THE NEW ZEALAND
MATHEMATICAL SOCIETY (INC.)

NEWSLETTER

CONTENTS

PUBLISHER'S NOTICE

The Newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was assembled at the University of Auckland and offset printed in Dunedin. The official address of the Society is:

However, correspondence should normally be sent directly to the Secretary:

Dr D R Breach,
Department of Mathematics,
University of Canterbury, Christchurch, New Zealand.

CORRECTION

Garry Tee has drawn attention to the fact that since Issue No. 32 (December 1984) the International Standard classification number of this Newsletter has been incorrectly printed on the cover as ISBN 0110-0025, when it should have been ISSN 0110-0025.

Editor

NOTICE OF ANNUAL GENERAL MEETING

The Annual General Meeting of the New Zealand Mathematical Society will be held at 4:30 pm on Tuesday May 16, 1989 during the New Zealand Mathematics Colloquium at Massey University, Palmerston North. Items for the Agenda should be sent to the Secretary.

D R Breach
Hon Secretary, NZMS

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Book Reviews	David Alcorn (Auckland University)
Conferences	Michael Carter (Massey University)
Problems and Queries	Graeme Wake and Mike Hendy (Massey University)
Visitors to New Zealand	Marston Conder (Auckland University)

Honorary Correspondents

Prof R H T Bates	Electrical and Electronics Engineering (University of Canterbury)
Dr K A Broughan	Mathematics and Statistics (Waikato University)
Dr M R Carter	Mathematics and Statistics (Massey University)
Mr M Doherty	Department of Statistics (Wellington)
Dr J Hannah	Mathematics (University of Canterbury)
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Mr J H Maindonald	(DSIR, AMD, Mt Albert)
Dr M McGuinness	(DSIR, AMD, Wellington)
Mr G J Tee	Mathematics and Statistics (University of Auckland)
Prof D A Nield	Theoretical and Applied Mechanics (University of Auckland)
Dr J Rayner	Mathematics and Statistics (University of Otago)

LOCAL NEWS

DSIR

AMD, Wellington

We welcome Deborah Donnell, who has joined the Industrial Statistics section, and is recently from Bell Labs in the States. We also welcome Martin Rowe to the Operations Research section. Martin is hot from an ME in Traffic Engineering at Auckland University.

A number of us (Rona Bailey, Hugh Barr, Mark McGuinness, John Burnell) attended the Mathematics in Industry Study Group that was held at Monash University in Melbourne early this year. Six problems were brought to the group from Australian Industry, including a whirling car propshaft, spangle formation in galvanised iron, airburn of carbon anodes in aluminium smelting, compression of audio signals for disc storage, safe operation of a gas pipeline and optimal operation of railway wagons (where do I send the empties?). Progress made on these problems was impressive. That was followed by the 25th Australian Applied Mathematics Conference in Ballarat, and Graham Weir and Warwick Kissling joined Mark and John for a most enjoyable and instructive time. There was time also to defend Kiwi honour in a game of volleyball against the Australians, a break which all seemed to enjoy.

The pressure on office space is apparent in AMD at present, with drilling and hammering noises from the team of builders who are creating a new room by reducing the size of the computer room—a clear benefit of smaller computers in this modern age.

<div align="right">Mark McGuinness</div>

UNIVERSITY OF AUCKLAND

Mathematics and Statistics

Mike Lennon has transferred to the Department of Computer Science, joining Jennifer there. They are both on leave for 1989 at the University of Wisconsin, on exchange with Tom Kreuger and Professor Ron Dettmers. John Butcher, Kevin Burrage and Garry Tee have transferred from the Department of Computer Science, with John Butcher becoming Head of the new Unit of Computational and Applied Mathematics and Kevin Burrage joining that Unit.

Dr. M. K. Vamanamurthy has been promoted to Associate Professor.

Brian Weatherly has been appointed as Technician, and he is now responsible for computing equipment in the Department.

Robert Chan is a Temporary Senior Tutor; and Richard Bruynel (ex VUW), Shaun Cooper, Mrs. Sharon Duley, Mrs. Sina Greenwood, Warren Moors, Peter Mullins, Malcolm Pullan, Mrs. Helen Scott and Thomas Yee are this year's Temporary Tutors.

Joel Schiff is on leave in England, and Chris Wild is on leave at the University of Waterloo.

Professor Bruce Richmond, of the Department of Combinatorics and Optimization, University of Waterloo, is visiting for a month. Professor Ray Zahar, of the Université de Montréal, is visiting for 6 months. Dr. Dragan Jankovic is continuing as a Post-Doctoral Fellow.

Sir Michael Atiyah, Royal Society Research Professor at the University of Oxford, visited the Department from February 26th to March 1st, as the second Forder Lecturer. He spoke enthusiastically about Vaughan Jones's work on knots, which he described as being "at the cutting edge of advance in mathematics and physics"!

The NZMS textbook *Linear Algebra*, by Kee L. Teo and David J. Smith, is being used in courses at Otago, VUW, Massey and Auckland. George Seber and Chris Wild's large text *Nonlinear Regression* has been published by John Wiley.

Wayne Walker attended the International Conference and Tutorial Session on Signal Processing, held at the University of Warwick in December 1988.

The Basic Skills programme (non-credit) has been popular with students who needed assistance to prepare them for taking courses in this Department. Late in 1988, adequate funds for such a service were made available, and the Student Learning Unit now operates that programme, preparing students to take courses in English as well as in Mathematics and Statistics.

At the end of enrolment week enrolments amounted to 830 EFTS, as against 730 EFTS last year. During the past two years, enrolments in this Department have increased by 35%. An introductory course in algebra and calculus, 26.101, has been started. It is designed for students with weak mathematical background who intend to proceed to standard Stage 1 courses later. Nearly 200 students have enrolled for the new course "Introduction to Computational Applied Mathematics", 26.165. A new Diploma of Mathematics Education has been organized by the University Department of Education, in collaboration with this Department and with the Department of Mathematics at Auckland College of Education. Sixteen teachers have enrolled for that Diploma.

Alastair Scott has been elected as President of the New Zealand Statistical Association, and Peter Mullins has been elected as Secretary. Peter Mullins collaborated with three surgeons in writing a statistical study of cervical cancer patients at National Women's Hospital, which was published in the *Journal of the American College of Obstetricians and Gynecologists* (1984). That paper was reprinted in **The Report of the Cervical Cancer Inquiry 1988**, with Judge Silvia Cartwright commending highly the authors of that paper, commenting that "all the writers used extraordinary determination to find the truth" (page 99).

Seminars

Professor Mary E. Rudin (University of Wisconsin), "Is the climate for women in mathematics changing?"

Dr. Grant Keady (University of Western Australia), "Proving the Dupuit approximation for the rectangular dam problem" and "Maps and other Macintosh packages"

Dr. M. Ganster (Technische Universität Graz), "Spaces in which Lindelöf subsets are closed"

Mr. C. Barry (South Australian College of Education), "Mathematics and mathematics education—Partners or rivals? Some ICME6 perspectives."

Dr. Akira Saito (Tohoku University), "Secret sharing scheme realizing general access structure".

Professor J. Robertson (Washington State University), "How many cuts are required for fair division?"

Dr. H. Luckok (University of Newcastle Upon Tyne) "Quantum geometry of strings and membranes".

Dr. C. M. Drake (University of Washington), "Efficiency and bias of estimated treatment effects in observational studies when conditioning the propensity score".

Dr. V. Anantharam (Cornell University), "Adaptive control of Markov chains".

Professor Peter J. Nyikos (University of South Carolina), "Various smoothings of the long line and their tangent bundles".

Sir Michael Atiyah (University of Oxford), "Knots and braids", and "New ideas in 3-dimensional geometry".

Professor Bruce Richmond (University of Waterloo), "Zero One One laws for random planar maps".

Dr. C. A. Macken (University of Auckland), "Protein evolution on rugged landscapes".

G J Tee

Theoretical and Applied Mechanics

Ian Collins is back from leave and has resumed the H.O.D.'s seat which in Ian's absence was kept nicely warm by Mervyn Rosser. In January Ian attended a workshop on two-phase waves in fluidized beds, sedimentation and granular flows at the University of Minnesota. Also back from leave is Sue Byrne. In August Andy Philpott attended an International Symposium on Mathematical Programming in Tokyo. More recently Peter Hunter presented a paper at the Winter Meeting of the ASME, and Andrew McCulloch who is now in San Diego spent four weeks here. Mike O'Sullivan and Robert McKibbin spent two weeks in Indonesia lecturing on geothermal reservoir engineering. Don Nield and Julie Falkner presented papers at the Australian Applied Mathematics Conference at Ballarat. David Ryan has departed on leave.

Robert McKibbin is now a member of the Editorial Board for the journal *Transport in Porous Media*. Andy Philpott received the 1988 Teaching Award in our Engineering Faculty. He also won a Highly Commended Award for his MacSimplex interactive teaching tool from the journal *Bits and Bytes*.

Andrew Pullan has joined the staff on a one-year appointment as a Lecturer. Prof. Ken Johnson FRS from the University of Cambridge is visiting the Department for the months of March and April. He is an expert on contact mechanics and friction.

TAM now has a network of seven Vax workstations, which provide a multi-tasking, multi-user

interactive graphics environment well suited to the program development needs of the Department. The latest addition is a Vaxstation 3200. This will be the most powerful workstation in New Zealand and will be used primarily for finite element modelling and geothermal simulations. Expected shortly is a Vaxstation 3100, recently released by DEC. This machine is intended primarily to support a number of OR projects in the Department. The workstations are linked with each other, with the Department's Appletalk network, with the Computer Centre's mainframe computers, and various peripheral facilities. Under the new University licensing system with DEC we have obtained or are obtaining a wide range of software at low cost. Our software includes a number of program packages developed in the Department for specialized applications in Geothermal modelling, Biomechanics and Operations Research. Although the workstations are intended primarily for research they are also used in teaching applications in final year undergraduate and in postgraduate courses, which benefit from the combination of interactive graphics and powerful computational facilities.

D A Nield

UNIVERSITY OF CANTERBURY

Mathematics

After something of a lull last year, sabbatical traffic has returned to normal levels. We have just welcomed back David Wall, who spent most of his year at the Centre for Mathematical Analysis at ANU in Canberra, and followed this with a short visit to Ames Laboratory at Iowa State University.

During the summer Easaw Chacko left to spend a year at Nanyang Technological Institute in Singapore, and Brent Wilson left to visit the Tata Institute (Bombay) and the University of Cambridge. Finally, Allan McInnes has gone for a shorter period of leave and is currently at Purdue University.

A visitor to the department this year is Tony Davidson, who holds a Teaching Fellowship. He comes to us from Shirley Boy's High School, and will be teaching first year statistics, as well as preparing materials for the seventh form Mathematics with Statistics projects.

Another visitor, this time on an Erskine Fellowship, is Wim Blok form the Department of Mathematics and Statistics at the University of Illinois at Chicago. Wim's speciality is Logic, and during the second term he will be offering a final year honours course on Logic with Robert Bull.

Seminars

Professor Finbarr Holland (University College, Cork, Ireland), "Variations on a theme of Archimedes."

Professor Paul Ressel (University of Eichstätt, West Germany), "A general De Finetti-type theorem."

Professor Michael Atiyah (Oxford University, England), "Quantum Mechanics and Topology" and "Quaternions and geometry."

Professor Brian Alspach (Simon Fraser University, British Colulmbia), "Cayley graphs and optimal fault tolerant networks."

Professor Katherine Heinrichs (Simon Fraser University, British Columbia), "Dudeney's round table problem."

J Hannah

MASSEY UNIVERSITY

Mathematics and Statistics

This year has seen a pleasing rise in enrolments in our third-year papers, extending to a doubling of size in some instances and generally substantial. Postgraduate programs are also flourishing—3 DipSc, 5 BSc Hons, 2 MPhil, 4 MSc, and 10 PhD enrolments are on the books this year. Are we seeing the start of a sustained reversal of the gentle decline in numbers of advanced students that has been taking place over the last decade or so?

The Certech Learning Centre opened its doors for the first time this summer. Its aim is to provide introductory bridging courses and tutorial support in Mathematics, Physics and Chemistry for students with less than adequate preparation who wish to study science or technology. In particular, it is hoped to encourage more women students and students from minority groups to aim towards technologically-oriented careers. Bruce Dunning, the Certech maths tutor, is arranging a number of tutorial programs which will be a valuable adjunct to our first-year teaching.

Kee Teo returned in January after a year's leave spent at the National University of Singapore. His hosts seem to have done their best to turn him from a lattice theorist to a graph theorist, but whether the change will be permanent it is too soon to say.

Several people took short periods of leave over the summer—Graeme Wake and Adrian Swift to the Australian Applied Mathematics Conference and other trans-Tasman activities, and "Ganes" Ganesalingham to two meetings on mathematical ecology in Italy.

Congratulations to Graeme Wake on being elected to the Executive Committee of the Division of Applied Mathematics of the Australian Mathematical Society—the first non-Australian resident to be so— and on being invited to join the Editorial Board of their Journal. Congratulations also to Bob Sisson, our Commonwealth Scholar, whose paper on numerical modelling of spontaneous ignition was "highly commended" in the student paper section of the Australian Applied Mathematics Conference.

Seminars

Rob Goldblatt (Victoria), "Logic and computer science."

Bob Sisson, "Spontaneous ignition: numerical estimation of critical conditions."

Christiana Drake (Washington State), "Bias in observational studies: adjustment by prognostic variables versus the propensity score."

Marijke Vlieg, "Solitons."

