

# *Ergodic theory and dynamical systems*

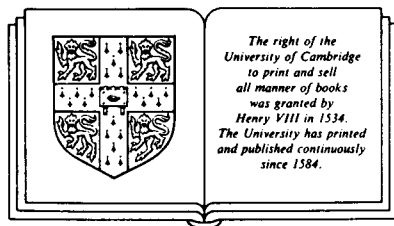
## EDITORS

John Franks   Hillel Furstenberg   Anthony Manning   William Parry

## EDITORIAL BOARD

- |   |   |
|---|---|
| A. Connes (IHES)                              | D. S. Ornstein (Stanford University)                              |
| M. Gromov (IHES)                              | D. J. Rudolph (University of Maryland)                            |
| M. R. Herman (Ecole Polytechnique, Palaiseau) | D. Ruelle (IHES)  |
| A. B. Katok (CalTech)                         | K. Schmidt (University of Warwick)                                |
| M. Keane (Technische Hogeschool Delft)        | Ya. G. Sinai (L. D. Landau Inst. for Theoretical Physics, Moscow) |
| U. Krengel (University of Göttingen)          | J. P. Thouvenot (University of Paris 6)                           |
| R. Mañé (IMPA)                                | W. A. Veech (Rice University)                                     |
| G. A. Margulis (USSR Acad. of Sciences)       | P. Walters (University of Warwick)                                |
| J. N. Mather (Princeton University)           | B. Weiss (Hebrew University)                                      |
| M. Misiurewicz (Warsaw University)            | R. F. Williams (University of Texas, Austin)                      |
| J. Moser (ETH, Zürich)                        | R. Zimmer (University of Chicago)                                 |
| S. E. Newhouse (University of North Carolina) |   |

VOLUME 8  
1988



CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE

LONDON   NEW YORK   NEW ROCHELLE  
MELBOURNE   SYDNEY

PUBLISHED BY  
THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE

The Pitt Building, Trumpington Street, Cambridge CB2 1RP  
32 East 57th Street, New York, NY 10022, USA  
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

© Cambridge University Press 1988

*Printed in Great Britain by J. W. Arrowsmith Ltd, Bristol*

# Contents

## PART 1 MARCH 1988

Dynamics induced on the ends of a non-compact manifold <i>S. Alpern and V. S. Prasad</i>	1
The speed interval: a rotation algorithm for endomorphisms of the circle <i>J. Barkmeijer</i>	17
Points génériques de Champernowne sur certains systèmes codes: application aux $\theta$ -shifts <i>A. Bertrand-Mathis</i>	35
An invariant for rigid rank-1 transformations <i>N. Friedman, P. Gabriel and J. King</i>	53
Cohomology of chain recurrent sets <i>M. W. Hirsch and C. C. Pugh</i>	73
On the number of periodic reflecting rays in generic domains <i>V. M. Petkov and L. N. Stojanov</i>	81
Another proof of Jakobson's Theorem and related results <i>M. R. Rychlik</i>	93
Asymptotic behaviour of iterated piecewise monotone maps <i>J. Willms</i>	111
Measure theoretic entropy of the system of hard spheres <i>M. Wojtkowski</i>	133

## PART 2 JUNE 1988

Minimal flows of finite almost period rank <i>J. Auslander and N. Markley</i>	155
Duality for automorphisms on a compact $C^*$ -dynamical system <i>D. E. Evans and A. Kishimoto</i>	173
Some compact invariant sets for hyperbolic linear automorphisms of tori <i>A. Fathi</i>	191
The attracting centre of a continuous self-map of the interval <i>Xiong Jincheng</i>	205
Geodesic flows of negatively curved manifolds with smooth stable and unstable foliations <i>M. Kanai</i>	215
Propriétés des attracteurs de Birkhoff <i>P. Le Calvez</i>	241
On the construction of smooth ergodic skew-products <i>M. G. Nerurkar</i>	311
Book review <i>A. F. Williams</i>	327

## PART 3 SEPTEMBER 1988

A method for constructing attractors <i>M. Barge</i>	331
Joint ergodicity for group actions <i>V. Bergelson and J. Rosenblatt</i>	351

## INSTRUCTIONS TO AUTHORS

### 1 *Submission of typescripts*

Two copies of the manuscript should be submitted to one of the four Executive Editors (addresses on outside front cover). The editor will acknowledge receipt of the manuscripts. **It is important that authors inform the editor of any changes of address** whilst their paper is under consideration.

### 2 *Typescript*

Papers should be typed, double-spaced, on one side only and with generous margins. The pages must be numbered.

The first page should give the title, the author's name and institution, and a short abstract intelligible to mathematicians.

The title, while brief, must be informative (e.g. *A new proof of the ergodic theorem*, whereas *Some applications of a theorem of Birkhoff* would be useless).

