Thomas Stieltjes Institute for Mathematics

Annual Report 2002

Contents

Introduction

The present annual report of the research school Thomas Stieltjes Institute for Mathematics deals with the tenth year of its existence. The tenth anniversary of the Stieltjes Institute was celebrated in The Hague on November 12, 2002. In the same month M.A. Kaashoek retired as professor of the Vrije Universiteit in Amsterdam and as Chairman of the Board of the Stieltjes Institute. He is one of the founders of the institute and his continuous leadership during ten years chairmanship have contributed much to the present state and status of the institute.

Professor C.A.J. Klaassen of the University of Amsterdam has been appointed as the new Chairman of the Board. At the same time he replaced professor T.H. Koornwinder as member of the Board representing the University of Amsterdam. However Koornwinder remains chairman of the Scientific Committee and continues to participate into the meetings of the Board. Another board member who left after ten years is dr. G. Zoutendijk. He has given many valuable advices; the Stieltjes Institute has not found a good replacement yet.

In 2002 there were important developments at a national level. The OOW, a joint venture of the five Dutch research schools for mathematics, produced in cooperation with the advising committee for mathematics of NWO a plan to strengthen the position of mathematical research in The Netherlands entitled *Nieuwe dimensies, ruimer bereik*. This report, written by M.A. Kaashoek and H.A. van der Vorst, was formally presented in The Hague on April 18, 2002, and well received. In line with the ideas in the report the OOW took the initiative for national coordination of Master Courses and for forming clusters of researchers getting extra support from NWO and the government. One of the fundamental concepts in the above mentioned report is that new developments are found at the borderlines of different mathematical disciplines or neighboring scientific fields. The Stieltjes Institute stimulates the cooperation with other disciplines by forming so-called

theme groups. The first theme group, Financial Mathematics, was extended and therefore renamed as Mathematics and Economics. Contact has been made with the Tinbergen Institute to develop joint activities. A second theme group, Mathematical Biology, was started. Such theme groups are not restricted to Stieltjes members, but the Stieltjes Institute provides a framework to facilitate the cooperation.

In many ways the Stieltjes Institute contributed to mathematical activities. Professor A. Mikhailov (University of Leeds, United Kingdom) and professor A.J. van der Poorten (Macquarie University, Northryde, N.S.W., Australia) were special guests supported by the institute. Dr. J.M. Peng (TU Delft) was awarded the Stieltjes prize for the best thesis in 2001.

The Stieltjes Weeks with their impressive contribution to the mathematical program and several other conferences and workshops were financially supported. The institute also continued to support graduate students for participation in conferences and the publication of their theses. In order to reward good teaching a new prize was created, the *Stieltjes Onderwijsprijs*.

The main part of this report is devoted to the basic activities within the school, research and teaching. It is impressive to see how many publications appear every year. The quality of the research, underlined by the presence of Spinoza grant winner H.W. Lenstra and Pioneer grantees S.M. Verduyn Lunel, E. Opdam, and N.P. Landsman was confirmed by a VICI grant for R.W.J. Meester. All this and much more information can be found in this report.

R. Tijdeman
Scientific Director

About the Stieltjes Institute

The Thomas Stieltjes Institute for Mathematics is a Dutch research institute in mathematics, in which participate the University of Amsterdam, the Free University of Amsterdam, the Delft University of Technology, the Eindhoven University of Technology, the University of Leiden and the Erasmus University of Rotterdam. The Institute collaborates with the Centre for Mathematics and Computer Sciences (CWI) in Amsterdam and with the European Institute for the Study of Randomness (EURANDOM) in Eindhoven. The University of Leiden is administrator of the Institute.

The Stieltjes Institute, founded in 1992, carries out research in four main areas of fundamental and applied mathematics: Algebra & Geometry, Analysis, Stochastics, and Operations Research. It has been accredited as a Research School by the Royal Netherlands Academy of Arts and Sciences (KNAW). Each year an outstanding mathematician joins the Institute as a Stieltjes Visiting Professor. The Institute has a research training programme for Ph.D. students and each year a Stieltjes Prize is awarded for the best Ph.D. thesis in the Institute.

Mathematics has many different branches and two different aspects: the fundamental and the applied. However, it is a single coherent body of knowledge. This is demonstrated time and again by sometimes unexpected links between the various parts of mathematics and by the possibilities to apply even the most abstract developments. Also, direct contact with fields of application often generate new challenges for mathematical research. For this reason the Stieltjes Institute does not stress the distinction between fundamental and applied mathematics, and encourages research that crosses the dividing lines between the various parts of mathematics. The Stieltjes Institute combines the expertise of three general, two technical and one economics and medical university. This provides an excellent opportunity for interaction between mathematics and its applications in the life sciences, the natural sciences and engineering, computer science and economics.

Research Programmes

Algebra and Geometry

1.1 Number Theory

Programme leaders: H.W. Lenstra, R. Tijdeman

Number theory studies the properties of integers, with a historically strong emphasis on the study of diophantine equations, that is, systems of equations that are to be solved in integers. The methods of number theory are taken from several other branches of mathematics.
Traditionally, these include algebra and analysis, but in recent times algebraic geometry has been playing a role of increasing importance as well. It has also been discovered that number theory has important applications in more applied areas, such as cryptography, theoretical computer science, dynamical systems theory and numerical mathematics. These new developments stimulated the design, analysis and use of algorithms, now called computational number theory. They led to a unification rather than diversification of number theory.
For example, the applications in cryptography are strongly connected to algebraic geometry and computational number theory; and algebraic number theory, which used to stand on itself, is now pervading virtually all of number theory.

Themes of the program reflect the mentioned research areas. They include finding points on algebraic curves, applications of group theory and algebraic number theory, the theory of finite fields, diophantine approximation, words and sequences, discrete tomography, primality tests and factorization methods, and the development of efficient computer algorithms.

The biweekly national Intercity Number Theory Seminar continued to be the meeting place for the participants. Besides there were several activities supported by the Spinoza grant of H.W. Lenstra, the Stieltjes Institute, the Lorentz Center and NWO.

The instructional Stieltjes week on Explicit Algebraic Number Theory was well attended and appreciated. So was the subsequent NWO-OTKA workshop with the same title.

The project to fill the white spot in Escher's lithograph "Prententoonstelling" was particularly successful. In numerous publications and lectures Lenstra, De Smit and others explained the application of mathematical research to art showing how mathematical analysis helps in explaining structure.

1.2. Geometry

Programme leaders: R.H. Dijkgraaf, G.B.M. van der Geer

Central research themes are:

Real Algebraic Geometry. The study of algebraic varieties with the real numbers as base field. Special interest is given to mappings between real algebraic varieties, cycle classes and homology classes in real algebraic geometry, approximations of smooth mappings between non-singular real algebraic varieties by algebraic morphisms. Semi-algebraic sets, complexification of real algebraic varieties.

Arithmetic Geometry. One studies polynomial equations over the rational numbers or over the integers. The goal of arithmetic geometry is to understand the relations between algebraic geometry and number theory. Modular varieties and modular forms play a key role.

Algebraic Geometry of Curves and Abelian Varieties. The study of moduli spaces of abelian varieties and curves both in characteristic zero and characteristic p. Also the moduli spaces of vector bundles and K3 surfaces are studied. Curves and varieties over finite fields are studied in relation with coding theory.

Mathematical Physics The study of mathematical aspects of quantum field theory and string theory. Special emphasis on the relations with algebraic geometry, such as quantum cohomology, mirror symmetry, moduli space of Riemann surfaces. Topological field theory and manifold invariants. Nonperturbative string theory, string duality and extended objects such as D-branes.

1.3. Topology

Programme leaders: J.M. Aarts, J. van Mill

Central in this programme has been and will be the study of various topological objects ranging from the classical — Hilbert cube, plane continua arising in dynamical topological dynamics and the Čech-Stone compactification — to the more recent — function spaces with the topology of pointwise convergence, two- and n-points sets, and non-metric continua.
Techniques from many branches of mathematics are brought to bear on the study of these objects; first and foremost from the world of (general) topology itself but also from Functional Analysis, set Theory, Model Theory and Geometry.

Recent work on the structure of hereditarily indecomposable continua illustrates this: purely topological methods were combined with results from Model Theory in the construction of interesting examples of such spaces. In a totally different vein is the study of the structure of sets in the plane that meet every line in a specific number of points; the techniques here are very geometric in nature.

History and Philosophy of Mathematics
Since the last report the programme has been enriched by the addition of researchers in the history and philosophy of mathematics.

Status of the programme
The Dutch topology groups enjoy an excellent international reputation, and collaborate extensively with renowned researchers in Canada, the United States, Poland and the Czech republic for instance. They play an important role in the international organization of topological research. Within the Netherlands there are links to analysis, dynamical systems theory and probability theory, which sometimes provide sources of problems for topological research. Especially the links with dynamical systems theory could provide insights in the asymptotical behaviour of physical systems. This requires a deep understanding of the topology of the underlying spaces, and a solid knowledge of dimension theory and other branches of topology.

Analysis

2.1. Functional Analysis, Operator Theory and Applications

Programme leaders: Ph.P.J.E. Clément, S.M. Verduyn Lunel

This programme focusses on operator theoretical methods to analyze problems arising from concrete classes of integral, differential and difference equations. Both linear and non-linear equations are studied, and the problems may have a finite dimensional or infinite dimensional character. Typical for this programme is a strong interaction with dynamical systems, partial differential equations, probability theory and complex function theory. Important themes are the asymptotic behaviour of deterministic and of non-deterministic systems, applications and further development of the state space method, nonselfadjoint problems and completeness, the analysis of nonexpansive maps, stochastic differential equations in Banach spaces, operator-valued multiplier theorems, noncommutative analysis, higher-order elliptic and parabolic equations.

2.2. Representation Theory, Operator Algebras and Complex Analysis

Programme leader: E.M. Opdam

The central research themes are:
1- Harmonic analysis on groups, homogeneous spaces and related structures, such as Hecke algebras. Interactions with operator algebras, noncommutative geometry and quantization.
2- Special functions associated with root systems and their interpretation in relation to the above mentioned structures.
3- Special functions and orthogonal polynomials in one variable: analysis, asymptotics, approximation theoretic properties and algorithmic aspects.
4- Approximation theory and its applications.
5- Analysis in several complex variables.
6- Analysis aspects of mathematical physics. This includes topics from operator algebras, noncommutative geometry, quantization theory and quantum field theory. This theme also includes the study of integrable systems and evolution equations.
7- Analysis on Lie Groups. The main topics studied are: representations of Lie groups, harmonic analysis on homogeneous spaces and quantization.

We make special study of canonical representations (in the sense of Gelfand, Graev, Vershik) and oscillator representations (in the sense of R. Howe). Close cooperation exists with research groups in Russia, in particular in Tambov (Molchanov) and with Pevzner in Paris.

This programme unites a number of themes which are mutually connected and have a stimulating influence on each other. Some of the themes have an algebraic or geometric flavor, while others belong to classical analysis. We mention the following highlights of research in 2002.

- Theme 1: There has been stimulating progress in the study of canonical representations (in the sense of Gelfand, Graev, Vershik) and oscillator representations (in the sense of R. Howe). Another vein of research within (1) concerns applications of ideas from noncommutative geometry to various completions of affine Hecke algebras.

- Theme 2: There has been a lot of activity on quantum groups, double affine Hecke algebras and the related q-special functions. New ideas have led to involvement of elliptic functions. Another result that fits in (2) is the construction of a quasi-hereditary covering of the representation category of a Hecke algebra, by means of the study of certain differential equations.