Wayne Burrows, "The vehicle routing problem with load splitting: a heuristic approach."

Ludvik Bass (Queensland), "Determinants of longevity."

Sir Michael Atiyah (Oxford), "A survey of 4-dimensional manifolds," and "Convex polygons and a theorem of Archimedes."

Aroon Parshotam, "A study into the mathematical information content of music and languages."

As well as these, we were joined by several visitors from DSIR in Wellington, MAF in Palmerston North and elsewhere for a half day workshop on "Chaos in dynamical systems" held in mid-March.

M R Carter

OTAGO UNIVERSITY

Mathematics and Statistics

Dr. Gloria Olive has retired from the department after a long and fruitful association. She will be a Visiting Professor from August to January at Anderson University (Indiana, USA), where three of the four members of the Mathematics Department are her former students. Gloria is the subject of this issue's centrefold.

Dr. Robert (Tank) Aldred is to replace Gloria Olive. He arrives in August to assume a three year fixed term appointment.

Prof. Bryan Manly has returned from sabbatical leave spent mainly at the Statistics Department at the University of Wyoming, Laramie, USA. In January 1988 he helped to organize a conference sponsored by the United States - New Zealand Cooperative Science Program on "The Estimation and Analysis of Insect Populations". June and July were spent at the University of Alaska, Fairbanks, teaching an introductory statistics course at a summer school. During late summer Bryan visited Britain, attended the International Biometrics Conference in Namur, Belgium, and an International Statistical Institute conference on the teaching of statistics in Budapest, Hungary.

Prof. Derek Holton organised a Combinatorial Workshop which ran from February 1 to 18.

Recent visitors to the department include:

> Prof. Finbarr Holland from Ireland, for one month;
> Prof. Kathy Heinrich and Prof. Brian Alspach, from Simon Fraser University, Burnaby, Canada for most of first term;
> Dr Ray Watson from Melbourne, for one month;
> Prof. Saunders Maclane from The University of Chicago, for term one;
> Prof. Robert Sulanke from USA, for most of the year;
> Prof. Lo Yang from the Institute of Mathematics, Academia Sinica, Beijing, PRC, for one month;
> Marijke van Rossum from LaSalle, for half a year;
> Prof. Zhang Ke Min, Nanjing University, PRC;
> The Mathematical Society's Forder Lecturer, Prof. Sir Michael Atiyah, from the University of Oxford, from March 15 to 18;
> Five Canadian students for term one.

Readers may be interested to learn that Otago University has a new management structure. The Department of Mathematics and Statistics will be in the new Division of Sciences. In December Professor Derek Holton was elected to the position of Deputy Chairman of the division, and Dr John Clark to the Divisional Board.

The national television news carried the story that university enrolments, led by the South Island universities, are up. Mathematics and Statistics numbers are certainly up by about 15%, with the big increase being in our second year Statistics "service" courses. Paper 222 on regression and multivariate analysis is now attracting nearly 100 students. This compares with 25 three years ago and 45 last year. Paper 223 on survey analysis and the design and analysis of research studies has an enrolment approaching 50 in this, the first year it has been offered.

The first six booklets in Derek Holton's University of Otago Problem Solving Series are now available and selling well. The series will eventually contain about a dozen booklets designed to interest and encourage mathematically able high school students. Emphasis is on extension material not contained in most secondary school syllabuses. The topics covered are

1. How To.
2. Combinatorics I.
3. Graph Theory.
4. Number Theory.
5. Geometry I.
6. Proof.

Each sells for $1.75 including GST and postage, with a reduction for multiples of 10 selling for $13. In the same line John Rayner is acting as Publications Officer for the NZSA. His "School Projects in Mathematics and Statistics" sells for $1.50 per copy. It has gone into a second printing, with about a thousand copies sold

so far.

John Rayner has taken over from Gloria as the Otago correspondent. I will be visiting my long time friend and colleague, John Best of the CSIRO's IAPP Biometrics Unit from May 8 to 20. The return trip will be via Auckland (22/5), Hamilton (23/5), Wellington (24/5) and Christchurch (25/5). Each afternoon will be spent at the university giving a talk on recent research, while in the evenings I hope to talk to high school teachers about school projects.

Seminars

Jack Robertson (Washington State University), "Partition graphs", 28/11/88.

Christiana Drake (University of Washington) 5/12/88.

Finbarr Holland, "Variations on a theme of Archimedes", 13/2/89.

R. Watson (University of Melbourne), "Some stochastic thoughts on models for interacting populations", 14/2/89.

Saunders Maclane (University of Chicago), "Coherence Feynmann diagrams and string theory", 6/3/89; "Some great departments of mathematics", 9/3/89; "The mystery and magic of mathematics", 30/3/89.

J. Butcher (Auckland University), "Numerical ordinary differential equations and mathematics", 14/3/89.

Professor Sir Michael Atiyah (Oxford University), "Knots and braids", 16/3/89; "Convex polygons and a theorem of Archimedes", 17/3/89.

John Rayner

UNIVERSITY OF WAIKATO

Mathematics and Statistics

The Department is going through a period of expansion, unknown since the early seventies. Two new lectureships, half a lectureship in Mathematics Education, a post-doctoral fellowship and a professorial fellowship in the Centre for Applied Statistics have all been established during the past year. The appointment made to the last of these positions was commented on in the previous Newsletter. In addition to these new positions, Professor Douglas Bridges of the University of Buckingham has been appointed to the Chair in Mathematics. He takes up his position in early June. His field is constructive analysis—his work is well known to many New Zealand mathematicians since he has been a frequent visitor in recent years.

Hamish Spenser took up his position as lecturer in February. He completed a PhD in the Department of Organismic and Evolutionary Biology at Harvard University with a thesis entitled "An investigation of the theories of speciation by founder effect." He is interested in questions in theoretical population genetics, especially genetic variation, its maintenance within populations and its partitioning among populations.

Peter Danaher joined us in the latter part of 1988. He came from the Statistics Department of University College Dublin of the National University of Ireland. His DPhil was entitled "Estimating multidimensional tables form survey data: prediction magazine audiences." Statistical modelling of media exposure rates is his principal interest. He is also involved in developing the asymptotic theory of random variables.

Garth Ritchie has been appointed to a postdoctoral fellowship in the Science and Mathematics Educational Research (SMER) Centre. His topic for research is how seven and eight year olds learn

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mathematics.

Mark Schroder and Alfred Sneyd both returned from leave at the beginning of the year. Mark spent most of his time at Manheim, delving into matters categorial, topological, functional and geometrical. Alfred spent time at the University of Grenoble developing magnetic stirring techniques for aluminium reduction cells and at Cambridge DAMPT modelling the evolution of current sheets in force free magnetic fields.

Heather Rae has been promoted to senior lecturer (1/2 time) and appointed to a position as Study Skills Advisor in Basic Mathematical Skills (the other 3/4). Graham French has been carrying the Head of Department burden and has the gratitude of all for this. An increase of 11% in our course enrollment comes on top of a large increase last year. We are overflowing office and lecture room facilities and look forward to the commissioning of Building G (Maths and Stats, Computer Science, Computer Services). The structure grows higher each day.

Judy McWhirter is expecting a child on 23 May and will have a one term maternity leave. We wish her well. Her PhD thesis work continues apace—analysis of pulsatile data is the topic. Murray Jorgensen is offering an interesting graduate course this year: "Uncertainty in expert systems." One final item of information which may interest some readers: We have introduced a tutorial system for our core first year mathematic courses to try and improve math receptivity, calm math anxiety and stem math leakage. Guinevere Nalder is responsible for the organisation of the system and is fulfilling this task very professionally.

Kevin Broughan

GRANTEE REPORTS

ROBERT SISSON

The purpose of leave (3-16 February, 1989) was primarily to attend the 25th Australian Applied Mathematics Conference at the Ballarat College of Advanced Education, Victoria. The conference is an annual gathering of applied mathematicians working throughout Australia and New Zealand. It gave me an ideal opportunity to meet and exchange ideas with mathematicians and fellow research students studying a wide range of mathematical problems.

My paper "Spontaneous ignition" Numerical estimation of critical conditions", based on work being carried out at Massey by myself, under the supervision of Professor Graeme Wake and Mr Adrian Swift, was one of 22 PhD student papers presented at the conference. We were competing for the T M Cherry Student Prize, the award being presented annually for the best student paper. My paper was judged as being in the top 6 of those presented (the prize being won jointly by students from Oxford and Melbourne.

After the conference I travelled to Sydney where myself, Professor Wake and Mr Swift spent a very informative day with Professor Brian Gray of the School of Chemistry, Macquarie University. We discussed many areas of possible future work in the self-heating field. I gained some valuable insights into the physical behaviour of self-heating systems.

While in Sydney I also made contact with Dr Clifford Jones of the School of Chemical Engineering and Industrial Chemistry, University of New South Wales. Dr Jones is a chemist involved in the experimental side of self-heating. We discussed the possibilities of collaboration between our two departments in the future.

I found the entire visit to Australia very stimulating and enjoyable. The experience gained at the conference will be invaluable to me in my future studies. It was also enlightening to meet two experimental chemists working in my field.

I am very grateful for a travel grant of $500 from the New Zealand Mathematical Society, as well as a grant of $220 form the Massey University Dean's fund. I also wish to express my thanks to the Association of Commonwealth Universities for their scholarship which paid the balance of my expenses.

Robert Sisson
Massey University

COMBINATORIAL WORKSHOP
University of Otago, February 1st-18th 1989

The Combinatorial Workshop organised by the Department of Mathematics at the University of Otago was a quite successful event. It attracted many participants from all over the world.

During the workshop the following talks were given:

Brian Alspach	The Double Cover Conjecture
Katherine Heinrich	Shelah's Proof of van der Waerden's Theorem
Charles Little	A Constructive Proof of the 2-Ear Theorem
Peter Lorimer	Symmetry, Groups and Graphs
Ebad Mahmoodian	Designs and Graphs
Brendan McKay	Random Graphs
Gloria Olive	Some Special Functions that arise in Combinatorics
Raymond Scurr	Generalised Powers Revisited

The organisers wish to thank the New Zealand Mathematical Society and the Beverly Fund of the University of Otago for their financial support.

Derek Holton

NOTICES

QUANTITATIVE PROBLEM-SOLVING CONSULTANCY ESTABLISHED AT MASSEY UNIVERSITY

A quantitative problem solving consultancy has been established at Massey University, Palmerston North. The consultancy, the first of its type in New Zealand, provides the skills of mathematicians, statisticians, computer scientists and technologists. It is able therefore to assist with all three stages of a project; the collection and processing of data, the construction and solution of mathematical models, and the use of these models to predict how desired goals can be achieved in an efficient way.

In a community where it is almost a matter of pride to have no quantitative ability, managers and decision-makers are often unaware of the benefits these skills can offer. Examples of the problems which staff working with the consultancy have already tackled show how broadly applicable their skills can be:

- What is the rolling resistance of a car?
- What caused the fire in a commercial laundry?
- Predict future energy consumption.
- Design an optimal controller for an industrial evaporator.
- Which babies are at risk of developing jaundice?
- Do river levels affect recreational users?

- How do the job aspirations of middle managers affect their satisfaction and feelings of stress?
- What would the 1987 NZ election results have been under proportional representation?

Professor Graeme Wake of the Department of Mathematics and Statistics said that similar groups operated in north America, Europe and Australia and had proved highly successful in opening up university expertise to private sector groups. "The benefits are two-way", he said. "Industries, government agencies and business are able to tap into a pool of problem-solving talent, while university staff tackle the problems in a 'real world' context".

Leading American industrial mathematics expert, Professor Stavros Busenberg of the Claremont Mathematics Clinic has been appointed to spearhead the new Massey facility on the three-month secondment in mid-year supported by the United States Fulbright Visitor program. Further annual support has also been approved. Professor Busenberg is a leading figure in the Claremont clinic and is known for his work in differential equations.

A leaflet and further details are available from the QPSC Executive Group, (Professor Graeme Wake, Convenor), at the Department of Mathematics and Statistics, Massey University, Palmerston North.

NZMS MONOGRAPHS?

The NZMS publishes a number of lower level textbooks. A number of people have suggested that we might consider publishing a more prestigious series of graduate level texts and monographs in conjunction with some major book company. What is envisaged is something like the Australian Mathematical Society Series published by Cambridge University Press. Before we could even consider such a notion, it is clearly important to know if there are enough prospective authors and material. Therefore at this stage, what we need is for anybody currently planning or writing such a book to please contact the NZMS Publications Committee, Mathematics Department, Victoria University of Wellington.

Rod Downey

MASSEY MATHEMATICIAN AT CONFERENCE IN INDONESIA

Professor Graeme Wake of the Department of Mathematics and Statistics will be an invited speaker at the South East Asian Mathematical Society 1989 Regional Conference in June to be held in Yogyakarta, Indonesia. This Society is a regional grouping of mathematical scientists from the major South East Asian Countries. Countries in the region host the conference in rotation biennially, and this is only the second time it has been held in Indonesia. The theme of the conference this year is "MATHEMATICS IN TECHNOLOGY: APPLICATION AND PROGRESS". In addition to speaking of our NZ experiences in this regard, Professor Wake will give a review lecture on his own work concerning the theory of the reaction-diffusion equations. The timing of this meeting, being just a month after Massey's Department of Mathematics and Statistics hosts the 1989 New Zealand Mathematics Colloquium, gives an excellent opportunity for the further development of links between mathematicians in New Zealand and South East Asia.

