The
Pacific Institute for the Mathematical Sciences
Newsletter

http://www.pims.math.ca
pims@pims.math.ca

Summer 2001
Vol. 5 Issue 2

Contents

APCTP, Perimeter and PIMS Collaborate on *Frontiers in Mathematical Physics*

The newly established Perimeter Institute for Theoretical Physics has joined the Asia Pacific Center for Theoretical Physics (APCTP) and PIMS in sponsoring the *Frontiers in Mathematical Physics* (FMP) workshop held annually in Vancouver.

The Asia Pacific Center for Theoretical Physics (**www.apctp.org**) is an international organization based in Seoul, South Korea. The member countries or regions of the institute are Australia, China, Japan, Malaysia, Philippines, Singapore, Taiwan, Thailand and Vietnam.

PERIMETER INSTITUTE FOR THEORETICAL PHYSICS

ASIA PACIFIC CENTER FOR THEORETICAL PHYSICS • APCTP •

*Please see **Frontiers,** page 10.*

NSF and ASRA Join NSERC Site Visit for Banff Research Station

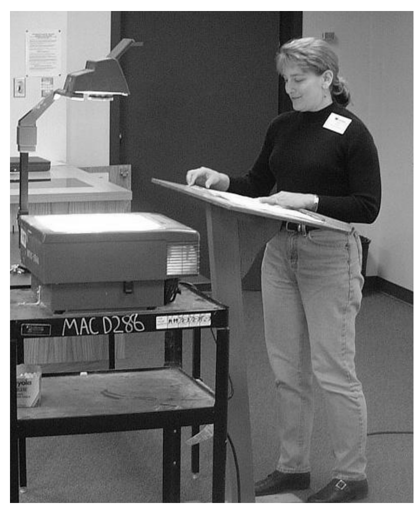
Site visit team (from left to right): Alan Mackworth (Director, Laboratory for Computational Intelligence, UBC), Arvind Gupta (Director, MITACS), Joe Buhler (Deputy Director, MSRI), Robert Moody (Scientific Director, BIRS), David Gross (Director, ITP), Nassif Ghoussoub (Director, PIMS) and David Eisenbud (Director, MSRI). Missing from photo: Michael Lamoureux (Managing Director, BIRS) and Steve Halperin (Dean of Science, Univ. of Maryland).

*Please see **Banff Site Visit,** page 3.*

Month of Industrial Math at PIMS: A wealth of opportunities for Canadian and US graduate students

The month of June 2001 witnessed a succession of scientific events in industrial mathematics at PIMS. More than 300 researchers, graduate students and senior undergraduates came from 25 Universities in Canada and the US to learn, research, interact, network and solve industrial problems at several interrelated events. The timetable was configured so that visiting students could participate in more than one of the worskhops.

*Please see **Industrial Math,** page 5.*



Lisa Korf (U. of Washington) speaks on *Web Hosting Agreements* at the PIMS Industrial Graduate Camp.

Director's Notes

Nassif Ghoussoub, FRSC

The messages of support for the establishment of the *Banff International Research Station* poured in from all continents. Hundreds of people took the time and made the effort to write us a few lines of support, of encouragement and of their wishes for the station's success. The solidarity of the world's most prominent research mathematics institutes was overwhelming and particularly appreciated: Oberwolfach, Luminy, IHES, Isaac Newton, Steklov, IPAM, IMA, DIMACS, Fields and others.

Most mathematicians spoke of it with Oberwolfach and Luminy in mind, the physicists with Aspen and the computer scientists with Schloss Dagstuhl. Musicians among us shared their childhood memories playing the violin at the Banff Music School. Some recalled their youthful hikes in the heavenly surroundings. Many spoke fondly of the impact of similar institutions on their early research and on how their professional lives were formed in such places. They wrote about the moments where mathematical truths eased into their consciousness and about the intensely productive times they experienced at comparable European centers.

Nigel Horspool, Head of Computer Science at the University of Victoria, wrote that he always wondered "why I had to travel all the way to Germany for a meeting like that" (Dagstuhl's). Ragnar-Olaf Buchweitz, Head of Mathematics at the University of Toronto, spoke about the "dream coming true". George Elliott stated "that it is a sign that our country is approaching maturity, that leadership on such a scale should be coming from the West". Carl Amrhein, Dean of Arts and Science at the University of Toronto wrote about "the splendid opportunity to raise the international profile of the mathematical sciences in Canada even higher" before generously pledging a financial contribution as a concrete statement of support from his faculty. Vitali Milman, President of the Israel Mathematical Union commented that, "The choice of Banff is absolutely the best place I could think of in your part of the world". Arthur Carty, President of the National Research Council (NRC) writes, "I expect that we [NRC] will be able to participate in activities of the Research Station including workshops and roundtables". A proud Albertan wrote, "Until now, I've had to describe the University of Alberta to foreigners as the place where Bob Moody is. Soon I'll be able to add: and it's close to BIRS! This is a wonderful project!".

I hope that this show of support for the Banff Station is only the first chapter in the history book of a hugely successful institution.

Call For Nominations

The Pacific Institute for the Mathematical Sciences is accepting nominations for the following prizes:

1. **PIMS Research Prize**: Awarded for a particular outstanding contribution to the mathematical sciences that was disseminated during the five-year period prior to the award being given. Open to Canadian citizens, permanent residents of Canada and residents of Pacific Rim countries who maintain academic ties to the Canadian mathematical sciences community.
2. **PIMS Education Prize**: Awarded to a member of the PIMS community who has made a significant contribution to education in the mathematical sciences. This prize is intended to recognize individuals from the PIMS member universities or other educational institutions in Alberta and British Columbia, who have played a major role in encouraging activities which have enhanced public awareness and appreciation of mathematics, as well as fostering communication among various groups and organizations concerned with mathematical training at all levels.
3. **PIMS Industrial Outreach Prize**: Awarded to an individual who has employed mathematical analysis in the resolution of problems with direct industrial, economic or social impact. This prize is intended for individuals from the academic, private and government sectors. This prize will be given to individuals who at the time of nomination are Canadian citizens or permanent residents of Canada.

Nominees for each prize should be nominated by three sponsors. They are to provide a cover letter explaining the nominee's contribution, impact and relevance for the prize. The nomination should also include a CV of the nominee, a publication list, a list of creative works or list of industrial products, and relevant samples of the nominee's work, such as reprints, patents or educational materials.

Nominations should be sent to:

Attention: PIMS Prizes
PIMS Director's Office
1933 West Mall
University of British Columbia
Vancouver BC V6T 1Z2
Canada

Nominations must be received by **Sept. 15, 2001**. For more information, please see the webpage **http://www.pims.math.ca/prizes**.

Joint NSF, ASRA, NSERC Site visit for Banff Research Station

Continued from page 1.

On June 15, 2001 there was a site visit at the Banff Centre at which three major granting agencies were present: the *Natural Sciences and Engineering Research Council of Canada,* the *National Science Foundation* of the United States, and the *Alberta Science and Research Authority.* The committee was profoundly affected by the world-wide enthusiastic support for the BIRS initiative, as illustrated by more than 500 letters of support which were received from all over the world and by the obvious need for a facility such as this in North America.

The BIRS Executive, David Eisenbud (Director, MSRI), Robert Moody (Scientific Director, PIMS) and Nassif Ghoussoub (Director, PIMS) discuss outside Corbett Hall in Banff.

The site visit was coordinated by Nassif Ghoussoub (Director of PIMS and Principal Applicant for the NSERC proposal), David Eisenbud (Director of MSRI) and Robert Moody (Scientific Director of BIRS), with considerable help from Arvind Gupta (MITACS Scientific Director), Michael Lamoureux (Deputy Director of PIMS and Managing Director of BIRS) and Joe Buhler (Deputy Director of MSRI). The site visit received a huge boost from the presence and active participation of Steve Halperin (Dean of Science at the University of Maryland), David Gross (Director of ITP in Santa Barbara) and Alan Mackworth (Director of the Laboratory for Computational Intelligence at UBC).

Several senior administrators from the PIMS institutional universities also made the effort to participate in person: Mike Boorman (Dean of Science, University of Calgary), Dick Peter (Dean of Science, University of Alberta), Keith Archer (VP-Research, University of Calgary), Bruce Clayman (VP-Research, Simon Fraser University), Martin Taylor (VP-Research, University of Victoria), Indira Samarasekera (VP-Research, University of British Columbia) and Roger Smith (VP-Research, University of Alberta).

The visiting reviewers also heard, through conference calls, from more than fifteen heads of departments of mathematics, computer science and statistics in Canada and the USA: R. Buchweitz (Math, University of Toronto), D. Gross (Math, Harvard), N. Circone (Computer Science, University of Waterloo), R. Goebel (Computer Science, University of Alberta), H. Rossi (Math, University of Utah), H. Brunner (Math, Memorial University), W. Rundell (Math, Texas A & M), D. Marshall (Math, University of Washington), E. Saab (Math, University of Missouri), P. March (Math, Ohio State University), G. Benkart (Math, University of Wisconsin at Madison), E. Campbell (Math, Queen's University), N. Kamran (Math, McGill University), K. Taylor (Math, University of Saskatchewan), Doug Arnold (Director of the Institute for Mathematics and Its Applications, Minnesota) and N. Reid (Statistics, University of Toronto).

The site visit concluded with a tremendous show of support from Mary Hofstetter (President and CEO of the Banff Conference Centre) and from Robert Church (President of the Alberta Science and Research Authority).

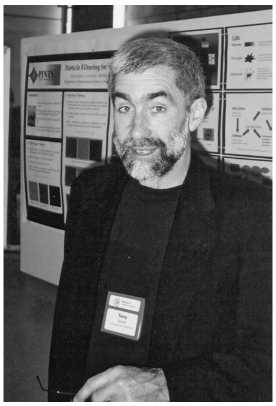
Every piece of information that we have received from each of the funding agencies has been extremely encouraging and we are now confident that BIRS will become a reality. At the time of the site visit we had received close to 75 letters of intent to run programs at BIRS, showing yet again the enthusiasm of the community for the project. The selection process will be highly competitive, as it should be!

A Call for Proposals for BIRS is available in the centrefold of this newsletter. Please visit the webpage **www.pims.math.ca/birs** for more information about BIRS.

Mathematicians Gather in Montréal for 2nd MITACS AGM

Contributed by Donald Bilodeau, MITACS Communications Officer.

On May 11th and 12th, MITACS (The Mathematics of Information Technology and Complex Systems) held its 2nd **Annual General Meeting and Poster/Demo Exhibition** at McGill University in Montreal. Dubbed *Novel Uses of Mathematics in the Biomedical Sector,* the annual event offered attendees a wide array of plenary and sessional presentations.



Prof. Terry Speed

Among the invited plenary speakers, Terry Speed (University of California) presented a dynamic talk on *Statistics & DNA Microarray Data*, wherein he outlined two interesting case studies that displayed some of the novel challenges that this technology poses.

Ivar Ekeland (Paris-Dauphine University) presented a riveting discussion on *The Mathematics of Information Asymmetry.* In the session, Prof. Ekeland discussed the two types of information asymmetry in economic theory: moral hazard and anti-selection. While focusing on the latter, he described how the design of incentive-compatible contracts leads to new problems in the calculus of variations, for which he gave some mathematical results and stated some open problems. Later that evening, Prof. Ekeland also captivated the audience during his banquet address.

Prof. Ivar Ekeland

Christos Papadimitriou (University of California) presented another dynamic plenary session on the subject of *Algorithmic Problems Related to the Internet.* He surveyed some recent research done in collaboration with Joan Feigenbaum, Dick Karp, Elias Koutsoupias and Scott Shenker. According to Prof. Papadimitriou, the internet has arguably superseded the computer as the most complex cohesive artifact and is the source of a new generation of foundational problems for theoretical computer science. These new challenges stem from two novel aspects of the internet: (a) its novel nature as a computer system that intertwines a multitude of economic interests in varying degrees of competition and (b) its history as a shared resource architecture that emerged in a remarkably ad hoc yet gloriously successful manner.

More than 300 MITACS members, post-doctoral fellows, graduate students, and media representatives attended this annual event. The Poster and Demo Exhibition attracted 56 entries, highlighting research breakthroughs from several MITACS projects. Graduate students and Ph. D.'s from across Canada presented their research for judging by academic and industrial professionals. Prizes were awarded during Friday night's Banquet held at the prestigious McGill Faculty Club.

The first place winners were from left: **Nicolas Chapados** (University of Montreal), *High-Dimensional Data Inference for Automobile Insurance Premia Estimation* and **Julien Arno** (University of Victoria), *Reproduction Numbers for Compartmental Models of Disease Transmission.*

The second place winners were from left: **Joanna Biernacka** (University of Toronto), *A Genetic Model in which Multiple Gene Weighting does not improve Gene Localization*; **Alexandra Chavez-Ross** (University of British Columbia), *Application of Chemotaxis Models to Alzheimer's Disease*; **Magdaleana Luca** (member of Alexandra's team); **Ichiro Takeuchi** (University of Montréal), *A Robust Learning Method for Regression with Asymmetric Heavy-Tail Noise*; **Radu Bradean** (Simon Fraser University), *Modelling of Heat and Mass Transfer in Porous Fuel Cell Electrodes.*

*Please see **MITACS AGM**, page 7.*

PIMS Month of Industrial Mathematics: A wealth of opportunities for Canadian, US graduate students

Continued from page 1.

The program started by the *PIMS-MITACS-Ballard Inc. Workshop on Computational Dynamic Fuel Cells* at Simon Fraser University held on June 4–8. This was organized by the MMSC-MITACS team led by Brian Wetton (University of British Columbia) and Keith Promislow (Simon Fraser University) in conjunction with the **PIMS Center for Scientific Computing** led by Bob Russell (Simon Fraser University). (See page 20.)

This was followed on June 9-10, by a PIMS-NSF-MITACS Workshop on *Inverse Problems and Imaging* at the PIMS facility at the University of British Columbia. The workshop was organized by the POTSI-MITACS team led by Michael Lamoureux and Gary Margrave (University of Calgary) in conjunction with the *PIMS Center for Inverse Imaging and Applications* led by Gunther Uhlman (University of Washington). (See page 6.)

Between June 11–15, the 4th PIMS Graduate Industrial Mathematics Modelling Camp was held at the University of Victoria. This year, 20 US graduate students were admitted to the program in addition to the customary 40 Canadian participants (See page 7.). As usual, it was followed by the 5th PIMS Industrial Problem Solving Workshop held this year at the University of Washington in Seattle between June 18–22.

