

Journal of Applied Nonlinear Dynamics

Editors

Albert C.J. Luo

Department of Mechanical and Industrial Engineering
Southern Illinois University Edwardsville
Edwardsville, IL 62026-1805, USA
Email: aluo@siue.edu

Miguel A. F. Sanjuan

Department of Physics
Universidad Rey Juan Carlos
28933 Mostoles, Madrid, Spain
Email: miguel.sanjuan@urjc.es

Associate Editors

Viktor Avrutin

Institute for Systems Theory and
Automatic Control,
University of Stuttgart
Pfaffenwaldring 9, 70569 Stuttgart,
Germany
Email: avrutin.viktor@gmail.com

Irina Bashkirtseva

Ural Federal University
Lenina, 51, 620000, Ekaterinburg,
Russia
Email: Irina.Bashkirtseva@urfu.ru

Tassos Bountis

Department of Mathematics
University of Patras, Patras 26500
Greece
Email: tassosbountis@gmail.com

Eric Campos Cantón

División de Matemáticas Aplicadas
Instituto Potosino de Investigación
Científica y Tecnológica
San Luis Potosí, México
Email: eric.campos@ipicyt.edu.mx

Lock Yue Chew

Division of Physics & Applied Physics
School of Physical & Mathematical
Sciences
Nanyang Technological University
21 Nanyang Link, SPMS-PAP-04-04
Singapore 637371
Email: lockyue@ntu.edu.sg

Jorge Duarte

ISEL-Engineering Superior Institute of
Lisbon
Mathematics Department
Rua Conselheiro Emídio Navarro
1949-014 Lisboa
Portugal
Email: jduarte@adm.isel.pt

Igor Franović

Center of Excellence for the Study of
Complex Systems
Institute of Physics Belgrade
Pregrevica 118, 11080 Belgrade, Serbia
Email: franovic@ipb.ac.rs

Sajad Jafari

Biomedical Engineering Faculty,
Amirkabir University of Technology,
424 Hafez Ave, 15875-4413, Tehran,
Iran
Email: sajadjafari@aut.ac.ir

Nikolay V. Kuznetsov

Mathematics and Mechanics Faculty
Saint-Petersburg State University
Saint-Petersburg, 198504, Russia
Email: n.v.kuznetsov@spbu.ru

Edson Denis Leonel

Departamento de Física
UNESP - Univ Estadual Paulista
Av. 24A, 1515 - Rio Claro - SP
Brazil - 13.506-900
Email: edleonel@rc.unesp.br

Antonio M Lopes

UISPA-LAETA/INEGI
Faculty of Engineering
University of Porto
Rua Doutor Roberto Frias, s/n, 4200-465
Porto, Portugal
Email: aml@fe.up.pt

Jun Ma

Department of Physics
Lanzhou University of Technology
Lanzhou 730050 China
E-mail: hyperchaos@163.com,
hyperchaos@lut.edu.cn

Arturo C. Martí

Instituto de Física, Facultad de Ciencias
Iguá 4225, 11400 Montevideo, Uruguay
marti@fisica.edu.uy,
artuomarti@gmail.com

Riccardo Meucci

Istituto Nazionale di Ottica-CNR
Largo E. Fermi 6, 50125 Firenze, Italy
Department of Physics and Astronomy,
Università di Firenze, 50125 Firenze,
Italy
riccardo.meucci@ino.cnr.it

Minvydas Ragulskis

Center for Nonlinear Systems
Department of Mathematical Modelling
Kaunas University of Technology
Studentu 50-146,
Kaunas LT-51368, Lithuania
Email: minvydas.ragulskis@ktu.lt

Shanmuganathan Rajasekar

School of Physics
Bharathidasan University
Tiruchirappalli - 620 024
Tamilnadu, India
Email: srj.bdu@gmail.com; srj@bdu.ac.in

Gonzalo Marcelo Ramírez-Ávila

Instituto de Investigaciones Físicas
Universidad Mayor de San Andrés
Campus Universitario Cota-Cota
Calle 27, La Paz, Bolivia
Email: mravila@fiumsa.edu.bo

Charalampos (Haris) Skokos

Department of Mathematics and
Applied Mathematics,
University of Cape Town
Rondebosch, 7701, South Africa
Email: haris.skokos@uct.ac.za

Journal of Applied Nonlinear Dynamics

Volume 12, Issue 2, June 2023

Editors

Albert Chao-Jun Luo

Miguel A. F. Sanjuan



L&H Scientific Publishing, LLC, USA

Publication Information

Journal of Applied Nonlinear Dynamics (ISSN 2164-6457 (print), eISSN 2164-6473 (online)) is published quarterly (March, June, September, and December) by L & H Scientific Publishing, LLC, 25 Glen Ed Professional Park, Glen Carbon, IL62034, USA. Subscription prices are available upon request from the publisher or from this journal website. Subscriptions are accepted on a prepaid basis only and entered on a calendar year basis. Issues are sent by standard mail (Surface in North America, air delivery outside North America). Priority rates are available upon request. Claims for missing issues should be made within six months of the date of dispatch.

