Proceedings of the International Conference on Algebra

Dedicated to the Memory of A. I. Mal'cev

Part 1
Recent Titles in This Series

131 L. A. Bokut', Yu. L. Ershov, and A. I. Kostrikin, Editors, Proceedings of the International Conference on Algebra Dedicated to the Memory of A. I. Mal'cev, 1992
130 L. Fuchs, K. R. Goodearl, J. T. Stafford, and C. Vinsonhaler, Editors, Abelian groups and noncommutative rings, 1992
129 John R. Graef and Jack K. Hale, Oscillation and dynamics in delay equations, 1992
128 Ridgley Lange and Shengwang Wang, New approaches in spectral decomposition, 1992
127 Vladimir Oliker and Andrejs Treibergs, Editors, Geometry and nonlinear partial differential equations, 1992
126 R. Keith Dennis, Claudio Pedrini, and Michael R. Stein, Editors, Algebraic K-theory, commutative algebra, and algebraic geometry, 1992
125 F. Thomas Bruss, Thomas S. Ferguson, and Stephen M. Samuels, Editors, Strategies for sequential search and selection in real time, 1992
124 Darrell Haile and James Osterburg, Editors, Azumaya algebras, actions, and modules, 1992
123 Steven L. Kleiman and Anders Thorup, Editors, Enumerative algebraic geometry, 1991
121 Alex J. Feingold, Igor B. Frenkel, and John F. X. Ries, Spinor construction of vertex operator algebras, triality, and E8(1), 1991
120 Robert S. Doran, Editor, Selfadjoint and nonselfadjoint operator algebras and operator theory, 1991
119 Robert A. Melter, Azriel Rosenfeld, and Prabir Bhattacharya, Editors, Vision geometry, 1991
117 Morton Brown, Editor, Continuum theory and dynamical systems, 1991
114 Jeffrey C. Lagarias and Michael J. Todd, Editors, Mathematical developments arising from linear programming, 1990
113 Eric Grinberg and Eric Todd Quinto, Editors, Integral geometry and tomography, 1990
112 Philip J. Brown and Wayne A. Fuller, Editors, Statistical analysis of measurement error models and applications, 1990
111 Earl S. Kramer and Spyros S. Magliveras, Editors, Finite geometries and combinatorial designs, 1990
108 Melvyn S. Berger, Editor, Mathematics of nonlinear science, 1990
107 Mario Milman and Tomas Schonbek, Editors, Harmonic analysis and partial differential equations, 1990
106 Wilfried Sieg, Editor, Logic and computation, 1990
105 Jerome Kaminker, Editor, Geometric and topological invariants of elliptic operators, 1990
104 Michael Makkai and Robert Paré, Accessible categories: The foundations of categorical model theory, 1989
103 Steve Fisk, Coloring theories, 1989
102 Stephen McAdam, Primes associated to an ideal, 1989

(Continued in the back of this publication)
Proceedings of the International Conference on Algebra

Dedicated to the Memory of A. I. Mal'cev

Part 1
Proceedings of the International Conference on Algebra

Dedicated to the Memory of A. I. Mal’cev

Part 1

L. A. Bokut’
Yu L. Ershov
A. I. Kostrikin
Editors
The International Conference on Algebra dedicated to the memory of A. I. Mal'cev took place on August 21-26, 1989, in Novosibirsk, USSR. This conference was supported by the International Mathematical Union, the Soviet Academy of Sciences, the Siberian Mathematical Society, and the Novosibirsk Systems Institute.

1991 Mathematics Subject Classification. Primary 00, 03, 06, 08, 12, 13, 14, 16, 17, 18, 20, 22, 51; Secondary 05, 11, 15, 19, 53.

Library of Congress Cataloging-in-Publication Data

p. cm.—(Contemporary mathematics, ISSN 0271-4132; 131)
Conference held at Akademgorodok, Novosibirsk, USSR, Aug. 21-26, 1989.
Includes bibliographical references.
V. Title. VI. Series: Contemporary mathematics (American Mathematical Society); v. 131.
QA150.I56 1989 92-9983 512—dc20 CIP

Copying and reprinting. Individual readers of this publication, and nonprofit libraries acting for them, are permitted to make fair use of the material, such as to copy an article for use in teaching or research. Permission is granted to quote brief passages from this publication in reviews, provided the customary acknowledgment of the source is given.

Republication, systematic copying, or multiple reproduction of any material in this publication (including abstracts) is permitted only under license from the American Mathematical Society. Requests for such permission should be addressed to the Manager of Editorial Services, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940-6248.

The appearance of the code on the first page of an article in this book indicates the copyright owner's consent for copying beyond that permitted by Sections 107 or 108 of the U.S. Copyright Law, provided that the fee of $1.00 plus $.25 per page for each copy be paid directly to the Copyright Clearance Center, Inc., 27 Congress Street, Salem, Massachusetts 01970. This consent does not extend to other kinds of copying, such as copying for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale.

Copyright ©1992 by the American Mathematical Society. All rights reserved.
The American Mathematical Society retains all rights except those granted to the United States Government.
Printed in the United States of America.
The paper used in this book is acid-free and falls within the guidelines established to ensure permanence and durability.