John Chadam (University of Pittsburgh) speaking to graduate students on *Portfolio Analysis.*

The last 2 events were superbly organized by Chris Bose (University of Victoria), Randy LeVeque (University of Washington), Huaxiong Huang (York University), Mark Paulhus (University of Calgary), Keith Promislow (Simon Fraser University) and Ian Frigaard (University of British Columbia).

John Chadam wrote to the organizers: "Just wanted to thank you all for your efforts in organizing three wonderful workshops. All three were intellectually stimulating and exceptionally well run. Hope I see you all soon in the east."

A student participant in both GIMMC and IPSW, Theodore Kolokolnikov, wrote to the Director: "These two weeks, in many ways, exceeded my expectations. We worked not just on 'toy examples', but on real problems with enough interest to the industry that they were willing to pay money to participate. On the other hand, these problems were also very interesting from a mathematician's point of view. They required a variety of skills from the participants; and thanks to different backgrounds, many different approaches were tried.

Chris Bose (University of Victoria), an organizer of the Industrial Graduate Camp and the Industrial Problem Solving Workshop.

Graduate students doing numerical simulations.

"For example, in my group (Canadian National Security agency), we used various techniques from graph theory as well as probability theory. All of these methods involved interesting mathematical results, such as theorems about random graphs or how to catch a robber on

Please see ***Industrial Math****, page 9.*

Report on PIMS-MITACS Inverse Problems and Imaging Workshop

University of British Columbia
June 9–10, 2001

Contributed by Michael Lamoureux (Univ. of Calgary).

On June 9 and 10, PIMS welcomed over 30 researchers to the Inverse Problems and Imaging Workshop 2001, held at the UBC campus in Vancouver. This meeting was the first gathering of the newly formed **PIMS Centre for Inverse Problems and Imaging** and the third Inverse Problems Seminar of the Pacific Northwest (IPSPN), which builds on the successes of the 1999 IPSPN in Seattle, and 2000 IPSPN in Corvallis. With support from the NSF, PIMS, and the POTSI project of MITACS, the purpose of the new PIMS Centre and this seminar series is to bring together mathematicians and other scientists in the Pacific Northwest working on different aspects of the field, to appraise the current status of development and to encourage interaction with researchers working directly on applications.

This year's workshop featured a baker's dozen of speakers presenting talks on a wide range of topics in inverse problems and imaging, including medical tomography, seismic exploration, synthetic aperture radar, statistical image recovery, and parameter estimation of ODEs and PDEs. Real applications include such things as forming three-dimensional "pictures" of the human body via electrical, magnetic, or X-ray transmission measurements; forming images of the earth's subsurface by measuring the propagation of seismic waves or the electrical conductivity of soil; taking aerial photographs of a landscape via a single pass of an aircraft/spacecraft dragging a microwave transmitter. Mathematical techniques presented included microlocal analysis of pseudo-differential operators, Fourier integral operators, sampling techniques, least square methods applied to inversion and imaging, and many others.

A particularly valuable result of this series of seminars is the initiation of new collaborative links between researchers at various PIMS universities as well as at other Pacific-linked institutions, including one as far away as New Zealand. One clear message learned at the meeting is that the various mathematical techniques developed for any one application in inverse problems and imaging can have a direct impact on several of the other applications due to the similarities in the theoretical formulation of the problems. Forging links between the various researchers is essential to the rapid dissemination of these powerful techniques, and we are pleased to see this year's workshop playing a role in these emerging collaborations.

The organizers, Michael Lamoureux (U. Calgary), Gary Margrave (U. Calgary) and Gunther Uhlmann (U. Washington) would especially like to thank the administrative staff of PIMS at UBC and PIMS at UCalgary for their excellent assistance in coordinating the organisational details of this workshop, which was key to making this event a pleasant success.

PIMS-MITACS-Ballard Workshop on Computational Fuel Cell Dynamics

Simon Fraser University
June 4–8, 2001

Contributed by Keith Promislow (SFU).

The PIMS-MITACS-Ballard Workshop on Computational Fuel Cell Dynamics (CFCD) was held June 4–8, 2001 at Simon Fraser University. This workshop addressed the modelling and numerical resolution of the processes of phase change, multi-phase transport, electro-chemistry, and interface dynamics in the porous electrodes of Proton Exchange Membrane (PEM) fuel cells.

The world's major automotive manufacturers are engaged in an historic race to develop PEM fuel cells as alternatives to internal combustion engines for automotive power. Ballard Power Systems, based in Burnaby BC, is broadly recognized as the world leader in this technology, which holds out the promise not only of a highly efficient, environmentally friendly automobile, but also of an extremely versatile power generation system with a broad spectrum of possible applications.

PEM fuel cells convert oxygen and hydrogen into water and useful electric potential in a highly efficient catalysed reaction. An effective model of water management in fuel cells, which predicts condensation and subsequent motion of liquid water, must include the effects of multi-species, multi-phase transport, and electro-chemistry. The porous electrodes of PEM fuel cells are treated with Teflon which renders the liquid-solid surfaces a high-energy interface, and traditional models of two-phase flow break down in this context. The interconnected physical processes underlying PEM fuel cell dynamics require sophisticated models to predict performance under a bewildering host of operating conditions, and transient modes, including start-up and shut-down. The numerical resolution of the models poses significant problems, including moving boundary layers and a tremendous range of interconnected time-scales for differing physical processes spanning over 10 orders of magnitude.

The CFCD workshop was multi-disciplinary, uniting world class experimental, model building, and computational scientists with industrial researchers. It was an extremely lively event with an extended, and occasionally heated, discussion session after each of the more than 25 talks. The 40 plus participants came from General Motors, Bristol Univ., Univ. of Southampton, Univ. of Nottingham, National Research Council, Motorola, Saskatchewan Research Council, National Science Foundation USA and Univ. of Bath, as well as various North American Universities and Ballard Power Systems.

The workshop was broadly acknowledged to have been an exceptional event, and plans are underway for a sequel at the new BIRS centre in Banff.

The organizers were Keith Promislow (Mathematics, SFU) and Brian Wetton (Mathematics, UBC).

4th PIMS Graduate Industrial Math Modelling Camp
University of Victoria, June 11–15, 2001

Contributed by Chris Bose (University of Victoria).

From June 11–15, the University of Victoria hosted the fourth annual **PIMS Graduate Industrial Math Modelling Camp** (GIMMC). The students followed up with a second week of industrial mathematics at the IPSW in Seattle, June 18–22. A record 58 students attended the Camp, led by 8 academic mentors on a selection of industrial problems. Our sincere thanks to this year's hard-working mentors:

Sergei Bespamyatnikh (UBC, Watchtower Placement)

John Chadam (Univ. of Pittsburgh, Portfolio Analysis)

Ian Frigaard (UBC, Metal Spray Casting)

Lisa Korf (U. Washington, Web Hosting Agreements)

Hedley Morris (San Jose State, Imaging Problem)

Tim Myers (Univ. of Capetown, Modeling Ice Accretion)

Miro Powojowski (Algorithmics Corp., Risk Neutral Measures)

Moshe Rosenfeld (Univ. of Washington, Control of Streetlight Networks)

As with previous camps, students from all regions of Canada were eligible to attend. This year the programme was expanded to include 60 invited participants, up from the usual cap of 40. Further, in recognition of our newest PIMS institution, University of Washington, a special effort was made to attract students from US universities. In all, we had more than 130 applicants to the Camp, and we accepted participants representing 25 North American Universities. Thirty-nine participants were from Canada and the remaining 19 were from the United States. Many favourable comments were collected from our mentors attesting to the excellent academic preparedness and to the enthusiasm of the students.

Increased exposure throughout North America given to this year's Camp will result in even more applications next year. Students wishing to attend GIMMC 2002 should watch for an announcement this fall on the PIMS website and apply as soon as possible.

Detailed problem descriptions and a photo album may be found on the GIMMC website at **http://pims.math.ca/industrial/2001/gimmc/**.

Proceedings from the workshop will be available for download from the PIMS website later this summer.

MITACS AGM

Continued from page 4.

Arvind Gupta (Scientific Director of MITACS) stated that, "I'm very pleased with the overwhelming attendance and I'm proud to announce that since its inception, MITACS' partners and research groups have published more than 60 preprints, 400 research papers, and co-sponsored more than 75 workshops and seminars. Moreover, MITACS has trained more than 300 students for new employment opportunities in the following sectors: biomedical, commercial & industrial, information technology, manufacturing, and trading & finance." On behalf of MITACS, Dr. Gupta sincerely thanks Drs. Speed, Ekeland, and Papadimitriou and all of the poster judges for their contribution to the success of the MITACS AGM and Poster/Demo Exhibition.

Visit the website **www.mitacs.math.ca**, for a listing of upcoming workshops.

Participants at the 4th annual PIMS GIMMC enjoyed dry days and summer sunshine in Victoria.

5^{th} PIMS Industrial Problem Solving Workshop

University of Washington, June 18–22, 2001

Contributed by Randy LeVeque (U. Washington), Marc Paulhus (U. Calgary) and Chris Bose (U. Victoria).

Participants in IPSW 2001 outside the Miller Building at the University of Washington.

This year's **Industrial Problem Solving Workshop** (IPSW) was held at the University of Washington in Seattle. About 100 people registered for the event, including the 58 graduate students who had taken part in the graduate modelling camp the week before. Faculty from a number of universities around the world were also involved. Participants split up into six groups to attack the industrial problems brought to the workshop, spanning a broad range of applications and mathematical techniques. Most of the industrial participants were able to stay all week this year, and were actively involved in working with the groups. A brief description of the problems and some of the progress made is given below. More complete problem descriptions may be obtained from the website, **http://www.pims.math.ca/industrial/2001/ipsw** and proceedings papers are being written by each group.

Representing local Seattle industry, **John DeTreville** brought a problem from **Microsoft** on optimizing the layout of files on a disk, given an expected order in which the files will be accessed. The group learned a great deal about the complex details involved in hard drive technologies. They also quickly established that the problem was equivalent to the intractable Travelling Salesman Problem. After building some one- and two-dimension disk models, they applied various heuristic techniques to try to find the optimal solution for some sample data that Microsoft provided. It was concluded that the heuristic methods appear to provide better solutions more quickly using the 2-D model than with the 1-D model, suggesting that the more realistic 2-D (or the even more realistic 3-D model not studied) should be used when disk performance is critical. Current hardware limitations make the 1-D model the industry standard.

Many of the participants who specialize in continuous modelling were attracted to the problem presented by **Bill Micklethwiate** of **Firebird Semicondutors**, arising from growing large single crystals of Indium Antimonide (InSb) from a melt. These crystals, about the size of a wine bottle, may develop imperfections due to thermal stresses as they cool. This problem contained something for everyone in continuum mechanics – fluid dynamics coupled with convective, diffusive, and radiative heat transfer, Stefan problems for the moving phase boundary, and temperature-dependent stress analysis within the solid phase. This group split into several subgroups to tackle various aspects of the problem by both analytical and numerical approaches. Some new insights were gained into the expected shape of the moving boundary and the relative importance of different heat-transfer mechanisms.

Allan Douglas from the **Communications Security Establishment** brought a problem relating to computer security on the large computer networks, such as the internet. Mobile software objects that move around between computers are becoming more common and the problem concerns the ability of the "good guys" to track down malicious software of this form. This led to an extensive literature search on problems of graph searching and random walks. The group discovered a vast and richly developed literature that was directly applicable to the problem at hand. They then expanded on that literature and established some new results based on the particulars of the problem.

Ron Forth presented a problem from the **Alberta Energy Company** on decline analysis, attempting to extrapolate trends in production rate data from oil and gas wells to forecast future production. The current practice is for a petroleum engineer to perform the extrapolation using visual curve fitting biased heavily by personal experience. The data is typically very noisy and has the additional feature that physical parameters in operation during the period of data collection are randomly changing (changes to pumping schedules, shutdowns, production enhancement, etc) so no one model can be expected to fit the entire time series. The workshop group concentrated on three aspects of the problem. First, the partitioning of the time series into intervals over which one physical model may be applied. Moving average and wavelet techniques were investigated; both seemed sufficient to perform the partition, provided reasonable thresholding values were used. Second, a curve fitting over each subinterval was performed. This was fairly straightforward as physical considerations lead to a parametric family of model curves and a simple, weighted, least-squares fit within that family appears to suffice. Finally a weighting of the various extrapolations obtained in the previous step determines the final decline curve estimate. A heuristic weighting scheme was proposed and tested with reasonable results on a restricted data set. The possibility that this last step would lend itself to a neural-net approach was discussed.

Alan King of **IBM** brought a problem on properly pricing web-hosting service agreements. A web-hosting service provider may have a large number of clients with different needs, and a finite amount of computer resources to distribute amongst those customers in order to satisfy certain Quality-of-Service (QoS) agreements. However, the web-hosting service can also dynamically reallocate its resources based on the observed needs of its clients at any given time. The team tackled this extremely complex problem and built a very realistic model taking into account a wide range of complexities such as requests of different size with different priorities, time-lag in the hardware re-distribution, as well as penalties for failing to meet the QoS agreements.

The final problem came from **Algorithmics**, a financial mathematics firm. **Alex Kreinin** presented a problem on measuring the credit risk of a given portfolio, based on the credit ratings of the obligors. Standard Monte-Carlo techniques do not work very well since the interesting events (default by the obligors) are very rare and hence require a large number of simulations. Algorithmics came to the workshop with a very well thought out model and everyone was pleasantly surprised that the group discovered an analytical solution based on using the Lindberg-Feller Theorem (basically the Central Limit Theorem in this context) to approximate the credit risk of all counterparties in a single (credit driver) scenario. This resulted in approximating the risk across scenarios by a mixture of Gaussians, the latter being one of the current methods for treating distributions with long tails. The group then proceeded to test this fast, approximate solution against much more time-consuming full Monte Carlo simulations for one time step. They found reasonable agreement and expect much better results for longer time horizons since the CLT is better suited when the number of independent random variables increases. This was viewed as a significant development in the important area of credit risk, and we look forward to seeing it developed further.

Month of Industrial Math

Continued from page 5.

an n-dimensional cube. In addition, we simulated some results to verify their correctness. Most of the methods we used were new to most members of the group.

"Part of the success came from working together with other dedicated students. Not only did we manage to make progress on posed problems, but we had lots of fun doing it, and made friendships that will last well beyond the workshops.

"Overall, this workshop was an excellent experience and I will gladly go back next year."

