

Mathematics



Department of Mathematics

University of Toronto

February 1998

Letter from the Chair

It is a pleasure to be able to report to our alumni, students, colleagues and friends that things are going well in the Department of Mathematics.

We were very fortunate in our ability to attract some outstanding new colleagues for this year (Lisa Jeffrey, Eckhard Meinrenken and Jeremy Quastel), and Jeremy's joint appointment with Statistics will strengthen the links between the two departments. Now we are recruiting for three more tenure-stream positions: in algebra and number theory, in algorithmic mathematics (joint with Computer Science) and in applied mathematics (physical science), and also for a number of limited term positions. Faculty renewal keeps a department alive, and this is especially true in a discipline like Mathematics which develops and changes with remarkable speed.

You will also be pleased to know that we have completed the first stage of a major curriculum reform. The department has always been justly proud of its Mathematics Specialist Program, whose graduates are welcomed in every major US graduate school. This year, under the leadership of Ed Bierstone, we have introduced a parallel program in Applied Mathematics and a program in Mathematics with Applications.

This last program is a very exciting concept. It permits students to 'marry' an interest in mathematics with an interest in another field. Thus within the program the student selects an area of concentration from computer science, probability/statistics, finance, physical science or teaching. As time goes on we will modify this list depending on student interest and external demand. Indeed, the ability to 'think mathematically' in context is increasingly important in a wide variety of jobs, and this program is specifically intended for students needing that ability in their careers.

Elsewhere in this newsletter you will read about the honours our faculty and students continue to accumulate, enhancing our stature as Canada's premier mathematics department. You will also read about the University of Toronto Mathematics Association for our friends and alumni, established last year with a lot of work by an initial committee consisting of several of our alumni, some

of whom constitute the first board of directors. This is a wonderful thing for the department. The Association has now grown to a membership of 90 and is already organizing reunions and a lecture series. Finally, you will read about the activities of the UT Math Network in support of high school students and teachers. I am very proud of what has been accomplished here in the last two years and I would particularly like to thank Nami Bland for her work as coordinator.

This positive tone may be surprising given the terrible stress that universities in Canada are experiencing because of very significant reductions in government support from levels that were already substandard in the international context. That stress has a direct impact on our department. It affects what we can offer students, the size of our classes, the quality of infrastructure we can provide, the amount of student support we can offer, and the number of graduate students we can teach. To do well in times of genuine hardship requires: committed faculty, staff and students, all of the highest caliber, true support from the university administration and significant contribution from our friends and alumni. We are fortunate to have all three.

Many of you, in fact, have been active participants with your contribution to the Coxeter Scholarship Fund. We have over 200 contributors, including more than 50 members of the department. Contributions are also regularly coming for the Malcolm Slingsby Robertson endowment for a graduate fellowship. Unfortunately the University is in the middle of switching computer systems and this has made it impossible to get an up-to-date report of the totals. As soon as I know I will report to contributors, as well as in the next newsletter.

You will also remember that we are searching for the first holder of the Ted Mossman Chair in Mathematics. This permanently endowed Chair was the generous gift of James Mossman. It is with great pleasure that I can announce that the department has just received a second endowed chair. This has just happened as the newsletter is going to press and no more details are available; I will report on this at length in the next newsletter! I can also report that three new permanent undergraduate scholar-

ships in mathematics will be established, at a value of \$4,000 each. Again, details will have to wait till the next newsletter. Altogether, however, it is a wonderful way to start the year.

I referred earlier to the support of the University administration. This has been steady and reliable over the last several years, with perhaps the most exciting moment being the successful university-led winning of the competition for the site of the Fields Institute. But in this letter I want particularly to thank Marsha Chandler, now Senior Vice-Chancellor – Academic Affairs, at University of California at San Diego, whose leadership as Dean of Arts and Science has been truly a key element for us. This fall we welcomed Carl Amrhein, Chair of Geography, as the new Dean. Since I have known Carl for several years as a fellow Chair, I will take this opportunity to wish him well and to say the University could not have done better. As with Marsha, the department will have to earn the support it receives from Carl; as with Marsha I am confident it will receive the support it earns.

– Steve Halperin

Calling all Beatty Award Winners

From 1960 until 1966, and again from 1977 to the present, the Samuel Beatty Fund has awarded in-course scholarships to over 400 students. Perhaps you were one of them.

The Fund, established in 1952 by the alumni to honour Professor Beatty, a well-respected and long-standing Head of Mathematics and Dean of Arts and Science, is supervised by a Board of Trustees which includes five alumni and chairs of departments in the mathematical sciences. It has supported the cause of mathematics in Ontario and at the University of Toronto in many ways, notably through library grants and awards to students.