Most of the articles in this volume were printed directly from copy prepared by the authors.
Some articles were prepared using \LaTeX, the American Mathematical Society's \TeX macro system.
Contents

Foreword
L. Bokut', Y. Ershov, O. Kegel, and A. Kostrikin xvii

Introduction xix

Brief Scientific Contents of Plenary Reports xxiii

PART 1

Section 1–Groups
Groups Associated with Some Types of Infinite Dimensional Lie Algebras
EIICHI ABE 3

The Method of Classification of Periodic Words and the Burnside Problem
S. I. Adian and I. G. Lysionok 13

On Mal'cev's Theorem on Elementary Equivalence of Linear Groups
C. I. Beidar and A. V. Mikhalev 29

The Mal'cev Correspondence Revisited
O. V. Belegardek 37

When is Multiplication by $P$ a Closed Map?
K. Benabdallah and A. Mader 61

A Maximal Subgroup in the Simple Finite Group $E_8(q)$
A. V. Borovik 67

On Group Algebras with Solvable Unit Groups
A. A. Bovdi 81

The Category of Quasi-Homomorphisms of Abelian Torsion Free Groups of Finite Rank
A. A. Fomin 91

A Generalization of Mal'cev's Correspondence between Rings and Groups and a Class of Lie Groups
THOMAS A. FOURNELLE AND KENNETH W. WESTON 113
Isomorphisms of the General Linear Group $GL_n(R), n \geq 4$, over an
Associative Ring
I. Z. Golubchik 123

Fong’s Reduction, the Correspondences of Brauer and Glauberman, and
Alperin’s Weight Conjecture
P. G. Gres’ 137

On Quadratic Equations in Free Groups
R. I. Grigorchuk and P. F. Kurchanov 159

On Representations of Finite Groups over Some Factorial Rings
P. M. Gudivok 173

Some Recent Results on Automorphism Groups
C. K. Gupta 183

Some Problems in Free Group Rings
Narain Gupta 189

Partial Orders of the Group of Automorphisms of the Real Line
W. Charles Holland 197

The Subgroup Structure of the Classical Groups
Oliver King 209

On the Identities of Representations of Groups by Triangular Matrices
over a Commutative Ring
A. N. Krasil’nikov 217

Chevalley Groups and their Unipotent Subgroups
V. M. Levchuk 227

Maximal Subgroups of Finite Simple Groups and their Automorphism
Groups
Martin W. Liebeck and Jan Saxl 243

On Extensions of a Separable $p$-Group by a Quasi-Cyclic $p$-Group
A. I. Moskalenko 261

Exceptional Simple Lie Group $F_4$ and Spin Representations
Shingo Murakami 269

Weak Second Order Logic in Group Theory
A. G. Myasnikov and V. N. Remeslennikov 273

Abstract Isomorphisms of Algebraic Solvable Groups
K. N. Ponomaryov 279
The Isomorphism Problem for Finite Group Rings
K. W. Roggenkamp

On Representations of the Braid Groups by Matrices
V. A. Roman'kov

On Subgroups of Free Products of Cyclics
Gerhard Rosenberger

On a Conjecture of Zassenhaus, and Beyond
L. L. Scott

On Extensions of Po-Groups
E. E. Shirshova

On Successive Free Central Extensions of $F/\gamma_n(R)$ Groups
V. E. Shpilrain

On Nontrivial Factorizations of a One-Generated Local Formation of
Finite Groups
A. N. Skiba

Some Arithmetical Properties of Finite Groups and Their Linear
Representations
S. P. Strunkov

On Groups with Fan Subgroups
I. Ya. Subbotin and N. F. Kuzennyi

Minimal Polynomials of Elements of Order $p$ in Irreducible
Representations of Chevalley Groups over Fields of Characteristic $p$
I. D. Suprunenko

Wreath Product and Factorization of Groups
V. I. Suschansky

Bounded Generation of Normal and Twisted Chevalley Groups over
the Rings of $S$-Integers
O. I. Tavgan

On Weak Approximation in Algebraic Groups
Nguyen Quoc Thang

Vertex Stabilizers of Symmetric Graphs with Projective Subconstituents
V. I. Trofimov

Automorphisms of Groups Rings
D. A. R. Wallace
Automorphisms of the Free Group of Rank Two
M. J. Wicks

Group Rings of Locally Finite Groups and Representation Theory
A. E. Zalesskii

Open Subgroups of Free Profinite Products
P. A. Zalesskii

Addition to My Talk at the Conference
A. Yu. Ol'shanskii

On Some Classes of Periodic FC-groups
L. A. Kurdacenko

Section 2–Geometry

Planes with Nondivision Coordinate Rings
John R. Faulkner

Equivalence of Homomorphisms of Surface Groups to Free Groups and Some Properties of 3-Dimensional Handlebodies
R. I. Grigorchuk, P. F. Kurchanov, and H. Zieschang

Automorphism Groups of Free Geometries
Oddvar Iden

Flat Conformal Structures on 3-Manifolds (Survey)
M. E. Kapovich

Singular Solutions as Semi-Algebraic Sets: The Singular Solutions of Generic First Order Differential Equations
S. A. Khabbaz