- Theme 3: Involvement with the production of a new and edition of the famous *Handbook of mathematical functions'* (Abramowitz & Stegun). This new edition will also become available as an interactive database on the internet.

- Theme 4: A new result on the determinacy of the simultaneous distribution of non-negative random variables has been obtained.

- Theme 5: There has been progress towards the Gleasons problem. Questions around complete pluripolarity of maximal analytic varieties have been studied. Korevaar is writing an extensive monograph on Tauberian theorems. The manuscript is expected to be completed by 2004.

- Theme 6: This theme concerns the interaction between operator algebras, noncommutative geometry, quantization theory, and quantum field theory. In 2002, the mutual relationship between all these fields and both K-theory and the index theory of elliptic operators has been added as an important research theme. The central goal is the quantization of singular spaces, with applications to physics. Also in (6) important results have been obtained towards the classification of evolution equations by the existence of infinitely many generalized symmetries.

- Theme 7: Van Dijk and Molchanov completed a study on so-called H-invariants in the irreducible representations of the universal covering group

of SL(2,R). Progress was made with a textbook on harmonic analysis on hyperboloids in 3-dimensional space, a joint project with Molchanov. With Pevzner and Aparicio a first step was set in the study of the multiplicity free decomposition of Hilbert spaces invariant under the action of the oscillator representation.

2.3. Differential Equations, Dynamical Systems and Numerical Analysis

Programme leaders: A. Doelman, C.J. van Duijn

The main theme of this programme is the analysis of nonlinear differential equations and dynamical systems, from low dimensional systems such as maps (or discrete systems) and ordinary differential equations, to high dimensional systems, such as partial differential equations and lattice equations. It is the aim of the programme to develop fundamental insight in the complex behavior exhibited by nonlinear systems. The combination and cross-fertilization of mathematical analysis and numerical methods plays an essential role in this context. The character of the scientific research may be of a pure mathematical nature, but can also be mostly numerical. The motivation may be intrinsically mathematical, or can be driven by interactions with applications.

Status of the programme
On the one hand, the mathematical theory of nonlinear systems has developed in an almost explosive fashion in recent years. On the other hand, nonlinear systems are a natural link between mathematics and a growing number of related disciplines, or applications, such as physics, biology, economics, etc. In other words, the field of differential equations, dynamical systems and numerical analysis has a pivotal position, both within mathematics and between mathematics and its applications.
Within this programme, close cooperation exists with research groups in Atlanta, Bath, Bonn, Bordeaux, Boston, Houston, Madrid, Minneapolis, Nottingham, Paris, Parma, Pittsburgh, Providence, Princeton, Sapporo, Tel Aviv, Warwick, etc.

Stochastics

3.1. Probability

Programme leaders: F.M.Dekking, W.Th.F.den Hollander

Research in this programme is carried out in a very broad range of topics, covering most of the aspects of the mathematical discipline of probability theory and its applications to other mathematical areas, other sciences, and industry and technology. The basic themes of the research comprise among others extreme value theory and applications, optimal stopping, infinitely divisible distributions, stochastic recurrence, stochastic geometry, percolation and particle systems, modelling and simulation of geological structures, branching processes, queueing theory and applications, diffusions, ergodic theory, stochastic dynamical systems, fractal geometry and coding, non-commutative probability theory, stochastic inequalities, and simulation.

Probability theory and its applications develops mathematically precise models for quantitatively describing uncertain situations, and applies these models in order to arrive at optimal or nearly optimal decision procedures. Research carried out in this domain in The Netherlands, and in particular in the Stieltjes Institute, is broad-ranging. Inside of the Institute, there are common interests and collaborations with the programmes Statistics, Stochastic Operations Research, Topology and Dynamical Systems and Number Theory.

3.2. Statistics

Programme leaders: S.A. van de Geer, A.W. van der Vaart

This program studies the statistical modelling and analysis of stochastic phenomena. Its main focus point is the development of nonparametric models for complex situations, where data may be high-dimensional or with little structure, arise from observational studies rather then from experimentally controlled studies, and be subject to censoring, missing, or partially observed. Such data may come for instance from epidemiological and medical studies, life sciences, economic studies, satellites, financial markets or industrial settings.

The programme explores various new procedures and infinite-dimensional models. The classical statistical theory needs to be extended, and sometimes in fact abandoned because not being appropriate in the context of large data sets. Concepts such as optimality and efficiency are given a new dress, and parsimony is no longer considered as essential. The study of computational aspects and algorithms is also an important topic within the programme. The rapid increase of computer power makes complex modelling and computation possible, but also quite urgent due to the enormous amounts of data that are collected. Apart from the general mathematical statistical and computational theory, the programme also investigates practical implementations in numerous concrete settings.

Some keywords are: classification and statistical learning, computer simulation, coarsening at random, curve estimation, efficiency bounds, empirical processes, experimental design, fair estimators, financial models. inverse problems, likelihood and Bayes methods, longest increasing subsequence and Hammersley's process, model selection and adaptive methods, multivariate robust methods, non- and semiparametric models, resampling techniques, statistical quality control, statistics of extremes, stochastic geometry, time series and dependent processes.

Practical work carried out in this programme includes: demography, DNA microarrays, finance, growth of cancer cells, imaging, ion channels, statistical process control in industry, the spread of aids, the spread of herbs, and tomography.

The research group has numerous international contacts and an excellent international reputation. The reseachers form a notable group within the statistical community, which is a mix of mathematicians, theoretical and applied statisticians and data-analysts. The programme organizes regular international workshop with help of the Stieltjes Institute. At a national level, the research group has close interactions with other projects, in particular probability, and has good connections with the statisticians in the Mathematical Research Institute, and with the Vereniging voor Statistiek. There is a strong involvement with the Aio-network stochastics, which organizes the national graduate program in stochastics. The European research institute Eurandom in Eindhoven is an important meeting point for the researchers in this programme.

Operations Research

4.1. Discrete Mathematics and Optimization

Programme leaders: C. Roos, A. Schrijver

Aim of the programme:
- The analysis of large and complex combinatorial structures (like networks) with mathematical methods (algebra, geometry, topology, graph theory).
- The design of efficient and robust (modelling and algorithmic) methods for optimization and decision problems, and testing and applying the results to problems from practice (logistics, distribution, transport, engineering).

Some results in the evaluation period:
- CWI and UvA
Stable sets. D.C. Gijswijt and A. Schrijver showed that the b-stable set polyhedron of graphs not containing a bad K_4-subdivision is determined by the edge and odd circuit inequalities.
Combinatorial Optimization - Polyhedra and Efficiency. A. Schrijver finished the book "Combinatorial Optimization - Polyhedra and Efficiency", which will appear in 2003 at Springer-Verlag.
Combinatorial Optimization - Semidefinite Relaxations. M. Laurent proved a linear lower bound for the number of iterations needed for representing the cut polytope of a complete graph as projection of semidefinite relaxations; she gave concise semidefinite representations for the polytopes whose vertices form a real variety associated to a radical zero-dimensional ideal, extending results of Lasserre in the grid case, and also proved combinatorial analogues of results of Curto and Fialkow about flat extensions of moment matrices, with applications to semidefinite representations of 0/1 polytopes.
Binary matroids. J.F. Geelen (Canada), A.M.H. Gerards, and G. Whittle (New Zealand) continued their work towards a grid theorem for binary matroids. First they proved, in cooperation with N. Robertson (USA), a bound on the excluded minors for the matroids with branch-width k (to appear in *Journal on Combinatorial Theory, Series B*) and a structural characterization for high branch-witdh in matroids representable over fixed finite fields (a report is almost finished). Later they proved that matroids that are representable over a fixed finite field have large grid-minors if they have huge branch-width. This provides (among other things) evidence for Rota's conjecture.

Polyhedral Combinatorics. A.M.H. Gerards, G. Maroti, and A. Schrijver derived very short and easy proofs for recently appeared results of Aguilera, Escalante, and Nasini, on the disjunctive index of relaxations of stable set polyedra.

- TUD and EUR

Barrier functions for convex cones. Jointly with A. Nemirovski and A. Ben-Tal (Technion, Haifa), Roos wrote a paper on a generalized matrix cube problem. A monograph (with Peng and Terlaky) on new, so-called self-regular barrier functions for primal-dual interior point methods was published by Princeton University Press. The research on this subject was continued and has led to some new and interesting barrier functions, some of them being not self-regular but nevertheless sharing all the good properties of self-regular barriers, and with improved complexity results when compared with the classical logarithmic barrier function.

Non-convex Quadratic Optimization, Semidefinite Optimization. E. de Klerk, D. Pasechnik (jointly with D. Grigoriev, IRMAR, Univ. Rennes I) proved a $n^{O(k)}$-upper bound for the complexity of n-variate quadratic optimization subject to k (not necessarily convex) quadratic constraints. This bound in particular implies the sharpest known upper bound on the complexity of general semidefinite programming, claimed without a proof by L. Khachiyan and L. Porkolab in 1997. This result also shows that the so-called extended trust region subproblem is polynomially solvable (thus settling an open problem).

E. de Klerk, C. Roos (jointly with M. Halicka, Comenius Univiversity, Bratislava) gave a new characterization of the strict complementarity property for semidefinite programming in terms of the limiting behavior of the central path.

Convex Optimization. J. Brinkhuis worked on unification of necessary conditions (with Tikhomirov). A monograph on optimization theory based on these results will be finished in 2003 and published by Princeton University Press. The concept D-induced duality was developed (with Zhang).

Minimax results. J.B.G. Frenk was able to prove that some well known minimax results for infinite dimensional topological spaces using only finite dimensional separation. Moreover, a chain of well known minimax theorems starting with the famous minimax result of von Neumann published in 1928 were derived from each other using very elementary properties of compact sets and lower semi-continuous functions. Finally, some of these results were extended to the larger class of Borel probability measures by means of the

Riesz representation theorem for the dual space of the set of continuous functions on a compact Haussdorff space, the Banach-Alaoglu theorem and the Fubini-Tonelli theorem.

- TUE

L. Stougie, in cooperation with others, obtained several results.

On-line routing. Together with S. Krumke, D. Poensgen and W. de Paepe, M. Lipmann, X. Lu and R. Sitters several results have been obtained. A first step to study on-line elevator systems has been made. Together with R. Sitters and W. de Paepe the CNN-conjecture has been proven. This is considered one of the most important open problems in on-line optimization.

Minimum test set. Together with K.M.J. de Bontridder, B. Haldersson, M. Haldersson, C.A.J. Hurkens, J.K.Lenstra, and R. Ravi, a problem important in medical diagnostics and biological identification has been studied. Both approximation results has been obtained and exact algorithms have been designed.

Randomized Algorithms and Counting. Together with M. Dyer and R. Kannan a work on fast randomized algorithms for convex optimization has been completed. Together with M. Dyer the complexity of stochastic programming problems has been studied. Together with M. Dyer, M. Cryan and H. Mueller vertices of transportation polytopes have been counted approximately using Markov Chain techniques.

Transportation polytopes. A first strongly polynomial bound on the diameter of the transportation polytope was derived. Together with J. van den Heuvel the cubic bound was improved to a quadratic bound, which was afterwards, together with Graham Brightwell, improved to a linear bound.

