# MATHEMATICAL 

PROCEEDINGS
(formerly Proceedings)
of the
Cambridge Philosophical Society
V OLUME 173


CAMBRIDGE UNIVERSITY PRESS

Published by the Press Syndicate of the University of Cambridge The Pitt Building, Trumpington Street, Cambridge CB2 1RP, United Kingdom

## CAMBRIDGE UNIVERSITY PRESS

University Printing House, Shaftesbury Road, Cambridge CB2 8BS, United Kingdom
32 Avenue of the Americas, New York, NY 10013-2473, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
C/Orense, 4, planta 13, 28020 Madrid, Spain
Lower Ground Floor, Nautica Building, The Water Club, Beach Road,
Granger Bay, Cape Town 8005, South Africa
(c) Cambridge Philosophical Society 2022

Printed in the United Kingdom by Bell and Bain Limited, Glasgow

## INDEX FOR VOLUME 173

PAGE
Abdollahi, A. \& Malekan, M.S. Compact groups with a set of positive Haar measure satisfying a nilpotent law ..... 329
Aggarwal, D., Subedi, U., Verreault, W., Zaman, A. \& Zheng, C. Sums of random multiplicative functions over function fields with few irreducible factors ..... 715
Akhtari, S. A positive proportion of locally soluble quartic Thue equations are globally insoluble ..... 333
Bennett, J. \& Jeong, E. Fourier duality in the Brascamp-Lieb inequality ..... 387
Ben-Zvi, M., Kropholler, R. \& Lyman, R.A. Folding-like techniques for CAT(0) cube complexes ..... 227
Berger, A., Sah, A., Sawhney, M. \& Tidor, J. Non-classical polynomials and the inverse theorem ..... 525
Bley, W. \& Castillo, D.M. Congruences for critical values of higher derivatives of twisted Hasse-Weil L-functions, III ..... 431
Cela, A., Pandharipande, R. \& Schmitt, J. Tevelev degrees and Hurwitz moduli spaces ..... 479
Conlon, D. Some remarks on the Zarankiewicz problem ..... 155
Coppola, N. Wild Galois representations: a family of hyperelliptic curves with large inertia image ..... 619
Dunajski, M. \& Tod, P. Conformal geodesics on gravitational instantons ..... 123
Elbracht, C., Kneip, J. \& Teegen, M. Trees of tangles in infinite separation systems ..... 297
Erraoui, M. \& Hakiki, Y. Images of fractional Brownian motion with deterministic drift: Positive Lebesgue measure and non-empty interior ..... 693
Feller, P.\& Park, J. A note on the four-dimensional clasp number of knots ..... 213
Ford, K. Joint Poisson distribution of prime factors in sets ..... 189
Grishkov, A., Sabinina, L. \& Zelmanov, E. The restricted Burnside problem for Moufang loops ..... 201
Han, X. \& Schied, A. Step roots of Littlewood polynomials and the extrema of functions in the Takagi class ..... 591
Kloeckner, B.R. Optimal transportation and stationary measures for iterated function systems ..... 163
Laterveer, R. Algebraic cycles and intersections of three quadrics ..... 349
Lim, M.F. On the cohomology of Kobayashi's plus/minus norm groups and applications ..... 1
Lipham, D.S. Distinguishing endpoint sets from Erdős space ..... 635
Manuell, G. The spectrum of a localic semiring ..... 647
Mayrand, J. \& Senécal, C. Asymptotics of sloshing eigenvalues for a triangular prism ..... 539
Meyrath, T. \& Müller, J. Non-normality, topological transitivity and expanding families ..... 511
Okuyama, Y. Uniform perfectness of the Berkovich Julia sets in non-archimedean dynamics ..... 573
Parkkonen, J. \& Paulin, F. Counting and equidistribution in quaternionic Heisenberg groups ..... 67
Prendiville, S. Solving equations in dense Sidon sets ..... 25
Ramírez, F.A. Remarks about inhomogeneous pair correlations ..... 369
Reid, C.D., Wesolek, P.R. \& Le Maître, F. Chief factors in Polish groups ..... 239
Shah, R. \& Yadav, A.K. Distal Actions of Automorphisms of Lie Groups $G$ on $\operatorname{Sub}_{G}$ ..... 457
Shu, B. \& Zeng, Y. Centers and Azumaya loci for finite W-algebras in positive characteristic ..... 35
Rudnev, M. \& Stevens, S. An update on the sum-product problem ..... 411
Tsantaris, A. Permutable quasiregular maps ..... 105
Waibel, F. Uniform bounds for norms of theta series and arithmetic applications ..... 669

