Mathematical Surveys and Monographs Volume 238

# Algebraic Geometry Codes: Advanced Chapters

Michael Tsfasman Serge Vlăduţ Dmitry Nogin



# **Geometry And Codes**

**Wolfgang Ebeling** 

#### **Geometry And Codes:**

Geometry and Codes Goppa, 2013-06-29 Approach your problems from the right end It isn t that they can t see the solution It is and begin with the answers Then one day that they can t see the problem perhaps you will find the final question G K Chesterton The Scandal of Father The Hermit Clad in Crane Feathers in R Brown The point of a Pin van Gulik s The Chinese Maze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens guite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially in regional and theoretical economics algebraic geometry interacts with physics the Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical programming profit from homotopy theory Lie algebras are relevant to filtering and prediction and electrical engineering can use Stein spaces And in addition to this there are such new emerging subdisciplines as experimental mathematics CFD completely integrable systems chaos synergetics and large scale order which are almost impossible to fit into the existing classification schemes They draw upon widely different Advances In Algebraic Geometry Codes Edgar Martinez-moro, Carlos Munuera, Diego sections of mathematics Ruano, 2008-10-08 Advances in Algebraic Geometry Codes presents the most successful applications of algebraic geometry to the field of error correcting codes which are used in the industry when one sends information through a noisy channel The noise in a channel is the corruption of a part of the information due to either interferences in the telecommunications or degradation of the information storing support for instance compact disc An error correcting code thus adds extra information to the message to be transmitted with the aim of recovering the sent information With contributions from renowned researchers this pioneering book will be of value to mathematicians computer scientists and engineers in Algebraic-Geometric Codes M. Tsfasman, S.G. Vladut, 2013-12-01 Et moi si j avait su comment en information theory revenir One service mathematics has rendered the je n y serais point alle human race It has put common sense back Jules Verne where it belongs on the topmost shelf next to the dusty canister labelled discarded non sense The series is divergent therefore we may be able to do something with it Eric T Bell O Heaviside Mathematics is a tool for thought A highly necessary tool in a world where both feedback and non linearities abound Similarly all kinds of parts of mathematics serve as tools for other parts and for other sciences Applying a simple rewriting rule to the quote on the right above one finds such statements as One service topology has rendered mathematical physics One service logic has rendered com puter science One service category theory has rendered mathematics All arguably true And all statements obtainable this way form part of the raison d etre of this series Algebraic Geometry Codes: Advanced Chapters Michael Tsfasman, Serge

Vlådut, Dmitry Nogin, 2019-07-02 Algebraic Geometry Codes Advanced Chapters is devoted to the theory of algebraic geometry codes a subject related to local libraryBook Catalogseveral domains of mathematics On one hand it involves such classical areas as algebraic geometry and number theory on the other it is connected to information transmission theory combinatorics finite geometries dense packings and so on The book gives a unique perspective on the subject Whereas most books on coding theory start with elementary concepts and then develop them in the framework of coding theory itself within this book systematically presents meaningful and important connections of coding theory with algebraic geometry and number theory Among many topics treated in the book the following should be mentioned curves with many points over finite fields class field theory asymptotic theory of global fields decoding sphere packing codes from multi dimensional varieties and applications of algebraic geometry codes The book is the natural continuation of Algebraic Geometric Codes Basic Notions by the same authors The concise exposition of the first volume is included as an appendix Algebraic Geometry for Coding Theory and Cryptography Everett W. Howe, Kristin E. Lauter, Judy L. Walker, 2017-11-15 Covering topics in algebraic geometry coding theory and cryptography this volume presents interdisciplinary group research completed for the February 2016 conference at the Institute for Pure and Applied Mathematics IPAM in cooperation with the Association for Women in Mathematics AWM The conference gathered research communities across disciplines to share ideas and problems in their fields and formed small research groups made up of graduate students postdoctoral researchers junior faculty and group leaders who designed and led the projects Peer reviewed and revised each of this volume s five papers achieves the conference s goal of using algebraic geometry to address a problem in either coding theory or cryptography Proposed variants of the McEliece cryptosystem based on different constructions of codes constructions of locally recoverable codes from algebraic curves and surfaces and algebraic approaches to the multicast network coding problem are only some of the topics covered in this volume Researchers and graduate level students interested in the interactions between algebraic geometry and both coding theory and cryptography will find this volume valuable Introduction to Coding Theory and **Algebraic Geometry** J. van Lint, G. van der Geer, 2012-12-06 These notes are based on lectures given in the semmar on Coding Theory and Algebraic Geometry held at Schloss Mickeln Diisseldorf November 16 21 1987 In 1982 Tsfasman Vladut and Zink using algebraic geometry and ideas of Goppa constructed a segeunce of codes that exceed the Gilbert Varshamov bound The result was considered sensational Furthermore it was surprising to see these unrelated areas of mathematics collaborating The aim of this course is to give an introduction to coding theory and to sketch the ideas of algebraic geometry that led to the new result Finally a number of applications of these methods of algebraic geometry to coding theory are given Since this is a new area there are presently no references where one can find a more extensive treatment of all the material However both for algebraic geometry and for coding theory excellent textbooks are available The combination of the two subjects can only be found in a number of survey papers A book by C Moreno with a complete treatment of this area is in