Changes of Address

Send address changes to L&H Scientific Publishing, LLC, 25 Glen Ed Professional Park, Glen Carbon, IL62034, USA. Changes of address must be received at L&H Scientific Publishing eight weeks before they are effective.

Authors Inquiries

For inquiries relative to the submission including electronic submission where available, please visit journal website or contact journal Editors-in-Chief.

Advertising Information

If you are interested in advertising or other commercial opportunities, please email via lhscientificpublishing@gmail.com and your enquiry will be handled as soon as possible.

© 2023 L&H Scientific Publishing, LLC. All rights reserved

L&H Scientific Publishing, LLC requires the authors to sign a Journal Copyright Transfer Agreement for all articles published in L&H Scientific. The Copyright Transfer Agreement is an agreement under which the author retains copyright in the work but grants L & H Scientific Publishing LLC the sole and exclusive right and license to publish the full legal term of copyright.

Authors are responsible for obtaining permission from copyright holders for reproducing any illustrations, tables, figures or lengthy quotations published somewhere previously.

For authorization to photocopy materials for internal or personal use under those circumstances not falling within the fair use provisions of Copyright Act, requests for reprints and translations should be addressed to the permission office of L&H Scientific Publishing, LLC via lhscientificpublishing@gmail.com or call: +1-618-402-2267. Permission of the Publisher and payment of a fee are required for all other photocopying, including multiple or systematic copying, copying for advertising or promotional purposes, resale, and forms of document delivery. Special rates are available for educational institutions to make photocopies for non-profit educational classroom use.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the publisher is required for resale or distribution outside the institution.

Permission of the Publisher is required to store or use electronically any materials contained in this journal, including any entire or partial article, please contact the publisher for advice. Otherwise, no part of this publication can be reproduced, stored in retrieval systems or transmitted in any form or by means, electronic, mechanical, photocopying, recording or without prior written permission of the Publisher.

Disclaimer

The authors, editors and publisher will not accept any legal responsibility for any errors or omissions that may be made in this publication. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed in USA on acid-free paper.

Aims and Scope

The Journal of Applied Nonlinear Dynamics is a journal aiming at increasing the basic and applied knowledge in the interdisciplinary field of nonlinear sciences, including nonlinear dynamics, chaos and complex systems, and focusing on physics, applied mathematics, engineering and other applied disciplines. The aim of the journal is to stimulate research in nonlinear phenomena in science and engineering. Manuscripts in complex dynamical systems with nonlinearity and chaos are solicited, which includes physical mechanisms of complex systems and engineering applications of nonlinear dynamics. The journal provides a place to researchers for the rapid exchange of ideas and techniques in nonlinear dynamics.

No length limitations for contributions are set, but only concisely written manuscripts are published. Brief papers are published, either as technical notes or concise new results. Discussions of previous published papers are also welcome. The journal aims to be a forum of exchange of new research results for physicists, applied mathematicians, and engineers involved in Nonlinear Science and Numerical Simulation. Topics of interest includes but not limited to

- Deterministic chaos,
- Nonlinear dynamical systems and control,
- Fractional dynamics and applications,
- Synchronization phenomena,
- Fractal structures in nonlinear dynamics,
- Fluctuations and noise effects on dynamical systems
- Chaos in Hamiltonian systems,
- Nonlinearity and chaos in quantum mechanics,
- Chaos in Astrophysics and Celestial Dynamics,
- Integrable systems and solitons,
- Collective behaviors in many-body systems,
- Biological physics and networks,
- Nonlinear mechanical systems,
- Nonlinear phenomena and chaos in Physics
- Complex systems and complexity.

Peer Review

Journal of Applied Nonlinear Dynamics adopts the traditional blind-review policy in which the reviewers' names are concealed for submission author(s) for free submission. Each submitted manuscript is reviewed at least two referees in appropriate fields. In addition, the editorial board members' recommendation or established experts' recommendation publication are welcome.

Manuscript Submission Guidelines

Author(s) should submit manuscripts via the website: <https://www.editorialmanager.com/JAND/Default.aspx>. For any questions, authors can directly contact Editors-in-Chief. Manuscript preparation can follow the sample papers and journal manuscript templates (word file and Latex files), which can be downloaded from the website: <https://lhscientificpublishing.com/Journals/JAND-Default.aspx>.

Proofs and Electronic Offprints

Authors will receive a PDF proof of their articles and, on publication, electronic offprints of the article.

Open Access Options

After manuscripts were accepted, author(s) have a right to request the accepted manuscripts published by L&H Scientific publishing with open access, and the author(s) have a responsibility to paying the open access publication fee. The copyright is still held by the Publisher, but the open access permission is given to the author(s) as follows. Without any request of the open access publication, the accepted manuscripts are assumed to be published traditionally. This journal offers authors two choices to publish their research.

- *Open access:* Articles are freely available to both subscribers and the wider public with permitted reuse. An open access publication fee is payable by authors or their research funder.
- *Subscription:* Articles are made available to subscribers through our access programs. No open access publication fee.

L&H scientific does offer alternative open access publishing options in accordance with funding body requirements. Your publication choice will have no effect on the peer review process or acceptance of your submission.

