

THE JOURNAL OF SYMBOLIC LOGIC

Edited by

Enrique Casanovas, *Coordinating Editor*

Matthias Aschenbrenner

Steve Awodey

Veronica Becher

Lev Beklemishev

Michael Benedikt

Damir Dzhafarov

Stephen Jackson

Hiroshi Sakai

Anton Setzer

VOLUME 86 • 2021

Copyright © 2022 by the Association for Symbolic Logic. All rights reserved.
Reproduction by photostat, photo-print, microfilm, or like process by permission only.



PUBLISHED BY CAMBRIDGE UNIVERSITY PRESS FOR
AND ON BEHALF OF THE ASSOCIATION FOR SYMBOLIC LOGIC.

CONTENTS OF VOLUME 86

AGUILERA, JUAN P. Shortening Clopen games	1541
———. The order of reflection	1555
AGUILERA, J. P. and WELCH, P. D. $G_{\delta\sigma}$ games and induction on reals	1676
ALVIR, RACHAEL, GREENBERG, NOAM, HARRISON-TRAINOR, MATTHEW, and TURETSKY, DAN. Scott complexity of countable structures	1706
AMBOS-SPIES, KLAUS, DOWNEY, ROD G., and MONATH, MARTIN. On supersets of non-low ₂ sets	1282
ANDRÉKA, HAJNAL and NÉMETI, ISTVÁN. Two-variable logic has weak, but not strong, Beth definability	785
ANDREWS, URI and MERMELSTEIN, OMER. $[0, \omega] \cup \{\omega\}$ is a spectrum of a non-disintegrated flat strongly minimal model complete theory in a language with finite signature	1632
ANGLÈS d'AURIAC, PAUL-ELLIOT, and TAKAYUKI, KIHARA. A comparison of various analytic choice principles	1452
BALDWIN, JOHN and PAOLINI, GIANLUCA. Strongly minimal Steiner systems I: existence.....	1486
BEZHANISHVILI, GURAM, BEZHANISHVILI, NICK, LUCERO-BRYAN, JOEL, and VAN MILL, JAN. Characterizing existence of a measurable cardinal via modal logic	162
BEZHANISHVILI, NICK. see BEZHANISHVILI, GURAM	
BHARDWAJ, NEER and TRAN, CHIEU-MINH. The additive groups of \mathbb{Z} and \mathbb{Q} with predicates for being square-free	1324
BHASKAR, SIDDHARTH. Thicket density	110
BIENVENU, LAURENT, CSIMA, BARBARA F., and HARRISON-TRAINOR, MATTHEW. Some questions of uniformity in algorithmic randomness	1612
BODIRSKY, MANUEL, PINSKER, MICHAEL, and PONGRÁCZ, ANDRÁS. Projective clone homomorphisms	148
BRYANT, DAVID, NIES, ANDRÉ, and TUPPER, PAUL. Fraïssé limits for relational metric structures	913
CAMPION, TIM, COUSINS, GREG, and YE, JINHE. Classifying spaces and the Lascar group.....	1396
CANCINO, JONATHAN, GUZMÁN, OSVALDO, and MILLER, ARNOLD W. Ideal independent families and the ultrafilter number	128
CIABATTONI, AGATA, LANG, TIMO, and RAMANAYAKE, REVANTHA. Bounded-analytic sequent calculi and embeddings for hypersequent logics	635
CIARDELLI, IVANO and OTTO, MARTIN. Inquisitive bisimulation	77
CONANT, GABRIEL and GANNON, KYLE. Associativity of the Morley product of invariant measures in NIP theories.....	1293
COUSINS, GREG. see CAMPION, TIM	
COX, SEAN D. Forcing axioms, approachability, and stationary set reflection	499
CSIMA, BARBARA F. see BIENVENU, LAURENT	
CUMMINGS, JAMES, HAYUT, YAIR, MAGIDOR, MENACHEM, NEEMAN, ITAY, SINAPOVA, DIMA, and UNGER, SPENCER. The tree property at the two immediate successors of a singular cardinal	600
d'ELBÉE, CHRISTIAN. Forking, imaginaries, and other features of ACFG	669
DITTMANN, PHILIP and LEUNSE, DION. A class of fields with a restricted model completeness property	701
DOBRINEN, NATASHA and HATHAWAY, DAN. Classes of barren extensions	178
DOBROWOLSKI, JAN, KIM, BYUNGHAN, KOLESNIKOV, ALEXEI, and LEE, JUNGUK. The relativized Lascar groups, type-amalgamation, and algebraicity	531
DOWNEY, ROD G. see AMBOS-SPIES, KLAUS	
DŽAMONJA, MIRNA and SHELAH, SAHARON. On wide Aronszajn trees in the presence of MA	210
EGROT, ROB. Recursive axiomatisations from separation properties	1228
EHRlich, PHILIP and KAPLAN, ELLIOT. Surreal ordered exponential fields	1066
ENAYAT, ALI and ZACHIRI, MCKENZIE. Initial self-embeddings of models of set theory	1584
FISCHER, VERA and SOUKUP, DÁNIEL T. More ZFC inequalities between cardinal invariants	897