1989 MATHEMATICS COLLOQUIUM
Massey University, 14-17 May, 1989

The organisation is well in hand with the second circular distributed and the third circular including the detailed programme being prepared for distribution towards the end of April. To date (March 17) we have 36 contributed papers together with the 6 invited talks. These are being bound into the book of abstracts. We might be able to schedule further contributed papers, but these would need to be negotiated, and it would be

the author's responsibility to provide adequate copies of abstracts.

The deadline for on-campus accommodation was April 7. Beyond that date all unbooked hostel rooms are allocated to extramural students. However we are happy to receive late registration for the Colloquium at any time.

The education day programme (May 17) is currently being organised. Two invited speakers will give talks, Professor Derek Holton with David Wallace (NZ IMO silver medalist) on New Zealand in IMO territory, and Dr Jock Hoe on mathematics education in China: past and present. Various contributed papers on topics related to mathematics education will also be presented.

Seven workshop and panel discussions have been organised. They are

Chairperson	Topic
Robin Staples	August NZAMT Conference
Len Cooper	"Family Maths"
Ann Mitchell	"Equals" programme
Elaine Mayo	ICME 1988
Peter Hughes	Problem solving
Heather Rae	Basic skills at tertiary level
Yet to be confirmed	Form 5-7 syllabus

See you in May.

FIFTEENTH AUSTRALIAN CONFERENCE ON COMBINATORIAL MATHEMATICS AND COMBINATORIAL COMPUTING
University of Queensland, Brisbane, Queensland, 10-14 July, 1989.

Contributed papers are welcome in all areas of combinatorics and combinatorial computing, pure and applied. **Invited speakers** include C C Lindner (Auburn), B D McKay (ANU), R C Mullin (Waterlooo), A Rosa (McMaster), D R Stinson (Manitoba), R Tamassia (Illinois), C Thomassen (Tech. U. Denmark), and N Wormald (Auckland).

The conference registration fee is A$65 (members), A$75 (non-members).

The conference proceedings will be published by *Ars Combinatoria*, subject to the usual arrangements for refereeing.

The third circular will be sent to those who have requested it in April. The deadline for abstracts is 10th June.

For further information, contact the Secretary, CMSA, Dept of Mathematics, University of Queensland, St Lucia, Queensland, Australia 4067.

OPERATIONAL RESEARCH SOCIETY OF NEW ZEALAND 25TH ANNUAL CONFERENCE
Victoria University of Wellington, 21-22 August, 1989.

We invite papers on all aspects of the theory and practice of Operational Research. As this will be our Silver Jubilee conference, we especially welcome papers relating to the history and/or future of OR in New Zealand.

Each paper will be allocated about thirty minutes. Abstracts of intended papers should be submitted before 1st May 1989 to the Conference Secretary at the address below. We intend to publish papers in summary form (maximum four pages) prior to the conference. The deadline for summary papers is 2nd June 1989. Further details on the format of these will be sent to authors after receipt of abstracts.

Further information and registration forms are available from

> Miss R N Bailey, ORSNZ Conference Secretary
> c/- DSIR/AMD
> PO Box 1335
> Wellington

26TH AUSTRALIAN APPLIED MATHEMATICS CONFERENCE
### Coolangatta, Queensland, 11-15 February, 1990.

The conference will be held in the Greenmount Resort Hotel, Coolangatta. This hotel is a modern, well-equipped building, sited on the beach and on the NSW border. There are many restaurants and recreational facilities in the neighbourhood.

Major themes considered for the conference are Fluid Mechanics, Environmental Modelling and Diffusion, Mathematical Physics, Mathematical Biology, Optimisation and Operations Research.

The organizing committee for the conference consists of Vincent Hart (Director), Roger Braddock (Deputy Director), Larry Forbes (Secretary, at University of Queensland), Bill Hogarth (Treasurer).

Further information can be obtained from Department of Mathematics, University of Queensland, St Lucia 4067, Queensland, Australia.

PROFESSOR SIR MICHAEL ATIYAH
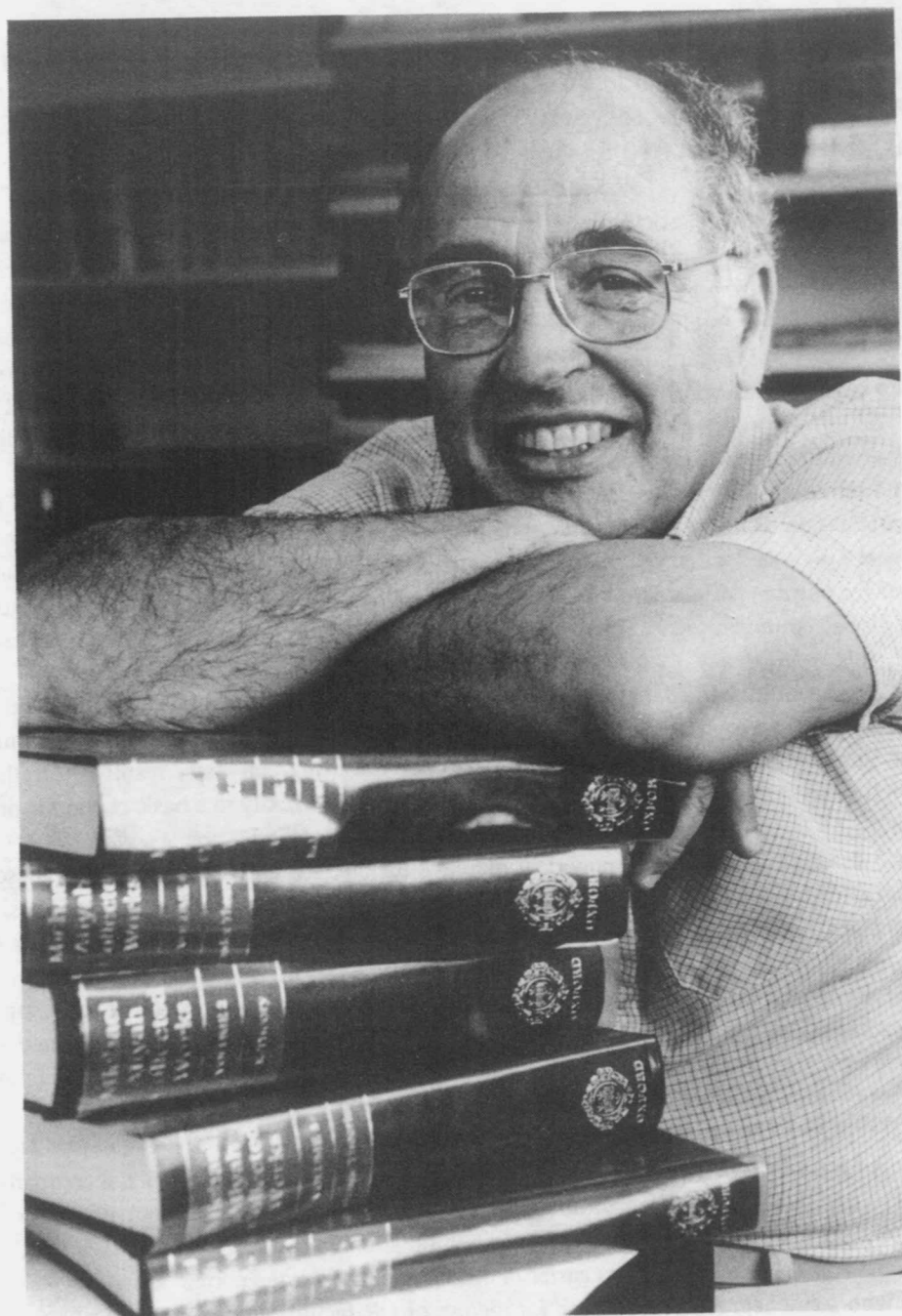
Professor Sir Michael Atiyah, Royal Society Professor of Mathematics at Oxford University, Forder Lecturer in New Zealand in February-March 1989, is pictured with the five volumes of his collected works which were published recently by the Oxford University Press. The latter are available for purchase from OUP in Auckland, at a considerable discount to commemorate this visit. The photograph is courtesy of the Manawatu Evening Standard in Palmerston North. The NZ coordinator of this visit, Professor Graeme Wake of Massey University, thanks all those who assisted with this visit in the six University centres, the British Council, and the Oxford University Press. The NZ Mathematical community wishes Sir Michael and Lily happy memories of their NZ visit. The next term in the sequence is

1987	1989	1991
Chris Zeeman	Michael Atiyah	?

BOOK REVIEWS

The Mathematics of Nonlinear Programming, by Anthony L. Peressini, Francis E. Sullivan, and J.J. Uhl, Jr.; (Undergraduate Texts in Mathematics. Eds: J.H. Ewing, F.W. Gehring, P.R.Halmos), Springer-Verlag, New York-Berlin-Heidelberg, 1988; 273 pp. 66 Illustrations, ISBN 3-540-96614-5.   (A \$71.75, on 25.3.88)

The subject of nonlinear programming is concerned with the minimisation (or maximisation) of a possibly nonlinear objective function on $\mathbb{R}^n$ subject to possibly nonlinear constraints which may be equations or inequalities or a mixture of both. The theory of nonlinear programming draws on many areas of mathematics including linear algebra, real analysis, and numerical mathematics. The textbook "The Mathematics of Nonlinear Programming" attempts to draw these areas together to form a course for students with some background in advanced calculus and linear algebra. The authors in their preface state that this book is an "attempt to provide such students with a careful, clear development of the mathematical underpinnings of optimization theory and a flavor of some of the basic methods."

Chapter 1 introduces first and second order optimality criteria for unconstrained optimisation problems. This chapter contains some introductory material on point-set topology and a brief discussion of the Hessian matrix, followed by three sections: quadratic forms, coercive functions and global optimisation, and eigenvalue tests for positive definiteness, in this rather perverse order. (One would have preferred to have the topology and global optimisation sections contiguous, and the quadratic forms and eigenvalues material likewise.)

Chapter 2 gives an outline of the theory of convex sets and convex functions, and illustrates some of the ideas by applying them to derive a solution technique for unconstrained geometric programming. The inequalities of Young, Hölder, and Minkowski are also derived using convexity results. Caratheodory's theorem and Helly's theorem are not mentioned. An illustration of convexity in a basic economic production model is given.

Chapter 3 describes some of the numerical methods for unconstrained optimisation. These include steepest descent, Newton's method, and the BFGS and DFP quasi-Newton methods. The quasi-Newton methods are derived in an enlightening way by analogy with the secant method for nonlinear equation solving. One section in this chapter which I found dissatisfying was that dealing with LU factorisation. There is not space enough here to do justice to this subject, which requires a discussion of the computational advantages of LU factorisation. The existence of these advantages is mysteriously mentioned, and a number of references are cited, but it would have been better to replace the entire discussion by referring the reader forthwith to a book which gives a complete account of these methods.

Chapter 4 deals with least squares optimisation in a standard way. The normal equations are derived, and used to prove a projection theorem for $\mathbb{R}^n$. The Gram-Schmidt method and its accompanying QR factorisation are outlined, and applied to an example of least squares optimisation. Unfortunately the example is poorly chosen to illustrate the advertised computational advantages of QR factorisation, since solving the normal equations is many times easier in this case, and gives the correct answer, which the book does not. Although some degree of motivation for the use of QR factorisation is given, the above criticism of the treatment of LU factorisation in the previous chapter also applies to the discussion of QR factorisation. The chapter finishes with an example of a portfolio analysis quadratic program which can be solved in a special case using least squares. It is a pity that there are very few books (not including this one) which solve these sorts of problems to completion with real data.

The remaining three chapters deal with constrained optimisation, and present three different mathematical approaches to deriving optimality conditions for constrained nonlinear programming problems. (These conditions used to be called the Kuhn-Tucker conditions until recently when it was discovered that Karush derived a version of these conditions in his Master's thesis in 1939, twelve years prior to the publication by Kuhn and Tucker.) The proof of the Karush-Kuhn-Tucker Theorem is preceded by clear and precise derivations of the separating hyperplane theorem and the supporting hyperplane theorem for convex

sets in $\mathbb{R}^n$, and a short section defining supremum, infimum, and what is meant by a "convex program". The appropriate place for this section is Chapter 1. The Karush-Kuhn-Tucker Theorem is stated and proved with the Slater constraint qualification, and then applied to problems in constrained geometric programming. Duality theory for convex programming is introduced here, and duality results are derived for linear and quadratic programming.

The second approach to the Karush-Kuhn-Tucker Theorem uses penalty functions. In Chapter 6, the authors show how the Courant-Beltrami penalty function and coercive functions can be combined together in a clever way to derive the Karush-Kuhn-Tucker Theorem without requiring the abstract results of the previous chapter. This chapter is well written and makes interesting reading.

The seventh and final chapter develops the Karush-Kuhn-Tucker theory for equality constrained problems, for which the Slater constraint qualification can not be applied. This leads to the well-known concept of a regular point, and an alternative constraint qualification. This chapter includes some nice worked examples which use Lagrange multipliers to solve constrained optimisation problems. The concluding section describes Wolfe's algorithm for quadratic programming. This requires a short course on the simplex method which is given in four pages immediately before the description of Wolfe's algorithm which concludes the book. This section is too brief and is unfortunately situated. The description of the tableau simplex method is unenlightening, and in view of the material presented earlier in the text, the authors miss the opportunity to give a description of this method which is based on duality theory. A far more satisfactory way to finish the book would have been to extend the brief discussion of constraint qualifications given in the previous section.

Although the authors indicate in their preface that they have not attempted to write an encyclopaedia, there are some notable omissions of material. Apart from the section on quadratic programming, very little is said about numerical methods for solving constrained optimisation problems. There are no references to sequential quadratic programming, or to interior-point methods for linear and nonlinear programming.