On Monday, April 6, the Board of Trustees will host a reception in honour of all Beatty Awardees from 2:30 until 4:30 pm at the Faculty Club, 41 Willcocks Street. We hope that you will be able to attend. Guests are also invited. If you know any other awardees, please pass the word.

If you plan to come, please respond to: Professor Nick Derzko, Secretary of the Samuel Beatty Fund Trustees at (416) 978-4107 (fax), (416) 978-5001 (phone), by mail to the department (Attn: Carolyn Bercu) or by electronic mail to bercu@math.utoronto.ca.

MARK YOUR CALENDARS

Tuesday, February 17:

4:30 pm in room 5017A, Sidney Smith Hall

Talk by John Maynard, FSA, FCIA (UTMA meeting)

Monday, April 6:

2:30 pm at the Faculty Club, 41 Willcocks Street

Reunion of Beatty Award Winners

Friday, May 22:

11:30 am at the North Bay OAME meeting

Talk by economics professor David Foot
followed by Alumni Lunch

Saturday, June 6:

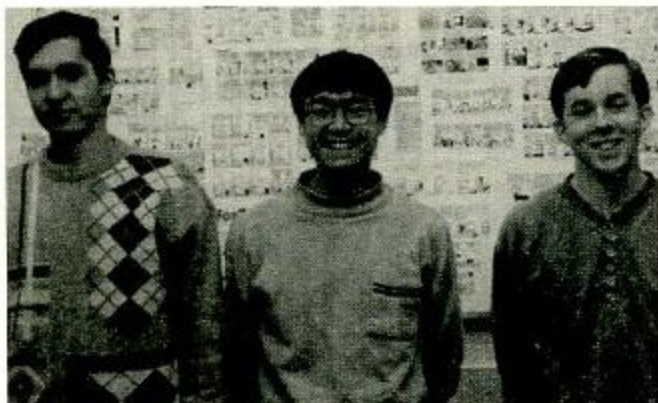
10-12 am and 2-4 pm at the
University Alumni annual spring reunion

University of Toronto Team Gets Top Position in the Mathematical Contest in Modelling

A University of Toronto team, consisting of undergraduates Adrian Corduneanu, Cyrus Hsia and Ryan O'Donnell, were designated as one of the two SIAM winners of the 13th Mathematical Contest in Modeling. Ryan O'Donnell presented the team's paper at the SIAM annual meeting at Stanford University in July, 1997, and it will be published in "The UMAP Journal".

In the 1997 contest, 400 teams from several countries competed. Two applied problems are presented to each team, one continuous and one discrete, on a Friday; it must select one of these, solve it and get a report off in the mail by the following Monday afternoon. About 250 teams, including the other winning team, Washington University at St. Louis, MO, chose the continuous problem. The University of Toronto team was one of 150 that selected the discrete problem.

This problem, bearing the title, "Mix well for fruitful



Adrian Corduneanu, Cyrus Hsia, Ryan O'Donnell

discussion", was to assign 29 corporate board employees to four morning and three afternoon discussion sessions, subject to a number of conditions designed to keep the size of the groups manageable and ensure that each member had a chance to interact with the other members.

The faculty advisor for the team was Professor Nick Derzko. While he did not have any contact with the team once they had the problem in hand, his was the important task of recruiting suitable students to represent the university and of ensuring that they were properly prepared.

New Appointments in Mathematics

The Mathematics Department has made three tenure-track appointments, Eckhard Meinrenken as assistant professor, Lisa Jeffrey as full professor at the Scarborough campus and Jeremy Quastel as associate professor, the last a joint appointment with the department of Statistics.

Professor Eckhard Meinrenken graduated in Physics from the University of Freiburg in 1994. However, while spending the academic year 1993-94 at the Massachusetts Institute of Technology, he became increasingly interested in mathematics, and returned to the Institute in 1995 for a three-year position as an instructor and Humboldt fellow. His current research is in symplectic geometry the natural framework for classical mechanics. He is working on Hamiltonian group actions and their "quantization", as well as their applications to mathematical physics and micro-local analysis.

Professor Lisa Jeffrey completed her doctorate in 1991 under the supervision of Michael Atiyah at Oxford University. She has since held positions at the Institute for Advanced Study in Princeton, and at McGill University. Her research used techniques from pure mathematics to prove results obtained by theoretical physicists using the

methods of quantum field theory. Using the functional integral (Feynman path integral), physicists have discovered many formulas which are very surprising and unexpected to pure mathematicians. This physical intuition is now complemented by rigorous mathematical proofs, another fine example of the symbiosis between the two disciplines.