preparation We hope that these notes will stimulate further research and collaboration of algebraic geometers and coding theorists G van der Geer J H van Lint Introduction to CodingTheory and Algebraic Geometry PartI CodingTheory Jacobus H vanLint 11 1 Finite fields In this chapter we collect without proof the facts from the theory of finite fields that we shall need Algebraic Geometry in Coding Theory and Cryptography Harald Niederreiter, Chaoping Xing, 2009-09-21 This textbook equips graduate students and advanced undergraduates with the necessary theoretical tools for applying algebraic geometry to information theory and it covers primary applications in coding theory and cryptography Harald Niederreiter and Chaoping Xing provide the first detailed discussion of the interplay between nonsingular projective curves and algebraic function fields over finite fields This interplay is fundamental to research in the field today yet until now no other textbook has featured complete proofs of it Niederreiter and Xing cover classical applications like algebraic geometry codes and elliptic curve cryptosystems as well as material not treated by other books including function field codes digital nets code based public key cryptosystems and frameproof codes Combining a systematic development of theory with a broad selection of real world applications this is the most comprehensive yet accessible introduction to the field available Introduces graduate students and advanced undergraduates to the foundations of algebraic geometry for applications to information theory Provides the first detailed discussion of the interplay between projective curves and algebraic function fields over finite fields Includes applications to coding theory and cryptography Covers the latest advances in algebraic geometry codes Features applications to cryptography not treated in other books **Algebraic Geometry Codes** Michael A. Tsfasman, 2014-05-21 This book is devoted to the theory of algebraic geometric codes a subject formed on the border of several domains of mathematics On one side there are such classical areas as algebraic geometry and number theory on the other information transmission theory combinatorics finite geometries and dense packings Coding Theory and Algebraic Geometry Henning Stichtenoth, Michael A. Tsfasman, 1992 About ten years ago V D Goppa found a surprising connection between the theory of algebraic curves over a finite field and error correcting codes The aim of the meeting Algebraic Geometry and Coding Theory was to give a survey on the present state of research in this field and related topics The proceedings contain research papers on several aspects of the theory among them Codes constructed from special curves and from higher dimensional varieties Decoding of algebraic geometric codes Trace codes Exponen tial sums Fast multiplication in finite fields Asymptotic number of points on algebraic curves Sphere packings Codes, Designs and Geometry Vladimir Tonchev, 2012-12-06 Codes Designs and Geometry brings together in one place important contributions and up to date research results in this important area Codes Designs and Geometry serves as an excellent reference providing insight into some of the most important research issues in the field Error-correcting Codes William Wesley Peterson, E. J. Weldon, 1972 The coding problem Introduction to algebra Linear codes Error correction capabilities of linear codes Important linear block codes Polynomial rings and galois fields Linear switching circuits Cyclic codes Bose chaudhuri

hocquenghem codes Arithmetic codes Codes and Curves Judy L. Walker, When information is transmitted errors are likely to occur This problem has become increasingly important as tremendous amounts of information are transferred electronically every day Coding theory examines efficient ways of packaging data so that these errors can be detected or even corrected The traditional tools of coding theory have come from combinatorics and group theory Since the work of Goppa in the late 1970s however coding theorists have added techniques from algebraic geometry to their toolboxes In particular by re interpreting the Reed Solomon codes as coming from evaluating functions associated to divisors on the projective line one can see how to define new codes based on other divisors or on other algebraic curves For instance using modular curves over finite fields Tsfasman Vladut and Zink showed that one can define a sequence of codes with asymptotically better parameters than any previously known codes This monograph is based on a series of lectures the author gave as part of the IAS PCMI program on arithmetic algebraic geometry. Here the reader is introduced to the exciting field of algebraic geometric coding theory Presenting the material in the same conversational tone of the lectures the author covers linear codes including cyclic codes and both bounds and asymptotic bounds on the parameters of codes Algebraic geometry is introduced with particular attention given to projective curves rational functions and divisors The construction of algebraic geometric codes is given and the Tsfasman Vladut Zink result mentioned above is discussed No previous experience in coding theory or algebraic geometry is required Some familiarity with abstract algebra in particular finite fields is assumed However this material is reviewed in two appendices There is also an appendix containing projects that explore other codes not covered in the main text Coding Theory and Algebraic Geometry Henning Stichtenoth, Michael A. Tsfasman, 2014-01-15 The Mathematical Theory of Coding Ian F. Blake, Ronald C. Mullin, 2014-05-10 The Mathematical Theory of Coding focuses on the application of algebraic and combinatoric methods to the coding theory including linear transformations vector spaces and combinatorics The publication first offers information on finite fields and coding theory and combinatorial constructions and coding Discussions focus on self dual and quasicyclic codes quadratic residues and codes balanced incomplete block designs and codes bounds on code dictionaries code invariance under permutation groups and linear transformations of vector spaces over finite fields. The text then takes a look at coding and combinatorics and the structure of semisimple rings Topics include structure of cyclic codes and semisimple rings group algebra and group characters rings ideals and the minimum condition chains and chain groups dual chain groups and matroids graphs and coding The book ponders on group representations and group codes for the Gaussian channel including distance properties of group codes initial vector problem modules group algebras andrepresentations orthogonality relationships and properties of group characters and representation of groups The manuscript is a valuable source of data for mathematicians and researchers interested in the mathematical theory of coding **Introduction to Coding Theory and** Algebraic Geometry Jacobus Hendricus van Lint, Gerard van der Geer, 1988 Algebraic Geometric Codes: Basic Notions