APCTP, Perimeter Institute and PIMS Collaborate on *Frontiers in Mathematical Physics*

Continued from page 1.

The APCTP has a mandate to promote and foster high level research in theoretical physics. Since its inception in 1996 it has maintained an active programme of international meetings which has earned it a worldwide reputation for excellence.

From left, Michael Stevenson (President, Simon Fraser University), Nassif Ghoussoub (Director, PIMS), Taejin Lee (Programme Coordinator, APCTP), K. S. Viswanathan (Simon Fraser University), Hugh Morris (Chairman, Board of Directors, PIMS), Gordon Semenoff (University of British Columbia) and B. K. Chung (Executive Director, APCTP) after signing the APCTP-PIMS Coopertaive Agreement at the Diamond University Centre, Simon Fraser University.

Since 1998, APCTP has cooperated with PIMS on jointly organizing and funding the *Frontiers in Mathematical Physics* workshops which have taken place in Vancouver every summer. This year's workshop was used an occasion to sign a cooperative agreement between PIMS and APCTP, which formalizes an already strong record of scientific collaboration and cements future plans for cooperation. Professor B. K. Chung, Executive Director of the APCTP, and Professor Nassif Ghoussoub, Director of PIMS joined SFU President Michael Stevenson and more than fifty participants of the workshop to celebrate this unprecedented collaborative event.

The Perimeter Institute for Theoretical Physics (**http://www.perimeterinstitute.com**) is based in Waterloo, Ontario, Canada. It was founded in 2000 through a personal donation by Mike Lazaridis, President and Co-Chief Executive Officer of Research In Motion Limited (RIM) to "serve as a state-of-the-art Canadian physics institute dedicated to bold, provocative research of the fundamental aspects of the physical world...". Both PIMS and APCTP welcome the involvement and support of the Perimeter Institute to the *Frontiers in Mathematical Physics* series.

This year, the fifth workshop in the Frontiers in Mathematical Physics Series focused on the consequences of recent breakthroughs in the rapidly developing areas of superstring theory and nonperturbative gauge field theory. The workshop was held from July 16–27 at the PIMS facility at Simon Fraser University. The organizing committee was K. S. Viswanathan (chair, Simon Fraser University), Taejin Lee (Kangwon University, Korea), Yuri M. Makeenko (Niels Bohr Institute, Copenhagen and ITEP, Moscow), John Ng (TRIUMF), Alexander Rutherford (PIMS) and Gordon W. Semenoff (University of British Columbia). Many of the lectures were video taped and will be made available from the PIMS streaming video web page (**http://www.pims.math.ca/video**). For more information on the workshop please see **http://www.pims.math.ca/science/2001/fmp**.

President Michael Stevenson of SFU witnessing the signing of The APCTP-PIMS Cooperative agreement by PIMS Director Nassif Ghoussoub and APCTP Executive Director B. K. Chung (at right).

Planning has already begun for next year's workshop, which will focus on supersymmetry and the physics of extra dimensions. This subject contains some very important new ideas which have revolutionalized our thinking on some of the long-standing problems in theoretical particle physics. This is particularly timely, as particle physics experiments will finally achieve the next energy threshold within the next five years. Many questions about nature at the high energy frontier could well be answered by these experiments. The organizing committee for next year's workshop is being chaired by John Ng (TRIUMF). Further information on the workshop and online registration are available from **http://www.pims.math.ca/science/2002/fmp**.

PIMS Hosts the 9th Canadian Conference on General Relativity and Relativisitic Astrophysics at the University of Alberta

Contributed by Eric Woolgar (University of Alberta).

Co-sponsored by PIMS, the Perimeter Institute for Theoretical Physics and the Canadian Institute for Theoretical Astrophysics (CITA), the Canadian Conference on General Relativity and Relativisitic Astrophysics (CCGRRA) was held at the University of Alberta on May 24–26. This was the ninth in the series of CCGRRA meetings, which have been held every two years since 1985. This year's CCGRRA was organized by Hans Kunzle (University of Alberta), Sharon Morsink (University of Alberta), and Eric Woolgar (University of Alberta). It was held in conjunction with the **Black Holes III** meeting in Kananaskis on May 19–22, which was also supported by PIMS. There were 82 participants for CCGRRA, with approximately 60 participants from Canadian universities.

The first day was devoted to developments in mathematical relativity and related areas of quantum gravity. After opening remarks by University of Alberta Theoretical Physics Institute Director **Wojciech Rozmus**, Fields Medalist **Shing-Tung Yau** (Harvard University) discussed *Conditions for the Existence of Black Holes using the Mean Curvature Flow.* **Amanda Peet** (University of Toronto) presented a talk on *Recent Progress in Superstring/M Theory,* while **John Baez** (University of California at Riverside) spoke about *Spin Networks in Loop Quantum Gravity.* The day's final plenary talk, by **Kristin Schleich** of UBC, surveyed *Topological Censorship.*

The second day's plenary speakers concentrated on astrophysics. **Eric Poisson** (University of Guelph) spoke on *Gravitational Radiation Reaction Calculations,* while **Virginia Trimble** (University of California at Irvine) gave a lively discussion of *Observations of Compact Objects.* Numerical relativity was also represented, with **Saul Teukolsky** (Cornell University) speaking on *Numerical Simulations of Black Holes.*

On the final day, **Kip Thorne** (California Institute of Technology) gave an outline of *Progress in the Construction of the LIGO Gravitational Wave Observatories* which are due to begin scientific data collection at the beginning of 2002. **Viqar Husain** (University of New Brunswick) spoke on *Dualities and Wilson Loops.* The closing talk of the conference was given by **J. R. Bond** (Director, Canadian Institute for Theoretical Astrophysics) who gave a lecture on the state of our knowledge of cosmological parameters, incorporating the latest data from the Boomerang experiment.

A detailed list of lectures given at the conference and scanned copies of the slides for many of the lectures are available from the conference website:
www.math.ualberta.ca/∼ccgrra.

Further information on the related **Black Hole III** meeting is available from the website:
fermi.phys.ualberta.ca/∼gravity/bh3conference.

Wave Phenomena III: Cornerstone of the PIMS Thematic Programme on Fluid Dynamics

Contributed by T. Bryant Moodie (University of Alberta).

PIMS at the University of Alberta hosted the workshop **Wave Phenomena III** on June 11–15. This workshop is the third event in the PIMS Thematic Programme on Fluid Dynamics, which also features the **Third PIMS Fluid Dynamics Summer School**, held May 27 – June 8 at the University of Alberta, and **The International Conference on Theoretical and Numerical Fluid Mechanics II**, to be held August 20–24 at the Coast Plaza Hotel in Vancouver.

The wave concept is probably the most widely used single notion in all of physical science. It links together such diverse disciplines as geophysics, oceanography, meteorology, astrophysics, physiology, and biology. In geophysical contexts, waves are a primary method by which energy is transported in fluids and they are thus responsible for global circulation of the atmosphere, the oceans, and the earth's mantle. In biological contexts, waves are used in the study of haemodynamics, neural networks, and respiratory flows. Waves are also studied intensively for their use in remote sensing and have been exploited to map our atmosphere from space, to explore and see the deep oceans, and to detect disease by non-invasive methods. The enormous range of spatial scales spanned by waves is indicative of their relevance to many disciplines.

The previous two Wave Phenomena meetings were also successful and focused on wave propagation phenomena in a wide spectrum of applications. For the third Wave Phenomena Meeting, we chose to focus on the fluid medium for wave transmission. We did this first because of the general importance of the subject at this time with its relation to world climate change and our concerns with this change and second in order to better mesh with the topics of the **3rd PIMS Summer School in Fluid Dynamics**, which immediately preceded the conference.

Waves III was attended by 145 delegates from Canada, Mexico, USA, Turkey, Ghana, France, Germany, The Netherlands, Scotland, Italy, India, Denmark, China, Japan, Sweden, New Zealand, Taiwan, Australia, and Russia. There were a total of 23 plenary talks that were given in the morning session each day. These were then followed by the contributed talks that were held in 5 parallel sessions during the afternoons.

The plenary talks were given by Peter Baines (CSIRO), David Benney (MIT), Jerry Bona (U. of Texas, Austin), Carlo Cercignani (Politecnico di Milano), Harindra Joseph Fernando (Arizona State), Roger Grimshaw (Loughborough), Richard Lindzen (MIT), Michael Longuet-Higgins (UCSD), Andrew Majda (Courant Institute), Michael McIntyre (Cambridge), James McWilliams (UCLA), Robert Miura (UBC), Alan Newell (U. of Arizona, Tucson), Richard Peltier (U. of Toronto), George Philander (Princeton), Raymond Pierrehumbert (U. of Chicago),

*Please see **Waves III**, page 12.*

Summer 2001 in Vancouver: Place to be for Nonlinear PDE

More than 500 researchers from 15 countries are participating in the PIMS Thematic Programme on Nonlinear PDE, which is being held at PIMS-UBC from July 2 to August 18. This programme deals with several interrelated topics originating in finance, physics, chemistry, biology and material sciences, as well as in geometry. The common feature of these topics is that they involve the interplay between nonlinear, geometric and dynamic components of partial differential equations. The focal point of each workshop is a series of minicourses given by some of the best world experts in the field. For further details, see **http://www.pims.math.ca/pde**.

1. **Minicourse Lecturers in the Workshop on Viscosity Methods in Partial Differential Equations:**

   Xavier Cabré (Universitat Politecnica de Catalunya) 2 lectures on *Nonconvex Fully Nonlinear Elliptic Equations: $C^{2,\alpha}$ Regularity for some Bellman-Isaacs Equations.*

   Craig Evans (Berkeley): 2 lectures on *Hamilton-Jacobi Equations and Dynamical Systems.*

   Robert Jensen (Loyola): 2 lectures on *Variational Problems in L^∞.*

   Panagiotis Souganidis (Austin): 2 lectures on *Fully Nonlinear Stochastic PDEs.*

   Andrzej Swiech (Georgia Tech): 5 lectures on *Viscosity Solutions in Infinite Dimensional Spaces and Optimal Control of PDEs.*

   Thaleia Zariphopoulou (Austin): 2 lectures on *Viscosity Solutions in Finance.*

2. **Minicourse Lecturers in the Workshop on Phase Transitions:**

   Henri Berestycki (Paris): 4 lectures on *Propagation of Fronts in Excitable Media.*

   David Kinderlehrer (Carnegie-Mellon): 4 lectures on *Topics in Metastability and Phase Changes.*

3. **Minicourse Lecturers in the Workshop on Concentration Phenomena and Vortex Dynamics:**

   Fang-Hua Lin (Courant Institute): 4 lectures on *Vortex Dynamics of Ginsburg-Landau and Related Equations.*

   Wei-Ming Ni (Minnesota) and **Changfeng Gui** (UBC): 4 lectures on *Diffusions, Cross-diffusions and their Steady States.*

   Michael Struwe (ETH): 4 lectures on *Wave Maps.*

4. **Minicourse Lecturers in the Workshop on Variational Methods and their Applications in PDEs, Hamiltonian Systems & Mathematical Physics:**

   Yann Brenier (Paris): 4 lectures on *Variational problems related to fluid and plasma modelling.*

   Maria Esteban (Paris): 3 lectures on *Variational Problems in Relativistic Quantum Mechanics: Dirac-Maxwell Equations.*

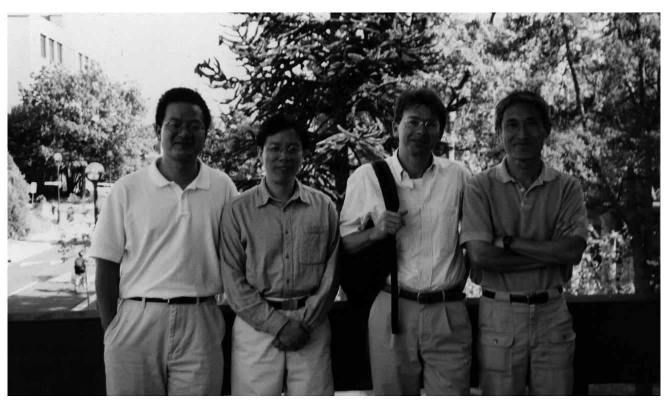
   Eric Séré (Paris): 3 lectures on *Variational Problems in Relativistic Mechanics: Dirac-Fock Equations.*

5. **Minicourse Lecturers in the Workshop on Geometric PDEs:**

   Clifford Taubes (Harvard): 4 lectures on *Pseudo-holomorphic geometry as a tool to study smooth 4-dimensional manifolds.*

   Gang Tian (MIT): 4 lectures on *Recent progress in Complex Geometry.*

   Rick Schoen (Stanford): 4 lectures on *Geometric Variational Problems.*



Changfeng Gui (UBC), Fang Hua Lin (Courant Institute), Michael Struwe (ETH) and Wei-Ming Ni (Minnesota), the minicourse lecturers for the Workshop on Concentration Phenomena and Vortex Dynamics.

Waves III

Continued from page 11.

Peter Rhines (U. of Washington), Colin Rogers (U. of New South Wales), P. L. Sachdev (Indian Institute of Science), Ted Shepherd (U. of Toronto), Melvin Stern (Florida State), Steve Thorpe (Southampton Oceanography Centre) and John Whitehead (Woods Hole).

Waves III was organized by Andrew Bush, Bryant Moodie, Bruce Sutherland, and Gordon Swaters, all of the University of Alberta, with the very able assistance of Lisa and Lina from the University of Alberta PIMS office. The opening address was given by Dick Peter (DEan of Science, University of Alberta) who emphasized the important role that has been played in the mathematics community by The Pacific Institute for the Mathematical Sciences and how meetings of this calibre would not be possible without the support of PIMS.

Interested readers may view a complete list of speakers together with their abstracts, contact information, and pictures on the website **waves3.math.ualberta.ca**.

PIMS Thematic Programmes for 2002

Thematic Programme (A): Asymptotic Geometric Analysis, PIMS at UBC

Organizing committee: Vitali Milman (co-chair, Tel Aviv), Nicole Tomczak-Jaegermann (co-chair, U. Alberta), Nassif Ghoussoub (PIMS and UBC), Robert McCann (U. Toronto), Gideon Schechtman (Weismann Inst.).

Advanced Graduate Camp, June 15–30: Lectures on subjects connected with the whole program directed to young participants, advanced Ph.D. students and PDFs.