Professor Jeremy Quastel grew up in Vancouver; however, he studied at McGill University, where he became interested in mathematics, particularly probability and analysis. Good luck (and good advice) guided him to the Courant Institute in New York to study under Raghu Varadhan. He arrived just as a small group was embarking on a new direction to study hydrodynamic limits of large interacting systems. A key problem in statistical mechanics is to provide a link between the microscopic and macroscopic descriptions of materials; one can come to understand their relaxation to equilibrium by studying large stochastic systems. An example is the Navier-Stokes equations of fluid dynamics, now derived rigorously as a scaling limit of lattice gases. Such studies lead also to useful new methods in probability, for example in diffusion theory, large deviations and equilibration rates of Markov processes. He joins our department from the University of California at Davis.

Departmental Honors

Donald Coxeter has been named a Companion of the Order of Canada (this is the highest of the three possible levels). Professor Coxeter was also awarded the Sylvester Medal of the Royal Society of London.

James Arthur has been awarded the premier prize of the Academy of Science of the Royal Society of Canada, the **Henry Marshall Tory Gold Medal**, in recognition of his stature as one of Canada's leading scientists.

Dietrich Burbulla has received the **Professor of the Year Award** from the 2nd year Electrical and Computing Engineering class.

George Elliott has been selected as the next **Jeffery-Williams Lecturer** of the Canadian Mathematical Society.

Boris Khesin has won a **Sloan Fellowship** for 1997-99, and has also been awarded the **1997 Aisenstadt Prize** by the Centre de Recherches Mathématiques in Montreal. His prize lecture, "Complexification dictionary and holomorphic linking number" was given in Montreal on January 30.

Pierre Milman has been elected a **Fellow of the Royal Society of Canada**.

Joe Repka has won a **Faculty of Arts and Science**

Teaching Award. Since their inception a grand total of TEN awards have been made to faculty in the eight science departments. Of these, FOUR have now gone to mathematicians.

Michael Sigal has been appointed **University Professor**. This is the highest academic distinction at the University of Toronto, and is limited to about 25 faculty members at any time.

Catherine Sulem has been selected as the 1998 **Krieger-Nelson Prize Lec-**

turer of the Canadian Mathematical Society. She will lecture at the CMS Summer Meeting in St. John, New Brunswick. Professor Sulem also chairs the NSERC grant selection committee in applied mathematics.

The 1997 winners of the **DeLury Teaching Awards** awarded by the Mathematics Department are graduate students *Ovidiu Calin*, *Paul Centore* and *Stephen Gustafson*. The selection committee consisted of Peter Botta, Joe Repka and William Weiss.

The 1997 **Malcolm S. Robertson Prize**, awarded by the Mathematics Department to a graduating Ph.D. student who has demonstrated excellence in research has been awarded to *Stephen Theriault*. Stephen is a student of Paul Selick, who has gained his degree with a thesis entitled, "A reconstruction of Anick's fibration". Currently, he holds an NSERC Postdoctoral Fellowship at the Massachusetts Institute of Technology.

Fields Institute Program on Microlocal Methods

A research program on Microlocal Methods in Geometric Analysis and Mathematical Physics was the principal activity at the Fields Institute for the period August to December, 1997. It was organized by a committee consisting of three members of our department, Peter Greiner, Victor Ivrii and Maciej Zworski, as well as Johannes Sjöstrand of the Ecole Polytechnique in Paris and Steven Zelditch of The Johns Hopkins University. Through international workshops, graduate courses, lecture series and seminars, the event facilitated interaction between various areas of mathematical physics and linear and nonlinear partial differential equations. The underlying motif was the use of *phase space* techniques, or microlocal methods, in the study of solutions to partial differential equations. Michael Sigal and Luis Seco of our department gave talks at the opening sessions.

Week-long workshops early in September and at the end of October dealt with microlocal analysis and mathematical physics and microlocal methods in geometric analysis respectively. In conjunction with these, there were two series of distinguished lectures. In September, Professor Johannes Sjöstrand presented the sixth annual series of three R.A. Blyth lectures. They were entitled: Microlocal methods in partial differential equations, Trace formulae for resonance and applications, Resonances: Introduction and overview of some recent results. At the end of October, Richard B. Melrose of the Massachusetts Institute of Technology was a Fields Institute Distinguished Lecturer. His three lectures were entitled: Scattering theory, traveling waves and geodesics, The scattering matrix, trace formulae and asymptotics, and Invertibility, index formulae and global invariants.

RiskLab Update

The RiskLab at Erindale College, described in the last Newsletter (March 1997), is proving to be a roaring success, so much so that it has become a model for similar ventures elsewhere. The concept of an international network of research laboratories in Mathematical Finance was first mooted in discussions between Algorithmics Incorporated, the University of Toronto and the Fields Institute. Algorithmics is a leading provider of sophisticated software for the financial industry; the company donated this software towards the setting up of the first laboratory at Erindale College in collaboration with the U of T Mathematics Department.