Lie Groups and Transmission Problems on Riemann Surfaces
G. N. Khimshiashvili

Analogues of the Riemannian Structure for Classical Superspaces
D. Leites and E. Poletaeva

The Hochschild-Serre Spectral Sequence for Bounded Cohomology
Gen. A. Noskov

A Survey of Finite Flag-Transitive Locally Classical $c \cdot C_2$-Geometries (Groups for Geometries in Given Diagrams, I)
Antonio Pasini
CONTENTS

Superstrings and Holomorphic Supergeometry
D. H. Phong 659

Transformations of Lie Groups that Map One-Dimensional Cosets into One-Dimensional Cosets
M. N. Podoksyonov 689

On Spread Sets and Collineations of Projective Planes
N. D. Podufalov 697

Smooth Quasigroups and Loops. New Results
L. V. Sabinin 707

PART 2

Section 3–Lie algebras

Structure Constants of Simple Lie Algebras
R. Ž. Aleev 3

Quartic Cayley Algebras and Some Lie Algebras of Type $D_4$
B. N. Allison 15

Gelfand-Zetlin Modules Over Lie Algebra $SL(3)$
Yu. A. Drozd, S. A. Ovsienko, and V. M. Futorny 23

Cohomology and Nonsplit Extensions of Modular Lie Algebras
A. S. Dzhumadil’daev 31

The Parabolaic Subsets of Root System and Corresponding Representations of Affine Lie Algebras
V. M. Futorny 45

The Word Problem for Solvable Groups and Lie Algebras, a Boundary between Solvability and Unsolvability
O. Kharlampovich 53

Simple Lie Algebras in Characteristic 2 Recovered from Superalgebras and on the Notion of a Simple Finite Group
Yuri Kochetkov and Dimitry Leites 59

Lattices of Subalgebras of Solvable Lie Algebras
A. A. Lašši 69

The Composition Lemma for Color Lie Superalgebras and for $P$-Superalgebras
A. A. Mikhalev 91

The Structure of Lie Algebras of Prime Characteristic
J. Marshall Osborn 105
New Examples of Continuum Graded Lie Algebras
M. V. Saveliev and A. M. Vershik

Structurable Algebras
R. D. Schafer

Analogues of Finite-Dimensional Representations of
Infinite-Dimensional Classical Lie Algebras
George B. Seligman

Simple Volichenko Algebras
V. Serganova

Lie Algebras Having a Modular Subalgebra which is Either a Modular
Lie Algebra or Simple of Rank One
Vicente R. Varea

Identities of Algebras and their Representations
Yu. P. Razmyslov

Section 4–Rings
A Relationship between Gröbner Bases of Ideals and Vector Modules
of G-Algebras
Joachim Apel

Intersection Property in the Radical Theory of Topological Algebras
V. I. Arnautov, C. I. Beidar, S. T. Glavatsky, and A. V. Mikhalev

Projective Modules and Groups of Invertible Matrices over Crossed
Products
V. A. Artamonov

Tame Posets with Equivalence Relation
V. M. Bondarenko and A. G. Zavadskij

Noncommutative Prüfer and Valuation Rings
H. H. Brungs and J. Gräter

Rank Functions on Projective Modules over Rings
P. M. Cohn

K-Theory of Rings with Idempotents
A. A. Davydov

Relations for the Cocharacter Sequences of T-Ideals
Vesselin Drensky
Representations of Bocses and Algebras
    Yu. A. Drozd 301

Tame and Wild Subspace Problems
    L. A. Nazarova, A. V. Roiter, P. Gabriel, and D. Vossieck 317

Normal g.p.p. Rings with Köthe Radical
    R. Gonchigdorzh 327

Partial Tilting Modules and Recollement
    Dieter Happel 345

Endomorphisms and Invariance of Radicals of Rings
    V. Mushrub 363

From Representations of Quivers via Hall and Loewy Algebras to Quantum Groups
    Claus Michael Ringel 381

On Regular Rings
    D. V. Tjukavkin 403

Trace Identities of Matrix Superalgebras with Involution
    A. A. Zolotykh 413

Section 5—Fields and Skew Fields/Differential Algebras

Finite Groups as Galois Groups over Arbitrary Fields
    C. U. Jensen 435

A Problem on Differential Polynomials
    E. R. Kolchin 449

Multiply Pseudo-$P$-Adically Closed Fields
    Urs-Martin Künzi 463

Dimension Polynomials of Filtered Differential $G$-Modules and Extensions of Differential $G$-Fields
    A. B. Levin and A. V. Mikhailov 469

Classification of Wild Cyclic Field Extensions and Division Algebras of Prime Degree over a Henselian Field
    J.-P. Tignol 491

Topological Fields—Results and Problems
    Witold Wieslaw 509
On the Defect of Valued Division Algebras
V. I. Yanchevskii 519

Irreducible Polynomials Over Local Fields and Higher Ramification
in Local Langlands Theory
Ernst-Wilhelm Zink 529