Conference on Convexity and Asymptotic Theory of Normed Spaces, July 1–5: Organised by Erwin Lutwak (Warsaw) and Alain Pajor (Marne-La-Vallée). Topics include classical convexity, Radon transform and Fourier methods in convexity, asymptotic theory of high dimensional convex bodies, geometric functional inequalities and probabilistic methods in convexity, isoperimetric-type inequalities.

Concentration Period on Measure Transportation and Geometric Inequalities, July 8–12: Organized by Robert McCann (U. Toronto). This concentration period will focus on transportation of measure methods and their applications, concentration of measure phenomenon, geometric functional inequalities (Brascamp-Lieb, Sobolev, entropy, Cramer-Crao, etc), “isomorphic” form of geometric inequalities and probabilistic methods.

Workshop on Phenomena of Large Dimensions, July 14–20: Organized by Vitali Milman (Tel Aviv), Michael Krivilevich, Laszlo Lovasz (Microsoft Research) and Leonid Pastur (U. Paris VII). Topics include different phenomena observed in complexity theory, asymptotic combinatorics, asymptotic convexity, statistical physics and other theories of very high parametric families (or large dimensional spaces).

Focused Research Groups on Random Methods and High Dimensional Systems, July 21–August 5: Coordinated by Vitali Milman (Tel Aviv) and Nicole Tomczak-Jaegermann (U. Alberta).

Workshop on Non-commutative Phenomena and Random Matrices, August 6–9: Organized by Gilles Pisier (U. Paris VI and Texas A & M) and Stanislaw Szarek (U. Paris VI and Case Western Reserve). Topics include the distribution of eigenvalues of random matrices, norms of such matrices, some aspects of free and quantum information theories, applications in many fields, quantized functional analysis and operator spaces and non-commutative L_p spaces.

Workshop on Banach Spaces, August 12–15: Organized by Bill Johnson (Texas A & M and Ted Odell (U. Texas, Austin). This workshop will focus on the asymptotic theory of Banach spaces and other applications of local theory to the geometry of infinite dimensional Banach spaces.

Thematic Programme (B): Selected Topics in Mathematical and Industrial Statistics

Workshop on the Role of Statistical Modelling in the 21st Century, May 4–6, PIMS at Simon Fraser University: Organized by Richard Lockhart and Charmaine Dean (SFU) and Peter Guttorp (U. Washington). This workshop will bring together leading practitioners and philosophers of scientific, Bayesian and frequentist modelling statistics with leading researchers in model assessment, validation and goodness-of-fit. The goals are to identify opportunities and challenges for model development and criticism and to begin to outline approaches to assessment of complex models.

International Conference on Robust Statistics (ICORS 2002), May 12-18, UBC: The Scientific Committee is Luisa Fernholz (Temple Univ.), Ursula Gather (Dortmund), Chris Field (Dalhousie) and R. H. Zamar (UBC). This conference will be a forum for new developments and applications of robust statistics and statistical computing. Experienced researchers and practitioners, as well as younger researchers, will come together to exchange knowledge and to build scientific contacts. The conference will centre on methods designed for processing large datasets of uneven quality (databases containing outliers, gross errors, missing data, etc.). This conference expects to touch upon many different aspects of data analysis in a fashion which integrates theoretical and applied statistics.

Design and Analysis of Experiments, July 14–18, Coast Plaza Suites Hotel, Vancouver: Organized by Randy Sitter (SFU), Derek Bingham (Michigan), Bruce Ankenman (Northwestern) and Agnes Herzberg (Queen’s U.). Many industrial problems are not well-explored in the statistical literature. To help North American industry compete globally, advanced statistical methods suitable for real applications need to be further developed. Statistical experimental designs, developed by Sir Ronald Fisher in the 1920’s, largely originated from agricultural problems. Although the design of experiments for industrial and scientific problems may have the same basic concerns as design for agricultural problems, there are many differences: (i) industrial problems tend to require investigation of a much larger number of factors and usually involve a much smaller total number of runs (observations), (ii) industrial results are more reproducible, (iii) industrial experimenters are obliged to run their experimental points in sequence and are thus able to plan their follow-up experiments guided by previous results, unlike agriculture, in which all results are often harvested at one time, and (iii) models can be very complicated in industrial and scientific experimentation, sometimes requiring the need for nonlinear models or for computer modelling and finite element analysis.

Second Canada-China Mathematics Congress

August 20–23, 2001 in Vancouver, BC, Canada

This initiative builds on the success of the first Congress held at Tsinghua University, Beijing, in August 1999, and is aimed at developing further the collaborative research effort between the two countries. It is sponsored by the 3×3 Canada-China initiative, the Centre de Recherches Mathématiques, the Fields Institute for the Mathematical Sciences, the Pacific Institute for the Mathematical Sciences and the MITACS Network of Centres of Excellence.

Organizing Committee: Nassif Ghoussoub (National Math. Coordinator for 3x3 Canada-China Initiative), Dale Rolfsen (PIMS UBC-Site Director), JingYi Chen (UBC), Xiao Jiang Tan (Peking University), Lizhong Peng (Peking University), Dayong Cai (Tsing Hua University), XingWei Zhou (Nankai University), JiaXing Hong (Fudan University).

Officers of the Chinese Delegation

- **Zhi Xing Hou** (President of Nankai University, Director of Mathematical Centre of Chinese Education Ministry)
- **Wang Jie** (Vice director of Chinese Nature Scientific Foundation)
- **Zhiming Ma** (President of the Mathematical Society of China)
- **L.Z. Peng** (Secretary of the Mathematical Society of China)
- **K.C. Chang** (Director of the Mathematical Centre of Chinese Education Ministry)

Officers of the Canadian Delegation

- **Tom Brzustowski** (President of NSERC)
- **Barry McBride** (Vice-President Academic, UBC)
- **Luc Vinet** (Vice-President Academic, McGill University)
- **Nassif Ghoussoub** (PIMS Director and National Math. Coordinator for 3x3 Canada-China Initiative)
- **Arvind Gupta** (MITACS program leader)
- **Ken Davidson** (Director, Fields Institute)
- **Jacques Hurtubise** (Director, CRM)
- **Jonathan Borwein** (President, Canadian Math Society)

Plenary Speakers:

- **Weiyue Ding** (Director of the Institute of Mathematics, Peking University), *On the Schrodinger Flow*
- **Jie Xiao** (Tsinghua), *Hall Algebras and Quantum Groups*
- **Yiming Long** (Director of the School of Mathematical Sciences, Nankai University), *Iteration theory of Maslov-type index with applications to nonlinear Hamiltonian systems*
- **Xiaoman Chen** (Fudan), *On the Structure, K-theory of Roe Algebras*
- **Zhiming Ma** (Academic Sinica), *Some New Results/Directions in Probability Theory*
- **Gordon Slade** (UBC): *Statistical Mechanics*
- **Mark Lewis** (Alberta): *Mathematical Biology*
- **Ian Putnam** (Victoria): *Operator algebras and hyperbolic dynamical systems*
- **Luc Vinet** (McGill): *Mathematical Physics*
- **Catherine Sulem** (Toronto): *PDE*
- **Henri Darmon** (McGill): *Number Theory*
- **Gang Tian** (MIT): *Complex Geometry*

Session Speakers

I. Algebra and Number Theory:

- **Qingchun Tian** (Peking): *Iwasawa Theory for p-adic Representation*
- **Xingui Fang** (Tsinghua): *On 1-arc Regular Graphs*
- **Weisheng Qiu** (Peking): *Completely Settling of the Multiplier Conjecture for the case of $n = 3p^3$*
- **Yonghui Wang** (Capital Normal): *Some Results on Analytic Number Theory*
- **Jim Carrell** (UBC)
- **Abraham Broer** (Montreal)
- **Kai Behrend** (UBC)
- **Terry Gannon** (Alberta)
- **Zinovy Reichstein** (UBC)
- **Jim Bryan** (UBC)
- **Kumar Murty** (Toronto)
- **Tony Geramita** (Queens)
- **Robert V. Moody** (Alberta)

II. Mathematical Physics and PDE:

- **Yunbo Zeng** (Tsinghua): *Two binary Darboux transformations for KDV hierarchy with self-consistent sources*
- **Peidong Liu** (Peking): *Entropy and Iyapunov Exponents for Stationary Random Maps*
- **Chengming Bai** (Nankai): *Puzzle Degeneracies and Yangian*
- **Songmu Zheng** (Fudan): *Maximal attractor for some non-linear PDEs*
- **Jiayu Li** (Fudan): *Geometric Analysis*
- **Li Ma** (Tsinghua): *New results about mean field equations*
- **Shuxiang Huang** (Shang Dong): *Global Solutions and Asymptotic Behaviour for Reaction-diffusion Equations*
- **Dmitry Jakobson** (McGill): *Geometric Analysis*
- **Jia Quan Liu** (Peking): *On Quasilinear Elliptic Equations*
- **Shoulin Zhou** (Peking): *On a Singular Equation*
- **Shenghong Li** (Zhejiang): *Second Boundary Problem for Parabolic Equations with Gradient Obstacle*
- **S. Gustafson** (UBC)
- **Victor Ivrii** (Toronto)
- **Peter Greiner** (Toronto)
- **G. Semenoff** (UBC)
- **I. Łaba** (UBC)
- **JiQuang Bao** (PIMS)
- **Richard Froese** (UBC)
- **Changfeng Gui** (UBC)
- **Peter Orland** (CUNY, visiting UBC) *$SU(2) \times SU(2)$ gauging of integrable XXX models*
- **John Harnad** (CRM, Concordia): *Math. Physics*

III. Probability and Statistics:

- **Guanglu Gong** (Tsinghua): *Iterative Systems*
- **Yongjin Wang** (Nankai): *A probabilistic analysis to one class of non-linear differential equations on unbounded domains and its application to superprocesses*
- **Tianping Chen** (Fudan): *Unified stabilization approach to principal minor components extraction algorithms*
- **Runchu Zhang** (Nankai): *Optimal Blocking of 2^{n-k} and 3^{n-k} Fractional Factorial Designs*

- **Martin Barlow** (UBC)
- **Ed Perkins** (UBC)
- **Jonathan Taylor** (McGill)
- **Gordon Slade** (UBC)
- **Remco Van der Hofstad** (Microsoft, Delft U of Tech)
- **Peter Hooper** (Alberta)
- **Harry Joe** (UBC)

IV. Wavelets and their Applications:

- **Xingwei Zhou** (Nankai): *Some results on Wavelet frames*
- **Lizhong Peng** (Peking): *Orthogonal Wavelets on the Heisenberg Group*
- **Heping Liu** (Peking): *The Joint Spectral Multipliers on Heidelberg Groups*
- **Ding-Xuan Zhou** (Hongkong City): *Wavelet Analysis*
- **Hoi Ling Cheung** (Hongkong City): *Wavelet Analysis*
- **Serge Dubuc** (Montreal)
- **Bin Han** (Alberta)
- **Rong-Qing Jia** (Alberta)
- **Jean-Marc Lina** (Montreal)
- **Remi Vaillancourt** (Ottawa)

V. Computational, Industrial & Applied Analysis:

- **Houde Han** (Tsinghua): *The Numerical solutions of Heat Equation on Unbounded Domains*
- **Dayong Cai** (Tsinghua): *Multi-solution of Power System and its Fast Algorithm*
- **Jianwei Hu** (Nankai): *Finite Element-Finite Volume Type Method for Nonlinear Convection-Diffusion Problems and its Applications*
- **Yongji Tan** (Fudan): *On some Inverse Problems*
- **Zhongmin Wu** (Fudan): *Quasi interpolation for solving ordinary differential equations*
- **Yangfeng Su** (Fudan): *Some problems on GTH algorithm for Stochastic matrices*
- **Xunjing Li** (Fudan): *On Optimal Control Theory for Infinite Dimensional Systems*
- **Shufang Xu** (Peking): *Numerical Analysis of the Maximal Solution of the matrix Equation $X + A^*X^{-1}A = P$*
- **Wenxun Xing** (Tsinghua): *Computational Applied Analysis*
- **Yanren Hou** (Xi'An Jiaotong): *Full Discrete Postprocessing Procedure to the Galerkin Approximation Based on AIMD*
- **Zheng Jian Hua** (Tsinghua): *Hyperbolic metric and its application in complex dynamics*
- **Huaxiong Huang** (York): *Industrial Analysis*
- **M. Fortin** (Laval): *Computational Analysis*
- **H. Brunner** (Memorial U. of Newfoundland)
- **J. Wu** (York): *Industrial and Applied Analysis*
- **A. Peirce** (UBC): *Industrial and Applied Analysis*
- **Brian Wetton** (UBC): *Industrial and Computational Analysis*
- **Michael Ward** (UBC): *Applied Analysis*
- **Uri Ascher** (UBC): *Computational Analysis*
- **S. Ruuth** (SFU): *Computational Analysis*

VI. Geometry/Topology:

- **Jinkun Lin** (Nankai): *Some new families of filtration six in the stable homotopy spheres*
- **Lei Fu** (Nankai): *Weight Filtration and Monodromy Filtration of Vanishing Cycles*
- **Xiaojiang Tan** (Peking): *Petri Map for Rank 2 Vector Bundles*
- **Shaoqiang Deng** (Nankai): *Dipolarizations in Lie Algebras and Homogeous ParaKaehler Manifolds*
- **Hui Kou** (Sichuan): *Topology*
- **K.C. Chang** (Peking): *An Evaluation of Minimal Surfaces*
- **Youcheng Zhou** (Zhejiang): *Topology*
- **Jacques Hurtubise** (CRM/McGill)
- **Kunio Murasugi** (Toronto)
- **McKenzie Wang** (McMaster)
- **Eckhard Meinrencken** (Toronto)
- **Denis Sjerve** (UBC)
- **Rick Jardine** (Western Ontario)
- **Olivier Collin** (Université du Québec à Montréal)
- **Maung Min-Oo** (McMaster)
- **Dale Rolfsen** (UBC)

VII. Operator Theory/Functional Analysis:

- **Guanggui Ding** (Nankai): *Some Recent Advances and the Open Problems on Perturbations and Extensions of Isometric operators*
- **Man Duen Choi** (Toronto)
- **Kenneth Davidson** (Waterloo)
- **George Elliott** (Toronto)
- **Michael Lamoureux** (Calgary)
- **James Mingo** (Queen's)
- **Andu Nica** (Waterloo): *Levels of operator-valued R-transforms in free probability*
- **Sam Walters** (UNBC)
- **Shuang Zhang** (Cincinnati): *Purely infinite simple C*-algebras generated by an isometry and a bilateral shift*
- **Allan Donsig** (Nebraska)
- **Thierry Giordano** (Ottawa)