The Director of the RiskLab is Professor Luis Seco. Although his doctorate is in mathematical physics, about two years ago, he became excited by the field of financial mathematics, which he regards as a "new type" of mathematical physics. Certainly the mathematics required to study financial systems, credit and risk management is both advanced and sophisticated. Partial differential equations, differential geometry, number theory, harmonic analysis and probability are all necessary tools. Seco emphasizes that, while the primary function of the Lab is research, it is an example of an area where advanced mathematics can play an important and useful role in society.

Current research projects treat the evaluation of credit risk, the evaluation of exotic options, volatility forecasts and stochastic optimization in pricing models.

Professor Seco, with the collaboration of Algorithmics and various local sponsors, is actively involved in the establishment of RiskLabs in other parts of the world. Toronto's pioneering lead has already been followed in Europe at Munich and Cambridge. Other sites are soon to follow in Austin, TX, at Cornell University in Ithaca, NY, and in Spain, Italy and Brazil.

Mathematics in the Industrial and Business Sectors

With the current dearth of new academic positions and the increasing number of areas of applications in mathematics, it is prudent for the modern student of mathematics to become acquainted with the opportunities available in the applied sector. Professor Nick Derzko has been for many years teaching mathematics appropriate to applications in business and industry and broadening the department's range of contacts. He currently chairs the Industrial Liaison Committee of the department that includes both faculty and students.

For the two years 1995-1997, he organized a series of industrial seminars in the mathematics department, with the aim of giving students a feel of a job in the industrial sector and an appreciation of the necessary preparation. The speakers were invited to give a 40-minute talk about their field, to be followed by a discussion period. The ros-

ter included Victoria Barclay of Sciex, Ron Dembo of Algorithmics Inc., Phil Morenz of the Bank of Nova Scotia, Bruno Scherzinger of Applanix Corp., Judd Sinton of IBM, Bruno di Stefano of Nuptek Systems Ltd., and Alan Thompson of Array Systems Computing. In the fall of 1997, this was superseded by similar series sponsored by the Fields Institute and involving the Universities of Toronto, Guelph, McMaster, Western Ontario, Waterloo and York. The first talk under this new regime was on cryptography, given by Scott Vanstone of the University of Waterloo and Certicom Corp.

Professor Derzko also initiated in the fall of 1997 a single-term graduate course in applied mathematics in which the students prepare seminar sessions and write a report on a topic of current interest that may either be of their own choice or selected from a list that is provided.

The Fields Institute Mathematics Education Forum

School mathematics education in Ontario has been undergoing quite a bit of turmoil in recent years, particularly with the current government's intention to reduce the number of high school years from five to four. In 1992, Steve Halperin, then recently appointed chair of the mathematics department, took an active interest in school education and brought together a representative group to examine the curriculum and make proposals. Somewhat later, the Fields Institute decided that, as part of its educational thrust, it could usefully act as a broker to bring together various interested persons from university mathematics and education departments, the teaching panel, community colleges and employers.

These two initiatives were brought together in March 1997 in the formation of the Fields Institute

Mathematics Education Forum. Its goal is to consider objectively new ideas and diverse views in mathematics education, to facilitate consensus and to promote the enhancement of mathematics education in Ontario and Canada. There are almost fifty members of the Forum, representing various constituencies, including several from the University of Toronto: Ed Barbeau, Nami Bland and Steve Halperin from the Department of Mathematics, and Gila Hanna, Brendan Kelly and Douglas McDougall from OISE/UT.

Currently, its activities have been focused on the Ontario situation, as there is considerable pressure to have a new curriculum in place for Grade 9 students in the fall of 1999. The provincial government is achieving this in three stages. The first was a background paper by Professor Geoff Roulet

of the Queen's University Faculty of Education to set out the educational issues and discuss current developments elsewhere. The second was the appointment of an eight-person expert panel consisting of representatives of the secondary and tertiary levels, as well as two members from outside the education community; the universities were represented by Steve Halperin. In the spring of 1997, under a great deal of time pressure, this group achieved a remarkable consensus in bringing curricular goals into focus and setting out a philosophy and set of guidelines for devising the syllabus. As of this writing, the government is in the process of selecting from among a number of applicants a writing team to flesh out the details. It is expected that the product of the writing team will be reviewed by the Expert Panel to ensure consistency with its directives.

The Department Lounge

Plans to improve the lounge facilities (room 5017B) have been in the works for several years now. Historically, the Lounge was a fairly empty place, and was perhaps regarded as a rather “impersonal” environment. Two years ago, graduate students started lobbying the administration to improve facilities, by, for example, installing a refrigerator and microwave oven. Also, many people complained about the quality of the existing coffee—it was surprising how many people were willing to go down 5 storeys and pay three times the cost for “Second Cup” coffee.