Open Access Articles

- User rights

All articles published gold open access will be immediately and permanently free for everyone to read and download. We offer authors a choice of user licenses, which define the permitted reuse of articles. We are continuously working with our author communities to select the best choice of license options, currently being defined for this journal as follows:

Creative Commons Attribution (CC BY): lets others distribute and copy the article, to create extracts, abstracts, and other revised versions, adaptations or derivative works of or from an article (such as a translation), to include in a collective work (such as an anthology), to text or data mine the article, even for commercial purposes, as long as they credit the author(s), do not represent the author as endorsing their adaptation of the article, and do not modify the article in such a way as to damage the author's honor or reputation.

Creative Commons Attribution-NonCommercial-NoDerivs (CC BY-NC-ND): for non-commercial purposes, lets others distribute and copy the article, and to include in a collective work (such as an anthology), as long as they credit the author(s) and provided they do not alter or modify the article.

- Open access publication fee

To provide open access, this journal has a publication fee which needs to be met by the authors or their research funders for each article published open access. The open access publication fee for this journal is USD 100 per page, excluding taxes.

Self-archiving Policy

Authors can share their research in a variety of different ways. The author(s) can also self-archive their author manuscript immediately and enable public access from their institution's repository after an embargo period. This is the version that has been accepted for publication and which typically includes author-incorporated changes suggested during submission, peer review and in editor-author communications.

An author is entitled to post the accepted manuscript in their institution's repository and make this public after an embargo period (known as self-archiving). The embargo period for this journal can be found below.

Without the L&H permission, the published journal article cannot be shared publicly, such as, on ResearchGate or Academia.edu, to ensure the sustainability of peer-reviewed research in journal publications.

Embargo period: For subscription articles, an appropriate amount of time is needed for journals to deliver value to subscribing customers before a manuscript becomes available for free to the public. This is called an embargo period and it begins from the date the article is formally published online in its final and fully citable form.

This journal has an embargo period of 24 months and the embargo period for the USA is 12 months.

Continued from inside front cover

Michael Small

Department of Mathematics and Statistics
The University of Western Australia
35 Stirling Highway, 6009 Perth Australia
Email: michael.small@uwa.edu.au

Juan Alejandro Valdivia

Departamento de Física
Universidad de Chile
Las Palmeras 3425, Nunoa
Santiago, Chile
Email: alejo@macul.ciencias.uchile.cl

Editorial Board

Ravi P. Agarwal

Department of Mathematics
Texas A&M University-Kingsville
700 University Blvd., MSC 172
Kingsville, Texas 78363-8202
USA
Email: Ravi.Agarwal@tamuk.edu

Fuhong Min

School of Electrical and Automation
Engineering,
Nanjing Normal University
Nanjing 210023, China
Email: minfuhong@njnu.edu.cn

Vsevolod Sakbaev

Moscow Institute of Physics and
Technology
Institutskiy per. 9, Dolgoprudny
Moscow region, 141701
Russia
Email: sakbaev.vzh@mipt.ru

Zhigang Zheng

Institute of Systems Science,
Huaqiao University,
No.668 Jimei Avenue,
Xiamen, Fujian 361021
China
Email: zgzheng@hqu.edu.cn

Vasily E. Tarasov

Skobeltsyn Institute of Nuclear Physics
Moscow State University
119991 Moscow, Russia
Email: tarasov@theory.sinp.msu.ru

Christos Volos

Department of Physics
Aristotle University of Thessaloniki
GR-54124 Thessaloniki, Greece
volos@physics.auth.gr

Hongjun Cao

Department of Mathematics
School of Science
Beijing Jiaotong University
Shang Yuan Cun 3, Haidian District
Beijing 100044
China
Email: hjcao@bjtu.edu.cn

Vladimir I. Nekorkin

Institute of Applied Physics of RAS
46 U'lyanov Street, 603950
Nizhny Novgorod
Russia
Email: vnekorkin@appl.sci-nnov.ru

Jianhua Yang

School of Mechatronic Engineering,
China University of Mining and
Technology,
Xuzhou, Jiangsu, 221116
China
Email: jianhuayang@cumt.edu.cn

Ricardo Viana

Departamento de Física
Universidade Federal do Paraná
81531-990, Curitiba, Paraná, Brasil
Email: viana@fisica.ufpr.br

Yuefang Wang

Department of Engineering Mechanics
Dalian University of Technology
Dalian, Liaoning, 116024, China
Email: yfwang@dlut.edu.cn

Lyudmila Efremova

Institute of Information Technologies
Mathematics and Mechanics
University of Nizhni Novgorod
Gagarin ave., 23a
Nizhni Novgorod, 603950
Russia
Email: lefunn@gmail.com

Lev Ryashko

Department of the Theoretical and
Mathematical Physics
Ural Federal University
Lenina, 51, 620000, Ekaterinburg
Russia
Email: lev.ryashko@urfu.ru

Yufeng Zhang

College of Sciences
China University of Mining and
Technology
Xuzhou, Jiangsu 221116
China
Email: mathzhang@126.com