VIII. Mathematical Finance:

- **Duo Wang** (Peking): *Bifurcation of the ABS model of fundamentals versus trend chasers with positive share supply*
- **Junyi Guo** (Nankai): *Compound models and their ruin probabilities for risk processes with correlated aggregate claims*
- **John Walsh** (UBC)
- **Uli Haussmann** (UBC)
- **Ali Lari-Lavassani** (Calgary)
- **Abel Cadenillas** (Alberta)

IX. ODE and Dynamical systems:

- **Weigu Li** (Peking): *Planar Analysis Vector Fields with Generalized Rational First Integrals*
- **Zhiming Zheng** (Peking): *Semi-uniform Ergodic Theory and its Application*
- **Meirong Zhang** (Tsinghua): *The rotation number approach to eigenvalues of the one-dimensional p-Laplacian*
- Weinian Zhang (Sichuan University): *Bifurcations of a Polynomial Differential System of Degree n in a Biochemical Reaction*
- **Yun Tang** (Tsinghua): *Singularities of quasi-linear DAE in the setting of real algebraic geometry*
- **Lan Wen** (Peking): *A C^1 Density Theorem*
- **Oleg Bogoyavlenskij** (Queen's)
- **Florin Diacu** (Victoria)
- **C. Rousseau** (Montréal)
- **J. Belair,** (Montréal)
- **B. Langford** (Guelph)
- **W. Nagata** (UBC)
- **M. Li** (Alberta)
- **V. LeBlanc** (Ottawa)
- **Leon Glass** (McGill): *Dynamics in High Dimensional Models of Genetic Networks*

The Fascinating Predator-Prey Equation and Development of HIV/AIDS in Canada

Contributed by B. D. Aggarwala (University of Calgary)

Introduction

Modelling in mathematics is as old as mathematics itself. Galileo Galilei (1564–1642), arguably the first modern mathematician, wrote down equations to 'model' the velocity of a piece of stone as it fell down the Tower of Pizza. Sir Issac Newton (1642–1727) considered his model of the Solar System as a towering achievement of his life, which indeed it was. In epidemiology, spread of childhood infectious diseases in constant populations was first modelled by Hamer [1] in 1906. In this article, we apply a simple predator-prey model in epidemiology to the spread of HIV/AIDS in Canada and arrive at some surprising conclusions.

In a predator-prey model, we look upon the HIV positive people as the predators and the HIV negative ones as the prey. Now the usual ratio dependent predator-prey model is

$$x'(t) = \alpha x(1-x) - xy/(x+y) \tag{1a}$$
$$y'(t) = -ay + kxy/(x+y) \tag{1b}$$

where $x(t)$ and $y(t)$ are the number of prey and the number of predators respectively at any time t. In this model, in the absence of the predators, the prey multiply logistically according to the equation $x'(t) = \alpha x(1-x)$. In encounters with predators, the prey die according to the term $k_1 xy/(x+y)$. We have non-dimensionalised the constant k_1 to 1 in equation (1a). The constant k is called the conversion factor, so that a 'sacrifice' of $xy/(x+y)$ prey adds $kxy/(x+y)$ to the population of predators (it takes more than one mouse to keep one cat alive). In the absence of the prey, the predators die according to the term '$-ay$', because they have no food. With this explanation, the equations (1) are the usual "rate of change = rate in minus rate out" equations, familiar from the first couple of chapters of most texts on differential equations.

If we write the equations (1) as $x'(t) = F(x,y), y'(t) = G(x,y)$, then the points where $F(x,y) = G(x,y) = 0$ are called the points of equilibrium of these equations. The idea is that you look upon $(x,y) = (x(t),y(t))$ as a moving point in the (x,y) plane and these are the points where its velocity is zero. If we know how the equations behave in the 'neighbourhood' of these points, then there are theorems in mathematics which tell that for large values of t, the moving point will end up either at one of these equilibrium points, or go to infinity, or 'get stuck' in a limit cycle. A limit cycle is simply a periodic solution of our equations which the moving point approaches for large values of t.

It is possible to prove that, in our system, if $x(0) > 0$, and $y(0) > 0$, then the moving point will stay in a closed and bounded region of the first quadrant, so that infinity is ruled out. If we now define $F(0,0) = G(0,0) = 0$ (notice that $F(x,y)$ and $G(x,y)$ have not been defined at the origin so far), then the origin is an equilibrium point of the system and we want to know how the system behaves in the neighbourhood of the origin. In the case of HIV/AIDS application, this point represents the annihilation of the society.

The behaviour of such a system 'near' an equilibrium point can be investigated by expanding $F(x,y)$ and $G(x,y)$ near such an equilibrium point in Taylor series and retaining only the linear terms. If such an equilibrium point is the origin, this leads to the equations $X'(t) = A\,X$, where A is a 2×2 matrix, $X = \begin{pmatrix} x \\ y \end{pmatrix}$ and the eigenvalues of the matrix A decide the behaviour of the system near the origin. The trouble in our case is that $F(x,y)$ and $G(x,y)$ do not have Taylor series expansions near the origin. What do we do?

We start with an example. We arbitrarily take $(a,k) = (.31, .62)$ and ask ourselves the question; starting from which points in the (x,y) plane do we approach the origin for large values of t? We notice that in addition to $P_1 = (0,0)$, there are two other equilibrium points of our equations, namely $P_2 = (1,0)$ and $P_3 = (x_1, y_1)$, where $x_1 = (k\alpha - k + a)/(k\alpha)$ and $y_1 = (k-a)x_1/a$, and that the eigenvalues at these 'other' equilibrium points are $(-\alpha, k-a)$ and the two roots λ of $\lambda^2 + B\lambda + C = 0$ where $B = (a+\alpha-1) - a^2(k-1)/k^2$ and $C = a(k-a)(k\alpha - k + a)/k^2$ respectively. In our example, we take $B = 0$ which gives $\alpha = .595$. We are now ready to go to the computer.

On the computer, we arbitrarily assume that if $x(t)^2 + y(t)^2$ is 'small' , less than 10^8 say, for some large values of t (we took $t = 150$), then we are aproaching the origin. After all, if we are approaching some other point, then we do not expect to find ourselves near the origin for large values of t. Here is the diagram plotting all such points in the first quadrant. The square symbol in this diagram gives the location of $P_3 = (x_1, y_1)$.

This does not throw much light on the problem. What is the bounding curve of the area in Fig. 1? We consider the path of two solutions starting very close to the boundary of all these points in the above diagram. We took $A_1(.9, .399)$ and $A_2(.9, .398$ as examples. We found that the solution starting from A_1 goes to the origin while the one starting from A_2 comes very close to the origin, then leaves the origin staying close to the x-axis (an eigenvector at the origin), comes close to $P_2(1,0)$ staying close to the x-axis (an eigenvector at this point as well), leaves $P_2(1,0)$ along the other eigenvector at this point, and finally approaches P_3 along a spiral. We strongly suspect that the same thing is happening at the origin. The bounding solution is approaching the origin along an eigenvector. But we cannot linearise our equations near the origin and we do not know this eigenvector. What do we do?

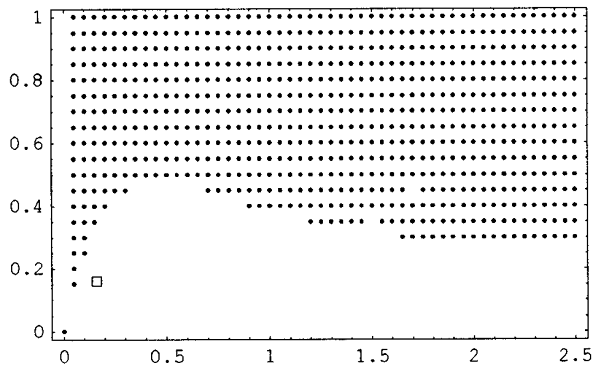


Fig. 1: This diagram shows the area from where the points in the first quadrant go to the origin for $(a, k, \alpha) = (.31, .62, .595)$. The square symbol gives the location of P_3.

For problems in the plane, there is another, simpler method for finding the eigenvalues and eigenvectors of our differential equations. If the equilibrium point is the origin, then the line $y = mx$ is an eigenvector if the differential equation is *satisfied* along this line in the neighbourhood of the origin, i.e. if $y' = mx'$ for "small" values of x and y. For our equations, this gives $m = (a + \alpha - k)/(1 - a - \alpha)$. Corresponding to this value of m, the quantity $\lambda = (\alpha - m)/(1 + m)$ is the eigenvalue. If $m > 0$ and $\lambda < 0$, then the solution is approaching the origin along $y = mx$ for large values of t. In our example, we get $m = 3$ and $\lambda = -.155$. Since the solution is approaching the origin for positive values of t, it must be going away from the origin for negative vaues of t. Here is the solution imposed upon the above diagram and running from $t = 0$ to $t = -118$. We conclude that this indeed is the solution which bounds the area from where the solutions go to the origin.

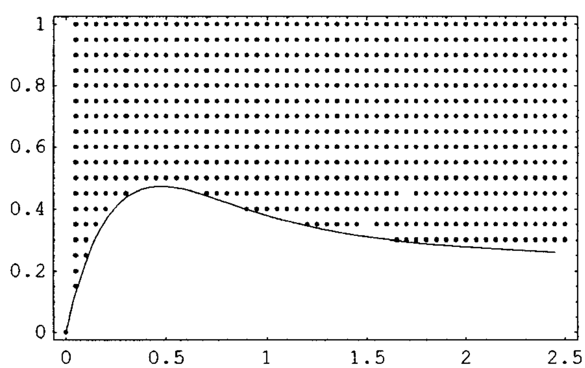


Fig. 2: This diagram shows the points in the first quadrant for $(a, k, \alpha) = (.31, .62, .595)$ from where the solutions go to the origin and a solution of our equations running along $y = mx$ (see text) from $t = 0$, to $t = -118$.

We conclude that in this example, there are three eigenvectors through the origin as against two when the equilibrium point is a 'regular' one with Taylor series expansions of $F(x, y)$ and $G(x, y)$. In this example, the eigenvectors at the origin are $x = 0$ (corresponding $\lambda > 0$, $y = 0$ (with $\lambda < 0$) and $y = mx$ (with $\lambda < 0$). If $m = \tan(\theta_1)$ then the origin is an unstable saddle point in the sector $0 < \theta < \theta_1$ and a stable node in the sector $\theta_1 < \theta < \pi/2$.

For other values of (a, k, α), m may be either positive or negative and the corresponding λ may also be either positive or negative. If m is negative, then there is no corresponding eigenvector through the origin (because the solution has to stay in the first quadrant) and with m positive, if λ is also positive, then the solution runs away from the origin in positive time. However, it cannot go very far (the solution must be bounded) and it turns back and comes back to the origin along the y-axis. We investigated the cases of $B > 0$ and $B < 0$ in a similar manner. Nothing unexpected was found. For $m < 0$, we can make the following two important statements:

Proposition 1 *If $a + \alpha < \min(1, k)$, then all solutions go to the origin.*

Proof: If we consider $u = x/y$ and x as the two dependent variables, then equations (1) reduce to

$$x'(t) = \alpha x(1 - x) - x/(1 + u) \tag{2a}$$

$$\& \quad u'(t) = -\alpha u(1 - x) - \frac{u}{1 + u} + au - \frac{ku^2}{1 + u} \tag{2b}$$

The desired result follows from the fact that $u'(t) \leq \alpha u + au - u \times \min(1, k)$, because writing $m = \min(1, k)$, this gives $u(t) \leq u(0)e^{(\alpha + a - m)t}$, which implies that if $\alpha + a < m$, then u goes to zero, and therefore x goes to zero, as t goes to infinity. The only equilibrium point with $x = 0$ is the origin and therefore all solutions approach this point. It is easy to see in this case that P_2 and P_3 are both unstable.

Proposition 2 *If $a + \alpha > \max(1, k)$, then no solution goes to the origin.*

Proof: If, for large values of t, $x < \epsilon$ for some small positive number ϵ, then it is easy to see from equation (2b) that $u'(t) \geq mu$ where $m = \min(a + \alpha - 1 - \alpha\epsilon, a + \alpha - k - \alpha\epsilon)$. But then $u(t)$ becomes arbitrarily large and consequently the second term in (2a) becomes arbitrarily small. This implies that x must increase, which proves the statement.

Also for $m > 0$, we can make the following two statements:

Proposition 3 *If $k < a + \alpha < 1$, then there are solutions of equations (1) which approach the origin.*

Proof: In this case $m = (a + \alpha - k)/(1 - a - \alpha)$ is a positive number and as we have pointed out above, there are solutions of our equations which approach the origin along the line $y = mx$. This happens if $x'(t) < 0$ along $y = mx$ near the origin, which is true if $k < a/(1 - \alpha) < a + \alpha < 1$ in this case. If for any value x_1 of x, the value of such a solution is y_1, then any solution which starts at (x_1, y_2) where $y_2 > y_1$ must approach the origin, because these two solutions cannot intersect each other except at the origin. Other solutions approach either P_2 or P_3 dependng upon other criteria.

Proposition 4 *If $1 < a + \alpha < k$, then there are solutions of equations (1) which approach the origin.*

Proof: In this case again, m is a positive number and there are solutions which approach the origin. In this case, $x'(t) < 0$ along $y = mx$ near the origin if $1 < a + \alpha < k < a/(1-\alpha)$. There are other solutions which approach P_3.

Application to HIV/AIDS

To describe the spread of HIV/AIDS in a society, we write our equations (1) as

$$x'(t) = \alpha x(1-x) - kxy/(x+y) \qquad (3a)$$

$$y'(t) = -\alpha y + kxy/(x+y) \qquad (3b)$$

where $x(t)$ and $y(t)$ stand for the number of the HIV negative and HIV positive individuals in our society, respectively. It is to be noted that in a random mating environment, the total number of mating partners to an x or to a y is $x + y$, so that an x may mate with a y with a probability of $kxy/(x+y)$. Hence the equations (3). These equations are equivalent to taking $k = 1$ in the foregoing discussion ($k = 1$ because if one HIV negative individual is lost, then one HIV positive individual is gained), but then the time scale is different. We take one year to be the unit of time in this section. Proposition 1 above now states that if $a + \alpha < k$, then all solutions go to the origin. The three points of equilibrium now are $P_1 = (0, 0)$, $P_2 = (1, 0)$ and $P_3 = (x_1, y_2)$ where $x_1 = (\alpha - k + a)/\alpha$ and $y_1 = (k - a)x_1/a$. These three points correspond to (a) the society being eliminated, (b) the disease being eliminated and (c) the disease becoming endemic, respectively. It is of utmost importance for us to know which values of the parameters lead to these three equilibrium points and particularly, to the annihilation of the society. This is what we have discussed so far.