Initially, a major barrier to progress was the total inadequacy of the Lounge’s electric power supply. All power was routed through one circuit, which also supplied offices 5018A through 5018H—essentially, the entire west end of the 5th floor of Sid Smith. This circuit could only sustain a small load. Power failures happened regularly when something as small as an electric kettle tripped the breaker.

Because of this, the original, hoped-for improvements to Lounge infrastructure were delayed. While we were waiting for these things, the Mathematics Graduate Students’ Association decided to try to qualitatively improve the Lounge in other ways. Last year, we experimented with a number of projects. The “MGSA Tea Box” provided people with a wide variety of teas and other do-it-yourself hot beverages at a low cost. The Tea Box was maintained by myself and Steve Gustafson. The “MGSA Games Box” was a collection of games and recreational supplies we placed in the Lounge, in an (unsuccessful) effort to facilitate leisure and social activities there. For example, I purchased decks of cards and a chess and checkers set. Also, John Chew III donated a deluxe Scrabble set. I also performed repairs on the Ping Pong table in the Lounge. Ping Pong briefly became quite popular with some people.

The “MGSA Magazine Rack” was a venture we started to provide the Lounge with reading material in the form of newspapers and periodicals, and has been highly successful. Our initial attempt to get a collective subscription to the Toronto Globe and Mail failed. However, we did receive generous donations of magazines from many people. Robert Velasquez donated month-old issues of Scientific American. Dr. Tim Rooney donated week-old copies of The Economist, and Grace Wong donated week-old copies of MacLean’s. Dr. Chandler Davis donated a subscription to the Mathematical Intelligencer, and Raymond Westcott donated a subscription to The Nation. The Lounge now has a burgeoning supply of stimulating reading material, which I believe has been thoroughly enjoyed by many people.

In the spring of 1997, money was found to pay for improvements to the electrical system and for new appli-

ances. This came from a donation by the family of the late Dr. Peter Fantham, a longtime member of the mathematics faculty. We purchased a microwave oven, a refrigerator, a new coffee maker, a new espresso/cappuccino maker, and a coffee grinder. I also arranged with the Chair that the MGSA would take over responsibility for the Lounge coffee facilities. The contract with the existing supplier, Red Carpet, was cancelled, and in September, the MGSA Lounge Concession became fully active, providing coffee, tea, and a variety of other beverages. For example, with our new fridge, we were able to sell cold pop—a very popular item. Peter Bubenik has more than once generously donated his car so that we could restock our supplies of pop.

At the present time, the Lounge is basically managed by the MGSA executive. The coffee and tea supplies are taken care of by myself, Steve Gustafson (MGSA vice president) and Todd Lawrence Parsons. (MGSA Social Coordinator). These latter two individuals are also usually responsible for actually making the coffee in the mornings and afternoons, and keeping the coffee area looking neat and tidy. They have heroically dealt with many disasters and messes resulting from early technical problems with the machinery, without my even knowing about it. Peter Bubenik (MGSA Social Coordinator) makes periodic pop runs in his car. Ruben Martinez is nominally responsible for keeping the fridge clean.

In the future, further improvements are planned. Right now, the MGSA is considering putting some potted plants in the Lounge, to improve the atmosphere there (both psychologically and physically). Also, we have discussed with Dr. Halperin the possibility of replacing the water fountain in the hallway with a proper water faucet, which would make refilling tea kettles and coffee machines an infinitely easier job than it presently is.

— President MGSA — *Marcus Pivato*

Outreach to the Community

In the past few years, the Mathematics Department has greatly increased its range of activities that bring it into contact with the wider community, particularly of secondary students and their teachers.

We hope that you will be able to visit the department’s home page on the net; the address is <http://www.math.toronto.edu>. This is the creation of Joel Chan, a mathematics undergraduate to whom the department is greatly indebted for his enthusiasm and contributions to so many aspects of the department’s outreach.



SOAR students with Ray Westcott (third from left, rear)

The home page contains information about the department, a list of faculty members, links to home pages of both students and faculty in the department, administrative information for students, and links to other mathematical web sites. The Mathematical Network of the home page (<http://www.math.toronto.edu/mathnet/>) is the purview of Professor Philip Spencer. This is where you will see most of the interaction between the high school community and the department.

For many years, Ed Barbeau and Marie Bachtis have administered the Ontario region of the American High School Mathematics Examination (AHSME), a contest of the Mathematical Association of America. For the past three years, Eugene Kantorovitch has organized the Tournament of the Towns competition for Toronto, and arranged to have students come to the university for preparatory sessions. (This Tournament originated in Eastern Europe and has spread to many countries; students in different cities solve the same set of problems and the results compared using a formula that allows for differing populations.) More recently, the Department has become a centre for the Gelfand Correspondence Program in which students send in solutions to problems in a particular branch of mathematics for marking. The Academic Director of the Gelfand program is Eugene Kantorovitch, and the administrative coordinator is George Andrews, an alumnus of the M&P program (1960).