# THE <br> JOY OF ABSTRACTION <br> An Exploration of Math, Category Theory, and Life EUGENIA CHENG 



## Save 20\% with code JOY20

Mathematician and popular science author Eugenia Cheng is on a mission to show you that mathematics can be flexible, creative, and visual. This joyful journey through the world of abstract mathematics into category theory will demystify mathematical thought processes and help you develop your own thinking, with no formal mathematical background needed. The book brings abstract mathematical ideas down to earth using examples of social justice, current events, and everyday life - from privilege to COVID-19 to driving routes. The journey begins with the ideas and workings of abstract mathematics, after which you will gently climb toward more technical material, learning everything needed to understand category theory, and then key concepts in category theory like natural transformations, duality, and even a glimpse of ongoing research in higher-dimensional category theory. For fans of How to Bake Pi, this will help you dig deeper into mathematical concepts and build your mathematical background.

> 9781108477222 | Hardback | $£ 20 / \$ 25.95$ | Ctober 2022
"This book is an educational tour de force that presents mathematical thinking as a right-brained activity."

- KEITH DEVLIN, Stanford University (Emeritus), author of The Joy of Sets
"Cheng is a brilliant writer, with prose that feels like poetry. Her contagious enthusiasm makes her the perfect guide."
- JOHN EWING, President, Math for America
4...Eugenia Cheng's latest book will appeal to a remarkably broad and diverse audience, from nonmathematicians who would like to get a sense of what mathematics is really about, to experienced mathematicians who are not category theorists but would like a basic understanding of category theory." - SIR TIMOTHY GOWERS, Collège de France, Fields Medalist, main editor of The Princeton Companion to Mathematics


## INSTRUCTIONS TO AUTHORS

## 1. Preparation of Manuscripts

A paper should be submitted electronically to mpeditor@hermes.cam.ac.uk in pdf form only. Authors are encouraged to prepare their manuscripts in LaTeX 2e using the PSP class file. The class file, together with a guide, PSP2egui.tex, and sample pages, PSP2esam.tex, can be downloaded from ftp://ftp.cambridge.org/pub/texarchive/journals/latex/pspcls in either packed or unpacked form. These files will be updated periodically: please ensure that you have the latest version.

A cover page should give the title, the author's name and institution, with the address to which mail should be sent.
The title, while brief, must be informative (e.g. A new proof of the prime-number theorem, whereas, Some applications of a theorem of G.H.Hardy would be useless).

Authors are asked to provide an abstract as a basis for search on the Web. This may be an explicit abstract at the start of the paper. Otherwise the first paragraph or two should form a summary of the main theme of the paper, providing an abstract intelligible to mathematicians. Please note that the abstract should be able to be read independently of the main text. References should therefore not be included in the abstract.

Authors are encouraged to check that where references are given, they are used in the text. Experience has shown that unused references have a habit of surviving into the final version of the manuscript.

For a typescript to be accepted for publication, it must accord with the standard requirements of publishers, and be presented in a form in which the author's intentions regarding symbols etc. are clear to a printer (who is not a mathematician). Please also check the Cambridge University Press website for information about the style in which the paper should be submitted.

## 2. Notation

Notation should be chosen carefully so that mathematical operations are expressed with all possible neatness, to lighten the task of the compositor and to reduce the chance of error. For instance $n$ 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:

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

should be shown in this and no other way.
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 $o, O$, o, $\mathrm{O}, 0 ; x, \mathrm{X}, \times ; \phi, \Phi, \varnothing ; 1,1 ; \epsilon, k, \kappa, k$.