Section 6—Nonassociative Rings

On the Valuations of Algebraic Division Rings over Global Fields
I. D. Chipchakov 567

Periodic Jordan Rings of Characteristic Two
S. González and C. Martínez 575

Generic Norms I
N. Jacobson 587

Proving $(x, x, x, x) = 0$
Erwin Kleinfeld 605

Prime Rings in the Join of Alternative and $(-1, 1)$ Rings
E. Kleinfeld and H. F. Smith 613

Jordan Triple Systems: Insights and Ignorance
Kevin McCrimmon 625

On the Structure of Mal’cev-Admissible Algebras
Hyo Chul Myung and Arthur A. Sagle 639

Quadratic Differential Equations and Algebras
Hyo Chul Myung and Arthur A. Sagle 659

Composition Algebras over the Projective Line
Holger P. Petersson 673

Polynomial Identities of Jordan Algebras
M. L. Racine 679

Simple and Semisimple Structurable Algebras
O. N. Smirnov 685

Left Jordan Rings
Armin Thedy 695

Algorithmic Properties of Free Rings
G. Krjažovskii and G. Kukin 701
PART 3

Section 7–Universal Algebra, Categories, and Combinatorics

Combinatorial Problems Connected with Finite Homogeneity
GREGORY L. CHERLIN

Lattices of Conjugacy Relations
STEPHEN D. COMER

A Categorical Theorem on Universal Objects and its Application in Abelian Group Theory and Computer Science
MANFRED DROSTE AND RÜDIGER GÖBEL

Minimal Faithful Permutation and Transformation Representations of Groups and Semigroups
DAVID EASDOWN

Free and Finitely Presented Lattices
RALPH FRESE

On Weak Automorphisms of Some Finite Algebras
KAZIMIERZ GLAZEK

The Goldie Dimension of Some Extensions of Modular Lattices
PIOTR GRZESZCZUK

A Note on Barr-Diaconescu Covering Theory
GEORGE JANELIDZE

On Identities of Cancellative Semigroups
JAN KREMPA AND OLGA MACEDONSKA

On the Ubiquity of Mal'cev Operations
J. LAMBEK

Trees and Inverse Semigroups
STUART W. MARGOLIS AND JOHN C. MEAKIN

A “Large” Essentially Minimal Clone over an Infinite Set
H. MACHIDA AND I. G. ROSENBERG

A Characterization of Decidable Locally Finite Varieties
RALPH MCKENZIE AND MATHEW A. VALERIOTE

A Lattice Theoretic Characterization of Equivalent Quasivarieties
DON PIGOZZI
Functionally Complete and Affine Complete Algebras and Associated Varieties
ALDEN F. PIXLEY 201

Some Algebraic Aspects of Database Theory
B. I. PLOTKIN 219

An Introduction to the Theory of Modes and Modals
ANNA ROMANOWSKA 241

Locally Residually Finite and Locally Representable Varieties of Semigroups
MARK V. SAPIR 263

Hyperidentities and Clone Congruences
D. SCHWEIGERT 283

Semigroup Varieties with Commuting Fully Invariant Congruences on Free Objects
M. V. VOLKOV 295

Section 8–Algebraic Geometry

Computer Method in Calculating $B$-Functions of Non-Isolated Singularities
A. G. ALEKSANDROV AND V. L. KISTLEROV 319

The Cone of Effective Divisors of Threefolds
VICTOR V. BATYREV 337

Parametrization and Embeddings of a Class of Homogeneous Spaces
MICHEL BRION 353

The Local Uniformization of Branches of an Algebraic Curve
A. D. BRUNO AND A. SOLEEV 361

Analytic Ax-Kochen-Ersov Theorems
LOU VAN DEN DRIES 379

Some Examples of Computation of a Regulator Map on Singular Varieties
HELENE ENSNAULT 399

An Intrinsic Elimination Theory by Means of Forms Associated to Algebraic Varieties
FEDERICO GAETA 419