During the course of the year, several members of the department give talks to students at events sponsored by the department, a cluster of departments or the Faculty of Arts and Science. For example, in October, 1997, fifty-six students from Hamilton to Unionville participated in the Mathematical Sciences Day involving lectures, interactive exercises and problem solving sessions given by R. Sharpe (Discover Eureka), S. McCahan (Thermodynamics), J. Rosenthal (Large average value), E. Sottile (Euler's island) and E. Barbeau (Geometry: how do you look at it?).

The SOAR day program for about 45 students interested in mathematics was again held last summer for a three-week period. The topic was geometry. Professor Erich Ellers mapped out the academic program, and Ray

Westcott, a graduate student, along with colleagues Heather Betel and Ali Miri, fleshed out the details, created problems and organized the sessions. Blair Madore spent three-days showing how the Maple software could be used for geometric investigation. About a dozen high school teachers provided a great deal of assistance as group leaders. The following University of Toronto graduate students and professors gave guest lectures at the camp: Brett Stevens (combinatorics), Vijay Patankar (number theory), H.S.M. Coxeter (5 spheres in mutual contact) and Arthur Sherk (finite projective plane).

Not everything is for students. About eight times each academic year, SIMMER, the Society Investigating Mathematical Mind-Expanding Recreations, meets to hear a presentation on some topic and engage in discussion over dinner. This society is sponsored jointly by the Fields Institute for Research in Mathematical Sciences and the University of Toronto Mathematics Education Network. Its mandate is to bring together enthusiastic mathematics educators to share ideas, and to investigate recreational mathematical problems and concepts that arise from these problems. So far, the following meetings have occurred or are planned, all at the Fields Institute: March 27, 1997: Brett Stevens (Combinatorial block designs) May 22, 1997: Will Traves (Numbers ancient and modern) Sept. 25, 1997: Luis Seco (Mathematics of risk management) Oct. 23, 1997: Nick Derzko (Linear programming – the cornerstone of optimization) Nov. 27, 1997: Antônio Sá Barreto (The caustic in a tea cup) Jan. 29, 1998: Ragnar Buchweitz (How to see in more dimensions) Feb. 26, 1998: A.I.F. Urquhart (Numbers – finite and infinite) Mar. 26, 1998: Alison Gibbs and Martin Van Driel (statistics and distributions) May 28, 1998: Nancy Gallini (Economics is based in mathematics)

All of this activity is due to the energy and organizational skill of Mrs. Nami Bland. However, with her husband going away on sabbatical leave, she will be yielding the reins to a new coordinator this year.

Hands-on geometry at SOAR



University of Toronto Mathematics Association

The University of Toronto Mathematics Association is well under way with approximately ninety members. The founding meeting was held On April 5, 1997, at which time a Board of Directors was formed and a constitution approved. Richard Cammidge, a graduate of the mathematics and physics program in 1953, shared some of his memorabilia and talked about his career after graduation. He went into the United Church ministry and served in London, Ontario, before accepting a position as a probation and parole officer for the Ontario Government, from which he is now retired.

The first weekend in June marked the University of Toronto's homecoming, and we opened the mathematics lounge and the mathematics aid centre to mathematics graduates on the seventh of June. Thanks to the efforts of Bill Lumsden in Brookfield, WI, by far the largest contingent present was the class of 1947. Two at least became actuaries; some became professors (of mathematics, economics and industrial engineering); one worked at Bell Labs and another for the government; two went into the ministry, one as a United Church minister and another as a Roman Catholic priest.

In the fall, there were two meetings. On October 29, Dr. Martin Taylor, a graduate of Engineering Science who proceeded to obtain a doctorate in experimental psychology at The Johns Hopkins University, spoke on "Structures of autonomous perceptual control systems". He was a scientist at the Canadian Defense Research Board from 1960 until 1995, when he retired as Senior Experimental Psychologist. Around 1980, he combined his computer and psychological interests to do research into human factors of computer usage.

On November 20, members of the association were

invited to join with the Statistics Department, OISE/UT and the Graduate Program in Women's Studies to hear a talk by Dr. Mary Gray, a statistician at the American University in Washington, who gave a talk on how statistics was involved in equity litigation. On each occasion, the members adjourned to the faculty club for a friendly get-together.

A meeting has been scheduled for Tuesday, February 17 at 4:30 p.m. in the seminar room of the Department of Mathematics (Room 5017A in Sidney Smith Hall). John C. Maynard will speak on "The Human Side of Mathematics".