We have found that in many cases, where the population of a country is more than the environment will support (i.e. $x > 1$), and k is large, as is the case in many developing countries of the world today, even a relatively low value of y, the number of infected people in the country, may force the solution to eventually go to the origin, a state which represents annihilation of the society (see Figure 1). In these cases, the number of infected people becomes very large for a while, and then the society gets annihilated. Perhaps this is what is happening in some countries in Africa today. In Botswana, according to *The Economist,* "the age-distribution of Botswana's population will change from the "pyramid" that is typical of countries with rapidly growing populations, to a "chimney-shaped" graph from which the young have been lopped out. Ten years from now, according to figures released at the conference by USAID, the American government's agency for international development, the life expectancy of somebody born in Botswana will have fallen to 29. In 20 years' time, the old will outnumber the middle-aged" [2]. Most of the old people in a situation like this are infected people so that the number of infected people has become very large, just as our theory predicts.

Before we congratulate ourselves however, we should look at Proposition 1 above which says that if $a + \alpha < k$, then all solutions go to the origin. We estimated the values of these constants for five consecutive years 1995, 1996, 1997, 1998 and 1999 from the data provided by Health Canada and Statistics Canada. In each year we found that $a + \alpha < k$ (though each one of these three numbers is going down). *According to this model,* therefore, the news for Canada is not good. The medical advances are buying us time for sure, but we must further reduce the value of k and/or increase the values of a and α. In addition to improving the methods of treatment and encouraging safe sex, a higher rate of increase of (healthy) population is called for. For more details see [3].

For Canada (and for any other society as well), the values of a, k, and α for any given year may be estimated from the data on HIV/AIDS published by Health Canada [4]. Also the estimates for the population of Canada are available from Statistics Canada [5]. We found, however, that there was no data available on the number of HIV positive people who are alive at any given moment. We assumed that one percent of HIV positive people die before they develop the AIDS disease (from accidents and such). Considering that the HIV positive people are living longer and longer, this is perhaps a reasonable hypothesis. The number alive at any moment t would then be the total number of HIV positive cases reported up to the time t (which was available) minus one percent minus the total number of deaths from AIDS reported (which number was also available). Based upon this data in any given year and the population figures for the succeeding year, we estimated the number of HIV positive people in the succeeding year. In this manner, we estimated the number of HIV positive people in Canada for the years 1996, 1997, 1998, 1999, and the year 2000. Thus the estimate for 1997 is based upon the HIV data for 1996 and the population figure for 1997, similarly for all other years. In Table 1, we give these estimates along with the actual numbers and the consequent error for the years 1995–1999. The actual numbers for the year 2000 are not available at the time of writing (May 2001). We have assumed the population of Canada to be 30.7501 million in the year 2000 [5]. If the actual population were different, then this estimate has to be revised. It should be noted that the error in any given year is less than one half of one percent. Thus our estimates are highly accurate.

We also estimated the number of HIV positive people in Canada in 1996, 1997, 1998, 1999 and the year 2000 based upon the HIV data for 1995 only and the population figure for each year. The results are given Table 2. The estimates are still highly satisfactory but not as good as the previous ones.

y	1996	1997	1998	1999	2000
Estimate	26130	28005	30278	32306	34411
Actual	26190	28110	30181	32253	n/a
% Error	.23	.37	.32	.16	n/a

Table 1

y	1996	1997	1998	1999	2000
Estimate	26130	27812	29603	31508	33536
Actual	26190	28110	30181	32253	n/a
% Error	.23	1.06	1.92	2.31	n/a

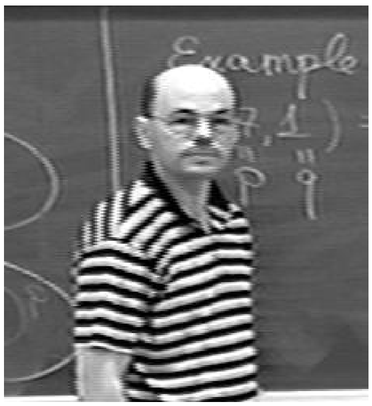
Table 2

Acknowledgement: Computer programming help from Arunas Salkauskas (University of Calgary) is gratefully acknowledged.

References:

1. W. H. Hamer, "Epidemic disease in England", *Lancet*, Vol. 1, pp.733–739.
2. "A turning point for AIDS?", *The Economist,* (July 15, 2000)
3. B. D. Aggarwala, "On two ODE models for HIV/AIDS development in Canada and a logistic seir model", *Research Paper #811, Departemnt of Mathematics and Statistics, University of Calgary,* (May 2001).
4. Surveillance Report to June 2000, *Centre for Infectious Disease Prevention and Control, HIV and AIDS in Canada,* (Nov. 2000).
5. Cansim Retrieval Output, *Quarterly estimates of population for Canada (2000).*

Vladimir Turaev and Gang Tian: PIMS Distinguished Chairs for 2001



Vladimir Turaev (Strasbourg)

Professor Vladimir Turaev (Research Director, CNRS IV, Strasbourg) is the PIMS Distinguished Chair at the University of Calgary for the months of July and August. He is giving a series of 6 lectures on *Torsion Invariants of 3-manifolds.*

Turaev has made several seminal contributions to quantum invariants of 3-manifolds and topological quantum field theory. His recent research has been motivated by the development of topological quantum field theory by Edward Witten in 1988. Witten used the Feynman path integral in his construction, even though there is no rigorous mathematical justification for the path integral in this context. Following the publication of Witten's work, Turaev and Reshetikhin proved that a system of topological invariants of 3-manifolds could be developed using the representation theory of quantum groups. In their work they exploited a relationship between the representation theory of quantum groups and solutions of the Yang-Baxter equation of statistical mechanics. This allowed them to use the theory of representations of the quantum group $U_q(sl_2(\mathbb{C}))$ to define invariants of 3-manifolds. They then went on to give a rigorous construction of a topological quantum field theory in dimension 3.

Professor Turaev's work has led to many advances in mathematics and physics. In particular, an understanding of the topological and geometric nature of quantum invariants is viewed by many to be essential for the deveopment of a quantum theory of gravity.

More information on Professor Turaev's lectures at PIMS-UC is available on the webpage **www.pims.math.ca/science/2001/distchair/turaev**.

Gang Tian (MIT)

PIMS is looking forward to hosting Gang Tian as PIMS Distinguished Chair at UBC during the month of August, 2001. Professor Tian is the Simons Professor of Mathematics at the Massachusetts Institute of Technology. While at UBC, he will lecture on *Recent Progress in Complex Geometry.*

Professor Tian's research covers such diverse areas as differential geometry, algebraic geometry, geometric analysis and partial differential equations. He has made fundamental contributions in each of these areas. In particular, he is well known for his work on the question of existence and obstructions for Kähler-Einstein metrics on complex manifolds with positive first Chern class, for his proof that the qantum cohomolgy ring is associative (joint with Y. Ruan) and for his work on higher dimensional dimensional gauge theory.

Tian received the 19^{th} Alan Waterman Award from the National Science Foundation in 1994, the Oswald Veblen Prize in 1996 and was an Alfred P. Sloan Research Fellow from 1991–93.

He has been invited to give many prestigious lectures around the world. A partial list includes the International Congress of Mathematicians in Kyoto (1990), the Bergmann Memorial Lecture at Stanford University (1994), the Courant Lecture at New York University (1996), Distinguished Visiting Lectures at the University of Wisconsin (1996), Nachdiplomvorlesung Lectures at ETH, Zürich (1997), Myhill Lectures at New York State University, Buffalo (1998) and the Andrejewski Lectures at Göttingen University (1999).

The lectures of both Professor Turaev and Professor Tian will be videotaped and made available from the PIMS streaming video webpage, **www.pims.math.ca/video**.

IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop

PIMS-UBC and PIMS-SFU
February 17–18, 2001

The annual SFU-UBC-PIMS Senior Undergraduate Math Modelling Workshop was held on February 17 and 18, with Saturday's portion organized by UBC's **Institute for Applied Mathematics** and Sunday's by SFU's **Centre for Scientific Computing**. The students came from across Canada — Acadia, University of Western Ontario, University of Alberta, University of Calgary, University of British Columbia, Memorial University of Newfoundland, McGill University, University of Toronto, York University, and SFU.

On Saturday, the students were given the choice of working on one of three projects: *Nonlinear Heat Conduction in the Microwave Heating of Ceramics* with Michael Ward (Math, UBC), *An Analytical and Numerical Study of Solitary Waves (Solitons)* with Bernie Shizgal (Chemistry, UBC and Director of the Institute for Applied Mathematics) or *Modelling the Flight Path of a Softball* with Douw Steyn (Earth and Ocean Science, UBC).

On Sunday, the students were given the choice of participating in one of two projects: *Liquid Mobility in Fuel Cells* run by Keith Promislow (Math, SFU) with help from Ron Haynes (Math Ph. D. student at SFU) or *Visualizing A Snowstorm* run by Dave Muraki (Math, SFU) and Torsten Moeller (Computing Science, SFU).

Both days of the workshop were highly successful, with the mentors being rewarded by an enthusiastic and lively response from the students. For more information, see **www.pims.math.ca/industrial/2001/suimw**.

Participants in the IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop.

3rd PIMS Fluid Dynamics Summer School

PIMS at the University of Alberta
May 27 – June 8, 2001

Eighteen graduate students from all over the world attended a comprehensive series of lectures, and were given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes. Topics included fluid dynamics fundamentals, industrial and environmental flows, geophysical fluid dynamics, turbulence modelling and computational fluid dynamics. Subjects were all taught at a graduate level.

This year's summer school was particularly rewarding for the students since it was held in conjunction with a PIMS Thematic Programme on Wave Phenomena and Fluid Dynamics. Special invited speakers were T. G. Shepherd (Univ. of Toronto) who spoke on *The Fluid Dynamics of the Middle Atmosphere* and H. J. S. Fernando (Arizona State) who spoke on *Turbulence and Mixing in Stably Stratified Fluid Layers.*

The Core Lecturers for the courses were **John C. Bowman** (Univ. of Alberta), *Turbulence Modelling*; **Andrew B. G. Bush** (Univ. of Alberta), *Climate Modelling*; **Peter Minev** (Univ. of Alberta), *Computational Fluid Dynamics*; **T. Bryant Moodie** (Univ. of Alberta), *Wave Theory*; **Bruce R. Sutherland** (Univ. of Alberta), *Stratified Flows* and **Gordon E. Swaters** (Univ. of Alberta), *Physical Oceanography.*

PIMS/MITACS Undergraduate Industrial Case Study Workshop

Centre for Operations Excellence at UBC,
October 25–29, 2001

Selected students in the summer preceding their senior year are invited by PIMS and MITACS to compete in a 3-day industrial case study competition. Fifteen students from across North America, in undergraduate programmes such as Engineering, Mathematics, Statistics, Computer Science and Economics, will be chosen for this intensive three-day industrial case study competition. Business problems will be selected to require mathematical analyses, complemented with problem formulation, problem solving, and presentation skills.

This workshop is designed to:

- Introduce students to current research initiatives and industrial problems in the operations research sector.
- Provide a unique opportunity for students to work in teams to solve challenging problems with mathematical and business content.
- Allow industry executives the opportunity to become acquainted with students and evaluate them for potential future employment.
- Inform students of the exciting opportunities for graduate studies in applied math and operations research.

For more information and registration please see **http://pims.math.ca/industrial/2001/uicsw**.

Statistical Genetics and Computational Molecular Biology

University of Washington, December 16–18, 2001

The programmes in **Statistical Genetics** and **Computational Molecular Biology** at the University of Washington will host a Workshop in Statistical Genetics and Computational Molecular Biology. The workshop is aimed at students from the mathematical, computational, and statistical sciences who may be considering graduate study and research in these areas of mathematical and computational biology. The intended participants are primarily undergraduate seniors or first-year graduate students at Colleges and Universities of the Pacific Northwest Region or Western Canada. PIMS will provide support for graduate students from the PIMS universities.

Topics will be in computational molecular biology, genomics, statistical genetics, and bioinformatics. Lectures will be given by: **David Baker** (Biochemistry, Univ. of Washington) *Protein Structure Prediction*; **Joe Felsenstein** (Genetics, Univ. of Washington); **Jinko Graham** (Statistics and Actuarial Science, SFU) *Testing and Estimation of Recombination Breakpoints in a Set of Aligned Sequences*; **Phil Green** (Molecular Biotechnology, Univ. of Washington) *Analyzing Genome Sequences*; **Kathleen Kerr** (Biostatistics, Univ. of Washington) *Gene Expression Microarrays: Classical Statistics and Modern Genomics*; **Leonid Kruglyak** (FHCRC); **John Mittler** (Microbiology, Univ. of Washington); **Stephanie Monks** (Biostatistics, Univ. of Washington); **Jim Mullins** (Microbiology, Univ. of Washington) *Genomics is Solving Problems in Infectious Diseases*; **Maynard Olson** (Univ. of Washington Genome Center) *Resequencing Segments of the Human Genome: Experimental and Statistical Considerations*; **Steve Self** (or other representative from the Bioinformatics Group of the FHCRC); **Elizabeth Thompson** (Statistics, Univ. of Washington) *Inferring Gene Locations from Genetic Data on Pedigrees*; **Martin Tompa** (Computer Science and Engineering, Univ. of Washington) *An Exact Algorithm to Identify Motifs in Orthologous Sequences from Multiple Species*; and **Ellen Wijsman** (Division of Medical Genetics, School of Medicine, Univ. of Washington).

For more information please see: **depts.washington.edu /statgen/Statgen/workshop.shtml**.

PIMS Postdoctoral Fellows for 2001/02

The following PIMS postdoctoral fellows were selected for the year 2001/2002. The members of the review panel were Gordon Slade (chair, UBC), Pauline van den Driessche (University of Victoria), Richard Lockhart (SFU), Robert Moody (University of Alberta), Nick Pippenger (UBC) and Rex Westbrook (University of Calgary).

Yuqing Wang: mathematical biology. Supervised by Robert Miura (Math, UBC) and Yue-Xian Li (Math, UBC).

Luis Lehner: general relativity, numerical relativity and quantum gravity. Supervised by Bill Unruh (Physics, UBC) and Matt Choptuik (Physics, UBC).