The most woeful omission is of that of a bibliography. No references are given to Duffin's work on penalty functions which is described in Chapter 6. References on other topics are cited occasionally throughout the text, but these should be collected together at least at the end of each chapter. It is important that a comprehensive list of references be included so that the interested student can pursue some of the ideas which are introduced in this book.

In general, the book is typeset attractively, with 66 very helpful illustrations. The only flaws I could detect were that some of the pages in chapters 4 and 5 are printed higher up the page than the rest of the text, and there are quite a number of typographical errors. The proofs of the results are conveyed meticulously, and the worked examples are generally well chosen. The exercises at the end of each chapter are compendious and well chosen.

In conclusion it must be said that this book does achieve the stated aims of its authors: it presents a reasonably careful and clear exposition of some of the mathematics of nonlinear programming, which to my knowledge contains no serious mathematical flaws. However I find myself questioning these aims. Nonlinear programming is a branch of applied mathematics in its own right: courses should be aimed at teaching nonlinear programming, not the mathematics of nonlinear programming. This book is written with the mathematics in mind rather than the nonlinear programming theory, and for this reason it is ultimately uninspiring. As befits a student text, it contains most of the well known results and ideas of nonlinear programming, and it is perhaps unfair to criticise the book for failing to excite someone who is already familiar with this material. Nevertheless, by concentrating on the mathematics at the expense of its underlying motivation, the book fails to identify and adhere to a central theme, and in doing this loses much of what is exciting about optimization theory.

Andy Philpott
Department of T.A.M.
University of Auckland

A Budget of Trisections, by Underwood Dudley, 169pp. Springer-Verlag, New York, 1987.

In the spirit of generations of angle trisectors who have communicated their claimed successes to bemused, bewildered or downright exasperated mathematicians, this is submitted as an unsolicited review of an irresistible book handsomely bound in the traditional yellow of Springer-Verlag and adorned with a Picassoesque silhouette of Don Quixote on horseback carrying straight-edge and compasses towards an innocent angle. The author, a sane professor of mathematics at De Pauw University in Indiana, in his introduction explains the title as an analog of De Morgan's *A Budget of Paradoxes* published last century. Both 'budget' and 'paradox' have altered in meaning since then: a 'budget' was a pouch or a bundle of papers: 'paradox' referred to arguments and thought not conforming to the accepted norm, so paradox and orthodox were contrasting terms and paradoxical argument was not necessarily invalid or self-contradictory. One of De Morgan's aims was to extinguish the enthusiasm of circle squarers. Underwood Dudley hopes to do the same for angle trisectors. To whet your curiosity here is an extract from his introduction:

' ... De Morgan and cranks gripped me and I have been gripped ever since. Whenever I came across a piece of crank literature, I held onto it. I began to try to search it out. I put an advertisement in *Fate* magazine, at the time a sort of *Reader's Digest* of the occult. I went to the Library of Congress and copied all that I could find. I wrote to 600 departments of mathematics, asking whether anyone there were a fellow collector or, if not, whether they had any material on file. *No* one would admit to collecting it. It was hard to believe: in a country where there are collectors of barbed wire and telephone insulators, is there no one collecting crank mathematics?'

And from a little further on:

'If, reader, you know of any mathematical crank literature, I would be pleased to have a copy of it: I have the collector's lust. I want it *all*.'

Let it be understood that 'trisecting an angle' is a short name for the problem of devising a construction that will enable any angle to be trisected by use of *only* a straight-edge and compass (pair of compasses, if you want to be pedantic). It is well known (but not universally, as this book shows) that such a construction cannot exist. If, however, one is allowed the luxury of a few extra items, such as two marks on the straight-edge, then trisection is possible. The first chapter of the book describes a number of such trisections, and very nice some of them are too, particularly one using a carpenter's square.

In the second chapter characteristics of trisectors are discussed; they are nearly always male, usually old, and very persistent in their attempts to gain recognition of their supposed successes. The most enthusiastic ones square circles and duplicate cubes as well. Do not become a correspondent of a trisector; they will not give up. If one writes to you, pray that another does so you can refer each to the other; it might work. But, better, use Einstein's formula:

'I am so overwhelmed with correspondence that despite every desire to do so I have no time to reply to all my letters'.

As a follow up, Underwood in Chapter 3 describes visits to three trisectors. The descriptions of the resulting interviews make funny/sad reading but Underwood treats all three in a kindly way as he does all the other trisectors who fill the pages of his book. Each is identified by initials only and most have had these initials altered to preserve anonymity, although this would seem to be the last thing most trisectors want. I suppose, too, that in a book like this if you call someone a crank you run the risk of a libel suit.

Chapter 4 is a calliope of more than 100 trisections culled (as one does sheep) from the author's collection. For each a figure, usually much simpler than the trisector's, is given together with a commentary and an estimate of the maximum error made when the trisection is applied to an acute angle. In many cases the equivalent trigonometrical non–identity is also stated. And so there parade across the pages, among others, in initialled anonymity and duly dated, these:

L.S.C (1982) with his claim that 'Present Text Books of Mathematics are fallacious and new Tables and Test Books are required'; N.B.C. (1982), a teacher of mathematics; D.C. (1981) with his 'necessity to revise ring theory'; S.I.C. (1968-75) who trisected only 60 and 120 degree angles; H.C. (1966) whose method was published in *Mechanix Illustrated*; N.R.E. (1956) who used Desargues' theorem; H.A.F.

(1904) a superintendent of city schools; J.J.G, (1934) who thought that trisection might make transmutation of the elements possible; V.H. (1908) a New Zealander; C.J. (1961) holder of an MD degree; M.L. with J.X.W. (1961) read into the *Congressional Record* and purveyors of RATIO CALIPERS; M.L. writes 'The author resents the negative implications since, if everyone were to accept statements as valid, there would be very little progress'; J.A.L. (1890) a B.A. and an M.D.; J.C.M. (1931) a high school instructor; A.M.P. (1963) for whom 'attempting to trisect an angle has been an exhilarating experience'; J.C.R. (1971) a Ph.D. in Mathematics; I.T. (1982) who attended Painting and Sculpture classes at the ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY; C.D.T. (1974) with a degree in engineering; W.H.T. (1902) a private tutor in mathematics; S.W. (1969) 'You will have to change all math books'; S.W.W. (1983) 'Descartes' Proof is now unproofed'; O.E.W. (1972) appearing in the *California Freemason* with 'I idly picked up a book of elementary trigonometry and the first illustration—a definition of radians— gave me an idea. I took my drawing instruments and in ten minutes had solved the ancient puzzle'; and lastly E.H.Y. (1931); after which Underwood Dudley writes, 'This ends the Budget of Trisections. Reader, do not add to it'.

So, have these trisectors achieved anything? In theory all their methods fail: in practice some of these trisections are remarkably accurate. In the index (a delight in itself) all the methods are listed in order according to the maximum error made in trisections of acute angles. The most accurate has an error of at most one second of arc and many others have errors not exceeding five minutes of arc. Thus if you wish to trisect angles in your everyday life and you do not have a protractor then there are many methods available as long as you do not mind a small error. And if you wish to know about them then consult this delightful and well-written book.

D.R. Breach

SPRINGER-VERLAG PUBLICATIONS

Information has been received about the following publications. Anyone interested in reviewing any of these books should contact

David Alcorn
Department of Mathematics and Statistics
University of Auckland.

Applied Mathematical Sciences

66	Hlaváček I (et al)	Solution of variational inequalities in mechanics. 325pp.
68	Teman R	Infinite dimensional dynamical systems in mechanics and physics. 615pp.
69	Golubitsky M (et al)	Singularities and groups in bifurcation theory II. 550pp.
70	Constantin P (et al)	Integral manifolds and inertial manifolds for dissipative partial differential equations. 165pp.
72	Lochak P, Meunier C	Averaging in classical dynamical systems. 370pp.
73	Wiggins S	Global bifurcation and chaos. 505pp.
75	Abraham R (et al)	Manifolds, tensor analysis and applications (2nd ed). 650pp.
76	Lagerstrom P A	Matched asymptotic expansions. 251pp.

Graduate Texts in Mathematics

119	Rotman J J	An introduction to algebraic topology. 450pp.

Grundlehren der Mathematischen Wissenschaften

250	Arnold V I	Geometrical methods in the theory of ordinary differential equations (2nd ed). 365pp.
289	Manin Y I	Gauge field theory and complex geometry. 297pp.

Lecture Notes in Mathematics

1308	Imkeller P	Two-parameter martingales and their quadratic variation. 177pp.
1309	Fiedler B	Global bifurcation of periodic solutions with symmetry. 146pp.
1310	Laudal O, Pfister G	Local moduli and singularities. 117pp.
1312	Shirokov N A	Analytic functions smooth up to the boundary. 213pp.
1313	Colonius F	Optimal periodic control. 177pp.
1314	Futaki A	Kähler-Einstein metrics and integral invariants. 140pp.
1319	Vuorinen M	Conformal geometry and quasiregular mappings. 209pp.
1323	Anderson D R, Munkholm H J	Boundedly controlled topology. 309pp.
1327	Bruns W, Vetler U	Determinantal rings. 236pp.
1335	Guillen F (et al)	Hyperrésolutions cubiques et descente cohomologique. 192pp.
1336	Helffer B	Semi-classical analysis for the Schrödinger operator and applications. 107pp.
1338	Mingarelli A B, Halvorsen S G	Domain of non-oscillation of second-order differential equations with two parameters and their extensions. 109pp.
1341	Dauge M	Elliptic boundary value problems on corner domains. 259pp.
1343	Ulrich H	Fixed point theory of parametrized equivariant maps. 147pp.
1349	Novak E	Deterministic and stochastic error bounds in numerical analysis. 115pp.
1353	Palais R S, Terng C-L	Critical point theory and submanifold geometry. 272pp.

Springer Series in Computational Mathematics

| 11 | Delahaye J-P | Sequence transformations. 250pp. |

Studies in the History of Mathematics and Physical Science

| 12 | Rosenfeld B A | The history of non-euclidean geometry. 488pp. |

Tata Institute Lectures on Mathematics

| | Keller H B | Numerical methods in bifurcation problems. 160pp. |

Undergraduate Texts in Mathematics

| | Brémaud P | Introduction to probability. 230pp. |

Universitext

| | Gårding L, Tambour T | Algebra for computer science. 210pp. |

Miscellaneous

| | Huo Z, Guo Q | Homogeneous denumerable Markov processes. 282pp. |
| | Ramanujan S R | The lost notebook. 419pp. |

ESSAY

ON MATHEMATICAL WORLDS
by Gloria Olive

When human beings acquired the ability to 'reason'. they without doubt   and of necessity considered questions involving order and chaos. A mathematician who creates a new world (or frontier) of mathematics also faces the question, 'Will there be order or chaos?'

On finding chaos, one may feel the influence of the 'devil'.   Or, more concretely, one becomes aware that the foundation is faulty.   If unable to strengthen this foundation, the mathematician will discard this   imperfect world. (Some theological communities believe that our 'real world' will be discarded—if it is   fundamentally chaotic).

On the other hand, the mathematician who discovers order may feel a supernatural influence. Leopold Kronecker said, 'God made the integers, all the rest is the work of man'.   However, it is difficult to believe that all of the order and beauty of mathematics could have been achieved without supernatural inspiration.

In addition to order, there is a question of fertility. That is, 'How fruitful   will this world be?' If it is really fruitful, its possibilities for expansion are limitless. If   it does not expand or ceases to be fruitful, it may become associated with a stronger world (and assume an insignificant role) or just vegetate—unless it   can be given some inspired impetus. Some theologians and political analysts   have made similar predictions regarding the future of an 'unfruitful world'.

Thus there is a basic relationship between a mathematical world and the 'real world'. Life in a fruitful mathematical world seems to have   more grounds for optimism—it has only logical forces acting!

Dr Gloria Olive

GLORIA OLIVE

By Saunders Mac Lane and John Rayner

Dr Gloria Olive, Senior Lecturer in Mathematics at the University of Otago from 1972, retired from this position in February, 1989. Throughout her varied career she displayed a steady enthusiasm for teaching and especially for encouraging able students. She has successfully combined her interest in teaching with active research in the area of Combinatorics. She taught at a considerable number of institutions, most notably at Otago University and Anderson College (now Anderson University in Anderson, Indiana) where she served as Professor and Chairman of the Mathematics Department from 1952 until 1968.

Gloria was born in New York City on 8 June 1923. She graduated in 1940 from Abraham Lincoln High School. Other coming mathematicians such as Richard Bellman (later at the University of Southern California) and Leon Henkin (University of California, Berkeley) had recently graduated from this school. In 1944 she received her B.A. from Brooklyn College, where her teachers included Jesse Douglas, Moses Richardson and Walter Prenowitz. Her first teaching experience was as a Graduate Assistant at the University of Wisconsin (1944-46). From here she received her M.A. in 1946, having worked with Professor R. H. Bruck, H. P. Evans, R. E. Langer, and C. C. MacDuffee.

Gloria then enjoyed a variety of teaching experiences, as an instructor at the University of Arizona (1946-48), at Idaho State University (1948-50), and as a Graduate Assistant at Oregon State University (1950-51). Then, after a brief tour of duty as a cryptographer in the U.S. Department of Defense in Washington, D.C., she went to Anderson College in 1952.