Prizes and awards

- On June 15, 2002, A. Schrijver received a honorary doctorate of mathematics from the University of Waterloo in Waterloo, Ontario.
- Jiming Peng received the Stieltjes price for the best mathematical thesis in 2001 of the Stieltjes Institute.
- H. van Maaren and M. Heule were awarded for developing the second best SAT-solver in the category on random benchmarks at the SAT-solver Competition 2002 at the 5th International Symposium on Theory and Applications of Satisfiability Testing, Cincinatti.

4.2. Stochastic Operations Research

Programme leaders: O.J. Boxma, G.M. Koole

The programme focuses on stochastic networks. These are networks of entities, with particles residing in and moving between these entities according to stochastic processes. A key example is a queueing network, where the entities are service facilities and the particles customers.

In the design of computer, communication, and manufacturing systems, the most important criterion presently is quality of service, in relation to the costs of the system. The quality of service is expressed in terms of performance and reliability of the systems in relation to their applications. Stochastic networks provide the mathematical models for the description and analysis of these systems. Technological developments have in recent years led to new forms of the processing, storage and transmission of information, and have changed considerably the way companies are organized. In its turn, this has given rise to a plethora of new and challenging problems in the analysis and control of stochastic networks.

The joint expertise of the groups covers queueing theory, Markov decision chains, reliability theory, algorithmic probability and stochastic simulation. The research groups interact in several ways, partly in the framework of the EURANDOM project *Stochastic networks* and international projects.

Theme Group

T.1. Financial Mathematics

Theme leader: P.J.C. Spreij

Financial Mathematics is a relatively new branch in applied mathematics. Recent years have seen a truly quantitative revolution in the world of finance. The call for advanced mathematical techniques has boosted research in new directions of applied mathematics, both of a theoretical and a practical nature. Many researchers from more traditional branches of mathematics have made major contributions.

Within the Netherlands only a few mathematicians devote a major part of their research to this field. The newly installed Stieltjes theme group on Financial Mathematics is a new initiative to coordinate research in The Netherlands and to be a platform on which various activities in this field

find a common base.

Activities of the theme group are by no means restricted to participants of the Stieltjes Institute itself. This is reflected by the composition of the steering committee and of the theme group as a whole, where also mathematicians from other research institutes have been included.

The theme group has strong connections with several research programmes of the Stieltjes Institute, in particular with Probability, Statistics, Operator theory and Evolutionary Systems, and equally well established links with other research institutes in the Netherlands like CentER, DISC, EURANDOM and MRI.

Status of the theme.

The members of the theme group have been active in various fields like probability theory, mathematical statistics, time series analysis and dynamical systems.

It is the ambition of the theme group to promote the research in Financial Mathematics in the Netherlands by organising a seminar series, workshops and special activities in the educational vein. All these activities will be conducted in close cooperation with members of the mathematical institutes associated with the Stieltjes Institute and with other research institutes both in mathematics and in economics. The theme group started its activities in mid 2000.

Activities.

The main activity in 2002, apart form research, aimed at promoting Financial Mathematics has been the organisation of a "Winter school on Mathematical Finance".

The Winter school has been held at the Conference centre Oud-Poelgeest (Oegstgeest) from December 16 to 18, 2001. The winter school has been organised by Hans Schumacher (UvT) and Peter Spreij (UvA).

Minicourses have been given by Marek Rutkowski (Warsaw) and Rama Cont (Palaiseau).

Special invited lectures have been presented by Jan Kallsen (Freiburg), Damiano Brigo (Milan) and Dilip Madan (College Park).

There were four additional short lectures by researchers on Financial Mathematics from The Netherlands.

Some fifty particpants have attended the winter school. Because of the enthousiastic reactions of the participants a follow up in December 2003 has already been planned. The winter school has been sponsored by the Stieltjes

Institute, MRI, CentER and NWO.

In 2003 the theme group will change its name into Theme group "Mathematics and Economics". The theme will enlarge its scope to include branches of Applied Mathematics (such as optimization theory) that are relevant for a variety of subfields of Economics.

International and National Programmes

European Programmes

– European Research Training Network

Galois theory and explicit methods in arithmetic
2000 - 2004
Cooperation with: Paris, Barcelona, Bonn, Bordeaux, Essen, Heidelberg, Leiden, Lille, Nottingham, Besancon, Rome, Tel Aviv
Project leaders: H.W. Lenstra, B. de Smit

Arithmetic algebraic geometry
2001 - 2003
Cooperation with: Strasbourg, Rennes, Regensburg, Padova, Paris 13, Orsay, Münster, Jerusalem, Durham, Cambridge, Bonn, Barcelona
Coordinator Stieltjes: S.J. Edixhoven

Classical analysis, operator theory, geometry of Banach spaces, their interplay and their applications
June 1999 - June 2003
Cooperation with: Barcelona, Bordeaux, Dublin, Leeds, Paris, St.Petersburg, Tel Aviv, Trondheim, Vienna
Coordinators Stieltjes: M.A. Kaashoek and S.M. Verduyn Lunel

System identification
March 1998 - March 2003
Cooperation with: Vienna, Leuven, Sophia Antipolis, Rennes, Cambridge, Padova, Stockholm, Linkoeping
Coordinator Stieltjes: J.H. van Schuppen

Control and computation
January 2002 - December 2004
Cooperation with: Grenoble, Zürich, Lund, Rome
Coordinator Stieltjes: J.H. van Schuppen

Algorithmic methods for optimizing the railways in Europe
December 1, 1999 - November 30, 2003
Cooperation with: Universität Konstanz, ETH Zürich, Danish Techical University, Lyngby, Computer Technology Institute, Patras, Dipartimento di Informatica e Sistemistica, Rome
Coordinator Stieltjes: A.M.H. Gerards

Statistical methods for dynamical stochastic models (DYN-STOCH)
September 1, 2000 - August 31, 2004
Cooperation with: Copenhagen, Berlin, Cartagena, Freiburg, Helsinki, London, Padua, Paris
Coordinator Stieltjes: P.J.C. Spreij

DONET - Discrete optimization: theory and applications
April 1 1997 - March 31 2003
Cooperation with: CORE, Université catholique de Louvain, London School of Economics, Université Pierre et Marie Curie, Paris, Rheinische Friedrich-Wilhems-Universität Bonn, CWI, Amsterdam, IASI-CNR Rome, University of Lisbon, Dash Associates Ltd, UK, Ecole polytechnique fédérale de Lausanne
Coordinator Stieltjes: A. Schrijver

Nonlinear parabolic partial differential equations: methods and applications
April 1, 1998 - March 31, 2002
Cooperation with: Bath, Bonn, Leiden, Madrid, Paris, Rome, Tel Aviv
Coordinator Stieltjes: J. Hulshof

– INTAS

The mathematics of stochastic networks
September 2001 - September 2002
Cooperation with EURANDOM (coord.), INRIA, France; University of Ulm, Germany; Cambridge University, UK; Technion, Israel; University of Patras, Greece; University of Novosibirsk, Russia; Institute of Information

Transmission Problems, Omsk State University, Russia; Eindhoven University of Technology, Ecole Normale Superieure (Paris 7), France; Brims, UK
Coordinators Stieltjes: O.J. Boxma, A. Hordijk

Mathematics of stochastic networks
2001 - 2003
Cooperation with INRIA, Ecole Normale Supérieure, University of Ulm, University Lund, University Cambridge, Technion Haifa, University of Patras, University of Novosibirsk, IPIT Moscow, Omsk State University
Coordinator Stieltjes: O.J. Boxma

Estimation of parameters and construction of goodness-of-fit tests in some non- and semi-parametric models
March 1999 - March 2002
Cooperation with: Limburgs Universitair Centrum, Diepenbeek, Belgium, Razmadze Mathematical Institute, Tbilisi, Georgia
Project leader: C.A.J. Klaassen

National Programmes

NWO/NCF project Computational number theory: factorization of large integers
1992 - 2002
Participants: UL, CWI, RUG
Coordinators Stieltjes: R. Tijdeman and H.J.J. te Riele

Performance analysis of communication networks
1996 - 2002
Cooperation with: TUE, Columbia University, Bell Laboratories, Lucent Technologies, INRIA
Coordinator Stieltjes: S.C. Borst

NWO Spinoza Project
January 1999 - January 2009
Projectleader: H.W. Lenstra

NWO Pionier Project Analysis, dynamical systems and applications
March 1999 - March 2005
Projectleader S.M. Verduyn Lunel

FOM-GBE Programme Mathematical Physics
1999 - 2006
Project leader: R.H. Dijkgraaf

NWO Earth Sciences Project Upscaling flow and transport processes in porous media: from pore to core
January 1, 2000 - January 1, 2003
Cooperation with TUD (Dept Water Management), UL, TUE, WAU
Stieltjes Coordinators: J. Hulshof, H. van Duijn

NWO Pionier Project Symmetry and symmetry breaking in mathematics and mathematical physics
July 2000 - June 2005
Project leader: E. Opdam

Co-algebra and control
2001 - 2003
Cooperation with CWI, J.J.M.M. Rutten
Project leader: J.H. van Schuppen

Stochastic analysis: Self-interacting random processes, measure-valued diffusions and stochastic evolution equations
2001 - 2005
Coordinators Stieltjes: Ph. Clment, F. den Hollander, S.M. Verduyn Lunel

NWO Pionier Project Quantization, noncommutative geometry, and symmetry
September 1, 2002 - August 31, 2007
Coordinator Stieltjes: N.P. Landsman

FOM programme String theory and quantum gravity
2002 - 2009
Project leader: R.H. Dijkgraaf

NWO VICI Project Long range stochastic dynamics
July 1, 2003 - July 1, 2008
Project leader: R.W.J. Meester

Various, International and National

Telematics Institute, Quality of service in future networks (QFN)
1999 - 2003
Cooperation with: CTIT, KPN Research, Bell Laboratories, Lucent Technologies, INRIA
Coordinator Stieltjes: S.C. Borst

Representations of Lie groups, harmonic analysis on homogeneous spaces and quantization
2000 - 2003
Cooperation with Russia: Moscow, St. Petersburg, Tambov
Project coordinator: G. van Dijk

Number theory, dynamical systems and combinatorics on words
November 2000 - November 2002
Cooperation of: Université Aix-Marseille II, TUD, UU, RUG, UL
Coordinator Stieltjes: R. Tijdeman

Financial time series analysis
2001-2002
Participants: IMG N.V., AOT N.V., UvA
Coordinator Stieltjes: R. de Vilder

NWO-OTKA Programme: Number theory and its applications
2001 - 2003
Cooperation of: Budapest, Debrecen (Hungary), CWI, UL, UU
Project leaders: K. Gyory (Debrecen), R. Tijdeman

Socrates Programme: Number theory
2001-2004
Cooperation of Ostrava (Czech Republic) and Leiden
Coordinator Stieltjes: R. Tijdeman

Cell biology & the silicon cell (ICES-KIS2)
1999 - 2002
Cooperation with: UvA (SILS/IvI), VU (IMBW)
Project leader: J.G. Blom (CWI)

INTRACON: Internet traffic control protocols - design, verification and performance analysis
2001 - 2005
Philips Research
Coordinators Stieltjes: S.C. Borst, O.J. Boxma

Service allocation in tandem queues with applications to access networks
2002-2005
Philips Research
Coordinator Stieltjes: O.J. Boxma

Ph.D. Programme

Stieltjes activities in 2002/2003

General (Stieltjes onderwijsweken)

Explicit algebraic number theory
Leiden, September 23-27, 2002
H.W. Lenstra, R. Schoof, B. de Smit, P. Stevenhagen (organiser)