Boundedness of $Q$-Fano Threefolds
YUJIRO KAWAMATA 439
<table>
<thead>
<tr>
<th>Title</th>
<th>Author/Co-author</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak Approximation in Algebraic Groups and Homogeneous Spaces</td>
<td>B. E. Kunyavskii and A. N. Skorobogatov</td>
<td>447</td>
</tr>
<tr>
<td>Diffeomorphism Criteria for Smooth Manifolds and Algebraic Varieties</td>
<td>Nikita Yu. Netsvetaev</td>
<td>453</td>
</tr>
<tr>
<td>Some Aspects of Computational Algebraic Number Theory</td>
<td>M. Pohst</td>
<td>461</td>
</tr>
<tr>
<td>Local-Global Principles in Algebra and Number Theory</td>
<td>V. Platonov</td>
<td>475</td>
</tr>
<tr>
<td>Some Open Problems in Invariant Theory</td>
<td>V. L. Popov and E. B. Vinberg</td>
<td>485</td>
</tr>
<tr>
<td>Positivity of Sheaves and Geometric Invariant Theory</td>
<td>Eckart Viehweg</td>
<td>499</td>
</tr>
<tr>
<td>Complex Divisors on Algebraic Curves and Some Applications to String Theory</td>
<td>A. A. Voronov</td>
<td>515</td>
</tr>
<tr>
<td>Algebraic Geometry via Model Theory</td>
<td>B. I. Zil'ber</td>
<td>523</td>
</tr>
<tr>
<td>Section 9–Logic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vector Spaces with a Distinguished Subgroup</td>
<td>Steven Buechler</td>
<td>541</td>
</tr>
<tr>
<td>A Guided Tour Through Nonstandard Analysis</td>
<td>A. E. Hurd</td>
<td>555</td>
</tr>
<tr>
<td>Heyting-Valued Analysis: P. S. Novikov’s Hypotheses</td>
<td>V. A. Lyubetsky</td>
<td>565</td>
</tr>
<tr>
<td>Definability and Interpolation in Classical Modal Logics</td>
<td>Larisa Maksimova</td>
<td>583</td>
</tr>
<tr>
<td>Algebraic Aspect of Logics without Structural Rules</td>
<td>Hiroakira Ono</td>
<td>601</td>
</tr>
<tr>
<td>Semantical Significances of Formulas in the Classical Predicate Logic</td>
<td>M. G. Peretyatkin</td>
<td>623</td>
</tr>
<tr>
<td>The Universal Theory of the Free Pseudoboolean Algebra $F_{\omega}(H)$ in the Signature Extended by Constants for Free Generators</td>
<td>V. V. Rybakov</td>
<td>645</td>
</tr>
</tbody>
</table>
Computing Degrees of Definable Classes of Sentences
V. L. SELIVANOV

657
Foreword

In memory of the eminent mathematician A. I. Mal'cev, 1909–1967, and near to his 80th birthday, an International Conference on Algebra and Related Areas took place, 21–26 August 1989, at Akademgorodok, Novosibirsk, USSR, organized by Novosibirsk State University and the Institute of Mathematics of the USSR, Academy of Sciences, Siberian Branch. This conference had the moral and financial support of the International Mathematical Union, the Soviet Academy of Sciences, the Siberian Mathematical Society, and the Novosibirsk Systems Institute.

There were more than 800 participants of whom 195 arrived from abroad. This huge number of participants put the local organization under considerable strain ... This conference consisted of invited main lectures and longer and shorter communications in many sections; there also was a cultural program. Most importantly, however, this conference gave a beautiful occasion for scientific and personal exchange on a larger scale than had been possible before. Intensive informal contacts on a personal level should be seen as a major contribution to furthering progress of scientific ideas and collaboration and to international understanding.

A good part of the scientific communications to this conference are gathered in these volumes. They are a testimony to the memory of A. I. Mal'cev, the width of his mathematical interest and ideas, and the stimulus which his work still provides.
Introduction

The International Conference on Algebra dedicated to the memory of A. I. Mal’cev (1909–1967) took place in Novosibirsk, August 21–26, 1989. This conference became a significant event in Soviet mathematics. It was the first time since the International Congress of Mathematicians in Moscow, 1966, that Soviet algebraists could meet a large number of their foreign colleagues. More than 700 Soviet algebraists and more than 200 foreign mathematicians (1000 in all, counting family members) participated in the conference. There were fifty-six people from the United States, thirty-five from Germany, fourteen each from Canada and Great Britain, eleven from Bulgaria, ten from Poland, nine from Japan, and eight from Italy. Participants also included mathematicians from Australia, Austria, Belgium, China, Czechoslovakia, Denmark, Egypt, Hong Kong, Holland, Hungary, India, Iran, Israel, Mongolia, Norway, Singapore, Sweden, Switzerland, Vietnam, and Yugoslavia. As for the USSR, there were more than 500 participants from Russia, ninety-two from the Ukraine, thirty-eight from Belorussia, twenty-three from Kazakhstan, and sixteen from Georgia, as well as representatives from Uzbekistan, Estonia, Latvia, Azerbaizhan, Armenia, Kirgizia, Lithuania, and Tadzhikistan. Together with specialists in the various branches of algebra, mathematicians interested in applications of algebraic methods in logic, number theory, geometry, analysis, theoretical physics, and computer science also participated in the conference. Traditional sessions on the theory of groups (finite, infinite), ring theory (including Lie algebras, associative and nonassociative rings, modules, and abelian groups), universal algebra (including semigroups and lattices), logic, and model theory were supplemented by the following sessions: algebraic geometry, algebraic topology, algebraic $K$-theory, category theory, representations of algebras, group rings and group representations, division algebras, linear groups over rings, topological algebra, ordered systems, rings and geometries, algorithmic problems in algebra, nonstandard and Boolean analysis, functional analysis and mathematical physics, computational analysis and computational topology, symmetric spaces and Jordan algebras, computer algebra, and applied algebra. Sessions started at
9:00 and went on until 19:00 (one day of afternoon sessions was cancelled for an excursion). Typically, there were four plenary talks (one hour each) in the morning (9:00 to 13:00), then five topical talks on five sessions (15:00 to 16:00), and finally (16:00 to 19:00) five to six half-hour talks in smaller sessions. Extensive personal contacts in a nonofficial atmosphere (including those during the excursion over the river Ob on two passenger ships and the subsequent picnic) complete the picture, showing that the participants worked hard indeed. Although the living conditions could not be called excellent, the general high scientific level of the conference helped many participants to form the very best feeling about it.

