

# **Springer Proceedings in Mathematics & Statistics**

Volume 180

## **Springer Proceedings in Mathematics & Statistics**

This book series features volumes composed of selected contributions from workshops and conferences in all areas of current research in mathematics and statistics, including operation research and optimization. In addition to an overall evaluation of the interest, scientific quality, and timeliness of each proposal at the hands of the publisher, individual contributions are all refereed to the high quality standards of leading journals in the field. Thus, this series provides the research community with well-edited, authoritative reports on developments in the most exciting areas of mathematical and statistical research today.

More information about this series at <http://www.springer.com/series/10533>

Lluís Alsedà i Soler · Jim M. Cushing  
Saber Elaydi · Alberto A. Pinto  
Editors

# Difference Equations, Discrete Dynamical Systems and Applications

ICDEA, Barcelona, Spain, July 2012

*Editors*

Lluís Alsedà i Soler  
Departament de Matemàtiques  
Universitat Autònoma de Barcelona  
Cerdanyola del Vallès, Barcelona  
Spain

Saber Elaydi  
Department of Mathematics  
Trinity University  
San Antonio, TX  
USA

Jim M. Cushing  
Department of Mathematics  
University of Arizona  
Tucson, AZ  
USA

Alberto A. Pinto  
Faculty of Sciences, Department of  
Mathematics,  
University of Porto  
Porto  
Portugal

ISSN 2194-1009                      ISSN 2194-1017 (electronic)  
Springer Proceedings in Mathematics & Statistics  
ISBN 978-3-662-52926-3              ISBN 978-3-662-52927-0 (eBook)  
DOI 10.1007/978-3-662-52927-0

Library of Congress Control Number: 2016944486

Mathematics Subject Classification (2010): 37-XX, 39-XX, 58-XX

© Springer-Verlag Berlin Heidelberg 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer-Verlag GmbH Berlin Heidelberg



Group picture of the participants of the ICDEA 2012 on the main stairs of Casa de Convalescència (venue of the meeting)

# Preface

This volume contains the proceedings of the 18th International Conference on Difference Equations and Applications held in Barcelona (Catalonia, Spain) from July 23rd to 27th, 2012. The conference was organized by the Departament de Matemàtiques of the Universitat Autònoma de Barcelona (UAB), under the auspices of the International Society of Difference Equations (ISDE).

The purpose of the conference was to bring together experts and novices in the theory and applications of difference equations and discrete dynamical systems. The main theme of the meeting was the interplay between difference equations and dynamical systems.

The plenary speakers were experts chosen from many different areas of difference equations, *broadly defined*, and discrete dynamical systems and their interplay with nonlinear science.

There were 129 presentations which included 14 plenary talks (including the Special talk of the winner of the “Best JDEA paper” prize), 39 contributed talks, and 87 special sessions talks. The main topics of the meeting were represented by the six special sessions which were organized during the conference. They cover the theory of difference equations and discrete dynamical systems and their applications to biology and economics and are described below.

- *Combinatorial and Topological Dynamics* (14 talks organized by S. Kolyada and L'. Snoha);
- *Complex Dynamics* (23 talks organized by B. Devaney, N. Fagella and X. Jarque);
- *Applications of Difference Equations to Biology* (10 talks organized by J. Cushing, S. Elaydi and J. Li);
- *Asymptotic Behavior and Periodicity of Difference Equations* (20 talks organized by I. Györi and M. Pituk);
- *Chaotic Linear Dynamics* (9 talks organized by J.P. Bès, P. Oprocha and A. Peris); and
- *Economic Dynamics and Control* (11 talks organized by A.A. Pinto and A. Yannacopoulos).

There were 157 participants (120 male and 37 female) from Austria, Belarus, Belgium, Bosnia-Herzegovina, Brazil, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Iran, Ireland, Israel, Italy, Jamaica, Japan, Latvia, Mexico, Oman, Poland, Portugal, Russia, Serbia, Slovakia, Spain, Sweden, Ukraine, United Kingdom, and USA.

We would like to acknowledge the financial support of the following institutions: Centro Internacional de Matemática, Institut de Matemàtiques de la Universitat de Barcelona, Centre de Recerca Matemàtica, Ministerio de Economía y Competitividad, Generalitat de Catalunya, Grup de Sistemes Dinàmics de la Universitat Autònoma de Barcelona. Also, we would like to thank the organizing committee that ensured a good organization and the success of the conference as well as the scientific committee that took care of the high scientific standards and the quality of the conference.

We warmly thank all the speakers and participants of the meeting for their contributions and helping to create a wonderful, friendly, and fruitful atmosphere.

All participants of ICDEA2012 were invited to submit a contribution to these proceedings, and all papers that were accepted had to pass through a refereeing process appropriate for a mathematical research journal.