While at Anderson, she developed her "generalized powers", an interest that eventually led to her Ph.D. at Oregon State University in 1963. Professor C. C. MacDuffee of the University of Wisconsin agreed to accept a visiting professorship at Oregon State University in order to supervise her Ph.D. thesis. His unexpected death in 1961 resulted in a situation which led to her being her own thesis supervisor. Formal approval for her thesis was given by Professor Arvid T. Lonseth, Chairman of the Department as well as the motivator for her Ph.D. A modification of her thesis was published in the American Mathematical Monthly under the title "Generalized Powers" (Vol. 72, 1965, pp 619-627).

Her accomplishments at Anderson led to a marked increase in the number of mathematics students and majors (staff numbers increased from 1 to 4), the establishment of a chapter of Kappa Mu Epsilon (a national mathematics honor society) and the arrangement of visits by some leading mathematicians (such as Charles Curtis and Saunders Mac Lane). She was also a visiting professor during summers at some Canadian universities.

After leaving Anderson in 1968, she became a Professor of Mathematics at the University of Wisconsin-Superior.

Gloria's mathematical interests have revolved about some special functions which arise from the study of combinatorics. These include generalized powers [J.M.A.A. (Journal of Mathematical Analysis and Applications), 74 (1980), 270-285], the b-transform [J.M.A.A., 60 (1977), 755-778], binomial functions [J.M.A.A., 70 (1979), 460-473; and 83 (1981), 110-126 (with Donald Krouse)], and extended Catalan Numbers, [J.M.A.A., 111 (1985), 201-235]. Some of her work on binomial functions overlaps that of Gian-Carlo Rota's "polynomials of binomial type". She has had a special interest in the polynomials which are generated by her generalised powers, and hopes that someone will prove or disprove her conjecture, now about 30 years old, that all their zeros lie on the unit circle. This conjecture has now been verified for infinitely many special cases.

While in New Zealand, Gloria has served the mathematical community in various ways. For example, she has been a member of the NZMS Council and the convener of the New Zealand National Committee for Mathematics. Also, her strong convictions on various academic matters have, on occasion, led to strong communications.

Her retirement will be spent mainly in Dunedin, where, among other activities, she is looking forward to exploring more cycleways on her bicycle. At present she is serving as Appointments Secretary to Professor Saunders Mac Lane (who is William Evans Visiting Professor) and supervisor for Raymond Scurr's M.Sc. thesis. In August she is to return (for one semester) as a Visiting Professor at Anderson University, where three of the four members of the Mathematics Department are her former students.

For all of her time with the Mathematics and Statistics Department of Otago University, Gloria has been the only female on the staff with tenure, and as such has been a shining example to both staff and students. She has fought hard for the issues she championed, and contributed to several worthwhile changes (such as the current internal assessment policy applauded by both staff and students). Her colleagues will miss her lively contributions to the debates in departmental meetings. We all wish her health and every happiness in a long and constructive retirement.

MATHEMATICAL VISITORS TO NEW ZEALAND

List No.22 : 1 March 1989

The information for each item is arranged as follows:

Name of visitor; home institution; whether accompanied; principal field of interest; dates of visit; principal host institution; principal contact person; comments.

One of the main purposes of this list is to enable other institutions to invite visitors to spend time with them. Anyone wishing to issue such an invitation should do so through the principal contact person.

Professor Brian Alspach; Simon Fraser University, Burnaby, Canada; Prof. Katherine Heinrich; combinatorics/graph theory; January – March 1989; University of Otago; Prof. Derek Holton.

Professor Sir Michael Atiyah; University of Oxford; wife (Lady Atiyah); topology, differential equations, mathematical physics; 26 February – 26 March 1989; the New Zealand Mathematical Society; Prof. Graeme Wake (Massey University). Professor Atiyah is the 1989 Forder Lecturer, and will be visiting all the N.Z. universities.

Professor Heinz Bauer; University of Erlangen-Nürnberg; potential theory and probability; 1 September – 8 October 1989; University of Canterbury; Dr. Neil Watson. Professor Bauer is an Erskine Visitor for 1989.

Professor Wim Blok; University of Illinois at Chicago; wife (Mary); logic, universal algebra; February – November 1989; University of Canterbury; Dr. Robert Bull. Professor Blok is an Erskine Visitor for 1989.

Professor Katherine Heinrich; Simon Fraser University, Burnaby, Canada; Prof. Brian Alspach; combinatorics/graph theory; January – March 1989; University of Otago; Prof. Derek Holton.

Professor R.N. Horne; Stanford University, California; petroleum engineering; November 1989; University of Auckland; Prof. Ian Collins.

Professor D.S. Jankovic´; East Central University, Ada, Oklahoma; topology; July 1988 – June 1989; University of Auckland; Assoc. Prof. I.L. Reilly.

Professor K.L. Johnson, F.R.S.; University of Cambridge; contact mechanics, friction and wear; March – April 1989; University of Auckland; Prof. Ian Collins.

Dr. Charikleia Konstadilaki; Aristotle University of Thessaloniki, Greece; general topology; October 1988 – April 1989; University of Auckland; Assoc. Prof. I.L. Reilly.

Professor M.R. Leadbetter; University of North Carolina, Chapel Hill; point processes and extreme value theory; April 1989; Victoria University of Wellington; Prof. David Vere-Jones.

Professor Saunders Mac Lane; University of Chicago; wife; topos theory; 15 February – 14 May 1989; University of Otago; Dr John Harris.

Professor E. Palm; University of Oslo; fluid mechanics; October – December 1989; University of Auckland; Prof. Ian Collins.

Dr. Ahmad Parsian; Shiraz University, Iran; multivariate statistics; January – December 1989; Victoria University of Wellington; Prof. David Vere-Jones.

Professor M.J.D. Powell; University of Cambridge; wife; optimization and approximation, numerical analysis; 10 September – 2 December 1989; University of Canterbury; Dr. Ian Coope. Professor Powell is an Erskine Visitor for 1989.

Dr. A.T. Richardson; University of Bristol; fluid dynamic stability; July – September 1989; University of Auckland; Prof. Ian Collins.

Professor Bruce Richmond; University of Waterloo; asymptotics in combinatorics; March 1989; University of Auckland; Dr. Nick Wormald.

Professor Gerhard Rosenberger; Universität Dortmund, West Germany; wife and daughter; group theory; 10 – 24 September 1989; University of Auckland; Dr. Marston Conder.

Dr. Akira Saito; Tohoku University, Sendai, Japan; wife and one child; graph theory; April 1988 – March 1989; University of Otago; Professor Derek Holton.
Dr Akira Saito is a William Evans Visiting Fellow.

Professor Robert Sulanke; Boise State University, Idaho; combinatorics, graph theory; February – August 1989; University of Canterbury; Dr. Derrick Breach.

Dr. Tim Swartz; Simon Fraser University, Burnaby, Canada; spouse; statistics; January – March 1989; Massey University; Greg Arnold.

Professor M.A.J. van Montfort; Wegeningen Agricultural University, Netherlands; extreme value theory and applications in meteorology; April – June 1989; N.Z. Meteorological Office and Victoria University of Wellington; John Revfeim, N.Z. Meteorological Office.

Professor Yang Lo; Institute of Mathematics, Academia Sinica, Beijing; complex function theory; March 1989; University of Otago; Dr. Peter Fenton.

Professor Ray Zahar; University of Montreal; numerical analysis; December 1988 – May 1989; University of Auckland; Prof. John Butcher.

Please note: Production of these lists is dependent on my receiving information. When you know about a visit (whether it be definite, very likely, or possible), would you please forward the details to me at the earliest convenient time. Thank you.

Marston Conder
N.Z. Mathematical Society Visitors' Co-ordinator
Department of Mathematics and Statistics
University of Auckland

CONFERENCES

** 1989 **

May 4-5 (Pittsburgh) **Twentieth Annual Pittsburgh Conference on Modeling and Simulation**
Contact M.H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pennsylvania 15261, USA.

May 8-12 (Berkeley, California) **Workshop on Arithmetic Groups and Buildings**
Contact I. Kaplansky, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720, USA.

May 15-17 (Palmerston North, N.Z.) **1989 New Zealand Mathematics Colloquium**
Contact Dr M.D. Hendy, Department of Mathematics and Statistics, Massey University, Palmerston North, New Zealand.

May 17-19 (Sophia Antipolis, France) **Joint IMA/SMAI - GAMNI Conference on Computational Methods in Aeronautical Fluid Dynamics**
Contact IMA (see (1) below).

May 17-19 (San Francisco) **SIAM Conference on Control and Systems Theory**
Contact SIAM Conference Coordinator, 117 South 17th Street, 14th Floor, Philadelphia, Pennsylvania 19103-5052, U.S.A.

May 22-24 (Iowa City) **International Conference on Algebraic Methodology and Software Technology**
Contact AMAST Conference, Computer Science and Mathematics Departments, University of Iowa, Iowa City, Iowa 52242, U.S.A.

May 22-24 (Portland, Oregon) **SIAM Conference on Sparse Matrices** Contact SIAM Conference Coordinator, 117 South 17th Street, 14th Floor, Philadelphia, Pennsylvania 19103-5052, U.S.A.

May 22-24 (Salishan Resort, Oregon) **Sparse Matrix Meeting**
Contact SIAM Conference Coordinator, 117 South 17th Street, Suite 1400, Philadelphia, Pennsylvania 19103-5052, USA.

May 22-24 (Berkeley, California) **Workshop on Vortex Methods**
Contact I. Kaplansky, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720, U.S.A.

May 22-25 (Dublin) **Second Dublin Differential Equations Meeting**
Contact Dr D.W. Reynolds, School of Mathematical Sciences, NIHE, Dublin 9, Republic of Ireland.

May 22-June 3 (Columbus, Ohio) **NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications**
Contact OPs Conf, C/o P. Nevai, Department of Mathematics, The Ohio State University, 231 West Eighteenth Avenue, Columbus, Ohio 43210-1174, U.S.A.

May 23-26 (Antibes, France) **Third International Conference on Numerical Combustion**
Contact INRIA, Service des Relations Extérieures, Bureau des Colloques, Domaine de Voluceau, BP 105, Rocquencourt, 78153 Le Chesnay cedex, France.

May 23-27 (Toronto) **International Conference on Computing and Information**
Contact W. Koczkodaj, Conference Secretary, Laurentian University, Sudbury, Ontario, Canada P3B 3X8.

May 25-26 (Washington D.C.) **Eleventh Symposium on Mathematical Programming with Data Perturbations**
Contact A.V. Fiacco, Department of Operations Research and the Institute for Management Science and Engineering, School of Engineering and Applied Science, The George Washington University, Washington, District of Columbia 20052, U.S.A.

May 25-27 (Bethlehem, Pennsylvania) **Fourth Annual Lehigh University Geometry and Topology Conference**
Contact D. Davis, Department of Mathematics, Lehigh University, Bethlehem, Pennsylvania 18015, U.S.A.

May 26-30 (Sundance, Utah) **AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory**
Contact W. Drady, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, U.S.A.

May 29-June 1 (Tokyo) **Third International Conference in Mathematics: Fractional Calculus and its Applications**
Contact K. Nishimoto, Mathematics Department, College of Engineering, Nihon University, Tamuracho, Koriyama, Japan.

May 29-June 9 (Blacksburg, Virginia) **AMS-SIAM Summer Seminar on the Mathematics of Random Media**
Contact B. Verducci, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, U.S.A.

May 30-June 2 (Ottawa) **1988 Annual Meeting of the Statistical Society of Canada**
Contact Statistical Society of Canada 1989, International and Professional Relations Division, Statistics Canada, 10-K R.H. Coats Building, Tunney's Pasture, Ottawa, Ontario K1A OT6, Canada.

May 30-June 30 (Montreal) **Analytic Number Theory, Modular Forms and Related Topics**
Contact F.H. Clarke, Director, Centre de recherches mathématiques, Université de Montréal, CP 6128-A. Montréal, Quebec H3C3J7, Canada.

May 31-June 2 (Edinburgh) **Workshop on Blow-up and Extinction for Parabolic and Other Systems**
Contact J.M. Ball, Department of Mathematics, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, United Kingdom.

May 31-June 3 (Crantham, Pennsylvania) **Seventh Biennial Conference of the Association of Christians in the Mathematical Sciences**
Contact R. Brabenec, Department of Mathematics, Wheaton College, Wheaton, Illinois 60187, U.S.A.

June 1-10 (Dubrovnik-Kupari, Yugoslavia) **Third Annual Meeting of the International Workshop in Analysis and its Applications**
Contact C.V. Stanojevic, Department of Mathematics and Statistics, University of Missouri-Rolla, Rolla, Missouri 65401, U.S.A.

June 4-8 (San Diego, California) **1989 IEEE International Conference on Computer Vision and Pattern Recognition**
Contact R. Chellappa, PHE324, Department EE-Systems, University of Southern California, University Park, MC-0272, Los Angeles, California 90089, US.A.

June 4-9 (Cetraro, Italy) **Geometrical and Algebraical Aspects in Several Complex Variables**
Contact D.C. Struppa, Department of Mathematical Sciences, George Mason University, 4400 University Drive, Fairfax, Virginia 22030, U.S.A.

June 5-7 (Winnipeg, Canada) **International Symposium on Asymptotic and Computational Analysis**
Contact R.Wong, Department of Applied Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada.

June 5-8 (Bucharest, Romania) **International Colloquium on Complex Analysis**
Contact Professor C. Andreian Cazacu, Central Institute of Mathematics, str. Academei 14, Bucharest, Romania.

June 5-8 (Asilomar, California) **Fourth Annual Symposium on Logic in Computer Science**
Contact R. Parikh, LICS, Department of Computer Science, Brooklyn College of CUNY, Bedford Avenue and Avenue H, Brooklyn, New York, 11210, U.S.A.