Stability analysis in pde's
Leiden, March 3-7, 2003
J.B. van den Berg, A. Doelman (organiser), H. van Duijn, S. van Gils, M.
van Hecke, G. Hek, J. Hulshof, J. King, V. Rottschäfer, H. Schuttelaars

Algebra & Geometry

Intercity Seminar p-Adic Hodge theory
Utrecht, Amsterdam, Spring 2002
B. Moonen, G. van der Geer

Intercity seminar Number theory
Leiden, Utrecht, Groningen, Nijmegen, throughout 2002
B. de Smit

Seminar Moduli spaces and modular forms
Leiden, Fall 2002
S.J. Edixhoven, G. Wiese

Seminar Geometry
Leiden, Spring 2003
S.J. Edixhoven, G. Wiese

Seminar Topology
Amsterdam, Delft, bi-weekly
J.J. Dijkstra, J. van Mill

Analysis

Crossroads colloquium, topic PDEs from the life sciences
Amsterdam, CWI, April 16, 2002
J.G. Verwer, M.A. Peletier

Seminar Control and system theory
Amsterdam (CWI), bi-weekly
J.H. van Schuppen

Seminar on Canonical bases
Amsterdam, Spring 2002
T.H. Koornwinder, E.M. Opdam

Seminar on Tensor categories in mathematical physics
Amsterdam (UvA) and Utrecht, Spring 2002
N.P. Landsman, I. Moerdijk, M. Müger

Euro Summer School in Orthogonal polynomials and special functions
Leuven, Belgium, August 12-16, 2002
E. Koelink

Seminar on noncommutative geometry
Amsterdam, Fall 2002
N.P. Landsman, E.M. Opdam

Stochastics

Local CWI seminars:
- Signals and images Seminar: R.S. Stoica, bi-weekly
- PNA Colloquium: M.N.M. van Lieshout, bi-monthly
- Spatial stochastics Seminar: M.N.M. van Lieshout (with PNA3), bi-weekly

Weekly seminar Probability theory and statistics
Delft
E.A. Cator, L.E. Meester

11th Meeting of AIO's in stochastics
Hilversum, May 19 - 21, 2003
A.W. van der Vaart, R.W.J. Meester

Operations Research

Seminar Capacity Management - How operations research models support
decision makers
Lunteren, January 17, 2002
L.C.M. Kallenberg

LNMB Course Convex analysis for optimization
Utrecht, Fall 2002
E.J. Balder

LNMB Course Convex optimization
Utrecht, Fall 2002
C. Roos, H. van Maaren

LNMB Course Operations research and logistics
Utrecht, Fall 2002
A.G. de Kok, W.H.M. Zijm

LNMB Course Game theory
Utrecht, Spring 2003
P.E.M. Borm, O.J. Vrieze

LNMB Course Stochastic programming and randomized algorithms
Utrecht, Spring 2003
M.H. van der Vlerk, L. Stougie

LNMB Course Applications of game theory to operations research
Utrecht, Spring 2003
P.E.M. Borm, H.J.M. Hamers

Financial Mathematics

Stieltjes Winter School on Financial mathematics
Leiden, December 17-19, 2002
J.M. Schumacher

Colloquium Probability, statistics and financial mathematics
Amsterdam
A.A. Balkema, M.F.M. Nuyens, P.J.C. Spreij

Ph.D. Theses

E.G. van den Heuvel   Resolvent conditions in the stability analysis of numerical processes for solving delay differential equations
Thesis advisors: M.N. Spijker, J.G. Verwer
January 9, 2002   Leiden University

N. Litvak   Collecting n items randomly located on a circle
Thesis advisors: J. Wessels, W.H.M. Zijm, I.J.B.F. Adan
January 22, 2002   Eindhoven University of Technology

C. Quant   On the construction and stationary distributions of some spatial queueing and particle systems
Thesis advisor: R.W.J. Meester
February 6, 2002   Utrecht University

E.H. van Brummelen   Numerical methods for steady viscous free-surface flows
Thesis advisors: P.W. Hemker, H.C. Raven
February 8, 2002   University of Amsterdam

F.A.M.O. Lemmers   On the Gleason problem
Thesis advisors: T.H. Koornwinder, J.J.O.O. Wiegerinck
February 26, 2002   University of Amsterdam

D. Lanser   Numerical methods for atmospheric flow and circu-
                             lation problems
                             Thesis advisor: J.G. Verwer
March 7, 2002   University of Amsterdam

S.W.W. Rolles   Random walks in stochastic surroundings
                             Thesis advisor: M.S. Keane
March 20, 2002   University of Amsterdam

P. van der Wal   Random substitutions and fractalpercolation
                             Thesis advisor: F.M. Dekking
March 25, 2002   Delft University of Technology

M. Klok   Performance analysis of advanced third generation
                             receivers
                             Thesis advisors: F.M.Dekking, G. Hooghiemstra
April 8, 2002   Delft University of Technology

J. de Mast   Quality improvement from the viewpoint of statis-
                             tical method,
                             Thesis advisor: R.J.M.M. Does, C.B. Roes
April 10, 2002   University of Amsterdam

T. Vredeveld   Combinatorial approximation algorithms. Guaran-
                             teed versus experimental performance
                             Thesis advisors: J.K. Lenstra, C. Roos,
                             C.A.J. Hurkens
April 23, 2002   Eindhoven University of Technology

P.R. Beneker   Strongly exposed points in unit balls of Banach
                             spaces of holomorphic functions
                             Thesis advisors: M.A. Kaashoek,
                             J.J.O.O. Wiegerinck
May 21, 2002   University of Amsterdam

T. Lin	Statistics of extremes in the space of continuous fractions
	Thesis advisors: J.H.J. Einmahl, L.F.M. de Haan
May 22, 2002	Tilburg University
S.H. Cavallar	On the number field sieve integer factorisation algorithm
	Thesis advisors: R. Tijdeman, H.J.J. te Riele
June 5, 2002	University of Leiden
S. Bhulai	Markov decision processes: the control of high-dimensional systems
	Thesis advisor: G.M. Koole
June 11 2002	Free University of Amsterdam
L. Booth	Random spatial structures and sums
	Thesis advisor: R.W.J. Meester
June 13, 2002	Utrecht University
T.L. van Noorden	New algorithms for parameter-swing reactors
	Thesis advisors: A. Bliek, S.M. Verduyn Lunel
June 26, 2002	Free University of Amsterdam
E. Oldenkamp-Bazsa	Decision support systems for inventory models with complete backordering
	Thesis advisors: R. Dekker, P.H. Zipkin, J.B.G. Frenk
June 14, 2002	Tinbergen Institute
K. Zuideveld	Mechanism-based pharmacokinetic-pharmaco-dynamic modeling: application to 5-HT receptor mediated response
	Thesis advisors: M. Danhof, L.A. Peletier
September 5, 2002	Leiden University

B. Lastdrager   Numerical time integration on sparse grids
                                 Thesis advisors: J.G. Verwer, B. Koren
September 18, 2002   University of Amsterdam

K. Boujhar   On the structure of n-point sets
                                 Thesis advisors: J. van Mill, J.J. Dijkstra
October 29, 2002   Free University of Amsterdam

M. El Bachraoui   Relation algebras, multigroupoids, and degree
                                 Thesis advisors: J. van Mill, M. van de Vel
October 29, 2002   Free University of Amsterdam

A. Ferreira   Statistics of extremes: estimation and optimality
                                 Thesis advisors: J.H.J. Einmahl, L.F.M. de Haan
November 25, 2002   Tilburg University

Stieltjes Prizes

Stieltjes Thesis Prize

Each year a *Stieltjes Prijs* (Stieltjes Prize) will be given to the Stieltjes student with the best Ph.D. thesis. It consists of a certificate and an amount of 1.200 Euro.

Winner 2001
The Stieltjes prize for 2001 has been awarded to dr. J.M. Peng for his dissertation "New design and analysis of interior-point methods"(June 20, 2001, Delft University of Technology, the Netherlands). On February 12, 2003, the former Rector Magnificus of the University of Amsterdam, Prof.dr. J.J.M. Franse has presented this Stieltjes certificate and the amount of 1.200 euro to him.

Winner 2002
The 2002 Prize will be awarded in 2003.

Stieltjes Propedeuse Prize

For stimulating the study in mathematics at Dutch universities the Stieltjes Institute has established in 2001 six *Stieltjes Propedeuseprijzen Wiskunde* (Stieltjes Propedeuse Prizes Mathematics) for the best first year students at the general universities. These prizes consist of a certificate, a sculpture of a falcon and an amount of 500 Euro.

On the recommendation of the *Koninklijke Hollandsche Maatschappij der Wetenschappen* (Royal Holland Society of Sciences and Humanities) at Haarlem the prizes 2002 have been awarded to:
Pieter J. Bruin (University of Leiden)
Bart van den Dries (Utrecht University)

Wouter J. Peyrot (university of Amsterdam)
Jeroen R. Sijsling (University of Groningen)
Bart J. Slingerland (Free University of Amsterdam)

On November 28, 2002, during a meeting in the Hodshon House in Haarlem, the seat of the Koninklijke Hollandsche Maatschappij der Wetenschappen, they received the prizes from the Chairman of the Education Committee and the Secretary of the Stieltjes Institute.

During this meeting also the two *CIVI Propedeuseprijzen Wiskunde* for the best first year students at the technical universities were presented to:
Matthijs W. Bijl (University of Twente)
Paulien van Slingerland (Delft University of Technology).

Number of Researchers

Situation at September 1, 2002

	I. Funded by universities				II. Funded by NWO & KNAW			Total I + II
	perma-nent	post doc	Ph.D.	total	post doc	Ph.D.	total	
UvA	24	3	9	36	8	14	22	58
VU	24	5	11	40	1	4	5	45
TUD	24	1	9	34	-	3	3	37
TUE	21	-	2	23	-	5	5	28
UL	20	1	14	35	5	4	9	44
EUR	10	-	1	11	-	1	1	12
Total	123	10	46	179	14	31	45	224

CWI participants	23
Eurandom participants	23

Stieltjes Guests

During the year 2002 two outstanding mathematicians were the guest of the Stieltjes Institute for one month:
- Alf van der Poorten (Masquarie University, Sydney, Australia), host Rob Tijdeman of the University of Leiden,
- Alexander Mikhailov (University of Leeds, U.K., and Landau Institute, Moscow, Russia), host Jan Sanders of the Free University Amsterdam.

Professor A. van der Poorten

In the course of my visit from September 22 until October 22, 2002, I gave four talks:
- 'Periodic continued fractions and torsion on the jacobians of hyperelliptic curves' (NWO-OTKA workshop at the Lorentz Center at Leiden),
- 'Quadratic number fields with small regulator' (Intercity Seminar at Groningen),
- 'An introduction to continued fractions' (to undergraduate and graduate students at Leiden),
- 'Some questions suitable for the Monthly' (Intercity Seminar at CWI, Amsterdam).

I completed a paper 'Torsion on Elliptic Curves and Periodic Continued Fractions' and made significant advances in research on and writing of its successor, which is to deal with analogous issues in genus two.