Michael Tsfasman, Serge Vlådut, Dmitry Nogin, 2022-04-15 The book is devoted to the theory of algebraic geometric codes a subject formed on the border of several domains of mathematics On one side there are such classical areas as algebraic geometry and number theory on the other information transmission theory combinatorics finite geometries dense packings etc The authors give a unique perspective on the subject Whereas most books on coding theory build up coding theory from within starting from elementary concepts and almost always finishing without reaching a certain depth this book constantly looks for interpretations that connect coding theory to algebraic geometry and number theory There are no prerequisites other than a standard algebra graduate course The first two chapters of the book can serve as an introduction to coding theory and algebraic geometry respectively Special attention is given to the geometry of curves over finite fields in the third chapter Finally in the last chapter the authors explain relations between all of these the theory of algebraic geometric codes

Fundamentals of Error-Correcting Codes W. Cary Huffman, Vera Pless, 2010-02-18 Fundamentals of Error Correcting Codes is an in depth introduction to coding theory from both an engineering and mathematical viewpoint As well as covering classical topics there is much coverage of techniques which could only be found in specialist journals and book publications Numerous exercises and examples and an accessible writing style make this a lucid and effective introduction to coding theory for advanced undergraduate and graduate students researchers and engineers whether approaching the subject from a mathematical engineering or computer science background **Lattices and Codes** Wolfgang Ebeling, 2013 The purpose of coding theory is the design of efficient systems for the transmission of information The mathematical treatment leads to certain finite structures the error correcting codes Surprisingly problems which are interesting for the design of codes turn out to be closely related to problems studied partly earlier and independently in pure mathematics In this book examples of such connections are presented. The relation between lattices studied in number theory and geometry and error correcting codes is discussed The book provides at the same time an introduction to the theory of integral lattices and modular forms and to coding theory In the 3rd edition again numerous corrections and improvements have been made and the text has been updated Content Lattices and Codes Theta Functions and Weight Enumerators Even Unimodular Lattices The Leech Lattice Lattices over Integers of Number Fields and Self Dual Codes Readership Graduate Students in Mathematics and Computer Science Mathematicians and Computer Scientists About the Author Prof Dr Wolfgang Ebeling Institute of Algebraic Geometry Leibniz Universit t Hannover Germany **Algebraic Geometry Modeling In Information Theory** Edgar Martinez-moro, 2012-12-18 Algebraic geometry methods have constituted a basic background and tool for people working on classic block coding theory and cryptography Nowadays new paradigms on coding theory and cryptography have arisen such as Network coding S Boxes APN Functions Steganography and decoding by linear programming Again understanding the underlying procedure and symmetry of these topics needs a whole bunch of non trivial knowledge of algebra and geometry that will be used to both evaluate those methods and search for new codes and cryptographic applications. This book shows

those methods in a self contained form *Codes and Algebraic Curves* Oliver Pretzel,1998-01-08 The geometry of curves has fascinated mathematicians for 2500 years and the theory has become highly abstract Recently links have been made with the subject of error correction leading to the creation of geometric Goppa codes a new and important area of coding theory This book is an updated and extended version of the last part of the successful book Error Correcting Codes and Finite Fields It provides an elementary introduction to Goppa codes and includes many examples calculations and applications The book is in two parts with an emphasis on motivation and applications of the theory take precedence over proofs of theorems The formal theory is however provided in the second part of the book and several of the concepts and proofs have been simplified without sacrificing rigour

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