June 5-9 (Sherbrooke, Canada) **International Symposium on Bayesian Decision Theory**
Contact J.F. Angers, Department of Mathematics and Information, University of Sherbrooke, Sherbrooke, PQ, J1K 2R1, Canada.

June 5-9 (Salisbury, Maryland) **Chaos and the Microcomputer**
Contact B.A. Fusaro Department of Mathematical Sciences, Salisbury State University, Salisbury, Maryland 21801, U.S.A.

June 5-10 (Saint Louis, Missouri) **William H. Roever Lectures in Geometry, and Algebraic Geometry Conference**
Contact D. Wright, Department of Mathematics, Washington University, Saint Louis, Missouri 63130, U.S.A

June 5-16 (Berkeley, California) **Workshop on the Geometry of Hamiltonian Systems**
Contact I. Kaplansky, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720, U.S.A.

June 6-8 (Windsor, Ontario) **Fourth International Conference on Boundary Element Technology**
Contact N.G. Zamani, Department of Mathematics and Statistics, University of Windsow, Windsor, Ontario, Canada N9B 3P4.

June 6-10 (Montréal) **Analytic Number Theory**
Contact F.H. Clarke, Director, Centre de recherches matématiques, Université de Montréal, CP 6128-A, Montréal, Québec H3C 357, Canada.

June 7-9 (Winnipeg, Canada) **Canadian Applied Mathematics Society Tenth Annual Meeting**
Contact R. Wong, Department of Applied Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada.

June 7-10 (Colorado Springs, Colorado) **International Conference on Differential Equations: Theory and Applications in Stability and Control**
Contact S. Elaydi, Department of Mathematics, University of Colorado, Colorado Springs, Colorado 80933-7150, U.S.A.

June 7-9 (Winnipeg, Canada) **CAMS/SCMA 10th Annual Meeting and Symposium on Asymptotic and Computational Analysis**
Contact Professor R. Wong, Department of Applied Mathematics, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada.

June 8-16 (Singapore) **Singapore Probability Conference**
Contact J.H. Lou, The Organising Secretary, Singapore Probability Conference, Department of Mathematics, National University of Singapore, Lower Kent Ridge Road, Singapore 0511, Republic of Singapore.

June 12-16 (Salisbury, Maryland) **Decision Making and the Microcomputer**
Contact B.A. Fusaro, Department of Mathematical Sciences, Salisbury State University, Salisbury, Maryland 21801, U.S.A.

June 12-16 (Cambridge, Massachusetts) **Computers and Mathematics**
Contact H. Schmidt, Conference Secretary, 62 Eastview, Pleasantville, New York 10570, U.S.A.

June 12-17 (Linz, Austria) **Geometry of Banach Spaces**
Contact Dr. Walter Schachermayer, Johannes Kepler Universität Linz, Institut für Mathematik, A 4040 Linz, Austria.

June 14-16 (Capri, Italy) **Non Linear Control Systems Design**
Contact IFAC Symposium, NOLCOS 89, Dipartimento di Informatica e Sistemistica, Universita di Roma "La Sapienza", Via Eudossina 18, 00184 Rome, Italy.

June 14-17 (Dayton, Ohio) **International Conference on Dynamical Systems Control Theory and Applications**
Contact G.H. Fricke, Department of Mathematics and Statistics, Wright State University, Dayton, Ohio 45435, U.S.A.

June 15-17 (New York) **Northeast Conference on General Topology and Applications**
Contact P.R. Misra, Department of Mathematics, College of Staten Island, 130 Stuyvesant Place, Staten Island, New York 10301, U.S.A.

June 15-23 (Varenna Lake, Italy) **CIME Course on Methods of Nonconvex Analysis** Contact P. Zecca, Secretary CIME, Institute Matematico "U. Dini", Viale Morgagni 67A, 50134 Firenze, Italy.

June 19-22 (Eugene, Oregon) **Fourth Annual Conference on Structure in Complexity Theory**
Contact P. Young, Visiting Professor, Department of Computer Sciences, University of Wisconsin, 1210 West Dayton Street, Madion, Wisconsin 53706, U.S.A.

June 19-23 (Amsterdam) **1989 International Symposium on the Mathematical Theory of Networks and Systems**
Contact M.A. Kaashoek, C/o Bureau Congreszaken, Vrije Universiteit, P.O. Box 7161, 1007MC, Amsterdam, The Netherlands.

June 20-22 (Boston, Massachusetts) **1989 National Educational Computing Conference**
Contact NECC '89, International Council for Computers in Education, University of Oregon, 1787 Agate Street, Eugene, Oregon 97403-9905, U.S.A.

June 20-23 (Yogyakarta, Indonesia) **Regional Conference on Mathematics 1989**
Contact The Organising Committee, Department of Mathematics, FMIPA, Gadjah Mada University, Sekip III, Yogyakarta, Indonesia.

June 21-23 (Calgary, Canada) **32nd Meeting of the Society for Natural Philosophy on Geometrical and Topological Methods in Mechanics**
Contact M. Epstein, Department of Mechanical Engineering, University of Calgary, Calgary, Alberta T2N 1N4, Canada.

June 25-July 1 (Madison, Wisconsin) **18th Conference on Stochastic Processes and Their Applications**
Contact Stochastic Processes Conference, Department of Mathematics, University of Wisconsin-Madison, Madison, Wisconsin 53706, U.S.A.

June 26-28 (Montréal) **Qualitative Theory of Vector Fields**
Contact F.H. Clarke, Director, CRM, Université de Montréal, C.P. 6128-A, Montréal, Québec H3C 357, Canada.

June 26-29 (Como, Italy) **The Riccati Equation in Control, Signals and Systems**
Contact Professor S. Bittanti, Dipartimento di Eletronica, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italy.

June 26-July 1 (Vilnius, Lithuania) **5th International Conference on Probability Theory and Mathematical Statistics**
Contact V. Statulevicius, Institute of Mathematical Cybernetics, Academy of Science, Lithuanian SSR, Akademijos 4, Vilnius 232600, USSR.

June 27-30 (Charlottesville, Virginia) **Second Conference of the International Federation of Classification Societies**
Contact IFICS-89, Department of Mathematics, University of Virginia, Charlottesville, Virginia 22903, U.S.A.

June 27-30 (Dundee, Scotland) **Dundee Biennial Conference on Numerical Analysis**
Contact Dr. D.F. Griffiths, Department of Mathematics and Computer Science, The University, Dundee DD1 4HN, Scotland.

July (Pereslavl-Zalessky, USSR) **Logic at Botik '89: A Seminar on Logical Foundations of Computer Science**
Contact Logic at Botik '89, P.O. Box 11, Program Systems Institute of the U.S.S.R. Academy of Sciences, 152140 Pereslavl-Zalessky, U.S.S.R.

July 2-7 (Gregynog, Wales) **Fourth Gregynog Symposium on Differential Equations**
Contact W.D. Evans, University of Wales College of Cardiff, School of Mathematics, Sengenhydd Road, Cardiff CF2 4AG, United Kingdom.

July 2-16 (Kolymbari, Crete) **Fifth Workshop on Non-linear Evolution Equations and Dynamical Systems**
Contact NEEDS '89, C/- F. Calogero, Dipartimenta di Fisica, Universita di Roma "La Sapienza", p. Aldo Moro 2, 00185 Roma, Italy; with copy of letter to NEEDS '89, c/o A. Verganelakis, N.R.C. Demokrioos, P.O. Box 60228, 15310 Aghia Paraskevi, Attiki, Greece.

July 3-7 (Sopron, Hungary) **Third Hungarian Colloquium on Limit Theorems in Probability and Statistics**
Contact J. Bolyai Mathematical Society, Limit Theorems, Budapest, Anker köz 1-3, H-1061, Hungary.

July 3-7 (Sydney) **3rd Annual Meeting of the Australian Mathematical Society**
Contact Professor John Loxton, School of Mathematics, Macquarie University, NSW 2109, Australia.

July 3-7 (Bangor, Wales) **International Category Theory Meeting** Contact T. Porter, School of Mathematics, University of Wales, Bangor, Gwynedd LL57 1UT, United Kingdom.

July 3-7 (Oxford) **Mathematical Theory of the Dynamics of Biological Systems**
Contact IMA (see (1) below.)

July 3-7 (London) **Computational Ordinary Differential Equations**
Contact IMA (see (1) below.)

July 3-7 (Leipzig) **14th IFIP Conference on System Modelling andOptimization**
Contact Dr. K. Tammer, Leipzig University of Technology, Department of mathematics and Informatics, PF 66, Leipzig 7030, German Democratic Republic.

July 3-7 (Roskilde, Denmark) **Fourth International Conference on the Teaching of Mathematical Modelling and Applications**
Contact Professor Mogens Niss, Chairman IMFUFA, Roskilde University Centre, P.O. Box 260, DK-4000 Roskilde, Denmark.

July 3-7 (Norwich, England) **Twelfth British Combinatorial Conference**
Contact Twelfth BCC, School of Mathematics, University of East Anglia, Norwich NR4 7TJ, United Kingdom.

July 3-7 (Dalian China) **International Symposium on Approximation, Optimization and Computing**
Contact A.G. Law, University of Regina, Saskatchewan, Canada S4S OA2

July 3-11 (Pistoia, Italy) **CIME Course on Microlocal Analysis and Applications**
Contact P. Zecca, Secretary CIME, Institute Matematico "U. Dini", Viale Morgagni 67A, 50134 Firenze, Italy.

July 10-12 (Brisbane) **International Conference on Computational Techniques and Applications**
Contact School of Australian Environmental Studies, Griffith University, Nathan, Queensland 4111, Australia.

July 10-14 (Brisbane) **Fifteenth Australasian Conference on Combinatorial Mathematics and Computing**
Contact Professor Anne Penfold Street, Director, CMSA, Department of Mathematics, University of Queensland, St. Lucia, Queensland 4067, Australia.

July 10-21 (Berkeley, California) **Microprogram on Noncommutative Rings**
Contact Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720, U.S.A.

July 10-30 (Santa Cruz, California) **AMS Summer Research Institute on Several Complex Variables and Complex Geometry**
Contact W. Drady, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, U.S.A.

July 11-14 (Dublin) **Sixth International Conference on Numerical Analysis of Semiconductor Devices and Integrated Circuits**
Contact NASECODE VI Conference, Institute for Numerical Computation and Analysis, P.O. Box 2, Dun Laoghaire, Ireland.

July 11-12 (Cardiff) **International Conference on Mathematics in Transport Planning and Control**
Contact IMA (see (1) below).

July 12-14 (Loughborough, England) **Robotics: Applied Mathematics and Computational Aspects**
Contact IMA (see (1) below).

July 16-29 (Tuscany, Italy) **1989 NATO Advanced Study Institute: Fourier Analysis and its Applications**
Contact J.S. Byrnes, President, Prometheus Inc., 21 Arnold Ave., Newport, Rhode Island 02840, U.S.A.

July 17-21 (San Diego, California) **SIAM Annual Meeting**
Contact SIAM Conference Coordinator, Suite 1400, Architects Building, 117 South 17th Street, Philadelphia, Pennsylvania 19103-5022, U.S.A.

July 17-August 4 (Laramie, Wyoming) **Conference on Matrix Theory for Applications**
Contact D. Porter, Department of Mathematics, University of Wyoming, Laramie, Wyoming 82071, U.S.A.

July 19-29 (West Berlin) **1989 European Meeting of the Association for Symbolic Logic**
Contact E.-J. Thiele, Fachberich Mathematik, MA 8-1, Strasse der 17 Juni 135, D-1000 Berlin 12, West Germany.

July 24-27 (Guaruja, Brazil) **Gauss Symposium on Mathematics and Theoretical Physics**
Contact Gauss Symposium, Pos-Graduacoa e Pesquisa-Unisantos, Rua Euclides da Cunha no. 241, CEP 11060, Santos, S.P., Brazil.

July 24-29 (San Francisco) **Second China-U.S.A. Conference in Graph Theory, Combinatorics, Algorithms and Applications.**
Contact Directors, Second China-U.S.A. Conference, C/- Department of Mathematics and Statistics, Western Michigan University, Kalamazoo, Michigan 49008-5152, USA.

July 25-27 (Cambridge, England) **JOINT IMA/SPE European Conference on the Mathematics of Oil Recovery.**
Contact IMA (See (1) below).

July 27-29 (Paris) **International Symposium on Cauchy and the French Mathematical World.**
Contact U. Bottazzini, Universita di Bologna, Dipartimento di Matematica, Piazza di Porta San Donato 5, 40127 Bologna, Italy.

July 29-August 12 (St Andrews, Scotland) **Groups - St Andrews 1989**
Contact Dr C.M. Campbell, Mathematical Institute, University of St Andrews, North Haugh, St Andrews, Fife K416 95S, Scotland.

July 30-August 12 (Brunswick, Maine) **Harmonic Analysis on Reductive Groups**
Contact W. Barker, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, California 94720, U.S.A.

July 31-August 4 (New Hampton, New Hampshire) **39th Gordon Research Conference on Statistics in Chemistry and Chemical Engineering**
Contact L. Sheiner, University of California, C255, San Francisco, California 94143, U.S.A.

August-September (Novosibirsk, USSR) **International Conference on Algebra**
Contact Academician M.M. Lavrentjev, Director of the Institute of Mathematics, Novosibirsk 630090, USSR.

August 1-9 (Hamburg and Munich) **18th International Congress of the History of Science**
Contact Professor C.J. Scriba, Institut für Geschichte der Naturwissenchaften, Bundesstr. 55, D-2000 Hamburg 13, Federal Republic of Germany.