Cerdanyola del Vallès, Spain  
Tucson, USA  
San Antonio, USA  
Porto, Portugal

Lluís Alsedà i Soler  
Jim M. Cushing  
Saber Elaydi  
Alberto A. Pinto

# Organization Committees

## Organizing Committee

Lluís Alsedà i Soler, Universitat Autònoma de Barcelona, Barcelona, Spain  
Francisco Balibrea, Universidad de Murcia, Murcia, Spain  
Zhaoyang Dong, Universitat Autònoma de Barcelona, Barcelona, Spain  
Eduardo Liz, Universidad de Vigo, Vigo, Spain  
Leopoldo Morales, Universitat Autònoma de Barcelona, Barcelona, Spain  
Henrique Oliveira, Instituto Superior Técnico de Lisboa, Lisboa, Portugal  
David Romero i Sánchez, Universitat Autònoma de Barcelona, Barcelona, Spain

## Scientific Committee

Lluís Alsedà i Soler, Universitat Autònoma de Barcelona, Barcelona, Spain  
Jim M. Cushing, University of Arizona, Tucson, Arizona, USA  
Sergii Kolyada, National Academy of Sciences, Kiev, Ukraine  
Alberto A. Pinto, Universidade de Porto and International Centre for Mathematics, Porto, Portugal  
Robert Sacker, University of Southern California, Los Angeles, California, USA  
André Vanderbauwhede, Gant University, Gant, Belgium



# Contents

<b>On the Second Order Rational Difference</b>	
<b>Equation <math>x_{n+1} = \beta + \frac{1}{x_n x_{n-1}}</math></b> . . . . .	1
Aija Anisimova	
<b>Moment Vanishing of Piecewise Solutions of Linear ODEs</b> . . . . .	15
Dmitry Batenkov and Gal Binyamini	
<b>Periodic Solutions of the Second Order Quadratic Rational Difference</b>	
<b>Equation <math>x_{n+1} = \frac{\alpha}{(1+x_n)x_{n-1}}</math></b> . . . . .	29
Inese Bula	
<b>Li–Yorke Chaos in Perturbed Rational Difference Equations</b> . . . . .	49
Francisco Balibrea and Antonio Cascales	
<b>Simple Mandelpinski Necklaces for <math>z^2 + \lambda/z^2</math></b> . . . . .	63
Daniel Cuzzocreo and Robert L. Devaney	
<b>R&amp;D Dynamics with Asymmetric Efficiency</b> . . . . .	73
M. Ferreira, J.P. Almeida, B.M.P.M. Oliveira and Alberto A. Pinto	
<b>Different Approaches to the Global Periodicity Problem</b> . . . . .	85
Anna Cima, Armengol Gasull, Víctor Mañosa and Francesc Mañosas	
<b>On Bifurcations of Homoclinic Tangencies in Area-Preserving</b>	
<b>Maps on Non-orientable Manifolds</b> . . . . .	107
Amadeu Delshams, Marina Gonchenko and Sergey Gonchenko	
<b>A Compact Invariant Set for the Ricker Competition Model</b> . . . . .	127
Göran Högnäs	
<b>On a Stochastic Ricker Competition Model</b> . . . . .	135
Göran Högnäs	
<b>A Repeated Strategy for Dumping</b> . . . . .	145
J. Martins, N. Banik and Alberto A. Pinto	

**Hypercyclic and Topologically Mixing Properties of Certain Classes of Abstract Time-Fractional Equations . . . . .** 155  
Marko Kostić

**Periods of Homeomorphisms on Closed Surfaces . . . . .** 171  
Juan Luis García Guirao and Jaume Llibre

**Polygonal Billiards with Strongly Contractive Reflection Laws: A Review of Some Hyperbolic Properties . . . . .** 179  
Gianluigi Del Magno, João Lopes Dias, Pedro Duarte, José Pedro Gaivão and Diogo Pinheiro

**Asymptotic Representation of Solutions of Linear Autonomous Difference Equations . . . . .** 191  
Hideaki Matsunaga

**Translation Arcs and Stability in Two Dimensions . . . . .** 201  
Rafael Ortega

**Integrated Exponential Functions, the Weyl Fractional Calculus and the Laplace Transform . . . . .** 223  
Pedro J. Miana

**A QRT-System of Two Order One Homographic Difference Equations: Conjugation to Rotations, Periods of Periodic Solutions, Sensitiveness to Initial Conditions . . . . .** 237  
Guy Bastien and Marc Rogalski

**Continuous Limit in Dynamics with Choice . . . . .** 267  
Lev Kapitanski and Sanja Živanović Gonzalez

**Answers to Some Problems on Self-similar Sets and the Open Set Condition . . . . .** 297  
Jakub Šotola

**Taylor Domination, Difference Equations, and Bautin Ideals . . . . .** 303  
Dmitry Batenkov and Yosef Yomdin

**On the Set of Periods of the 2-Periodic Lyness' Equation . . . . .** 321  
Guy Bastien, Víctor Mañosa and Marc Rogalski