FREIRE, ALFREDO ROQUE and DAVID HAMKINS, JOEL DAVID. Biinterpretation in weak set theories.....	609
FREUND, ANTON. Well ordering principles and Π_4^1 -statements: A pilot study.....	709
FRIEDMAN, SY-DAVID and HATHAWAY, DAN. Generic coding with help and amalgamation failure.....	1385
FUCHS, GUNTER. Aronszajn tree preservation and bounded forcing axioms.....	293
FUCHS, GUNTER and LAMBIE-HANSON, CHRIS. Separating diagonal stationary reflection principles.....	262
FUJIWARA, MAKOTO and KURAHASHI, TAISHI. Prenex normal form theorems in semi-classical arithmetic.....	1124
GANNON, KYLE. see CONANT, GABRIEL	
GOLDBERG, GABRIEL. Rank-to-rank embeddings and Steel’s conjecture.....	137
GORANKO, VALENTIN. see KELLERMAN, RUAAN	
GREENBERG, NOAM. see ALVIR, RACHAEL	
GUZMÁN, OSVALDO. see CANCINO, JONATHAN	
HALIMI, BRICE. Homotopy model theory.....	1301
HAMKINS, JOEL DAVID. see FREIRE, ALFREDO ROQUE	
HARRISON-TRAINOR, MATTHEW. see ALVIR, RACHAEL	
———, see BIENVENU, LAURENT	
HATHAWAY, DAN. see DOBRINEN, NATASHA	
———, see FRIEDMAN, SY-DAVID	
HAYUT, YAIR. see CUMMINGS, JAMES	
HE, JIALIANG, HRUŠÁK, MICHAEL, ROJAS-REBOLLEDO, DIEGO, and SOLECKI, SŁAWOMIR. Tukey order among F_σ ideals.....	855
HOFFELNER, STEFAN. NS saturated and Δ_1 -definable.....	25
HRUŠÁK, MICHAEL. see HE, JIALIANG	
INSELMANN, MANUEL J. and MILLER, BENJAMIN D. Recurrence and the existence of invariant measures.....	60
JANSANA, R. and MORASCHINI, T. The poset of all logics I: Interpretations and lattice structure.....	935
JOOSTEN, JOOST J. Münchhausen provability.....	1006
KAPLAN, ELLIOTT. see DOBROWOLSKI, JAN	
KAPLAN, ITAY, RZEPECKI, TOMASZ, and SINIORA, DAOUD. On the automorphism group of the universal homogeneous meet-tree.....	1508
KELLERMAN, RUAAN and GORANKO, VALENTIN. Approximating trees as coloured linear orders and complete axiomatisations of some classes of trees.....	1035
KIM, BYUNGHAN. see DOBROWOLSKI, JAN	
———, Weak canonical bases in NSOP ₁ theories.....	1259
KOLESNIKOV, ALEXEI. see DOBROWOLSKI, JAN	
KOMJÁTH, PÉTER. Notes on some Erdős–Hajnal problems.....	1116
KURAHASHI, TAISHI. see FUJIWARA, MAKOTO	
KURILIĆ, MILOŠ S. Vaught’s conjecture for almost chainable theories.....	991
LAMBIE-HANSON, CHRIS. see FUCHS, GUNTER	
LANG, TIMO. see CIABATTONI, AGATA	
LEE, JUNGUK. see DOBROWOLSKI, JAN	
LE GOH, JUN, PAULY, ARNO, and VALENTI, MANLIO. Finding descending sequences through ill-founded linear orders.....	817
LEIJNSE, DION. see DITTMANN, PHILIP	
LÓPEZ, JUAN PABLO ACOSTA. One dimensional groups definable in the p -adic numbers.....	801
LUCERO-BRYAN, JOEL. see BEZHANISHVILI, GURAM	
LÜCKE, PHILIPP and MÜLLER, SANDRA. Closure properties of measurable ultrapowers.....	762
MAIETTI, MARIA EMILIA and MASCHIO, SAMUELE. A predicative variant of Hyland’s effective topos.....	433
MAGIDOR, MENACHEM. see CUMMINGS, JAMES	