Antal Jarai: mathematical physics (percolation theory). Supervised by Gordon Slade (Math, UBC).

Kazuyuki Furuuchi: theoretical physics (string theory). Supervised by Gordon Semenoff (Physics,UBC).

Joachim Stadel: numerical astrophysics. Supervised by Julio Navarro (Physics, UVic) and Arif Babul (Physics, UVic).

Inhyeop Yi: dynamical systems and operator algebras. Supervised by Ian Putnam (Math, University of Victoria).

Nils Bruin: number theory and arithmetic algebraic geometry. Supervised by Peter Borwein (Math, SFU), David Boyd (Math, UBC), Imen Chen (Math, SFU), Rajiv Gupta (Math, UBC) and Nike Vastal (Math, UBC).

William Galway: computational number theory. Supervised by Jonathan Borwein (Math, SFU), Peter Borwein (Math, SFU), Imin Chen (Math, SFU), Stephen Choi (Math, SFU) and Petr Lisonek (Math, SFU).

Sumati Surya: quantum gravity. Supervised by Kristin Schleich (Physics, UBC), Don Page (Physics, University of Alberta) and E. Woolgar (Math, UA).

Matthias Neufang: functional analysis, harmonic analysis and operator algebras. Supervised by Volker Runde (Math, University of Alberta).

Wen Chen: signal and image processing. Supervised by Bin Han (Math, University of Alberta) and Rong-Qing Jia (Math, University of Alberta).

Roman Vershynin: geometric functional analysis. Supervised by Nicole Tomczak-Jaegermann (Math, University of Alberta).

Christina Cobbold: mathematical biology. Supervised by Mark Lewis (Math and Biological Sciences, University of Alberta).

Luigi Santocanale: computer science and category theory. Supervised by Robin Cockett (Computer Science, University of Calgary).

Peter Hoyer: algorithmics, data structures, complexity theory and quantum computing. Supervised by Richard Cleve (Computer Science, University of Calgary).

Jorgen Rasmussen: conformal field theory and Kac-Moody algebras. Supervised by Mark Walton (Physics, University of Lethbridge).

MathCounts Vancouver Island Competition

Contributed by David Leeming,
UVic PIMS Education Coordinator

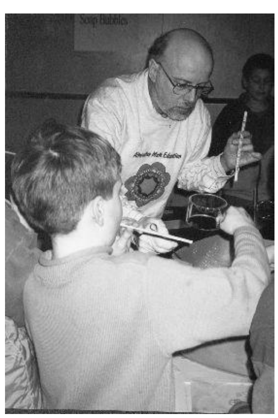
MathCounts Vancouver Island is a regional competition, which is part of MathCounts British Columbia. Sponsored locally by the Association of Professional Engineers and Geoscientists of BC (APEGBC) and PIMS, it provides a combination of math coaching and a competitive programme for students in grades eight and nine.

The 2001 competition was held on Friday, February 9 at **Lambrick Park Secondary School** in Victoria. Teams of four students competed in various rounds to determine the team and individual winners. There were six grade eight and seven grade nine teams in this year's competition. The competition concluded with the exciting Countdown Round. This year, the top grade eight team was **Cedar Hill Junior Secondary (Green) Team** and the top grade nine team was **Lambrick Park Secondary (IBS) Team**. The top grade eight individual was **Jeremy Li Foa Wing** of Cedar Hill and the top grade nine individual was **Kailyn Young** of Lambrick Park. The grade nine team from **Mt. Klitsa Junior Secondary School** in Port Alberni travelled the furthest to take part in the regional competition. David Leeming, UVic PIMS Education Coordinator, was the Site Coordinator and Leo Neufeld of Camosun College (retired) was the Head Judge. The event was co-hosted by James Bernldez and Jan Buermans of APEGBC along with the support of many volunteers from APEGBC, Camosun College and the University of Victoria.

Math Mania at Sir James Douglas Elementary School

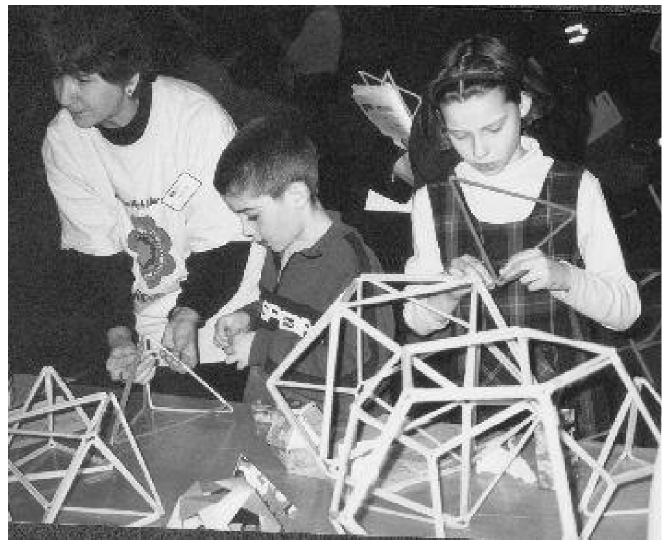
Contributed by David Leeming,
UVic PIMS Education Coordinator

Another very successful Math Mania Event was held at **Sir James Douglas Elementary School** in Victoria on February 28, 2001. Math Mania provides interactive displays, games and art along with hands-on activities including soap-bubbles, mathematical puzzles and paradoxes all showing kids and parents fun ways to learn math and computer science concepts.



Making bubbles with Dr. Denny Hewgill.

This event, sponsored by PIMS, was attended by over two hundred students, parents and teachers. Our outstanding volunteers included Dr. Pauline van den Driessche, Jan and Paul Nienaber, Dr. Julie Zhou, Dr. Denny Hewgill and Merilyn Hewgill, Kelly Choo, Irina Gavrilova, Dr. Florin Diacu, Elies Hoepner, Jeff Campbell, Charlie Burton, Elena Prieto, Shaun Pack, James Andersen, Peter Anderson, Geoff Schmidt, Dr. David Leeming, Mike Crowle and Dr. Rod Edwards. Enthusiastic family members and friends of the faculty, graduate students and undergraduate students of the University of Victoria contributed to making this event a success.



Students at Sir James Douglas Elementary School enjoy Math Mania.

Victoria's Fourth Annual FAME Builds on Success

Contributed by David Leeming,
UVic PIMS Education Coordinator

For the fourth consecutive year, students in the Greater Victoria School District participated in **FAME**, the Forever Annual Mathematics Exhibition. It was held at **S. J. Willis School** on April 21, 2001. This year, there were over eighty entries at three levels: Elementary (up to grade 7), Junior (grades 8-9) and Senior (grades 10-12). The event was organized by Wendy Swonnell, Betty Doherty, Betty McAskill and Tanis Carlow and was sponsored, in part, by the Pacific Institute for the Mathematical Sciences.

The exhibits presented at **FAME** are judged for creativity, skill, dramatic value and mathematical thought. For the first time this year, every entrant was given an award — the categories being Distinction, First Class and Runner Up. A School trophy is presented at each level (Elementary, Junior and Senior) based on the best aggregate score of the top three projects. With more schools participating in **FAME** each year, this annual event will continue to attract outstanding mathematical exhibits from students in a wide range of grades.

Changing the Culture 2001

The **Fourth Annual Changing the Culture Conference** was held at SFU, Harbour Centre on May 11. This annual conference, sponsored by PIMS, brings together mathematicians, mathematics educators and school teachers from all levels to work together towards narrowing the gap between mathematicians and teachers of mathematics. The theme was *Writing, Speaking and Thinking Mathematics.* The conference explored connections between numeracy and literacy, mathematics and language, mathematics and literature, and how we can use language to teach mathematics. There were two plenary talks:

Mathematics and Literature: Cross Fertilization by Brett Stevens, PIMS/IBM PDF, SFU.

Breaking the Cycle of Ignorance by John Mighton, NSERC postdoctoral fellow at the Fields Institute for Research in Mathematical Sciences.

John Mighton is the founder and coordinator of JUMP, Junior Undiscovered Mathematical Prodigies, an educational no-cost outreach program for students who are doing badly in mathematics in school. This program has been very successful and is rapidly gaining momentum in Toronto. John talked about his experiences with JUMP and how to make math accessible for kids whom the standard methods have not reached. John is also a Governor's General award winning playwright. Robert LePage's latest film, Possible Worlds, was adapted from one of his plays, and he was a math consultant and actor in *Good Will Hunting.* He is also a professional mathematician at the Fields Institute.

Each participant was able to attend two of the following workshops:

1. JUMP: Junior Undiscovered Mathematical Prodigies program. Leader: John Mighton
2. Contextualizing Mathematics. Leader: Brett Stevens and Karen Meagher
3. Connecting Early Numeracy and Literacy. Leaders: Cynthia Nicol and Heather Kelleher

For further information, see the webpage **www.pims.math.ca/education/2001/ctc**. Both plenary lectures are available via streaming video from this webpage.

Mathematics Projects in the Greater Vancouver Regional Science Fair

Contributed by Nataša Sirotić.

The **2001 Greater Vancouver Regional Science Fair** (GVRSF) took place at UBC, April 5–7. It held 26 projects within the Mathematical/Computer Sciences exhibit category. Within this category, there were 2 computer science projects while all others were mathematical.

In terms of the grade-level distribution, there were 10 junior projects (grades 7, 8), 10 intermediate (grades 9, 10), and 6 senior (grades 11, 12). Projects came from the following schools: University-Hill Secondary, Point Grey Mini School, Britannia Secondary School, York House, Collingwood School, Sir William Osler Elementary School, Windermere Secondary, and Vancouver Technical.

This is the third time that PIMS provided assistance and expertise to promote mathematics projects development within the GVRSF by informing and involving mathematics teachers, giving presentations and workshops to groups of students, helping and providing assistance to students that have undertaken mathematics projects, and by judging and awarding the projects. The special award judges for PIMS were David Boyd, Klaus Hoechsmann, Leah Keshet, and Sandy Rutherford.

Although participation did not increase (there were 26 math projects last year as well) we have witnessed a significant increase in the quality of projects. Two of the projects made it into the Canada Wide Science Fair in Kingston, Ontario,and won multiple awards even at this very top level. These projects were *"Trees A Math Lesson from Nature"* by **Christine Pop** from Sir William Osler Elementary and *"Calculating Equilateral Triangles within an Equilateral Triangular Grid"* by **Mahmoud Bazargan** from U-Hill Secondary.

Mahmoud Bazargan's project set out to determine how many triangles there are inside a general equilateral triangular grid without having to count them. He split the problem into considering those triangles that face upwardsand those that face downwards, and then by analyzing the pattern for the various triangle sizes within the grid he found a general formula.

Christine Pop's project was remarkably outstanding, and so in her words it is outlined:

"The purpose of my project is to find out if I can geometrically model natural objects and describe their shapes and motions using mathematical concepts.

There are two options I can work with: classical Euclidean geometry or new fractal geometry. Since Euclidean geometry deals strictly with the zero-dimensional point, the one-dimensional line, the two-dimensional plane, and the three-dimensional solid, the crinkly motions of nature cannot be defined in a satisfactory waywithin such rigid limits. Fractal geometry, though, deals with looking at objects of non-integer dimensions that are seen as dynamical systems, systems that form a result using iteration. Therefore, fractal geometry will serve best for my purpose, because nature itself does not contain any perfectly straight lines or flat planes. Nature is a fractal that can be modelled by fractal geometry, thus supporting my hypothesis, that I will be able to describe natural objects with math.

The natural object I decided to use is the tree. I can geometrically compose this using the properties of fractals to show that a tree grows under the different laws of fractal geometry. These properties are self-similarity and reduction or factor-scaling, which are both implied in the iterated process that creates a fractal. I can use these guidelines to create my tree structure. The main reason for choosing the tree is that it is a beautiful creation that can be represented from various perspectives ranging from a scribbled stick figure by a kindergarten child to a painting by a famous artist.

As a context for my research and findings, I composed a list of simple tree structures made up of mathematical concepts: the decimal tree, the H-fractal (tree), the binary tree, and the Pythagoras Tree. Spirals and geometric sequences are also an important part of my project because the Pythagoras Tree expresses these concepts.

Focusing only on the Pythagoras Tree, I tried to find out under which law it grew. The basic construction of this fractal consists of the association of three squares that, joined together, use the Pythagorean theorem, $a^2+b^2=c^2$. Using a, b, and c as the sides of the first right triangle and angle α and β (or $\pi/2-\alpha$) of that triangle, the operation would have to repeat indefinitely to show the transformations of the left and right rotations.

As part of my project, I determined, a general rule, the geometric sequence that takes place in the spirals of the Pythagoras Tree. The common ratio, also identified as the reduction factor, helped me calculate the sum of the terms of the geometric sequence, which is in fact the total length of the spiral formed by each branch of the Tree.

Modifying angle α of the right triangle introduced a first degree of liberty, which led to interesting 'composite trees', altered versions of the original Pythagoras Tree. Using an obtuse isosceles triangle and an equilateral one, a tree that looks like broccoli and periodic tiling, respectively, is formed. Connected to changing the angle, I also modelled a visual representation of the Tree when α was 90 degrees and 360 degrees, in both cases keeping the original measurements for the squares.

Introducing a different orientation of the triangle gave an even higher degree of liberty because the tree could be changed so that it looked more like a fir tree than a maple one. This new degree of freedom implies randomness and overlapping. I saw how the trees' growing law was influenced, calculated the length of the similarity transformations, and looked for patterns in the way that the 'branches' overlapped.

As stated in my hypothesis, through fractal geometry, I can successfully model the shape and movement of natural objects. Paradoxically, complex fractal graphics are derived from simple mathematical equations. The secret to making fractals is to explore to infinite depths. By choosing the tree structure to exploit my research and basing it on fractal geometry, I could record the images of its movements in space. They are pictures of the way things fold and unfold, feeding back into each other and into themselves.

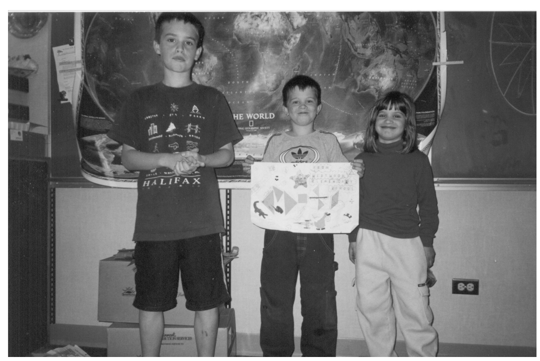
Fractal geometry is still a young field in math. In my project, I looked only at the primary formulas without going too much in depth. Like fractals, I am still young, but even at this stage, I realize that not only do fractals have interesting aspects and patterns, but that they will prove to be a new way of looking at the world around us. Fractals, for sure, will enhance our appreciation of math's austere beauty."