On Saturday, June 6, in conjunction with the University of Toronto Reunion Weekend, there will be a reunion of graduates in the mathematics department. The details follow below.

Apart from future activities of this type, we are planning to have an association magazine containing both news and some light mathematics and to explore the possibilities of amateur meetings and work with students.

The Founding Board consists of George Andrews, Ed Barbeau, Norm Burgess, John del Grande, Louis Levine and Christine Phillips, with the Chair of the Mathematics Department, as an ex officio member. The board has been assisted by Emile State, Sidney Soanes and David Sweeney. In particular, Dr. Soanes searched through the class lists from 1930 until 1970 to make sure that we had a complete list of alumni.

The Association welcomes new members. The annual dues are \$25 (which is waived for graduates continuing their studies). Please contact the secretary, Ed Barbeau at the Department of Mathematics for information. (fax 416-978-4107; email - barbeau@math.utoronto.ca).

The Spring Reunion

The University of Toronto 1998 Spring Reunion occurs on the first weekend of June. As we did last year, we would like to have a reunion of Mathematics and Physics Graduates on the Saturday - June 6. The mathematics lounge (Room 5017B) and the math aid center (Room 1071) in Sidney Smith Hall will be

open from 10 until 12 in the morning and from 2 until 4 in the afternoon. For lunch, we can either attend the university barbecue at Hart House, or people can make their own arrangements - there are lots of very nice restaurants close to the university.

If you would like to make an

advance arrangement with your classmates, it is very easy for us to provide you with a list of students and addresses for any given year, as well as information about local facilities and accommodation. If you are interested, please contact Ed Barbeau at the mathematics department or at barbeau@math.utoronto.ca.

Alumni News

Mark Freiheit (M.Sc., 1997) has begun a job as software developer at Microsystems Software Inc. He will work on the Cypher Patrol product, whose purpose is to prevent children from accessing pornography on the internet.

Blake F. Kinahan (M.Sc., 1992) was elected Councillor for the new (mega) city of Toronto.

The Canadian Mathematical Society has recently instituted the G. de B. Robinson Prize for the best article published in recent issues of its journals. This prize honours Professor Robinson in particular for his crucial role in establishing the Canadian Journal of Mathematics, of which he was the managing editor from 1949 until 1977. The prize has just been awarded to Jason Levy (Ph.D., 1993) for his article "A note on the relative trace formula," which appeared in the Canadian Mathematical Bulletin (vol. 38, 1995, pp. 450-461). A summary of the article can be found in *Mathematical Reviews* (97d:11085). Dr. Levy, who

obtained his doctorate under Jim Arthur, is currently at the University of Ottawa.

J. Carson Mark (Ph.D., 1938) died on March 2, 1997 at the age of 83. After a brief teaching career at the University of Manitoba and two years at the National research Council in Montreal, he moved to the Los Alamos Scientific Laboratory in 1945, became its director in 1947 and retired in 1973.

Harold O. Seigel, Ph.D., U.C. class of 1946 in M. & P., has been appointed an Officer of the Order of Canada, in recognition of his scientific and industrial achievements in the geoscience field, both in Canada and internationally. Dr. Seigel is currently Chairman of the Board of Scintrex Limited, Concord Ontario.

The 1997 Canadian Association of Physicists Medal of Achievement has been awarded to Donald Sprung (BA, 1957). He is being honoured for a distinguished career of research leading to seminal contributions in

nuclear force and nuclear structure. He has been at McMaster University for 35 years, serving as Dean of Science (1975-1984) and Chair of Physics (1991-1997); he is retiring from active teaching this year.

Ravi Vakil (B.Sc., 1992) has obtained his doctorate from Harvard University with a thesis in algebraic geometry entitled, "Enumerative geometry of curves via degenerations" written under the supervision of Joe Harris. He is currently an instructor at Princeton University. While an undergraduate at the University of Toronto, Ravi helped found the magazine "Mathematical Mayhem" for students and was among the top five competitors in the Putnam Competition for four years. "Mayhem" became well-established and continued under other editors; it has now become incorporated with "Crux Mathematicorum", published by the Canadian Mathematical Society. Since 1992, he has been a member of the Board of Trustees for the Samuel Beatty Fund.

Discarding Billiard Balls – Must You Finish?

You have a supply of billiard balls, each imprinted with a positive integer. There are infinitely many balls available for each positive integer. Suppose that a finite set of these balls is placed in a barrel, and the following process for removing and adding balls occurs:

A ball is selected at random from the barrel. If the ball is labeled 1, then it is discarded and no balls are added to the barrel. However, if the ball bears a number k exceeding 1, then it is discarded and you may add to the barrel any finite number of balls whose labels are strictly less than k . This move is repeated indefinitely.