MARCONI, ALBERTO and VALENTI, MANLIO. The open and clopen Ramsey theorems in the Weihrauch lattice.....	316
MARUYAMA, YOSHIHIRO. Fibred algebraic semantics for a variety of non-classical first-order logics and topological logical translation.....	1189
MEIR, NADAV. Pseudo-finite sets, pseudo-o-minimality.....	577
MERMELSTEIN, OMER. see ANDREWS, URI	
MILDENBERGER, HEIKE and SHELAH, SAHARON. Higher Miller forcing may collapse cardinals.....	1721
MILLER, ARNOLD W. see CANCINO, JONATHAN	
MILLER, BENJAMIN D. see INSELMANN, MANUEL J.	
MILLER, JUSTIN. Intrinsic smallness.....	558
MINDEN, KAETHE. Combining resurrection and maximality.....	397
MONATH, MARTIN. see AMBOS-SPIES, KLAUS	
MONIN, BENOIT and NIES, ANDRÉ. Muchnik degrees and cardinal characteristics.....	471
MORASCHINI, T. see JANSANA, R.	
MOTTET, ANTOINE and PINSKER, MICHAEL. Cores over Ramsey structures.....	352
MÜLLER, SANDRA and SARGSYAN, GRIGOR. HOD in inner models with Woodin cardinals ...	871
NEEMAN, ITAY. see CUMMINGS, JAMES	
NÉMETHI, ISTVÁN. see ANDRÉKA, HAJNAL	
NICOLAI, CARLO and STERN, JOHANNES. The modal logics of Kripke-Feferman truth.....	362
NIES, ANDRÉ. see BRYANT, DAVID	
———, see MONIN, BENOIT	
NIES, ANDRÉ, TRIPLETT, MARCUS A., and YOKOYAMA, KEITA. The reverse mathematics of theorems of Jordan and Lebesgue.....	1657
OLŠÁK, MIROSLAV. Maltsev conditions for general congruence meet-semidistributive algebras.....	1432
OTTO, MARTON. see CIARDELLI, IVANO	
PAKHOMOV, FEDOR and WALSH, JAMES. Reflection ranks and ordinal analysis.....	1350
PAOLINI, GIANLUCA. see BALDWIN, JOHN	
PAULY, ARNO. see LE GOH, JUN	
PINSKER, MICHAEL. see BODIRSKY, MANUEL	
———, see MOTTET, ANTOINE	
POIZAT, BRUNO. Symétries et transvections, principalement dans les groupes de rang de Morley fini sans involutions.....	965
POL, ROMAN and ZAKRZEWSKI, PIOTR. Countably perfectly meager sets.....	1214
PONGRÁCZ, ANDRÁS. see BODIRSKY, MANUEL	
RAMANAYAKE, REVENTHA. see CIABATTONI, AGATA	
ROJAS-REBOLLEDO, DIEGO. see HE, JIALIANG	
RZEPECKI, TOMASZ. see KAPLAN, ITAY	
SARGSYAN, GRIGOR. see MÜLLER, SANDRA	
SCHUMACHER, SALOME. The relation between two diminished choice principles.....	415
SHAFER, PAUL and TERWIJN, SEBASTIAAN A. Ordinal analysis of partial combinatory algebras.....	1154
SHELAH, SAHARON. see DŽAMONJA, MIRNA	
———, see MILDENBERGER, HEIKE	
SINAPOVA, DIMA. see CUMMINGS, JAMES	
SINIORA, DAUD. see KAPLAN, ITAY	
ŠOBOT, BORIS. Congruence of ultrafilters.....	746
SOLECKI, SŁAWOMIR. see HE, JIALIANG	
SOUKUP, DANIEL T. see FISCHER, VERA	
STAROSOLSKI, ANDRZEJ. The Rudin-Keisler ordering of P-points under $\mathfrak{b} = \mathfrak{c}$	1691
STERN, JOHANNES. see NICOLAI, CARLO	
TAKAYUKI, KIHARA. see ANGLÈS d'AURIAC, PAUL-ELLIOT	
TERWIJN, SEBASTIAAN A. see SHAFER, PAUL	
TRAN, CHIEU-MINH. see BHARDWAJ, NEER	