August 2-5 (Chicago) **Seventh International Conference on Mathematical and Computer Modelling**
Contact Professor X.J.R. Avula, Department of Mechanical and Aeronautical Engineering and Engineering Mechanics, University of Missouri-Rolla, Rolla, Missouri 65401, U.S.A.

August 6-7 (Boulder, Colorado) **AMS Short Course on Cryptology and Computational Number Theory**
Contact M. Foulkes, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940, U.S.A.

August 7-11 (Poznan, Poland) **Fourth International Seminar on Random Graphs and Probabilistic Methods in Combinatorics and Computer Science**
Contact M. Karonski, Department of Discrete Mathematics, Adam Mickiewicz University, Matejki 48/49, 60-769 Poznan, Poland.

August 7-17 (Montréal) **Annual CMS Seminar: Lie Theory, Differential Equations and Representation Theory**
Contact F.H. Clarke, Director CRM, Université de Montréal, C.P. 6128-A, Montréal, Québec H3C 3J7, Canada.

August 10-12 (Brisbane) **International Conference on Computational Techniques and Applications**
Contact School of Environmental Studies, Griffith University, Nathan, Queensland 4111, Australia.

August 13-19 (Rousse, Bulgaria) **Fourth Conference on Differential Equations and Applications**
Contact Organising Committee CDE-IV, Technical University, Konsonolska Street N8, 7017 Rousse, Bulgaria.

August 13-19 (Szeged, Hungary) **Colloquium on Universal Algebra**
Contact A. Szendrei, Bolyai Institute, Aradi vertanuk tere 1, H-6270 Szeged, Hungary.

August 14-20 (Neuchatel, Switzerland) **3rd International Conference on Recent Developments in Statistical Sciences**
Contact Yadolah Dodge, Université de Neuchatel, Group d'Informatique et statistique, Pierre-à-Mazel 7, Ch-2000 Neuchatel, Switzerland.

August 20-25 (Vancouver) **Second Conference of the Canadian Number Theory Association**
Contact K.S. Williams, Department of Mathematics and Statistics, Carleton University, Ottawa, Canada K15 5B6.

August 20-26 (Detroit) **Eleventh International Joint Conference on Artificial Intelligence**
Contact C. Mazzetti, AAAI Office, 445 Burgess Drive, #100, Menlo Park, California 94025, U.S.A.

August 20-September 6 (Saint-Flour, France) **Nineteenth Ecole d'ete de Calcul des Probabilities**
Contact P.L. Hennequin, Université Blaise Pascal Clermont-Ferr., Department de Mathematiques Appliquées, B.P. 45-63170, Aubiere, France.

August 21-25 (Prague) **EQUADIFF 7**
Contact Professor Jaroslov Kurzweil, Chairman, EQUADIFF 7, Institute of Mathematics, Czechoslovak Academy of Science, Zitra ul. 25, 115 67 Praha 1, Czechoslovakia.

August 28-September 1 (San Francisco) **IFIP 89 - 11th World Computer Conference**
Contact IFIP Secretariat, 3 Rue du Marché, CH-1204 Geneva, Switzerland.

August 28-September 1 (Beijing) **International Conference on Symplectic Geometry and Computational Hamiltonian Dynamics**
Contact W. Dao-Liu, Computing Center, Chinese Academy of Sciences, P.O. Box 2719, Beijing 100080, China.

August 28-September 2 (Poznan, Poland) **Second International Conference on Function Spaces**
Contact J. Musielak, Institute of Mathematics, A. Mickiewicz University, Matejki 48/49, 60-769 Poznan, Poland.

August 28-September 8 (Trieste, Italy) **Topical Meeting on Variational Problems in Analysis**
Contact International Centre for Theoretical Physics, P.O. Box 586, Miramore, Strada Costiera 11, 34100 Trieste, Italy.

August 29-September 6 (Paris) **47th Session of the International Statistical Institute**
Contact International Statistical Institute, 428 Prinses Beatrixlaan, Voorburg, Netherland.

September (Cardiff) **International Conference on Mathematics in Transport Planning and Control**
Contact IMA (see (1) below)

September 1-10 (Czechoslovakia) **Summer School of Algebra and Ordered Sets**
Contact I. Chajda, Department of Algebra and Geometry, Faculty of Sciences, University of Olomouc, Leninova 26, 771 46 Olomouc, Czechoslovakia.

September 4-8 (Debrecen, Hungary) **Colloquium on Computational Number Theory**
Contact I. Gaal, Kossuth Lajos University, Mathematical Institute, 4010 Debrecen Pf. 12, Hungary.

September 5-6 (Cambridge, England) **IMA Silver Jubilee Conference**
Contact IMA (see (1) below).

September 5-15 (Minneapolis, Minnesota) **Opening Workshop: An Introduction To Dynamical Systems**
Contact Institute for Mathematics and its Applications, Minneapolis, Minnesota 55455, USA

September 6-8 (Ulm, West Germany) **Fourteenth Symposium on Operations Research**
Contact U. Rieder, Abteilung für Mathematik VII, Universität Ulm, D-7900 Ulm, Federal Republic of Germany.

September 8-14 (Wroclaw, Poland) **COSMEX '89: International Conference on Stochastic Methods in Experimental Sciences**
Contact A. Weron, Institute of Mathematics, Politechnika, 50-370 Wroclaw, Poland.

September 11-15 (Lausanne, Switzerland) **Fifth International Conference on Numerical Methods in Engineering**
Contact Professor R. Gruber, GASOV/Centre de Calcul, EPFL, 1015 Lausanne, Switzerland.

September 17-22 (Leeds) **The ICME Conference on the Popularization of Mathematics**
Contact A.G. Howson, Faculty of Mathematical Studies, University of Southampton, Southampton 509 5NH, England.

September 18-21 (Houston, Texas) **Siam Conference on Mathematics of Geophysical Sciences**
Contact SIAM Conference Co-ordinator, Suite 1400, Architects Building, 117 S.17th Street, Philadelphia, Pennsylvania 19103-5052, U.S.A.

September 18-22 (Vienna) **XII Österreichischer Mathematikerkongress**
Contact Professor Dr Werner Kuikh, Technische Universität Wien, Wiedner Hauptstrasse 8-10, A-1040, Vienna, Austria.

September 18-23 (Varna, Bulgaria) **Conference on Integral Equations and Inverse Problems**
Contact Institute of Mathematics at the Bulgarian Academy of Sciences, Conference on Integral Equations and Inverse Problems, P.O. Box 373, 1090 Sofia, Bulgaria.

September 21-22 (Warwick) **Mathematics in the Car Industry**
Contact IMA (see (1) below).

September 25-29 (Canberra) **Third International Conference on the Theory of Groups and Related Topics**
Contact J. Cossey, Mathematics Department, Faculty of Science, Australian National University, GPO Box 4, Canberra ACT 2601, Australia.

September 26-29 (Adelaide) **Traffic Theories for New Telecommunications Services**
Contact Dr L.T.M. Berry, Director, Teletraffic Research Centre, University of Adelaide, GPO Box 498, Adelaide, SA 5001, Australia.

September 27-29 (Delft, The Netherlands) **Eighth GAMM Conference on Numerical Methods of Fluid Mechanics**
Contact Mrs R. Komen-Zimmerman, Congressbureau TU Delft, Stevinweg 1, 2628 Delft, The Netherlands.

October 2-5 (Basel, Switzerland) **IMACS-GAMM International Symposium on Computer Arithmetic and Self-Validating Numerical Methods**
Contact C. Ullrich, Institut für Informatik, Universität Basel, Mittlere Strasse 142, CH-4056 Basel, Switzerland.

October 12-14 (Tallahassee, Florida) **Second Interdisciplinary Conference on Natural Resource Modeling and Analysis**
Contact M. Mesterton-Gibbons, Department of Mathematics, Florida State University, Tallahassee, Florida 32306-3027, U.S.A.

October 16-20 (Minneapolis, Minnesota) **Workshop: Patterns in Chemical Reactors**
Contact Institute for Mathematics and its Applications, Minneapolis, Minnesota 55455, U.S.A.

October 16-20 (Beijing, China) **Sixth World Congress on Medical Informatics**
Contacts Ms Shan Huiquin, Medinfo 89, Office of the Secretariat, China Computer Technical Service Corp, 29 Xueynan Nanlu, Haidian District, Beijing, China.

October 20-24 (Montréal) **Hamiltonian Systems, Transformation Groups and Special Transform Methods**
Contact F.H. Clarke, Director CRM, Université de Montréal, C.P. 6128-A, Montréal, Québec H3C 3J7, Canada

October 22-28 (Linz and Vienna, Austria) **Österreichisches Symposium Zur Geschichte Der Mathematik**
Contact Dr Christa Binder, Institut für Mathematik, Technische Universität Wien Wiedner Hauptstrasse 8-10, A-1040 Vienna, Austria.

November 6-10 (Tempe, Arizona) **SIAM Conference on Applied Geometry**
Contact SIAM Conference Co-ordinator, Suite 1400, Architects Building, 117 S.17th Street, Philadelphia, Pennsylvania 19103-5052, U.S.A.

November 13-17 (Minneapolis, Minnesota) **Workshop: Dynamical Issues in Combustion Theory**
Contact Institute for Mathematics and its Applications, Minneapolis, Minnesota 55455, USA.

December 11-13 (Chicago) **Fourth SIAM Conference on Parallel Processing for Scientific Computing**
Contact SIAM Conference Co-ordinator, Suite 1400, Architects Building, 117 S.17th Street, Philadelphia, Pennsylvania 19103-5052, U.S.A.

* * 1990 * *

February 11-15 (Coolangatta, Queensland) **26th Australian Applied Mathematics Conference**
Contact Dr V.G. Hart, Department of Mathematics, University of Queensland, St Lucia, Queensland 4067, Australia.

March 5-7 (New Orleans) **SIAM Conference on Applied Probability in Science and Engineering**
Contact SIAM Conference Co-ordinator, Suite 1400, Architects Building, 117 S.17th Street, Philadelphia, Pennsylvania 19103-5052, U.S.A.

March 18-24 (Hamburg, Germany) **Third Centenary Celebration of the Mathematische Gesellschaft in Hamburg**
Contact Mathematische Gesellschaft in Hamburg, Geschäftsstelle, Bundesstrasse 55, D-2000 Hamburg 13, Federal Republic of Germany.

May 21-25 (Tucson, Arizona) **Eleventh United States National Congress of Applied Mechanics**
Contact C.F. Chen, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, Arizona 85721, U.S.A.

May 25-31 (Atlantic City, New Jersey) **Tenth International Conference on Pattern Recognition**
Contact H. Freeman, CAIP Center, 605 Hill, Rutgers University, New Brunswick, New Jersey 08903, U.S.A.

June 6-12 (Barcelona) **1990 Barcelona Conference on Algebraic Topology**
Contact M. Castellet, Director, Centre de Recerca Matematica, Institut D'Estudis Catalans, Apartat 50-08193 Bellaterra, Barcelona, Spain.

June 11-14 (New York) **8th International Conference of Systems and Cybernetics**
Contact Professor C.V. Negoita, Department of Computer Science, Hunter College, City University of New York, 695 Park Avenue, New York, N.Y. 10021, U.S.A.

June 11-15 (Uppsala, Sweden) **Third International Conference on Hyperbolic Problems**
Contact Professor Dr B. Gustafason, Department of Computer Sciences, University of Uppsala, Sturegatan 4B 2TR, Uppsala, Sweden.

July 2-6 (Budapest) **XVth International Biometric Conference**
Contact Ms Eva Sos, Computer and Automation Institute, Hungarian Academy of Sciences, H-1502 Budapest, P.O. Box 63, Hungary.

July (Sydney) **10th Australian and 2nd Pacific Statistical Congress**
Contact D.J. Daley, Department of Statistics, Australian National University, GPO Box 4, Canberra, ACT 2601, Australia.

July 2-6 (Townsville) **34th Annual Meeting of the Australian Mathematical Society**
Contact Professor R.J. Hosking, Department of Mathematics, James Cook University, Townsville, Queensland 4811, Australia.

August (Uppsala, Sweden) **53rd Annual Meeting of the Institute of Mathematical Statistics and 2nd World Congress of the Bernoulli Society**
Contact Lynne Billard, Department of Statistics, University of Georgia, Athens, Georgia 30602, U.S.A.

August 21-29 (Kyoto, Japan) **International Congress of Mathematicians**
Contact ICM-90 Secretariat, RIMS (see (2) below).

August 19-24 (Dunedin, N.Z.) **Third International Conference on the Teaching of Statistics**
Contact the Secretary, ICOTS 3, Department of Mathematics and Statistics, University of Otago, P.O. Box 56, Dunedin, New Zealand.

September 10-14 (Dresden) **Mathematiker-Kongress**
Contact Professor G. Burosch, Sektion Mathematik, Wilhelm-Pieck-Universität, Universitätsplatz 1, Rostock 1, 2500 German Democratic Republic.

December 3-7 (Palmerston North, N.Z.) **1990 Australasian Conference on Combinatorics**
Contact Dr C.H.C. Little, Department of Mathematics and Statistics, Massey University, Palmerston North, New Zealand.

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July 8-12 (Washington D.C.) **Second International Conference on Industrial and Applied Mathematics**
Contact IMA (see (1) below).

Special Contact Addresses:

(1) **IMA:** Miss Shirley Wardle, Conference Officer, The Institute of Mathematics and its Applications, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY, England.

(2) **RIMS:** Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyo-ku, Kyoto 606, Japan.