The First International Conference on Algebra\(^1\) was in fact the Twentieth All-Union Conference on Algebra. The first such conference was organized in 1958 by A. G. Kurosh and A. I. Mal'cev (even earlier, in 1950, O. Yu. Schmidt (1892–1954) directed the All-Union Algebraic Meeting in Moscow, which can be considered a prototype of future conferences). At the Nineteenth Conference in Lvov in 1987, it was decided that the next conference would be international. Therefore, the years of “perestroika” in the USSR coincided with the birth of a new tradition in Soviet (Russian) algebra, and with a new era in the history of algebraic conferences.

The conference was dedicated to the memory of the outstanding Russian mathematician, specialist in algebra and mathematical logic, Anatolii Ivanovich Mal'cev. His contribution to the development of mathematics was quite noticeable. One can recall his local theorem in logic, results in the theory of Lie groups and Lie algebras, and results in group theory, ring theory, and universal algebra. A. I. Mal'cev was one of the founders of model theory and of constructive model theory (theory of numerations). As a mathematician, he was brought up by the Moscow mathematical school, of which he was later a noticeable representative. The great Russian mathematician, A. N. Kolmogorov, one of the leaders of this school, was his thesis advisor. Works of A. I. Mal'cev were closely related to the development of world mathematics. Mal'cev himself often indicated the influence of David Hilbert. Together with Alfred Tarski, Mal'cev started the development of modern model theory. At the end of his life, Mal'cev was connected to Tarski by warm personal friendship. Abraham Robinson wrote that it was Mal'cev who showed the way from logic to algebra. The conference proved that Mal'cev and his papers are not forgotten.

Concluding this introduction, we want to thank a number of people, both in our country and abroad, who actively participated in the organization of the conference and helped make it successful. We want to especially mention the contribution of D. K. Faddeev (1907–1989), who was one of the key members of the Organizing Committee, and whose contribution was decisive.

---

\(^1\)By the time this introduction was written, the Second International Conference, dedicated to the memory of A. I. Shirshov, had taken place in Barnaul on August 20–25, 1991.
in consolidating the Organizing Committee around the idea of a wide, large conference. Unfortunately, this was the last conference in which D. K. Faddeev participated. During the conference, a tragic incident occurred, and D. K. Faddeev died on October 20, 1989. M. M. Lavrent'ev, the director of the Institute of Mathematics in Novosibirsk, contributed to the success of the conference, if only by the fact that he was not afraid to invite a large (even huge, by Novosibirsk standards) number of foreigners. Nathan Jacobson was the first western mathematician who enthusiastically supported (at the very beginning of 1988) the idea of the conference, therefore helping it become successful. The contribution of O. Kegel was diverse, starting from the first version of the list of plenary speakers composed during his visit to Novosibirsk one year before the conference, continuing as an acting treasurer of the conference, and finally, actively participating in the preparation of these Proceedings. In a large part due to the activity of S. Mac Lane, the American delegation was the biggest among all foreign delegations. To all these people, and to a much larger number of people whom we did not mention here (especially to those from Novosibirsk and Moscow), who actively helped to organize the conference, we want to express our deep gratitude. We want to also thank the American Mathematical Society for publishing the proceedings of the conference.

L. A. Bokut'
Yu. L. Ershov
A. I. Kostrikin
Brief Scientific Contents of the Plenary Reports at the International Conference on Algebra Dedicated to the Memory of A. I. Mal'cev

An * indicates that the plenary report was delivered at the conference, but does not appear in this volume.

A. R. Kemer (Barnaul), *Identities of associative algebras*

Kemer's report dealt with a positive solution to the famous problem of Specht on the existence of a finite basis of identities in an arbitrary associative algebra over a field of zero characteristic. In the process of the proof, the author solved another well-known problem on representability of matrix algebras: he proved that every reduced free finitely generated associative algebra over a field of zero characteristic and satisfying a nontrivial polynomial identity can be imbedded in the matrix algebra over a commutative ring. The proof is based on the structure theory worked out by the author for varieties of associative algebras, which makes essential use of the apparatus of superalgebras.

S. S. Goncharov (Novosibirsk), *The development of ideas of Mal'cev in the contemporary theory of constructive algebras and models*

This was a discussion of the mathematical and methodological ideas of Mal'cev in his papers on the constructive theory of models, along with an analysis of their development in the work of contemporary authors connected with the problem of characterizing nonequivalent representations and self-stability, numerical invariants as a means of characterizing the existence of effective representations for groups, fields, and other systems, algebraic conditions for the constructibility of positive algebras, properties of recursive automorphisms of lattices of a subsystem, and so on.

R. McKenzie (U.S.A), *Families of equivalence classes: classification, structure, and Mal'cev families*

The report gave a brief survey of the contemporary state of universal algebra, including the theory of commutators and the theory of finite algebras. The courses of further development were sketched.