TRIPLETT, MARCUS A. see NIES, ANDRÉ	
TUPPER, PAUL. see BRYANT, DAVID	
TURETSKY, DAN. see ALVIR, RACHAEL	
UFTRING, PATRICK. The characterization of Weihrauch reducibility in systems containing $E - PA^\omega + QF - AC^{0,0}$	224
UNGER, SPENCER. see CUMMINGS, JAMES	
VALENTI, MANLIO. see MARCONE, ALBERTO	
VAN MILL, JAN. see BEZHANISHVILI, GURAM	
WALSH, JAMES. see PAKHOMOV, FEDOR	
WELCH, P. D. see AGUILERA, J. P.	
WELCH, PHILIP D. Stably measurable cardinals	448
YA'AR, UR. The modal logic of σ -centered forcing and related forcing classes	1
YE, JINHE. see CAMPION, TIM	
YOKOYAMA, KEITA. see NIES, ANDRÉ	
ZACHIRI, MCKENZIE. see ENAYAT, ALI	
ZAKRZEWSKI, PIOTR. see POL, ROMAN	



**UNITED STATES
POSTAL SERVICE®**

**Statement of Ownership, Management, and Circulation
(All Periodicals Publications Except Requester Publications)**

1. Publication Title Journal of Symbolic Logic	2. Publication Number 4 - 010	3. Filing Date 10/1/2021
---	----------------------------------	-----------------------------

4. Issue Frequency quarterly March-June-September-December	5. Number of Issues Published Annually 4	6. Annual Subscription Price \$528.00
---	---	--

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®) Association for Symbolic Logic Department of Mathematics University of Connecticut	Contact Person Richard A Shore Telephone (Include area code) 607-279-6135
--	--

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer)
Association for Symbolic Logic
Department of Mathematics
University of Connecticut

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)

Publisher (Name and complete mailing address)
Richard A Shore 14 Kenwood Avenue
Newton MA 024569

Editor (Name and complete mailing address)
Enrique Casanovas, Department of Mathematics and Computer Science, University of Barcelona, Gran Via 585, 08007 Barcelona, Spain

Managing Editor (Name and complete mailing address)
Enrique Casanovas, Department of Mathematics and Computer Science, University of Barcelona, Gran Via 585, 08007 Barcelona, Spain

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

Full Name	Complete Mailing Address
Association for Symbolic Logic	Department of Mathematics University of Connecticut 341 Mansfield Road, U-1009 Storrs, CT 06269-1009, USA

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box None

Full Name	Complete Mailing Address

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
 Has Not Changed During Preceding 12 Months
 Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

13. Publication Title		14. Issue Date for Circulation Data Below		
Journal of Symbolic Logic		MARCH 2021		
15. Extent and Nature of Circulation		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date	
a. Total Number of Copies (<i>Net press run</i>)		730	743	
b. Paid Circulation (<i>By Mail and Outside the Mail</i>)	(1)	Mailed Outside-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	258	232
	(2)	Mailed In-County Paid Subscriptions Stated on PS Form 3541 (<i>Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies</i>)	0	0
	(3)	Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	369	338
	(4)	Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail®)	0	0
c. Total Paid Distribution [<i>Sum of 15b (1), (2), (3), and (4)</i>] ▶		627	570	
d. Free or Nominal Rate Distribution (<i>By Mail and Outside the Mail</i>)	(1)	Free or Nominal Rate Outside-County Copies included on PS Form 3541	0	0
	(2)	Free or Nominal Rate In-County Copies Included on PS Form 3541	0	0
	(3)	Free or Nominal Rate Copies Mailed at Other Classes Through the USPS (e.g., First-Class Mail)	0	0
	(4)	Free or Nominal Rate Distribution Outside the Mail (<i>Carriers or other means</i>)	0	0
e. Total Free or Nominal Rate Distribution (<i>Sum of 15d (1), (2), (3) and (4)</i>)		0	0	
f. Total Distribution (<i>Sum of 15c and 15e</i>) ▶		627	570	
g. Copies not Distributed (<i>See Instructions to Publishers #4 (page #3)</i>) ▶		103	173	
h. Total (<i>Sum of 15f and g</i>)		730	743	
i. Percent Paid (<i>15c divided by 15f times 100</i>) ▶		100%	100%	

* If you are claiming electronic copies, go to line 16 on page 3. If you are not claiming electronic copies, skip to line 17 on page 3.