As one would expect, I benefited significantly from the ability to interact directly with a number of my colleagues (among whom Rob Tijdeman, Hendrik Lenstra, Bas Edixhoven, Peter Stevenhagen, Bart de Smit, Jan-Hendrik Evertse) with various research insights coming from incidental remarks I

overheard as well as from questions put to me (not to mention the useful library at the Math Institute). Of course my experience here was materially enriched by the happenstance of my being able to attend the Stieltjesweek (from which I learned a great deal both of the material as such and from the manner and quality of the presentations) and subsequent workshop on Explicit Algebraic Number Theory (which entailed my interacting with a yet wider group of mathematicians). My extensive conversations with Rob Tijdeman, and to a lesser extent Pingzhi Yuan, were instructive both from my meeting questions that had not heretofore intrigued me and, as always, from giving me opportunity to reflect upon my explanations of my emphases and interests.

A. van der Poorten

Professor A.V. Mikhailov

Professor Mikhailov visited the Free Universiteit of Amsterdam as a Stieltjes guest from October 10 to November 10, 2002. This time was used to start research on the application of the symbolic method to non-evolutionary equations, in collaboration with Dr V.S. Novikov (Landau Institute, visiting the VU for half a year) and Dr Jing Ping Wang (VU), research that is still going on, and to run a seminar in which each of the participants discussed methods that might be of use to the others, but also new research results.

Professor Mikhailov gave a talk with the title "What is Integrability? (Solitons, Inverse Scattering, Symmetries...)", directed to a general mathematical audience.

The visit was very fruitful and papers describing the results are in preparation.

Jan A. Sanders

Publications

Some publications of 2000 and 2001 that were missing in the Biennial Report 2000-2001 are also included.

Algebra and Geometry

1.1. Number Theory

Papers in journals and proceedings

V. Berthé, R. Tijdeman, (2002) Balance properties of multi-dimensional words, *Theor. Comput. Sci.* 273, 197-224.

W. Bosma, B. de Smit, (2002) On arithmetically equivalent number fields of small degree, in: C. Fieker, D. Kohel (Eds.), *Algorithmic Number Theory* (Proceedings of ANTS 5, Sydney), *Lecture Notes in Computer Science* 2369, Springer-Verlag.

J.H. Evertse, (2002) On resultant inequalities, *Acta Arith.* 105, 67-101.

J.H. Evertse, (2002) Points on subvarieties of tori, In: G. Wüstholz, ed., *A Panorama in Number Theory or the View from Baker's Garden, Proc. Conf. Number Theory in honour of the 60th birthday of Prof. Alan Baker,* Zürich in 1999, Cambridge Univ. Press, pp. 214-230.

J.H. Evertse, R.G. Ferretti, (2002) Diophantine inequalities on projective varieties, *Intern. Math. Res. Not.* 25, 1295-1330.

J.H. Evertse, N. Hirata-Kohno, (2002) Wirsing systems and resultant inequalities, In: *Number Theory for the Millennium, Proc. Millennial Conf. Number Theory,* (Urbana, IL, May 20-26, 2000), Vol. I, M.A. Bennett et al. eds., A.K. Peters, pp. 449-461.

J.H. Evertse, H.P. Schlickewei, (2002) A quantitative version of the Absolute Subspace Theorem, *J. reine angew. Math.* 548, 21-127.

J.H. Evertse, H.P. Schlickewei, W.M. Schmidt, (2002) Linear equations in variables which lie in a multiplicative group, *Ann. Math.* 155, 1-30.

H.W. Lenstra, (2002) Solving the Pell equation, *Notices Amer. Math. Soc.* 49, 182-192.

H.W. Lenstra, J. Pila, C. Pomerance, (2002) A hyperelliptic smoothness test II, *Proc. London Math. Soc.* (3) 84, 2361-2401.

H.W. Lenstra, (2002) On a problem of Garcia, Stichtenoth, and Thomas, *Finite Fields and their Applications* 8, 166-170.

H. Roskam, (2002) Artin's primitive root conjecture for quadratic fields, *J. Théor. Nombres Bordeaux* 14, 287-324.

J. Sander, R. Tijdeman, (2002) The rectangular complexity of functions on two-dimensional lattices, *Theor. Comput. Sci.* 270, 857-863.

N. Saradha, T.N. Shorey, R. Tijdeman, (2002) Some extensions and refinements of a theorem of Sylvester, *Acta Arith.* 102, 167-181.

R. Tijdeman, (2002) Some applications of Diophantine approximation, in: *Number Theory for the Milennium III,* ed. by M.A. Bennett et al., A.K. Peters, Natick MA, U.S.A., pp. 261-284.

R. Tijdeman, Pingzhi Yuan, (2002) On the irrationality of Cantor and Ahmes series, *Indag. Math., N.S.* 13, 407-418.

Ph.D. Theses

S.H. Cavallar, (2002) *On the Number Field Sieve Integer Factorisation Algorithm,* Leiden University.

Reports and pre-prints

S. Cavallar, (2002) *The three-large-primes variant of the number field sieve,* CWI Report MAS-R0219.

I. Chen, M. Grabitz, B. de Smit, (2002) *Relations between jacobians of modular curves of level,* www.math.leidenuniv.nl/ desmit/prep/

D. A. Cox, J. McKay, P. Stevenhagen, (2002) *Principal moduli and class fields,* MI report 2002-22.

J.H. Evertse, R. Ferretti, (2002) *A variation on Siegel's lemma,* Report MI-2002-03.

L. Hajdu, R. Tijdeman, (2002) *Polynomials dividing infinitely many quadrinomials or quintinomials,*
www.math.leidenuniv.nl/ tijdeman/preprints.html hajtij5.ps

J. Hančl, R. Tijdeman, (2002) *On the irrationality of Cantor series,*
www.math.leidenuniv.nl/ tijdeman/preprints.html hantij7.ps

P. Meijer, M. van der Vlugt, (2002) *The evaluation of Gauss sums for characters of 2-power order,* Report MI 2002-16.

P. Moree, H.J.J. te Riele, (2002) *The hexagonal versus the square lattice,* CWI Report MAS-R0214, and arXiv:math.NT/0204332.

B. de Smit, (2002) *An algebraic proof of Brauer's class number relations,* www.math.leidenuniv.nl/ desmit/prep/

B. de Smit, (2002) *On arithmetically equivalent fields with distinct p-class numbers,* www.math.leidenuniv.nl/ desmit/prep/

P. Stevenhagen, (2002) *Triangles, squares, oranges and cuboids,* MI report 2002-23.

P. Stevenhagen, (2002) *The correction factor in Artin's primitive root conjecture,* MI report 2002-30.

P. Stevenhagen, (2002) *The number field sieve,* www.math.leidenuniv.nl/ psh/

R.J. Stroeker, (2002) *On Q-derived polynomials,* Econometric Institute EUR, Report EI 2002-30.

Sz. Tengely, (2002) *On the Diophantine equation $F(x) = G(y)$,* www.math.leidenuniv.nl/ tengely/

R. Tijdeman, (2002) *Periodicity and almost periodicity,* www.math.leidenuniv.nl/ tijdeman/preprints.html tijbud.ps

R. Tijdeman, L. Zamboni, (2002) *Fine and Wilf words for any periods,* www.math.leidenuniv.nl/ tijdeman/preprints.html tijzam2.ps

H.C. Williams, H.J.J. te Riele, (2002) *New computations concerning the Cohen-Lenstra heuristics,* CWI Report MAS-R0215.

Other publications

R. Tijdeman, (2002) Getaltheoretische aspecten van discrete tomografie, in: *Vacantiecursus 2002: Wiskunde en Gezondheid, CWI Syllabus 50,* pp. 115-128.

1.2. Geometry

Papers in journals and proceedings

C. Bachas, J. de Boer, R. Dijkgraaf, H. Ooguri, (2002) Permeable conformal walls and holography, *J. High Energy Phys.* no. 6, no. 27, 33 pp.

J. Bochnak, W. Kucharz, (2002) A topological proof of the Grothendieck formula in real algebraic geometry, *Enseign. Math.* 48, no. 3-4, 237-258.

J. de Boer, R. Dijkgraaf, K. Hori, A. Keurentjes, J. Morgan, D. R. Morrison, S. Sethi, (2002) Triples, Fluxes, and Strings, *Adv. Theor. Math. Phys.* 4 995-1186.

B. Brent Gordon, M. Hanamura, J.P. Murre, (2002) Chow-Künneth projectors for modular varieties, *C.R. Acad. Sci. Paris,* Ser. I 335, 745-750.

A. Conte, M. Marchisio, J.P. Murre, (2002) On unirationality of double covers of fixed degree and large dimension; a method of Ciliberto, In: *Algebraic Geometry, A Volume in Memory of Paolo Francia,* pp.127-140. Published by W.de Gruyter, Berlin, New York.

R. Dijkgraaf, C. Vafa, (2002) On geometry and matrix models, *Nuclear Phys.* B 644, no. 1-2, 21-39.

R. Dijkgraaf, C. Vafa, (2002) Matrix models, topological strings, and supersymmetric gauge theories, *Nuclear Phys.* B 644, no. 1-2, 3-20.

B. Edixhoven, (2002) Rational elliptic curves are modular (after Breuil, Conrad, Diamond and Taylor), *Séminaire Bourbaki,* Vol. 1999/2000. *Astérisque* No. 276, 161-188.

H. Flenner, M. Lübke, (2002) Analytic moduli spaces of simple (co)framed sheaves, In: I. Bauer e.a. (eds.). *Complex analysis. Collection of papers dedicated to Hans Grauert* Springer Verlag.

G. van der Geer, T. Katsura, (2002) An invariant for varieties in positive characteristic, (2002) In: *Algebraic Number Theory and Algebraic Geometry,* Contemporary Mathematics 300, p.131-141.

G. van der Geer, M. van der Vlugt, (2002) An asymptotically good tower of curves over the field with eight elements, *Bull. London Math. Soc.* 34, no. 3, 291-300.

G. van der Geer, M. van der Vlugt, (2002) The coset weight distributions of certain BCH codes and a family of curves, *L'Enseignement Mathématique* 48, 3-21.

Reports and pre-prints

B. Conrad, S.J. Edixhoven, (2002) *The Néron model J/1(p) has connected fibers,* to appear in Documenta Mathematica.

R. Dijkgraaf, M.T. Grisaru, C.S. Lam, C. Vafa, D. Zanon, (2002) *Perturbative Computation of Glueball Superpotentials,* [arXiv:hep-th/0211017].

R. Dijkgraaf, S. Gukov, V.A. Kazakov, C. Vafa, (2002) *Perturbative Analysis of Gauged Matrix Models,* [arXiv:hep-th/0210238].

R. Dijkgraaf, A. Neitzke, C. Vafa, (2002) *Large N Strong Coupling Dynamics in Non-Supersymmetric Orbifold Field Theories,* [arXiv:hep-th/0211194].

R. Dijkgraaf, A. Sinkovics, M. Temurhan, (2002) *Matrix Models and Gravitational Corrections,* [arXiv:hep-th/0211241].

R. Dijkgraaf, C. Vafa, (2002) *A Perturbative Window into Non-Perturbative Physics,* [arXiv:hep-th/0208048].

R. Dijkgraaf, E. Verlinde, M. Vonk, (2002) *On The Partition Sum of The NS Five-Brane,* [arXiv:hep-th/0205281].

S.J. Edixhoven, C. Khare, (2002) *Hasse invariant and group cohomology,* math.NT/0210401, to appear in Documenta Mathematica.

B.J.J. Moonen, (2002) *Serre-Tate Theory for Moduli Spaces of PEL Type,* preprint math.AG/0203288 (44 pages), to appear in Annales Sci. de l'École Normale Sup.