Yu. L. Ershov (Novosibirsk), *Elementary theory of fields*

This report gave a survey of the problems of Mal'cev on decidability of elementary theories for fields of rational functions and fields of formal power series. Basic results were formulated on the decidability problem for the most interesting classes of fields.
S. I. Adian and I. G. Lysionok (Moscow), *A method for classifying periodic words and the Burnside problem*

A comparison was made of the methods for investigating the Burnside problem developed on the one hand by Novikov and Adian and on the other hand by Ol'shanskii. The estimate of the exponent for which the Burnside group is infinite was reduced from 665 to 115.

Shigefumi Mori, *Birational classification on three-dimensional algebraic manifolds*

The report was an exposition of recent results worked out according to the so-called Mori program in the theory of birational transformations and classification of three-dimensional algebraic manifolds.

A. Yu. Ol'shanskii (Moscow), *Diagrams of group homomorphisms*

The concept of the diagram of a group homomorphism was introduced. It was applied to the study of homomorphisms of surface groups and to the solution of quadratic equations in hyperbolic groups.

B. I. Zil'ber (Kemerovo), *Theory of models of algebraically closed fields*

The report dealt with questions at the boundary between the theory of models and algebraic geometry and having their roots in the theory of uncountable categoricity. In particular, it was shown that an algebraically closed field can be defined in sufficiently rich algebro-geometric structures.

M. Liebeck and J. Saxl (Great Britain), *Maximal subgroups of finite simple groups of Lie type*

The report reflected the impressive progress in the study of large subgroups of finite simple groups based on the classification of the simple groups and on successes in the theory of algebraic groups. An appreciable contribution here has been made by Soviet experts: A. V. Borovik, A. S. Kondrat'ev, and others.

Yu. A. Medvedev (Novosibirsk), *Sandwiches and absolute divisors of zero in Jordan algebras and Lie algebras*

Sandwiches and absolute divisors of zero have played a key role in the solution of many important problems in various classes of rings. Here it suffices to mention the restricted Burnside problem and classification problems in Jordan and Lie algebras. There is a close connection between the results obtained for Lie algebras and for Jordan systems. The basic result of the speaker asserts that if there is a nontrivial sandwich in a Lie algebra of characteristic $p$, then there is a sandwich of thickness $p-4$ in it. This result was reported earlier by A. I. Kostrikin under the additional assumption of the Engel condition, and played a key role in the solution of the restricted Burnside problem for groups of prime exponent. The ideas of Kostrikin lie at the basis of the speaker’s proof.
Yu. P. Razmyslov (Moscow), *Identities of algebras and their representations*

The report dealt with basic concepts and constructions in the theory of characters on two words. A survey was given of results obtained in the theory of identities of algebras and their representations with the help of the solution of a basic problem in the theory of characters—the problem of describing the spectra of \( \alpha \)-functions (multiplicative characters). Open problems of the theory of \( \alpha \)-functions were formulated that are important for the description of identities of representations of simple Lie algebras and Grassmann envelopes of Lie superalgebras.

E. I. Zel'manov (Novosibirsk), *The restricted Burnside problem* *

Zel'manov discussed the solution of the restricted Burnside problem for groups of prime-power exponent. As in the case of groups of prime exponent, the problem was first reduced to the problem of local nilpotence of Lie algebras with the Engel condition, and this problem was then solved positively by the author. The solution of Zel'manov included ideas from work of Kostrikin and Shirshov dealing with problems of Burnside type in Lie and Jordan algebras. With the use of the announced classification of simple finite groups, the results of Zel'manov yield a positive solution of the restricted Burnside problem for all exponents.

L. Van den Dries (U.S.A), *Analytic Ax-Kochen-Ershov theory*

The report communicates the author's extension of the Ax-Kochen-Ershov principle from the theory of local fields to a more general language—that of the theory of fields enriched by operations defined by convergent multiple power series.

A. N. Rudakov (Moscow), *Exceptional bundles on algebraic manifolds* *

The report discussed ways of constructing exceptional bundles and their roles in the description of the set of stable vector bundles on algebraic surfaces.

V. P. Platonov (Minsk), *Local-global methods in algebra and number theory*

A survey was given of new results obtained by the speaker and his students in the area of the theory of algebraic and arithmetic groups defined over global fields. The methods of proof led to the results as a consequence of corresponding local considerations.

R. Gabriel (France) and A. V. Roïter (Kiev), *Representations of finite-dimensional algebras* *

The report gave a survey of new results of the speaker and other authors in the theory of representations of finite-dimensional algebras.
G. A. Margulis (Moscow), *Flows on homogeneous spaces and number theory*  
Applications of methods from ergodic theory and the theory of algebraic groups to certain questions in number theory were discussed. A number of problems connected with this circle of questions were formulated on the dynamical properties of flows on homogeneous spaces.

A. A. Suslin (Leningrad), *SK₁ for division algebras and Galois cohomology*  
The speaker gave a survey of known and new results on the connections between the groups $SK₀K₁K₁$ for finite-dimensional division algebras and suitable Galois cohomology groups. In particular, connections were also established with the group.