Footnotes should be avoided.
Please use typewriter font for all addresses and email addresses.
Omit * from the end of proofs.
In listing assertions, conclusions, etc. do not use a vertical column of dots and do not follow (a) or (i) by a capital letter (eg. (i) the absolute value . . )

In making references precise use [3, theorem 5.1]

## 3. Diagrams

Diagrams should be in black ink or from a high-quality laser printer and should not be larger than 30 cm by 45 cm . Lettering to be inserted by the printer should be shown clearly on copies of the figures rather than on the original drawings. Please note that a charge may be made if hand-drawn diagrams need to be re-drawn for publication.

## Figure 1 here

A typed list of captions may be provided at the end of the manuscript in the following format:
Figure 1. A basis for ...
Note that there is no point at the end of the heading. All headings should be centred.

## 4.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:

$$
\text { Table } 3 \text { here }
$$

Heading for tables should be shown in the following way:
Table 1. A basis for...
Note that there is no point at the end of the heading. All headings should be centred over columns.

## 5. References

References should be collected at the end of the paper numbered in alphabetical order of the authors' names. Where references are given, they should be used in the text. Titles of journals should be abbreviated as in Mathematical Reviews. The following examples show the preferred style for references to a paper in a journal, a paper in a proceedings volume, a book and an unpublished dissertation:
[1] J. F. Adams. On the non-existence of elements of Hopf invariant one. Ann of Math. (2) 72 (1960), 20-104.
[2] M. P. Fouram and D. S. Scott. Sheaves and logic. In Applications of Sheaves Lecture Notes in Math. vol. 753 (Springer-Verlag, 1979), pp. 302-401.
[3] P. T. Johnstone. Stone Spaces. Cambridge Studies in Advanced Math. no. 3 (Cambridge University Press, 1982).
[4] F. W. Lawvere. Functional semantics of algebraic theories. PhD. thesis. Columbia University (1963).
6. Submission of papers accepted for publication

When a paper has been accepted for publication the relevant TeX files of the final version, accompanied by a pdf file, should be sent to the Editor by e-mail.

This journal issue has been printed on FSC-certified paper and cover board. FSC is an independent, nongovernmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see www.fsc.org for information.

# MATHEMATICAL PROCEEDINGS 

of the
Cambridge Philosophical Society

## VOLUME 173 PART 3, pages 479-726, November 2022

## CONTENTS

A. Cela, R. Pandharipande \& J. Schmitt Tevelev degrees and Hurwitz moduli spaces ..... 479
Thierry Meyrath \& Jürgen Müller Non-normality, topological transitivity and expanding families ..... 511
Aaron Berger, Ashwin Sah, Mehtaab Sawhney \& Jonathan Tidor Non-classical polynomials and the inverse theorem ..... 525
Julien Mayrand, Charles Senécal \& Simon St-Amant Asymptotics of sloshing eigenvalues for a triangular prism ..... 539
Yûsuke Okuyama Uniform perfectness of the Berkovich Julia sets in non-archimedean dynamics ..... 573
Xiyue Han \& Alexander Schied Step roots of Littlewood polynomials and the extrema of functions in the Takagi class ..... 591
Nirvana Coppola Wild Galois representations: a family of hyperelliptic curves with large inertia image ..... 619
David S. Lipham Distinguishing endpoint sets from Erdős space ..... 635
Graham Manuell The spectrum of a localic semiring ..... 647
Fabian Waibel Uniform bounds for norms of theta series and arithmetic applications ..... 669
Mohamed Erraoui \& Youssef Hakiki Images of fractional Brownian motion with deterministic drift: Positive Lebesgue measure and non-empty interior ..... 693
Daksh Aggarwal, Unique Subedi, William Verreault, Asif Zaman \&Chenghui Zheng Sums of random multiplicative functions over functionfields with few irreducible factors .715