B.J.J. Moonen, (2002) *A dimension formula for Ekedahl-Oort strata,* preprint math.AG/0208161 (23 pages).

M. Stupariu, (2002) *On the G-monopole equations,* to appear in Revue Roum. Math. Pures et Appl.

1.3. Topology

Papers in journals and proceedings

J.M. Aarts, G.A. Brouwer, R.J. Fokkink, J. Vermeer, (2002) Intersection properties for coverings of G-spaces, *Topology and its Applications,* 125 249-261.

J.M. Aarts, R.J. Fokkink, J. Vermeer, (2002) Coloring maps of period three, *Pacific Journal of Mathematics,* 202 257-266.

J.M. Aarts, R.J. Fokkink, J. Vermeer, (2002) A dynamical decomposition theorem, *Acta Mathematica Hungarica,* 94 191-196.

M. El Bachraoui, M. van de Vel, (2002) Matrix relation algebras, *Algebra Universalis,* 48 273-299.

S. Barov, J. Cobb, J.J. Dijkstra, (2002) On closed sets with convex projections, *Journal of the London Mathematical Society,* Second Series, 65 154-166.

S. Barov, J.J. Dijkstra, (2002) On boundary avoiding selections and some extension theorems, *Pacific Journal of Mathematics,* 203 79-87.

A. Bella, A. Dow, K.P. Hart, M. Hrušák, J. van Mill, P. Ursino, Embeddings into $\mathcal{P}(\mathcal{N})/fin$ and extension of automorphisms, *Fundamenta Mathematicae,* 174 271-284.

A. Clark, R. Fokkink, (2002) Bihomogeneity of solenoids, *Algebraic & Geometric Topology,* 2 1-9.

J.J. Dijkstra, J. van Mill, (2002) Topological equivalence of discontinuous norms, *Israel Journal of Mathematics,* 128 177-196.

J.J. Dijkstra, J. van Mill, (2002) On sets that meet every hyperplane in n-space in at most n-points, *Bulletin of the London Mathematical Society,* 34 361-368.

J.J. Dijkstra, J. van Mill, (2002) Infinite-dimensional topology, in M. Hušek, J. van Mill (eds.), *Recent Progress in General Topology II,* North-Holland Publishing Company, Amsterdam, 115-130

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Stieltjes Analysis Colloquium

As part of the cooperation within the Stieltjes Institute the analysis research groups of the University of Leiden, Free University Amsterdam, University of Amsterdam, Delft University of Technology, Eindhoven University of Technology, Erasmus University (EUR), and the Center for Mathematics and Computer Science Amsterdam, organize a joint analysis colloquium.

In 2002 the colloquium was organized by Joost Hulshof and Andre Ran at the Free University of Amsterdam. The meetings took place on April 8 and November 28 & 29 (Farewell symposium for Rien Kaashoek).

April 8, 2002
Speakers:
- A. Lindquist (KTH, Stockholm): A convex optimization approach to generalized moment problems.
- J. van Neerven (TUD): On the stochastic Cauchy problem in Banach spaces.
- A. Lunardi (Parma): Stability in free boundary problems.

November 28, 2002
Speakers:
- I. Gohberg (Tel-Aviv University): Matrix valued Szego orthogonal polynomials. One step extension and Krein's theorem.
- H. Bart (EUR): Vector-valued logarithmic residues: following a thirty year old lead by M.A. Kaashoek.
- P. Lancaster (University of Calgary): Analytic perturbation theory: the semisimple case.
- S. Goldberg (University of Maryland): Hilbert-Carleman determinants in an abstract setting.
- S.M. Verduyn Lunel (UL): Calculating Hausdorff dimensions of invariant

sets using spectral theory.

- L. Lerer (Israel Institute of Technology): On continuous analogues of orthogonal polynomials

- H.J. Woerdeman (College of William and Mary): Intersecting zeros of two-variable polynomials.

- T. West (Trinity College, Dublin): Compact semi-groups of positive matrices.

November 29, 2002
Speakers:
- A.S. Markus (Ben Gurion University of the Negev/VU): Subspaces in the algebra of all operators invariant for the similarity transformations.

- B. de Pagter (TUD): Differentiation of Operator Functions.

- R.F. Curtain (RUG): Infinite-dimensional linear systems and their reciprocals.

- H.A. van der Vorst (UU): Solution of linear algebra problems by dimension reduction.

- A.C.M. Ran (VU): Perturbation theorems for bisemigroups.

Celebration of 10 year Stieltjes Institute

On November 15, 2002, a celebration of 10 year Stieltjes Institute took place at the premises of the KIVI, the *Koninklijk Instituut Van Ingenieurs* at the Hague. This festive meeting was organised by: drs. F. Bakker, prof.dr.ir. L.A. Peletier, and prof.dr. A. Schrijver.

Speakers were:
- Ir. B. van Nederveen (President KIVI, Former Director Hoechst Nederland): "Kennis maken en gebruiken"
- Dr. A.P.Meijler (Secretay *Gebiedsbestuur Exacte Wetenschappen* of NWO): "Wiskunde in een ruimer bereik: de meerwaarde van de 2de ten opzichte van de 1ste geldstroom?"
- Prof.Dr. A. Schrijver (UvA-CWI): "Het kleuren van grafen"

Also presented were three cases from the *Sudieweken Wiskunde met Industrie:*
- Prof.Dr.J. Molenaar (TUE-UT): "Onkreukbare caravanvoortenten"
- Dr.V. Rottschafer (UL): "Rozen zijn onbaatzuchtig"
- Dr.G. Hek (UvA): "Koeling voor vissen in Artis"

Workshops, Conferences a.o.

Algebra and Geometry

1.1. Number Theory

Midterm Evaluation Conference Explicit methods in Galois theory and arithmetic
Leiden, June 10-14, 2002
B. de Smit

Diophantine Problems
Marseille, France, 5-11 May, 2002
R. Tijdeman

Periodicity and quasi-periodicity
Budapest, Hungary, 9-15 June, 2002
co-organizer: R. Tijdeman

Factoring Large Numbers
Amsterdam, June 4, 2002
H. te Riele

1.2. Geometry

Cohomology of moduli spaces
Amsterdam, December 16-10, 2002
C. Faber. G. van der Geer

Programme on M-Theory
Isaac Newton Institute for Mathematical Sciences
Cambridge, U.K., February 4 - July 19, 2002
R. Dijkgraaf

Programme on M-theory
Clay Mathematics Institute School on Geometry and M-Theory
Cambridge, U.K., March 25 - April 19, 2002
R. Dijkgraaf

Summer Workshop String theory and quantum gravity
Amsterdam, July, 2002
R. Dijkgraaf

Workshop Branes and cosmology
Leiden, November 18-22, 2002
R. Dijkgraaf

Analysis

2.1. Functional Analysis, Operator Theory and Applications

Challenges in Matrix Theory
Auburn, Alabama, U.S.A., June 10- 13, 2002
M.A. Kaashoek

2.2. Representation Theory, Operator Algebras and Complex Analysis

2002 Twente Conference on Lie groups
Enschede, December 16-18, 2002
G. van Dijk, E. Koelink, T.H. Koornwinder, E.M. Opdam

Symposium on elliptic operators, geometric analysis and related topics
Canberra, Australia, July 9-12, 2002
A.F.M. ter Elst

Symposium on the occasion of Ian Macdonald's honorary doctorate at UvA
Amsterdam, January 11, 2002
E.M. Opdam, T.H. Koornwinder

Representations of Lie groups, harmonic analysis on homogeneous spaces
and quantization
Leiden, December 9-13, 2002
G. van Dijk, V.F. Molchanov

2.3 Differential Equations, Dynamical Systems and Numerical Analysis

Meeting in honour of the Honorary Doctorate of Haim Brézis
Leiden, February 6, 2002
L.A. Peletier

Forty-Second European Study Group with Industry
Amsterdam, February 18-22, 2002
G.M. Hek, M.F.M. Nuyens, M.A. Peletier, R. Planqué, H. van der Ploeg, G.M. Terra

An afternoon on numerical methods for geophysical flows
Amsterdam, March 8, 2002
D. Lanser, J.G. Verwer

Workshop Innovative time integrators for PDEs
Amsterdam, November 25-27, 2002
J.G. Verwer, J.G. Blom, J.E. Frank, W. Hundsdorfer, B.P. Sommeijer

Nonlinear phenomena in science
Leiden, March 18-29, 2002
A. Doelman, J. Hulshof

Lecture series Stability and invariant manifolds in fully nonlinear parabolic problems, by Alessandra Lunardi
Amsterdam, April, 2002
J. Hulshof

Symposium on Nonlinear systems
Twente University, May 23-24, 2002
A. Doelman

Stochastics

3.1. Probability

Stochastic Models from Statistical Physics III
Eindhoven, November 7-11, 2002
F. den Hollander

Symposium "The age of regular variation: tales on tails" on the occasion of
dr. Guus Balkema's 65th birthday
Amsterdam, November 8, 2002
C.A.J. Klaassen, P.J.C. Spreij

3.2. Statistics

Meeting of the Section Mathematical Statistics of the VVS (Vereniging voor
Statistiek en Operationele Research) at the Statistische Dag 2002
Utrecht, March 25, 2002
P. Spreij, G. Jongbloed, M.N.M. van Lieshout, S. Borovkova

2nd Fraunhofer-CWI Workshop
Amsterdam, April 19, 2002
M.N.M. van Lieshout

Mini-symposium Stochastic geometry
Amsterdam, May 22, 2002
M.N.M. van Lieshout

Bijeenkomst Stochastici
Lunteren, November 11-13, 2002
R.D. Gill, M.C.M. de Gunst, M.S. Keane

Workshop on High-dimensional data
Leiden, September 9-20, 2002
S. van de Geer

Workshop Dependence structures in highly dynamic processes
Eindhoven, January 31 - February 1, 2002
A. Di Bucchianico

Workshop Statistical learning
Eindhoven, May 28-29, 2002
A. Di Bucchianico

Operations Research

4.1. Discrete Mathematics and Optimization

Tagung Geometric convex combinatorics
Oberwolfach, Germany, June 16 - 22, 2002
A.M.H. Gerards

7th International Workshop on High Performance Optimization
Tilburg, June 27 - 28, 2002
E. de Klerk, C. Roco

Fifth International Symposium on Theory and Applications of Satisfiability Testing
Cincinnati OH, U.S.A., May 6-9, 2002
H. van Maaren

19th International Symposium on Theoretical Aspects of Computer Science (STACS-2002)
Antibes, Juan-les-Pins, France, March 14-16, 2002
D.P. Pasechnik

First International Conference on Optimization Methods and Software
Hangzhou, China, December 15-18, 2002
C. Roos

4.2. Stochastic Operations Research

Queueing Colloquium
Amsterdam, May 15 & November 20, 2002
M. Mandjes, R. Núñez Queija

Miniconference on Heavy tails, during the annual Mathematics Congress of the Dutch WG
Eindhoven, April 4, 2002
O.J. Boxma

EURANDOM workshop on Analysis and optimisation of stochastic networks with application to telecommunication and manufacturing
Eindhoven, November 7-9, 2002
I.J.B.F. Adan, O.J. Boxma, J. Wessels

Twenty-Seventh Conference on the Mathematics of operations research
Lunteren, January 15-17, 2002
L.C.M. Kallenberg

International conference on the Performance and Control of Next Generation Networks
Orlando, FL, U.S.A., September 8-9, 2002
R.D. van der Mei

Foreign Visitors

The following data are given
- name, place and country of the visitor
- name(s) of the host(s)