**Statement of Ownership, Management, and Circulation
(All Periodicals Publications Except Requester Publications)**

16. Electronic Copy Circulation

	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Paid Electronic Copies		
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a)		
c. Total Print Distribution (Line 15f) + Paid Electronic Copies (Line 16a)		
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 16c × 100)		

I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.

17. Publication of Statement of Ownership

If the publication is a general publication, publication of this statement is required. Will be printed

Publication not required.

in the December 2021 issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner

Date

10/1/2021

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

THE JOURNAL OF SYMBOLIC LOGIC (ISSN print: 0022–4812, ISSN online: 1943–5886) is published quarterly, in the months of March, June, September, and December, by the Association for Symbolic Logic, Inc., Department of Mathematics, University of Connecticut, 341 Mansfield Road, U-1009, Storrs, CT 06269-1009, USA. Periodicals postage is paid at Storrs CT and at additional mailing offices. The JOURNAL is distributed with THE BULLETIN OF SYMBOLIC LOGIC. The 2021 annual subscription price for the two journals, in either print or electronic form, is US\$1005 or £630; the print/electronic bundle prices are \$1120 or £703: visit <http://cambridge.org/bsl> for more information. **Postmaster:** Send address changes to **Journals Customer Services Department, Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA.** Business correspondence should be sent to the Secretary-Treasurers of the Association, Russell Miller and David Solomon (address below).

Subscription orders for the JOURNAL and BULLETIN, or REVIEW should be sent to subscriptions_newyork@cambridge.org. All orders must be accompanied by payment by check, credit card (Visa, MasterCard, JCB or American Express only), or debit card. To receive a replacement copy of the JOURNAL, please report damaged, defective or missing issues within nine months of the date of publication.

All back volumes of the JOURNAL are available: volumes 1 through 74 are via JSTOR; volumes 1 through 85 via Cambridge University Press, <http://journals.cambridge.org/jsl> – access to the latter is free to members. Volume 26 is an index for Volumes 1–26, and Number 4 of Volume 45 is an index for Volumes 27–45. Number 4 of Volume 55 is a cumulative index for Volumes 27–55 (it includes the index published in Volume 45, Number 4, except for listings of reviews by subject, which has been discontinued). A revised edition of **A Bibliography of Symbolic Logic**, by Alonzo Church, may be purchased separately. Members of the Association may purchase back volumes for their personal use at a 50% discount. The discount also applies to institutional members. Orders should be sent to **Cambridge University Press**, address above. Reviews of articles and books in logic which in the past were published in the JOURNAL have been moved to the BULLETIN, beginning with the March 2000 issue.

Individual membership in the Association is open to anyone interested in its work. Annual dues for members are US\$102, £78 sterling or €85 (\$51, £39 sterling or €43 for student, emeritus and unemployed members; see <http://aslonline.org/membership/individual-membership/> for more information, including conditions and privileges). Dues include subscriptions to the current volumes of the JOURNAL, the BULLETIN, and the REVIEW.

Institutional membership in the Association is available to any academic institution or department. Annual institutional membership dues for 2021 are US\$1200 (full) or \$790 (basic); privileges include choices of current subscriptions, back volumes, and student memberships.

Requests for information, applications for *new* membership, renewals of institutional membership, business correspondence, and notices or announcements for publication in the BULLETIN should be sent to **ASL, Department of Mathematics, University of Connecticut, 341 Mansfield Road, U-1009, Storrs, CT 06269-1009, USA.** The electronic mail address of the Association's business office is asl@uconn.edu. Requests for back issues should be sent to Cambridge University Press, address above.

POSTMASTER: Individual membership *renewals*, notices of change of address, and dues payments, should be sent to **Association for Symbolic Logic, c/o Journals Customer Services Department, Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA**, USmemberservices@cambridge.org.

The paper used in the JOURNAL is acid-free and falls within the guidelines established to ensure permanence and stability.

The JOURNAL has been registered with the Copyright Clearance Center, Inc. The appearance of a code at the bottom of the first page of an article indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the US Copyright Law, provided that the per-copy fee stated in the code is paid directly to **Copyright Clearance Center Inc., 222 Rosewood Drive, Danvers, MA 01923, USA.** This consent does not extend to copying for general distribution, for advertising or promotion purposes, for creating new collective works, or for resale. Specific written permission for such copying must be obtained from the Association.

Cambridge Core

For further information about this journal
please go to the journal web site at:
[cambridge.org/jsl](https://www.cambridge.org/jsl)

CAMBRIDGE
UNIVERSITY PRESS