M R Carter
Massey University

PROBLEMS AND QUERIES

P15 "3816547890 and more of that"

Recall David Gauld's problem of December 1984 (Newsletter #32) to find the number $N(b)$ of numbers n whose b-ary representation is $n = a_{b-1}a_{b-2}...a_1a_{0(b)}$, $a_{b-1} \neq 0$, with the digits being a permutation of $\{0, 1, .., b_{-1}\}$ and $a_{b-1}...a_{b-k(b)}$ being divisible by k, $k = 1,2,...,b$.

David asked us to:

1. Show $N(10) = 1$;
2. Find $N(12)$, $N(14)$, $N(16)$, ...

No complete solution was found, the extensive response was David's published in Newsletter #42, April 1988.

Although several solutions to $N(10) = 1$ were based on exhaustive computer searches, the editors recently recieved the following analytic proof by K D Ling, Department of Mathematics, National University of Singapore.

On Gauld's "3816547290 and all that"

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Let us begin with the following definition of Gauld (1984).

Definition: A positive integer n is said to have the property $P(b)$, $b \geq 2$, if

(i) its b-ary representation, $n = a_{b-1}a_{b-2}...a_1a_{0(b)}$ $(a_{b-1} \neq 0)$, contains each of the b b-ary digits exactly once; and

(ii) k is a divisor of $a_{b-1}...a_{b-k(b)}$ for each $k = 1,2,...,b$.

For example, 3816547290 has the property $P(10)$ since $1|3$, $2|38$, $3|381$ and so on, and 228 has the property $P(4)$ since $228 = 3210_{(4)}$ and $1|3_{(4)}$, $2|32_{(4)}$, $3|321_{(4)}$ and $4|3210_{(4)}$.

Now let $N(b)$ be the number of positive integers with property $P(b)$. Gauld (1988) proved that $N(b) = 0$ if $b = 2n(2n-1)$ for $n > 1$, and also found by a computer search that

$$N(b) = \begin{cases} 1, & \text{if } b = 14, \\ 0, & \text{if } b \in \{16, 18, 20, 22, 24, 26, 28\}. \end{cases}$$

In this note we give a proof of $N(10) = 1$ (see Gauld (1984)). In other words, if n has the property $P(10)$, then it must be 3816547290.

Proof: Let $n = a_9 a_8 \ldots a_1 a_0$ be a positive integer with property $P(10)$. Gauld (1988) pointed out that the even indexed digits must be even and so the odd indexed digits must be odd. Therefore we may write n as follows:

$$n = \emptyset_5 E_5 \emptyset_4 E_4 \emptyset_3 E_3 \emptyset_2 E_2 \emptyset_1 E_1$$

where $\emptyset$'s and E's are distinct denary odd digits and even digits respectively. Further, $E_1 = 0$ since $10 | n$, and $\emptyset_3 = 5$ since $5 | \emptyset_5 E_5 \emptyset_4 E_4 \emptyset_3$. Also $4 | \emptyset_5 E_5 \emptyset_4 E_4$, it follows that $4 | \emptyset_4 E_4$ which in turn implies that $\emptyset_4 E_4 \in \{12, 16, 32, 36, 72, 76, 92, 96\}$. Therefore we have

$$E_4 \in \{2,6\}. \tag{1}$$

We also observe that $3 | \emptyset_5 E_5 \emptyset_4$ if and only if

$$3 | \emptyset_5 + E_5 + \emptyset_4, \tag{2}$$

$6 | \emptyset_5 E_5 \emptyset_4 E_4 \emptyset_3 E_3$ if and only if

$$3 | E_4 + \emptyset_3 + E_3, \tag{3}$$

and $8 | \emptyset_5 E_5 \emptyset_4 E_4 \emptyset_3 E_3 \emptyset_2 E_2$ if and only if

$$8 | E_3 \emptyset_2 E_2. \tag{4}$$

Combining (1) and (3), we have either $E_4 = 2$, $E_3 = 8$ or $E_4 = 6$, $E_3 = 4$; or equivalently we have the following two cases:

Case (I) $n = \emptyset_5 E_5 \emptyset_4 258 \emptyset_2 E_2 \emptyset_1 0$,
Case (II) $n = \emptyset_5 E_5 \emptyset_4 654 \emptyset_2 E_2 \emptyset_1 0$.

In case (I), let $E_5 = 6$. Then $n = \emptyset_5 6 \emptyset_4 258 \emptyset_2 4 \emptyset_1 0$. By (2), $\{\emptyset_5, \emptyset_4\} = \{3,9\}$ and so $\emptyset_2 \in \{1,7\}$. But $8 \nmid 814$ and $8 \nmid 874$ which contradicts (4). Hence $E_5 \neq 6$. Next, if $E_5 = 4$, by (2), $\{\emptyset_5, \emptyset_4\} = \{1,7\}$ and so $\emptyset_2 \in \{3,9\}$. We observe that $\emptyset_2 \neq 3$ since $8 \nmid E_3 \emptyset_2 E_2 = 836$ and $\emptyset_2 \neq 9$ since $7 \nmid 1472589$ and $7 \nmid 7412589$. Therefore n must come from Case (II).

For Case (II), by using the same argument above, we rule out the case that $E_5 = 2$. Hence $E_5 = 8$ and so by (3) we have

$$n = \emptyset_5 8 \emptyset_4 654 \emptyset_2 2 \emptyset_1$$

where $\{\emptyset_5, \emptyset_4\} = \{7,9\}$ and $\emptyset_2 \in \{1,3\}$ or $\{\emptyset_5, \emptyset_4\} = \{1,3\}$ and $\emptyset_2 \in \{7,9\}$. It can easily be checked that $7|\emptyset_5 8 \emptyset_4 65 \emptyset_2$ if $\{\emptyset_5, \emptyset_4\} = \{7,9\}$ and $\emptyset_2 \in \{1,3\}$. Therefore we conclude that $\{\emptyset_5, \emptyset_4\} = \{1,3\}$ and $\emptyset_2 \in \{7,9\}$. By (4) we have $8|4\emptyset_2 2$ which implies $\emptyset_2 = 7$ and so $\emptyset_1 = 9$. Finally $7|\emptyset_5 8 \emptyset_4 6547$ implies that $\emptyset_5 = 3$ and $\emptyset_4 = 1$. Hence n must be 3816547290. This completes the proof of $N(10) = 1$.

Acknowledgement: I wish to thank my colleague, Associate Professor Lee Peng Yee for bringing my attention to this problem.

References

[1]   D.B. Gauld (1984), "Problem 15: 3816547290 and all that". *New Zealand Mathematical Society Newsletter* **32** (December 1984), p.17.

[2]   D.B. Gauld (1988), 'A partial solution to Problem 15 "3816547290 and all that" '. *New Zealand Mathematical Society Newsletter*, **42** (April 1988), pp.19-20.

This problem is still open. Perhaps a similar assault on $N(b)$ for larger values of b may be fruitful.

P 9   The only solution to problem P9 (Newsletter #42, April 1988) is that supplied by the proposer, Emeritus Professor A. Zulauf, Waikato.

Let m be a given integer, $m \geq 2$. Let S be the set of all non-negative integers n for which the equation

$$x^4 - (mn+1)x^2 + n^2 = 0 \tag{1}$$

has four integer solutions x. The sequence $(n_k)_{k=1}^{\infty}$ of all elements of S arranged in ascending order of magnitude is given by

$$n_k = a_{k-1} a_k, \text{ where } a_0 = 0, \ a_1 = 1, \ a_k = m a_{k-1} - a_{k-2} \ (k = 2,3,...) \tag{2}$$

or equivalently by

$$n_1 = 0, \ n_2 = m, \ n_k = (m^2 - 2)n_{k-1} - n_{k-2} + m \ (k = 3,4,...).$$

Proof: The four solutions of (1) are $x = \pm a$, $y = \pm b$ with $0 \le a \le b$ where $a^2 + b^2 = mn+1$, $ab = n$. Clearly $a < b$. Thus $n \in S$ iff $(u,v) = (a,b)$ is an integral solution of

$$u^2 + v^2 - muv = 1 \qquad (3)$$

with $0 \le u < v$. Now the equation $a^2 + z^2 - maz = 1$ has two solutions:

$$z_1 = 1/2 \left(ma + \sqrt{m^2 a^2 - 4a^2 + 4} \right) > a$$

$$z_2 = ma - z_1 = (a^2 - 1)/z_2 < a.$$

Thus, $(u,v) = (ma-b, a)$ also satisfies (3) provided $u = (a^2-1)/b > 0$. Clearly we require $a \ge 1$. Thus given any solution (u,v) to (3), then so too is $(mu-v, u)$ provided $mu - v \ge 0$.

Now we define the strictly decreasing sequence of integers (u_j), where:

$$u_0 = b, \ u_1 = a, \ u_j = mu_{j-1} - u_{j-2}, \ (j = 2,3,...).$$

Thus $(u,v) = (u_j, u_{j-1})$ is an integral solution satisfying (3) for $j = 0,1,...,k$ where k is the positive integer for which

$$0 \le u_k < 1 \le u_{k-1}.$$

u_k is integral so $u_k = 0 = a_0$ which, because of (3), implies further that

$$u_{k-1} = 1 = a_1.$$

Since $u_{k-j} = mu_{k-j+1} - u_{k-j+2}$ for $j = 2,3,...,k$,

$$u_{k-j} = a_j, \ \text{for } j = 0,1,2,...,k,$$

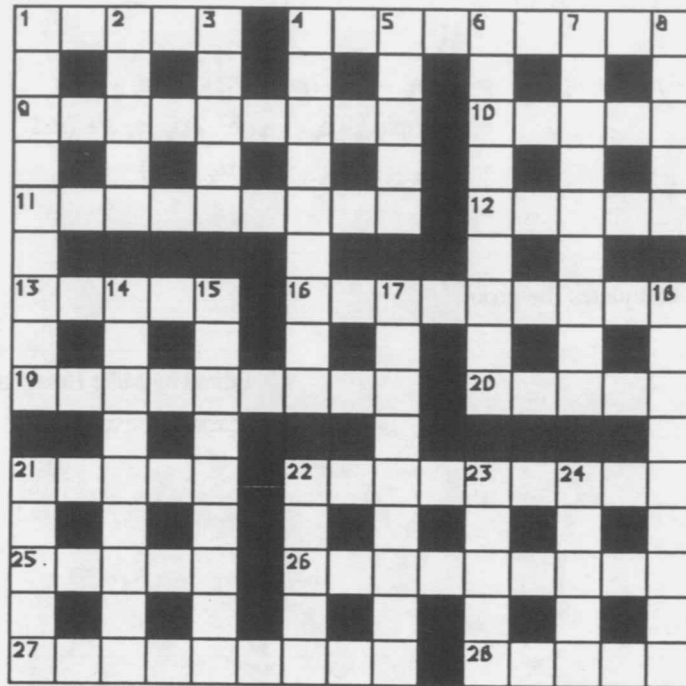where the a_j are given by (2). In particular $a = u_1 = a_{k-1}$ and $b = u_0 = a_k$, so

$$n = ab = a_{k-1} a_k.$$

It follows that $n \in S$ iff $n = n_k$ for some $k \geq 1$, n_k given by (2). Finally,

$$n_1 = a_0 a_1 = 1 \ , \ n_2 = a_1 a_2 = m \ ,$$

and as $(u,v) = (a_{k-2}, a_{k-1})$ satisfies (3),

$$\begin{aligned}
n_k - (m^2 - 2)n_{k-1} + n_{k-2} &= a_{k-1}a_k - (m^2-2)a_{k-2}a_{k-1} + a_{k-3}a_{k-2} \\
&= a_{k-1}(ma_{k-1} - a_{k-2}) - (m^2-2)a_{k-2}a_{k-1} + (ma_{k-2} - a_{k-1})a_{k-2} \\
&= m(a_{k-2}^2 + a_{k-1}^2 - ma_{k-2}a_{k-1}) \\
&= m
\end{aligned}$$

for $k = 3,4, \ldots$. This completes the proof.

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Crossword No. 26 Solution

CROSSWORD

The five-letter answers are entered normally. The nine-letter answers have a theme in common. Some of them consist of two words and one has three words. From each of the sixteen nine-letter answers the letters of a four-letter word can be removed to leave a five-letter word, except in three cases where the residual letters must be rearranged to make a five-letter word. The four-letter words are AGAR, BLUB, CERT, CUES, DACE, DALE, FORE, FUNK, HUSH, LOUT, MADE, RASP, SEES, SENT, SETS, SIDE.

The five-letter words are: ACORN, BEGUM, BERRY, CARGO, CAROL, CHEEP, DANDY, LEMAN, MOINE, NAVES, PUPPY, RE-MET, TRONA, ALARM, CRUMB, QUOTE. (The last three must be re-served.)

Across

1. All mixed up, blame the girl (5)
10. Fast one expert in Rolls Royce (5)

12. Indicative sign shot from bow (5)
13. The charged one in charge of Greek order (5)
20. The rest of the masterpiece (5)

21. Proverbially hidden by trees (5)
25. Four or six in the cover! Very angry! (5)
28. Loves to find the answer jumbled (5)

Down

2. Presumably A's act is over for the animal (5)
3. Sly in an ogling way (in the manner of W.S.'s Tradgedy? (5)
5. Iron-headed golf-club (5)
8. Art up in the quarters makes cut stalks (5)
21. To leave without paying; describing the principality (5)
22. Left in the car-horn's noise makes another (5)
23. Attic room over stable pigeon house (5)
24. Increase towards fifty making a noise (5)

(The solution to Crossword No. 26 is on the previous page.)