It is possible to empty the barrel in a finite number of moves, simply by not adding any balls to replace those removed or by putting, into the barrel only balls labeled 1.

However, since one can add any number of balls to the barrel at a move, it seems possible to devise a situation in which the process can be made to continue forever. The remarkable fact is that, while one can usually make the process go on as long as you wish, no matter what you do, it must terminate in a finite length of time. Can you prove this?

Prime Number Breakthrough by Friedlander and Iwaniec

Euclid showed that there are infinitely primes. His argument can be adapted to give an elementary proof that there are primes in certain arithmetic progressions, for example among the numbers 3, 7, 11, 15, 19, 23, ... that leave a remainder of 3 when divided by 4. In the early nineteenth century, Dirichlet initiated the field of analytic number theory with an argument that any infinite arithmetic progression whose initial term and common difference were coprime contained infinitely many primes. Another way of formulating this is that, for certain pairs of integers, a and b , there are infinitely many primes of the form $ax + b$. What of polynomials of higher degree? Here the situation becomes difficult and deep. For example, we do not know whether there are infinitely many primes of the form $x^2 + 1$. This is a special case of primes being the sum of two squares, and here the result is known: a prime is of the form $x^2 + y^2$ if and only if it is equal to 2 or leaves a remainder of 1 upon division by 4.

Recently, John Friedlander at the Scarborough campus and Henryk Iwaniec of Rutgers University in New Brunswick, New Jersey astounded the mathematical world (in the words of a press release from the American Mathematical Society) by announcing that they had solved an important problem upon which no progress had been made for the past century. They have shown that there are infinitely

many primes among numbers of the form $x^2 + y^4$. The set of numbers of this form is very sparse compared with the values of other polynomials with integer coefficients known to yield infinitely many primes. As Andrew Granville of the University of Georgia commented, among the first 10^{17} numbers, there are about 27 billion equal to the sum of two squares but less than one billion equal to the sum of a square and a fourth power. Friedlander and Iwaniec even determined the likely number of primes of this form to be found within a certain range.

In order to obtain this path-breaking result, they had to make fundamental refinements to a method known as the "asymptotic sieve" created by Enrico Bombieri of the Institute of Advanced Study at Princeton. The basic idea of the sieve is to estimate the proportion of numbers remaining in the set of values after you remove all composite multiples of the primes 2, 3, 5, 7 and so on; for such a sparse sequence, getting any kind of useful control of this estimate seemed to be out of reach until now. According to Bombieri, "nobody dreamed you could analyze such sequences; it's a major achievement".

A report was published in February, 1997 in the Proceedings of the National Academy of Sciences (USA) on pages 1054-1058 of Volume 94. The full paper will appear in the Annals of Mathematics.

The Undergraduate Program

The older readers of this newsletter will recall the Honours Program in Mathematics, Physics and Chemistry which continued until 1970. This was drastically changed in the 1970s, when qualifying for a degree was changed to require amassing fifteen or twenty full-course credits. This allowed much more flexibility in designing specialist programs, for students with a broader range of goals. The department, under the leadership of our current associate chair, Ed Bierstone, has just redesigned our undergraduate program to serve not only students heading for an academic career but those entering a variety of positions requiring a command of advanced mathematics.

There are three specialist programs sponsored by the department: Mathematics, Mathematics and its Applications, and Applied Mathematics. Each of these has optional areas of concentration, and graduating students will receive a transcript in which both the specialization and area of concentration are recorded.

The Mathematics Specialist Program has long been the flagship program of the department for students who want a deep knowledge of the subject and will continue into graduate work. The graduates of the program have become top mathematicians in Canada and internationally.

The new Specialist Program in Mathematics and its

Applications is intended for students with career goals in teaching, computer science, the physical sciences and finance. It begins with courses in Computer Science, Analysis and Linear Algebra. Later courses in the core program include probability and statistics, advanced calculus or analysis, advanced linear algebra, ordinary differential equations, complex variables, rings and fields, group theory. Optional areas of concentration cover the different student interests. There is provision for students to design their own concentrations; for example, a student may be interested in biology, another active area of applied mathematics.

The Applied Mathematics specialist program builds on a base of computer science, analysis, linear algebra and statistics in the first two years. Students in their final two years will be studying measure and integration theory, real and complex variables, differential geometry, partial differential equations, operations research, quantum theory and relativity.

Open to undergraduates, not only in mathematics but in other subjects, is the Professional Experience Year. After second year, incumbents interrupt their studies for a 16-month work term to gain industrial experience. This arrangement has proved to be particularly satisfactory as it provides the employer and student to initiate and complete a major project.