I. V. Kuznetsov (Khabarovsk), *Problems in analytic number theory from the point of view of automorphic forms*  
The report gave estimates of the Fourier coefficients of the eigenfunctions of the discrete spectrum of the Laplace operator on the Lobachevsky plane that are automorphic with respect to the modular group.

R. Freese (U.S.A.), *Free and finitely defined lattices*  
The report gave a survey of results on free and finitely defined lattices. The evolution of these areas was considered, beginning with the work of Whitman and including many recent yet unpublished results. Some unsolved problems were formulated. Applications to varieties of lattices were also considered.

Yu. I. Manin (Moscow), *On the number of roots of Diophantine equations*  
In the hypothetical asymptotics of the number of integer points of a projective variety, the numbers depending on the geometric properties of the variety and the numbers depending on the arithmetic properties of the variety are distinguished.

W. Strassen (West Germany), *Asymptotics of the spectrum of a product of matrices*  
The report gave a survey of contemporary work on a problem connected with the development of algorithms optimal with respect to the number of multiplications for solving linear algebraic systems.
Recent Titles in This Series

(Continued from the front of this publication)

100 W. Brent Lindquist, Editor, Current progress in hyperbolic systems: Riemann problems and computations, 1989
99 Basil Nicolaenko, Ciprian Foias, and Roger Temam, Editors, The connection between infinite dimensional and finite dimensional dynamical systems, 1989
98 Kenneth Appel and Wolfgang Haken, Every planar map is four colorable, 1989
97 J. E. Marsden, P. S. Krishnaprasad, and J. C. Simo, Editors, Dynamics and control of multibody systems, 1989
96 Mark Mahowald and Stewart Priddy, Editors, Algebraic topology, 1989
95 Joel V. Brawley and George E. Schnibben, Infinite algebraic extensions of finite fields, 1989
92 John W. Gray and Andre Scedrov, Editors, Categories in computer science and logic, 1989
91 David Colella, Editor, Commutative harmonic analysis, 1989
90 Richard Randell, Editor, Singularities, 1989
89 Richard Randell, Editor, Singularities, 1989
88 R. Fossum, W. Haboush, M. Hochster, and V. Lakshmibai, Editors, Invariant theory, 1989
87 Laszlo Fuchs, Rudiger Goebel, and Phillip Schultz, Editors, Abelian group theory, 1989
86 J. Ritter, Editor, Representation theory and number theory in connection with the local Langlands conjecture, 1989
85 Bor-Luh Lin, Editor, Banach space theory, 1989
84 Stevo Todorcevic, Partition problems in topology, 1989
83 Michael R. Stein and R. Keith Dennis, Editors, Algebraic K-theory and algebraic number theory, 1989
82 Alexander J. Hahn, Donald G. James, and Zhe-xian Wan, Editors, Classical groups and related topics, 1989
81 Kenneth R. Meyer and Donald G. Saari, Editors, Hamiltonian dynamical systems, 1988
80 N. U. Prabhu, Editor, Statistical inference from stochastic processes, 1988
79 Ernst Kunz and Rolf Waldi, Regular differential forms, 1988
78 Joan S. Birman and Anatoly Libgober, Editors, Braids, 1988
77 Wang Yuan, Yang Chung-chun, and Pan Chengbiao, Editors, Number theory and its applications in China, 1988
76 David C. Hobby and Ralph McKenzie, The structure of finite algebras, 1988
75 Frank M. Cholewinski, The finite calculus associated with Bessel functions, 1988
74 William M. Goldman and Andy R. Magid, Editors, Geometry of group representations, 1988
73 Rick Durrett and Mark A. Pinsky, Editors, Geometry of random motion, 1988
72 R. F. Brown, Editor, Fixed point theory and its applications, 1988
71 James A. Isenberg, Editor, Mathematics and general relativity, 1988
70 Jerome Kaminker, Kenneth C. Millett, and Claude Schochet, Editors, Index theory of elliptic operators, foliations, and operator algebras, 1988

(See the AMS catalogue for earlier titles)
Proceedings of the International Conference on Algebra
Dedicated to the Memory of A. I. Mal'cev
L. A. Bokut', Yu. L. Ershov, A. I. Kostrikin, Editors

In August 1989, more than 700 Soviet algebraists and more than 200 foreign mathematicians convened in Novosibirsk in the former Soviet Union for the International Conference on Algebra. Dedicated to the memory of A. I. Mal'cev, the great Russian algebraist and logician, the conference marked the first time since the International Congress of Mathematicians was held in Moscow in 1966 that Soviet algebraists could meet with a large number of their foreign colleagues. This volume contains the proceedings from this historic conference. Some of the Soviet contributions to this volume are not easily available from other sources.

Some of the major figures in the field, including P. M. Cohn, P. Gabriel, N. Jacobson, E. R. Kolchin, and V. Platonov, contributed to this volume. The papers span a broad range of areas including groups, Lie algebras, associative and nonassociative rings, fields and skew fields, differential algebra, universal algebra, categories, combinatorics, logic, algebraic geometry, geometry, topology, and mathematical physics.