### 3 *Notation*

It is important that mathematical expressions are clear to a printer (who is not a mathematician). For instance,  $n_k$  ( $n$  sub  $k$ ) is common usage, but avoid if possible using  $c$  sub  $n$  sub  $k$ . Fractions are generally best expressed by a solidus. Complicated exponentials like

$$\exp \{z^2 \sin \theta / (1 + y^2)\}$$

should be shown in this and no other way.

In the typescript, italics, small capitals and capitals are specified by single, double and triple underlining. Bold-faced type is shown by wavy underlining.

It helps if displayed equations or statements which will be quoted later are numbered in order on the right of their line. They can then be referred to by, for example, 'from (7)'.  
The author must enable the printer (if necessary by pencilled notes in the margin) to distinguish between similar symbols such as  $a$ ,  $O$ ,  $o$ ,  $O$ ,  $0$ ;  $x$ ,  $X$ ,  $\times$ ;  $\phi$ ,  $\Phi$ ,  $\emptyset$ ;  $1$ ,  $1$ ;  $\varepsilon$ ,  $\in$ ;  $\kappa$ ,  $k$ .

There is no need to underline Greek or script letters provided these are clearly typed. Any special symbols should be explained on a separate sheet of directions for the printer.

If an author wishes to mark the end of the proof of a theorem, the sign  $\square$  may be used.

Footnotes should be avoided.

### 4 *Diagrams*

Figures and drawings should be on separate sheets in black ink. Photocopies are acceptable only if

they are as clear as the originals. *Symbols, legends and captions should be given on a transparent overlay.* Each text figure must be numbered as Figure 1, Figure 2, ... and its intended position clearly indicated in the typescript. The author's name in pencil must be on all separate sheets of diagrams.

A figure is expensive to reproduce and should be included only when the subject matter demands it, or when it greatly clarifies the exposition.

The publisher recognizes that some authors do not have the facilities for producing drawings of a sufficiently high standard to be reproduced directly and is therefore willing to have such diagrams re-drawn, provided that they are clear.

### 5 *Tables*

Tables should be numbered (above the table) and set out on separate sheets. Indicate the position of each in the text as for figures.

### 6 *References*

References should be collected at the end of the paper numbered in alphabetical order of the authors' names. A reference to a book should give the title, in italics, and then in roman type the publisher's name and the place and year of publication;

[4] N. Dunford & J. T. Schwartz *Linear Operators* Part I. Wiley: New York, 1958.

A reference to a paper should give in italics the title of the periodical, the number of the volume and year, and the beginning and end pages of the paper. Titles should be abbreviated as in *Mathematical Reviews*:

[6] J. E. Littlewood. The 'pits effect' for functions in the unit circle. *J. Analyse Math.* 23 (1970), 236-268.

### 7 *Proofs*

Authors receive one set of proofs for correction. If excessive alterations to the original manuscript are requested after the paper has been typeset, the author will be charged the cost of resetting. For papers with more than one author the proofs are sent to the first named author unless the editor receives other instructions. **It is important that proofs are corrected and returned promptly.**

### 8 *Reprints*

There are 100 reprints, free of charge, for each paper. For papers with several authors these reprints are divided between the authors. There are no page charges.

# *Ergodic theory and dynamical systems*

VOLUME 8 PART 4 DECEMBER 1988

## CONTENTS

<i>Tihomirov, V. M.</i> Andrei Nikolaevich Kolmogorov	493
<i>Sinai, Ya G.</i> About A. N. Kolmogorov's work on the entropy of dynamical systems	501
<i>Baker, I. N.</i> Infinite limits in the iteration of entire functions	503
<i>Barge, M. and Swanson, R.</i> Rotation shadowing properties of circle and annulus maps	509
<i>Dani, S. G.</i> On orbits of endomorphisms of tori and the Schmidt game	523
<i>Donnay, V. J.</i> Geodesic flow on the two-sphere, Part I: Positive measure entropy	531
<i>Douady, R.</i> Regular dependence of invariant curves and Aubry-Mather sets of twist maps of an annulus	555
<i>Handel, M.</i> Entropy and semi-conjugacy in dimension two	585
<i>Lyons, R.</i> Mixing and asymptotic distribution modulo 1	597
<i>Patterson, S. E.</i> $\Omega$ -Stability is not dense in Axiom A	621
<i>Taniguchi, M.</i> Examples of discrete groups of hyperbolic motions conservative but not ergodic at infinity	633
<i>Walczak, P. G.</i> Dynamics of the geodesic flow of a foliation	637
Index to Volume 8	651

© Cambridge University Press 1988

CAMBRIDGE UNIVERSITY PRESS

The Pitt Building, Trumpington Street, Cambridge CB2 1RP

32 East 57th Street, New York, NY 10022, USA

10 Stamford Road, Oakleigh, Melbourne 3166, Australia

Printed in Great Britain by J. W. Arrowsmith Ltd, Bristol