynamical Systems: In Commemoration of the 100th Anniversary of the Birth of John von Neumann
Edited by *E. J. Doedel, G. Domokos & I. G. Kevrekidis*
- Volume 14: Dynamics and Control of Hybrid Mechanical Systems
Edited by *G. Leonov, H. Nijmeijer, A. Pogromsky & A. Fradkov*
- Volume 15: From Physics to Control Through an Emergent View
Edited by *L. Fortuna, A. Fradkov & M. Frasca*
- Volume 16: Frontiers in the Study of Chaotic Dynamical Systems with Open Problems
Edited by *Z. Elhadj & J. C. Sprott*

Published by

World Scientific Publishing Co. Pte. Ltd.

5 Toh Tuck Link, Singapore 596224

USA office: 27 Warren Street, Suite 401-402, Hackensack, NJ 07601

UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

World Scientific Series on Nonlinear Science, Series B — Vol. 16

**FRONTIERS IN THE STUDY OF CHAOTIC DYNAMICAL SYSTEMS
WITH OPEN PROBLEMS**

Copyright © 2011 by World Scientific Publishing Co. Pte. Ltd.

All rights reserved. This book, or parts thereof, may not be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage and retrieval system now known or to be invented, without written permission from the Publisher.

For photocopying of material in this volume, please pay a copying fee through the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, USA. In this case permission to photocopy is not required from the publisher.

ISBN-13 978-981-4340-69-4

ISBN-10 981-4340-69-3

Printed in Singapore.

Preface

Anyone who has never made a mistake has never tried anything new! —Albert Einstein (1879–1955)

For every problem, there is one solution which is simple, neat and wrong! —H. L. Mencken (1880–1956)

This collection of review articles is devoted to new developments in the study of chaotic dynamical systems with some open problems and challenges. The papers, written by many of the leading experts in the field, cover both the experimental and theoretical aspects of the subject. This volume presents a variety of fascinating topics of current interest and problems arising in the study of both discrete and continuous-time chaotic dynamical systems. Exciting new techniques stemming from the area of nonlinear dynamical systems theory are currently being developed to meet these challenges. This volume presents the state-of-the-art of the more advanced studies of chaotic dynamical systems.

Frontiers in the study of chaotic dynamical systems with open problems is devoted to setting an agenda for future research in this exciting and challenging field.

Zeraoulia Elhadj
Julien Clinton Sprott
October, 2010

This page is intentionally left blank

Contents

<i>Preface</i>	v
1. Problems with Lorenz's Modeling and the Algorithm of Chaos Doctrine <i>S. OuYang and Y. Lin</i>	1
2. Nonexistence of Chaotic Solutions of Nonlinear Differential Equations <i>L. S. Yao</i>	31
3. Some Open Problems in the Dynamics of Quadratic and Higher Degree Polynomial ODE Systems <i>F. Zhang and J. Heidel</i>	43
4. On Chaotic and Hyperchaotic Complex Nonlinear Dynamical Systems <i>G. M. Mahmoud</i>	59
5. On the Study of Chaotic Systems with Non-Horseshoe Template <i>A. Ray, A. Roy Chowdhury and S. Basak</i>	85
6. Instability of Solutions of Fourth and Fifth Order Delay Differential Equations <i>C. Tunç</i>	105

7. Some Conjectures About the Synchronizability and the Topology of Networks	117
<i>A. Caneco, J. Leonel Rocha, C. Grácio and S. Fernandes</i>	
8. Wavelet Study of Dynamical Systems Using Partial Differential Equations	149
<i>E. B. Postnikov</i>	
9. Combining the Dynamics of Discrete Dynamical Systems	155
<i>J. S. Cánovas</i>	
10. Code Structure for Pairs of Linear Maps with Some Open Problems	175
<i>P. Troshin</i>	
11. Recent Advances in Open Billiards with Some Open Problems	195
<i>C. P. Dettmann</i>	
12. Open Problems in the Dynamics of the Expression of Gene Interaction Networks	219
<i>L. S. Liebovitch and V. Naudot</i>	
13. How to Transform a Type of Chaos in Dynamical Systems?	231
<i>E. Zeraoulia and J. C. Sprott</i>	
<i>Author Index</i>	253
<i>Subject Index</i>	255