Algebra and Geometry

1.1. Number Theory

A. Bérczes, Debrecen, Hungary, R. Tijdeman
A. Biro, Budapest, Hungary, R. Tijdeman
N. Bruin, Vancouver, Canada, R. Tijdeman
J. Franke, Bonn, Germany, H. te Riele
M. Girard, Paris, France, B. de Smit
A. Greicius, Berkeley, U.S.A, H.W. Lenstra
K. Györy, Debrecen, Hungary, R. Tijdeman
L. Hajdu, Debrecen, Hungary, R. Tijdeman
J. Hancl, Ostrava, Czech republic, R. Tijdeman
I. Gaál, Debrecen, Hungary, R. Tijdeman
N. Kimura, Narashino, Japan, R.W. van der Waall
T. Kleinjung, Bonn, Germany, H. te Riele
A.K. Lenstra, Parsippany, U.S.A, H. te Riele
P. Leyland, Cambridge, England, H. te Riele
P.L. Montgomery, San Rafael, U.S.A, H. te Riele
A. Pethö, Debrecen, Hungary, H. te Riele
I. Pink, Debrecen, Hungary, R. Tijdeman
A. Pinter, Debrecen, Hungary, R. Tijdeman
B. Poonen, Berkeley, U.S.A, H. te Riele
A. van der Poorten, Sydney, Australia, R. Tijdeman
J. Voigt, Berkeley, U.S.A, H.W. Lenstra

1.2. Geometry

I. Bouw, Essen, Germany, S.J. Edixhoven
E. Ficatier, Palaiseau, France, S.J. Edixhoven
A. Mezard, Orsay, France, S.J. Edixhoven
L. Pharamond, Jussieu, France, S.J. Edixhoven
S. Wewers, Bonn, Germany, S.J. Edixhoven

1.3. Topology

S. Barov, Muncie, IN, U.S.A., J. J. Dijkstra
V. Fedorchuk, Moscow, Russia, J. van Mill
W. Marciszewski, Warsaw, Poland, J. van Mill
D. Repovs, Ljubljana, Slovenia, J.J. Dijkstra
A. Szymanski, Slippery Rock, PA, U.S.A., J. van Mill

Analysis

2.1. Functional Analysis, Operator Theory and Applications

E. Abraham-Mumm, Kiel, Germany, J.H. van Schuppen
Z. Arova, Odessa, Ukraine, M.A. Kaashoek
Z. Brzeźniak, Hull, England, J. van Neerven
R.C. Dalang, Lausanne, Switzerland, B. de Pagter
G. Da Prato, Pisa, Italy, Ph. Clément
W. Desch, Graz, Austria, Ph. Clément
M. Fila, Bratislava, Slovakia, G. Sweers
L. Fraenkel, Bath, England, G. Sweers
A.E. Frazho, West Layfette, Indiana U.S.A., M.A. Kaashoek
I. Gohberg, Tel-Aviv, Israel, M.A. Kaashoek
S. Goldberg, College Park, Maryland U.S.A., M.A. Kaashoek
B. Goldys, Sydney, Australia, J. van Neerven
L. Lerer, Haifa, Israel, A.C.M. Ran
S.-S. Lin, Hsin-Chu, Taiwan, S.M. Verduyn Lunel
S.-O. Londen, Helsinki, Finland, Ph. Clément
A. Lunardi, Parma, Italy, J. van Neerven

M. Mackey, Quebec, Canada, S.M. Verduyn Lunel
A. Markus, Beer Sheva, Israel, M.A. Kaashoek, A.C.M. Ran
J. McKenna, Connecticut, U.S.A., G. Sweers
C.V.M. van der Mee, Cagliari, Italy, A.C.M. Ran
W. Ricker, Eichstätt, Germany, B. de Pagter
L. Rodman, Williamsburg, U.S.A., A.C.M. Ran
A.L. Sakhnovich, Odessa, Ukraine, M.A. Kaashoek
A.L. Sakhnovich, Cardiff, Wales, M.A. Kaashoek
M. Scheutzow, Berlin, Germany, S.M. Verduyn Lunel
K. Siebert, U.S.A, S.M. Verduyn Lunel
E. de Sturler, Urbana-Champaign, U.S.A., S.M. Verduyn Lunel

2.2. Representation Theory, Operator Algebras and Complex Analysis

J. Arazy, Haifa, Israel, G. van Dijk
A. Besser, Beer-Sheeva, Israel, P. Moree
G. Carnovale, Padua, Italy, T.H. Koornwinder
P. Delorme, Luminy, France, E.M. Opdam
P. Duren, Ann Arbor, MI, U.S.A., J. Wiegerinck
A. Fällström, Umeå, Sweden, J. Wiegerinck
A. Fialowski, Budapest, Hungary, J.A. Sanders
A. Gil, Madrid, Spain, N.M. Temme
F. A. Grünbaum, Berkeley, CA, U.S.A., T.H. Koornwinder
S. Haran, Haifa, Israel, T.H. Koornwinder
J. Kustermans, Leuven, Belgium, E. Koelink
D. Lebedev, Bonn, Germany, E. Koelink
J.L. López, Pamplona, Spain, N.M. Temme
I.G. Macdonald, London, U.K., E.M. Opdam
A.V. Mikhailov, Leeds, U.K., J.A. Sanders
V.F. Molchanov, Tambov, Russia, G. van Dijk
A. Oblomkov, Cambridge, U.S.A., J.V. Stokman
M. Pevzner, Paris, France, G. van Dijk
D.W. Robinson, Canberra, Australia, A.F.M. ter Elst
J. Segura, Madrid, Spain, N.M. Temme
S. Suslov, Tempe, AZ, U.S.A., E. Koelink
M. Wakayama, Fukuoka, Japan, G. van Dijk

2.3. Differential Equations, Dynamical Systems and Numerical Analysis

P. Biler, Warsaw, Poland, I.A. Guerra
C.M. Brauner, Bordeaux, France, J. Hulshof
J. Cantarella, Athens, GA, U.S.A., B. Planqué
G. Derks, Surrey, U.K., A. Doelman
E. Doedel, Montreal, Canada, A.J. Homburg
J. Escher, Hannover, Germany, G. Prokert
A. Fasano, Firenze, Italy, C.J. v. Duijn
C. Gheorgiu, Cluj, Romania, I.S. Pop
F. Hamel, Marseille, France, A. Doelman, J. Hulshof
R. Helmig, Stuttgart, Germany, C.J. v. Duijn
J. Jaffré, Roquencourt, France, W. Hundsdorfer
K. Johansson, Heidelberg, Germany, C.J. v. Duijn
B. Krauskopf, Bristol, U.K., A.J. Homburg
B. van Leer, Ann Arbor, U.S.A., B. Koren
A. Lunardi, Parma, Italy, J. Hulshof
A. Meister, Hamburg, Germany, J.G. Verwer
A. Mikelic, Lyon, France, C.J. v. Duijn
B. Oldeman, Bristol, U.K., A.J. Homburg
C. Palencia, Valladolid, Spain, M.N. Spijker
V. Pasko, Pennsylvania State University, U.S.A., U. Ebert
J. Roberts, Roquencourt, France, W. Hundsdorfer
H.-G. Roos, Dresden, Germany, P.W. Hemker
J.M. Roquejoffre, Toulouse, France, A. Doelman, J. Hulshof
M. Sekhar, Bangalore, India, C.J. v. Duijn
G.I. Shishkin, Ekaterinburg, Russia, P.W. Hemker
L.P. Shishkina, Ekaterinburg, Russia, P.W. Hemker
M. Slodicka, Gent, Belgium, C.J. v. Duijn
M. Ward, University of British Columbia, Canada, A. Doelman
J.F. Williams, Bath, U.K., M.A. Peletier
D. Williamson, Boulder, U.S.A., J.G. Verwer
T. Young, Athens, U.S.A., A.J. Homburg

Stochastics

3.1. Probability

A. Bulinski, Lomonosov, Russia, S. Borovkova, F.M. Dekking
J.R. Chazottes, Palaiseau, France, F. Redig
S. Graf, Passau, Germany, F.M. Dekking
M. Iosifescu, Rumania, C. Kraaikamp
A. Sakai, Vancouver, Canada, R. van der Hofstad
A.N. Shiryaev, Moscow, Russia, C.A.J. Klaassen
K. Simon, Budapest, Hungary, F.M. Dekking

3.2. Statistics

A. Bulinski, Moscow, Russia, S.A. Borovkova
M. Craciun, Cluj-Napoca, Rumania, A. Di Bucchianico
D.L. Donoho, Stanford, U.S.A., S. van de Geer
S. Ghosal, Raleigh, NC, U.S.A., A.W. van der Vaart
P. Gregori Huerta, Castellon, Spain, M.N.M. van Lieshout
N. Gribkova, St Petersburg, Russia, R. Helmers
M Huskova, Prague, Czech Republic, A. Di Bucchianico
K. Klitgaard Berthelsen, Aalborg, Denmark, M.N.M. van Lieshout
Y. Kutoyants, Le Mans, France, H. van Zanten
C. Lacoste, Sophia-Antipolis, France, M.N.M. van Lieshout, R.S. Stoica
J.M. Robins, Harvard, U.S.A., G. Jongbloed, A.W. van der Vaart
Y. Rozenholc, Paris, France, S. van de Geer
A.N. Shiryaev, Moscow, Russia, C.A.J. Klaassen
M. Soerensen, Copenhagen, Denmark, A.W. van der Vaart
J. Wellner, Seattle, WA, U.S.A., A.W. van der Vaart
J. Zerubia, Sophia-Antipolis, France, M.N.M. van Lieshout, R.S. Stoica
W. Zhou, Hong Kong, China, R. Helmers

Operations Research

4.1. Discrete Mathematics and Optimization

R.E. Bixby, Houston, TX, U.S.A., A. Schrijver
S. Fiorini, Brussels, Belgium, L. Stougie

T. Fleiner, Budapest, Hungary, L. Stougie
J.L. Goffin, Montreal, Canada, C. Roos
A. Holder, University of Miss., U.S.A., C. Roos
C.T. Kelley, Raleigh, NC, U.S.A., C. Roos
J.-B. Lasserre, Toulouse, France, M. Laurent
L. Lovász, Redmond, Washington, U.S.A., A. Schrijver
Q. Louveaux, Louvain, Belgium, L. Stougie
X. Lu, Shanghai, China, L. Stougie
A. Marchetti Spaccamela, Rome, Italy, L. Stougie
P.D. Nguyen, Leuven, Belgium, C. Roos
B. Polyak, Moscow, Russia, C. Roos
V. Protassov, Moscow, Russia, J. Brinkhuis, J.B.G. Frenk, E. de Klerk
J. Sgall, Prague, Chzech Republic, L. Stougie
V. Tikhomirov, Moscow, Russia, J. Brinkhuis, J.B.G. Frenk
S. Zhang, Hong Kong, China, J. Brinkhuis, J.B.G. Frenk

4.2. Stochastic Operations Research

S. Alouf, Sophia Antipolis, France, G.M. Koole
A.A. Borovkov, Novosibirsk, Russia, O.J. Boxma
P. Dube, Sophia Antipolis, France, G.M. Koole
S.G. Foss, Edinburgh, U.K., O.J. Boxma
T. P. Hill, Atlanta, U.S.A., A. Hordijk
O. Kella, Jerusalem, Israel, O.J. Boxma
A. Mandelbaum, Haifa, Israel, G.M. Koole
Z. Michna, Wroclaw, Poland, K. Dębicki
Ph. Nain, Sophia-Antipolis, France, R. Núñez Queija
M.I. Reiman, Murray Hill, U.S.A., S.C. Borst
T. Rolski, Wroclaw, Poland, S.C. Borst, O.J. Boxma
K. Sigman, New York, U.S.A., S.C. Borst, O.J. Boxma, A. Hordijk
U. Yechiali, Tel-Aviv, Israel, O.J. Boxma, J. van der Wal

