

Advanced Lectures in Mathematics
Volume VIII

Recent Developments in Algebra and Related Areas

Editors: Chongying Dong and Fu-an Li



International Press
www.intlpress.com



高等教育出版社
HIGHER EDUCATION PRESS

Chongying Dong
University of California at Santa Cruz

Fu-an Li
Chinese Academy of Sciences: Academy of
Mathematics and Systems Science

Copyright © 2009 by International Press, Somerville, Massachusetts, U.S.A., and by
Higher Education Press, Beijing, China.

This work is published and sold in China exclusively by Higher Education Press
of China.

No part of this work can be reproduced in any form, electronic or mechanical,
recording, or by any information storage and data retrieval system, without prior
approval from International Press. Requests for reproduction for scientific and/or
educational purposes will normally be granted free of charge. In those cases where the
author has retained copyright, requests for permission to use or reproduce any
material should be addressed directly to the author.

ISBN 978-1-57146-135-3

Typeset using the LaTeX system.
Printed in the USA on acid-free paper.

ADVANCED LECTURES IN MATHEMATICS

Executive Editors

Shing-Tung Yau
Harvard University

Lizhen Ji
University of Michigan, Ann Arbor

Kefeng Liu
University of California, Los Angeles
Zhejiang University
Hangzhou, China

Editorial Board

Chongqing Cheng
Nanjing University
Nanjing, China

Zhong-Ci Shi
Institute of Computational Mathematics
Chinese Academy of Sciences
Beijing, China

Zhouping Xin
The Chinese University of Hong Kong
Hong Kong, China

Weiping Zhang
Nankai University
Tianjin, China

Xiping Zhu
Zhongshan University
Gangzhou, China

Tatsien Li
Fudan University
Shanghai, China

Zhiying Wen
Tsinghua University
Beijing, China

Lo Yang
Institute of Mathematics
Chinese Academy of Sciences
Beijing, China

Xiangyu Zhou
Institute of Mathematics
Chinese Academy of Sciences
Beijing, China

Preface

This volume contains papers presented at the International Conference on Algebra and Related Areas, held in Tsinghua University, Beijing, China, during August 18–20, 2007. The conference was dedicated to Professor Zhexian Wan in honor of his 80th birthday. About two hundred researchers, including graduate students and young mathematicians from China, Japan, Singapore, Australia, the Netherlands, Italy, and the United States, participated in this conference. There were fifteen invited lectures by well-known experts on algebraic geometry, combinatorics, coding theory, Lie algebras, representation theory of finite groups and algebraic groups, vertex operator algebras and their applications.

Professor Wan's contributions to mathematics are legendary. His extensive research covers many areas on mathematics, such as classical groups, geometry of matrices, finite fields and finite geometry, Lie algebras, combinatorics, graph theory, lattice theory, coding theory and cryptology, design theory with many fundamental results. In classical groups, Professor Wan investigated the structure and automorphism groups of various subgroups and quotient groups of classical groups over fields and skew fields. In particular, he and his former students Hongshou Ren and Xiaolong Wu proved in 1986 that all automorphisms of the two-dimensional special linear group over an arbitrary skew field are standard, and all isomorphisms between two-dimensional special linear groups over skew fields are standard with only one exception. This completely solved the very difficult problem on automorphisms and isomorphisms of linear groups over skew fields. In geometry of matrices, he systematically investigated the geometry of symmetric matrices, the geometry of alternate matrices, the geometry of hermitian and skew-hermitian matrices, generalizing the Fundamental Theorem of Projective Geometry to the geometry over arbitrary fields and skew fields with involution, and giving some applications to graph theory. The study of finite geometry and its applications in China was initiated by Professor Wan. He studied the action of various classical groups on vector spaces over finite fields. He developed a new theory to classify the orbits and to determine the lengths of orbits and related. He also applied these results to combinatorial design, information security, coding theory and graph theory, and obtained many important results. Besides, he gave a beautiful proof for a graphic method for solving the transportation problem and he solved a problem on linear shift register sequences. There is no doubt that Professor Wan is the leader in the Chinese algebra community, and the influence of his work over the half century will last for many years to come.

We are very grateful to the China and U.S. National Science Foundations, International Mathematical Union, Tsinghua University, Institute of Systems Science of Chinese Academy of Sciences, and many individuals for the organizing and support of this conference. We would like to sincerely thank all the participants, speakers, and authors for all their efforts and timely submissions, thereby making the conference a success. We appreciate the referees for their excellent review work. Thanks also go to the Higher Education Press and the International Press to publish these conference proceedings as one of the series Advanced Lectures in Mathematics.

Chongying Dong
University of California at Santa Cruz

Fu-an Li
Academy of Mathematics and Systems Science
Chinese Academy of Sciences

July 2008

Contents

Preface	
<i>Eiichi Bannai and Etsuko Bannai</i> : Spherical Designs and Euclidean Designs	1
<i>Yu Chen</i> : Minimal Representation Degree of Affine Kac-Moody Groups	39
<i>Huah Chu, Shou-Jen Hu and Ming-chang Kang</i> : A Rationality Problem of Certain A_4 Action	53
<i>Zongduo Dai, Kunpeng Wang and Dingfeng Ye</i> : Characterization of Multi-Continued Fractions for Multi-Formal Laurent Series	59
<i>Yi Fang and Zongzhu Lin</i> : Eulerian Trails and Hamiltonian Paths in Digraphs with Anti-involutions	81
<i>Rongquan Feng and Hongfeng Wu</i> : Efficient Pairing Computation on Curves	99
<i>Wenbin Guo</i> : Some Ideas and Results in Group Theory	111
<i>Tayuan Huang, Lingling Huang and Miaow-Ing Lin</i> : On a Class of Strongly Regular Designs and Quasi-semisymmetric Designs	129
<i>Huishi Li</i> : Γ -Leading Homogeneous Algebras and Gröbner Bases	155
<i>Jianbo Liu and Kaiming Zhao</i> : Automorphism Groups of Lie Algebras from Quantum Tori	201
<i>Yucui Su</i> : Quasifinite Representations of Some Lie Algebras Related to the Virasoro Algebra	213
<i>George Szeto and Lianyong Xue</i> : On Galois Extensions with an Inner Galois Group	239
<i>Nanhua Xi</i> : Representations of Algebraic Groups: Some Basics and Progresses	247
<i>Jiping Zhang and Zhikai Zhang</i> : Broué's Conjecture for Finite Groups with Abelian Sylow p -Subgroups	263

<i>Sujing Zhou and Dongdai Lin: An Interesting Member ID-based Group</i>	
Signature	279
Curriculum Vitae and Publications of Zhexian Wan	303