Research Staff

(Situation at September 1, 2002)

Algebra and Geometry

1.1. Number Theory

Permanent staff

Dr. J. Brinkhuis	EUR (from programme 4.1)
Dr. J.-H. Evertse	UL
Dr. C. Kraaikamp	TUD (from programme 3.1)
Prof.dr. H.W. Lenstra	UL
Dr. B. de Smit	UL-KNAW
Prof.dr. P. Stevenhagen	UL
Dr. R.J. Stroeker	EUR
Prof.dr. R. Tijdeman	UL
Dr. R.W. van der Waall	UvA

Post Docs

Dr. P. Yuan	UL-NUFFIC

Ph.D. students

drs. K.J. Batenburg	UL/CWI-NWO
drs. R.M. Bröker	UL
drs. R. Carls	UL/RUG
drs. R.P. Groenewegen	UL
drs. B.J.H. Jansen	UL
drs. D.A. van der Laan	UL (from programme 4.2)
drs. S. Tengely	UL
drs. C.E. van de Woestijne	UL
drs. C.G. Zaal	UL

CWI participants

Dr.ir. H.J.J. te Riele

1.2. Geometry

Permanent staff

Prof.dr. J. Bochnak	VU
Prof.dr. R.H. Dijkgraaf	UvA
Prof.dr. S.J. Edixhoven	UL
Prof.dr. G.B.M. van der Geer	UvA
Dr. M. Lübke	UL
Dr. B.J.J. Moonen	UvA-KNAW
Prof.dr. J.P. Murre	UL
Prof.dr. A.J.H.M. van de Ven	UL
drs. M.A.J.G. van der Vlugt	UL

Post Docs

Dr. M.S. Stupariu	UL-NWO

Ph.D. students

drs. T. van den Bogaart	UL
drs. D.B. Grünberg	UvA
drs. R.S. de Jong	UvA
drs. S. Kronemeijer	UvA-FOM
drs. L. Kubbe	VU
drs. L. Tomassini	UvA-Italy
drs. G. Wiese	UL-EU

1.3. Topology

Permanent staff

Prof.dr. J.M. Aarts	TUD
Dr. J.J. Dijkstra	VU
Dr. R.J. Fokkink	TUD
Dr. K.P. Hart	TUD
Dr.ir. T. Koetsier	VU
Prof.dr. J. van Mill	VU
Dr. M.L.J. van de Vel	VU

Ph.D. students

drs. M.E. Bachraoui	VU
drs. K. Bhoujar	VU
drs. H. Blaauwendraat	VU-NWO
drs. J.C.C. Langeveld	VU
ir. B.J. van der Steeg	TUD

Analysis

2.1. Functional Analysis, Operator Theory and Applications

Permanent staff

Prof.dr. H. Bart	EUR
Prof.dr. Ph.P.J.E. Clément	TUD
Dr. A.F.M. ter Elst	TUE (from programme 2.2)
Prof.dr. I. Gohberg	VU
Prof.dr.ir. J. de Graaf	TUE
Dr. B. Hanzon	VU
Prof.dr. M.A. Kaashoek	VU
Dr. J. van Neerven	TUD
Dr. B. de Pagter	TUD
Prof.dr. A.C.M. Ran	VU
Prof.dr.ir. J.H. van Schuppen	VU/CWI
Dr. F. van Schagen	VU
Dr. G. Sweers	TUD
Prof.dr. S.M. Verduyn Lunel	UL
Dr. R.A.C.M. van der Vorst	VU

Post Docs

Dr. O.W. van Gaans	TUD
Dr. A. Olofsson	VU
Dr. D.R. Pik	UL-NWO
Dr. V. Rottschäfer	UL-KNAW

Ph.D. students

drs. R. Beukema	TUE-NWO
drs. A. Dall'Acqua	TUD
drs. M. Frasson	UL-NWO
D. Jibetean MSc.	VU/CWI-NWO
drs. K.W. Homan	TUD-NWO
M. Petreczky MSc.	VU/CWI
drs. M. Reurings	VU
drs. B.A. van de Rotten	UL-NWO

CWI participants

Dr. L.C.G.J.M. Habets	CWI/TUE
Dr. J. Komenda	NWO

2.2. Representation Theory, Operator Algebras and Complex Analysis

Permanent staff

Dr. M.G. de Bruin	TUD
Prof.dr. G. van Dijk	UL
Dr. A.F.M. ter Elst	TUE
Dr. E. Hendriksen	UvA
Dr. R. Koekoek	TUD
Dr. H.T. Koelink	TUD
Prof.dr. T.H. Koornwinder	UvA
Prof.dr. J. Korevaar	UvA
Prof.dr. N.P. Landsman	UvA
Prof.dr. H.G. Meijer	TUD
Prof.dr. E.M. Opdam	UvA
Dr. P.J.I.M. de Paepe	UvA
Dr. J.A. Sanders	VU
Dr. J.J.O.O. Wiegerinck	UvA
Dr. R.A. Zuidwijk	EUR

Post Docs

Dr. M.F.E. de Jeu	UvA-NWO
Dr. P. Moree	UvA-NWO
Dr. M. Müger	UvA/UU-NWO
Dr. J.V. Stokman	UvA-KNAW
Dr. J.P. Wang	UV
Dr. H. Zhang	UvA-NWO

Ph.D. students

drs. R.D. Bos	UvA-FOM
drs. E. Emsiz	UvA-NWO
ir. W.G.M. Groenevelt	TUD
ir. Y. van Norden	TUD-NWO
drs. H.B. Posthuma	UvA-NWO
drs. K. Slooten	UvA
drs. N. Touhami	UvA

CWI participants

Dr. N.M. Temme

2.3. Differential Equations, Dynamical Systems and Numerical Analysis

Permanent staff

Prof.dr. A. Doelman	UvA/CWI
Dr. J.H. Brandts	UvA-KNAW
Prof.dr. C.J. van Duijn	TUE/CWI
Dr. G.M. Hek	UvA
Prof.dr. P.W. Hemker	UvA/CWI
Dr.ir. G.C. Herman	TUD
Dr. W. Hoffman	UvA
Dr. A.J. Homburg	UvA
Prof.dr. R. van der Hout	UL
Prof.dr. J. Hulshof	VU/CWI
Dr. J.F. Kaashoek	EUR
Prof.dr.ir. L.A. Peletier	UL/CWI
Dr. G. Prokert	TUE
Prof.dr. M.N. Spijker	UL
Prof.dr. M. van Veldhuizen	VU
Prof.dr. S.M. Verduyn Lunel	UL (from programme 2.1)
Prof.dr. J.G. Verwer	UvA/CWI
Dr. R.G. de Vilder	UvA

Post Docs

Dr. A. Beliaev	VU-NWO
Dr. P.R. Beneker	UvA
Dr. D. Iron	UvA

Ph.D. students

drs. D.P.L.D. Beuden	UvA/CWI-NWO
ir. E.H. van Brummelen	UvA/CWI-MARIN
ir. J.K. Krottje	UvA/CWI-NWO
drs. H.K. Nguyen	UvA-NUFFIC
N.N. Pham Thi MSc.	UvA/CWI-NWO
drs. B. Planqué	UL/CWI
ir. H. van den Ploeg	UvA-NWO
ir. M.H. van Raalte	UvA/CWI
drs. J.A. Rodriguez	UL
drs. G.M. Terra	UvA/NIOZ-FOM
drs. N.J.M. Valkhoff	UvA

CWI participants
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Prof.dr. U. Ebert
Dr. J. Frank
Dr. L. Frastia
Dr. W.H. Hundsdorfer
Dr.ir. B. Koren
drs. M. Nool
Dr. D.E.A. van Odijck
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Stochastics

3.1. Probability

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Dr. J. van den Berg	UvA/CWI
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Dr. J.L. Geluk	EUR
Prof.dr. L.F.M. de Haan	EUR/EURANDOM
Dr. K. van Harn	VU
Dr. R.W. van der Hofstad	TUE/EURANDOM
Prof.dr. W.Th.F. den Hollander	TUE/EURANDOM
Dr. G. Hooghiemstra	TUD
Prof.dr. M.S. Keane	UvA/EURANDOM
Dr. C. Kraaikamp	TUD
Dr.ir. L.E. Meester	TUD
Prof.dr. R.W.J. Meester	VU
Dr. J.L. Mijnheer	UL
Dr. P.J.C. Spreij	UvA/CWI
Prof.dr. F. Steutel	TUE

Ph.D. students

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drs. R. Brouwer	UvA/CWI-NWO
drs. A.M.S. Ferreira Gorjao Henriques	EUR/EURANDOM

Y. Hartono MSc.	TUD
drs. M.F.M. Nuyens	UvA
drs. R.T. Peters	UvA
F. Rusdi MSc.	TUD
Suyons MSc.	TUD
drs. P. Trapman	VU
drs. W.M. de Vries	VU
drs. D. Znamenski	VU
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Dr. K. Dzhaparidze	
Dr. J. Ferreira	
Dr. A. Jarai	
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Dr. A. Koloidenko	
Dr. A. Le Ny	
Dr. B. Lemmens	NWO
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Dr. A.J. van Es	UvA
Prof.dr. S.A. van de Geer	UL
Prof.dr. P. Groeneboom	TUD/VU
Dr. M.C.M. de Gunst	VU/EURANDOM
Prof.dr. L.F.M. de Haan	EUR/EURANDOM (from prg. 3.1)
Dr. M.H. Jansen	TUE

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Dr.ir. G. Jongbloed	VU
Prof.dr. C.A.J. Klaassen	UvA/EURANDOM
Dr. A.J. Koning	EUR
Prof.dr. P. van der Laan	TUE
Dr. H.P. Lopuhaä	TUD
Prof.dr. A.W. van der Vaart	VU/EURANDOM
Dr.ir. M.A. van de Wiel	TUE
Dr. J.H. van Zanten	VU
Prof.dr. W.R. van Zwet	UL/EURANDOM
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Dr. B. Kleijn	VU
Dr. A.J. Lenstra	UvA-NWO/EURANDOM
Dr. Y. Rozenholc	UL
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drs. V.N. Koulikov	TUD
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Dr. L.M. Artiles Martinez	
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Operations Research

4.1. Discrete Mathematics and Optimization

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Dr. L. Stougie	TUE/CWI

Ph.D. students

drs. D. Chaerani	TUD
drs. M. El Ghami	TUD
drs. D.C. Gijswijt	UvA/CWI-NWO
G. Maroti MSc.	TUE/CWI-EU

CWI participants

Dr. M. Laurent

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Prof.dr.ir. J. van der Wal	TUE

Prof.dr. J. Wessels	TUE/EURANDOM
Post Docs	
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drs. R. Bekker	TUE
drs. A.M. Dobber	VU-NWO
drs. D.A. van der Laan	UL
drs. D.T.M.B. van Ooteghem	TUE
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drs. M.J.G. van Uitert	TUE/CWI-TI
drs. M. Vlasiou	TUE/EURANDOM
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