Westwood Students Enjoy *Mathematics Unplugged*

Contributed by Pam Hagen.

Westwood Elementary School students recently took part in their annual math conference, **Mathematics Unplugged**. PIMS has supported this event since its beginning and this was the fifth Math Unplugged. The school is in Port Coquitlam, British Columbia, and has approximately 250 students.

The event is styled just like an adult conference with a keynote speaker followed by workshops for the students to attend during the day. The keynote speaker has a difficult job to do as he/she needs to be able to hold the attention of students from K – G5 for at least 30 minutes and make it fun and interesting. This year every student went home with a tangram set, and a copy of the Tangram story.



Christian Price (centre) with his siblings Jordan and Christina.

The goal of this event is to try to lay an enjoyable and fun foundation for further mathematical awareness and engagement, which can last a lifetime.

Klaus Hoechsmann, PIMS Education Coordinator, helped plan the conference and visited the school on the day. His help was very much appreciated.

The conference was a success with the students who participated in it. One student replied when told it was time to go out to recess, "Oh, do we have to go out to recess, Math Unplugged is so much more fun!" Christian Price who is in G3 particularly enjoyed the event. He is shown, with his older brother and younger sister, holding the thank you picture he made for the PIMS office. He used his tangram set on the picture.

PIMS ELMACON 2001

Contributed by Krisztina Vásárhelyi

The third annual PIMS **Elementary Grades Math Contest** (ELMACON) took place on May 26th at UBC. This contest is organised by PIMS under the guidance of Dr. Cary Chien of David Thompson Secondary School in collaboration with the BCAMT and volunteers from Lower Mainland schools of all levels. It is open to students in grades 5 to 7 and it is designed to complement the popular MathCounts competition for higher grades.

A total of 223 students attended the contest this year, a substantial increase from last year, with 73, 80 and 70 students in grades 5, 6 and 7, respectively. This year we implemented an improved online registration procedure allowing students to sign up for the contest as well as to download their admission tickets.

The format of the contest followed the formula of previous years. Students competed in three divisions in the sprint, target and countdown rounds. The sprint and target rounds consisted of two sets of written questions which were evaluated immediately while contestants enjoyed refreshments and listened to a lively presentation of problem-solving strategies.

In the countdown round, the top ten students in each division— determined by combined scores from Sprint and Target rounds (with correct answers in the latter counting double)—participated in individual competitions. The tenth ranking student competed against the ninth, the winner then faced the eighth, and so on. A projector displayed one question at a time, and the contestants were required to ring a buzzer—within a certain time limit—as soon as they had an answer. A correct answer, scored a point; otherwise the opponent had the rest of the time limit to come up with the solution. This was repeated several times to determine which of the two could advance. Eventually an overall winner was found.

Each contestant received a score between 0 and 49 based on the written competition alone. The score was calculated by adding their Sprint Round score (0–25) to double their Target Round score (0–24). The average scores for grades 5, 6 and 7 were 19, 20 and 20.5, respectively and a score of 27, 25 and 27 for these grades was enough to place a contestant in the top 25%.

The lists below show the top 10 winners in each grade. The top ten finishers received a commemorative T-shirt and medal, together with a stylish binder donated by the BC Association of Mathematics Teachers. The top three also received a trophy, and an electronic calculator.

Grade 5: 1. Jimmy He, 2. Sherwin Kwan, 3. Aram Ebtekar, 4. David Lam, 5. Bryan Huang, 6. Simon T.H. Tseng, 7. Christin Chan, 8. Sara Hyunjung Kim, 9. Alan Tung, 10. Tiffany Le Gentil.

Grade 6: 1. Steven Karp, 2. Arthur Yip, 3. Arthur da Silva, 4. Jason Ng, 5. Connor Joseph Wagner, 6. Serena Ip, 7. David Di, 8. Rickey Tam, 9. Nestor Choi, 10. Sviatoslav Moldavanov.

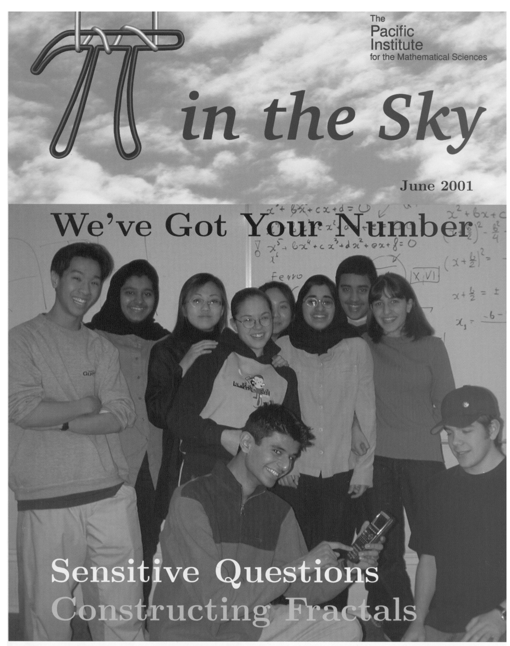
Grade 7: 1. Sam Wang, 2. William Wanki Kim, 3. Diane Wu, 4. Steven Hermann, 5. Yoshiaki Sono, 6. Howard Yan, 7. Carter (Wan Jae) Lee, 8. Fanhao Meng, 9. Jeffrey Nguyen, 10. Isaac Tang

Overall, the contest was a success. About 50 on-site volunteers from the UBC Science Ambassadors Program, various schools throughout BC as well as some parents helped the organising committee stage the event. Nine EL531VB scientific calculators which were awarded to the top three students in each grade, were donated by **Sharp**.

The New Issue of *Pi in the Sky*

The June 2001 issue of *Pi in the Sky* includes *We've Got Your Number* by Ted Lewis, *Have You Used Illegal Drugs Lately? or How to Ask Sensitive Questions* by Carl Schwarz, and *Constructing Fractals in Geometer's SketchPad* by Michael Lamoureux. These articles explain how visa card companies, for example, determine whether or not you have entered a valid number, the ideas behind randomized response surveys, and how to build fractals using Geometer's SketchPad software. The magazine also features articles about the history of algebraic equations, the Fields Medal and famous physicists who started out as mathematicians. There is also the usual exciting and challenging collection of mathematical exercises including problems about the principle of mathematical induction.

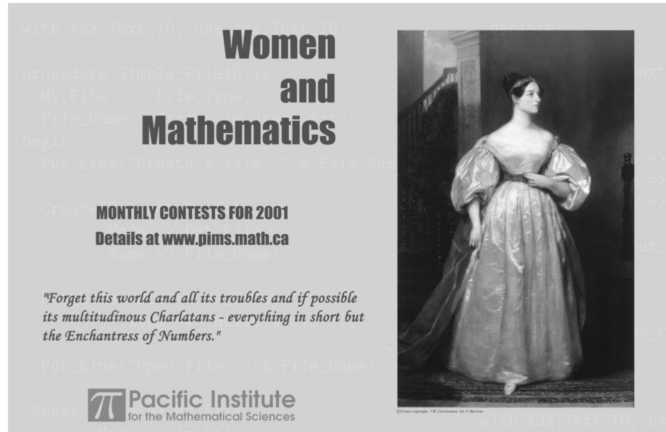
This time students from Old Scona Academic High School in Edmonton are featured on the cover.



The Women and Mathematics Poster Campaign

Contributed by Krisztina Vásárhelyi

The February poster featuring Hypatia of Alexandria.



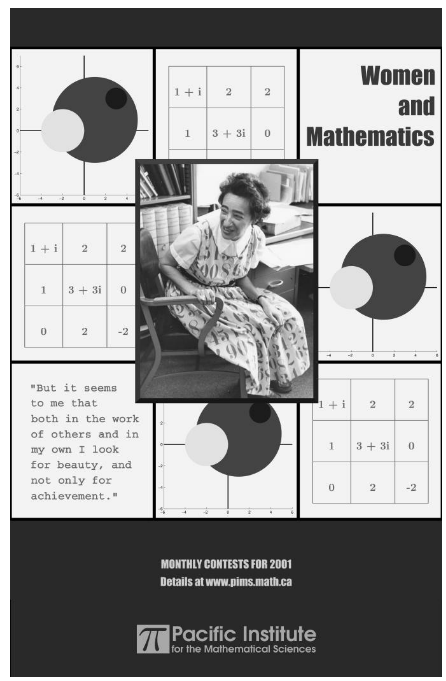
Ada Lovelace, namesake of the computer language Ada.

In February 2001, PIMS launched a new contest series with the title of **Women and Mathematics**. A poster is displayed on the PIMS website each month featuring a famous woman who contributed significantly to the mathematical sciences. The posters are accompanied by a quiz consisting of four questions about the life and work of the featured mathematician.

The concept of the present campaign is similar to the previous one but with a few key differences. This year, mathematical problem-solving is still a component of the contest, but it is not the only focus. The posters themselves depict images of the women featured but in most cases, the goal is also to use visual communication to convey something about the mathematical contributions of the featured individual. An intriguing quote is also a repeating component of the posters, which do not reveal the identity of the person involved but are designed instead to attract viewers to the website and explore further. The contest website typically includes four questions each month. Each question is introduced by some background information to set the context. Links to biographical resources are given on the webpage where the answers to the three biographical questions can be found. The fourth question always involves mathematical problem-solving. It is chosen to complement the biographical information and it is in some way related to the mathematician's area of specialisation.

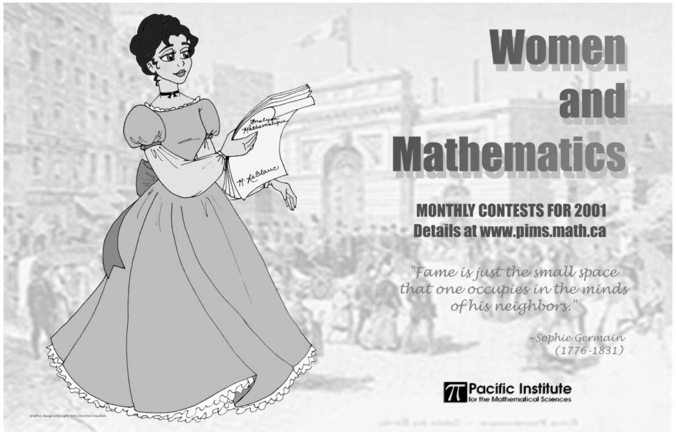
This year the posters are not displayed on the buses but instead they are distributed to schools in BC, Alberta and in Washington State. The theme is highly appropriate for high school students, especially girls, who stand before major decisions regarding a course of study to follow at university. The feeling that mathematics is dry and boring or too difficult is still highly prevalent among this age group. The main objective of the "Women and Mathematics" campaign is to show that women who engaged in the study and application of mathematics often lived fascinating lives. Thus these women may serve as role models for young people who are inclined to judge mathematical occupations and mathematicians in a negative light.

The stories of the colourful and often dramatic lives of the women featured in this contest provide plenty of material for challenging negative concepts about mathematicians. The first contest of the series in February told the tale of **Hypatia of Alexandria**. Hypatia, who lived around 400 AD, was the daughter of Theon, a mathematician and philosopher himself. She was legendary in her own time for her intellect, integrity of character, and great physical beauty. Her life ended tragically when she was murdered by a mob fearful of the concept of critical and independent thought which she symbolised.

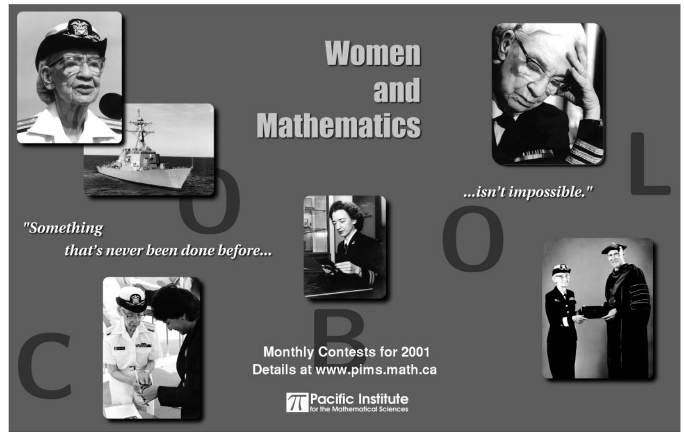


April featuring Olga Taussky-Todd.

Everyone is familiar with the famous poet Lord Byron but perhaps not many are aware that his daughter, **Ada Lovelace**, was a talented mathematician also. Ada was a vibrant character who died young at 36, just like her



The May poster designed by Jeni Rae Duschak.



Grace Hopper developed the computer language COBOL.

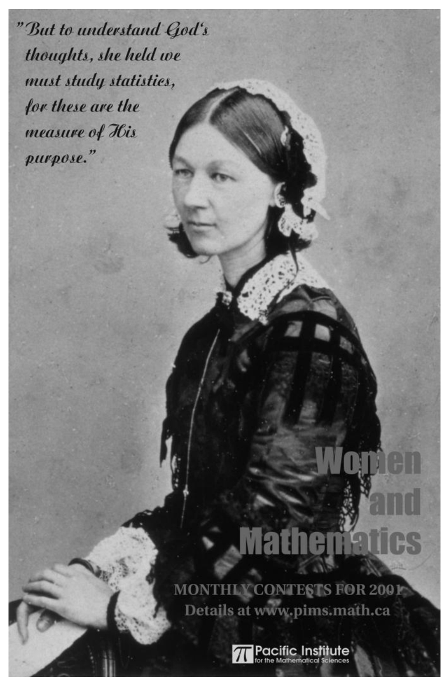
father. Her vivid imagination allowed her to play with abstract concepts of "poetical science" in the context of future possibilities. Her collaboration with Charles Babbage resulted in what now many call the first computer program ever written. Ada Lovelace was the subject of the March contest. **Olga Taussky-Todd**, multitalented in her youth, and growing up to be a brilliant mathematician, was presented in April, followed by the dynamic Grace Hopper, an officer of the Navy, the inventor of COBOL, who was featured in June.

Her life might have been the subject of a storybook: **Sophie Germain** dressed up as a man to be admitted to the École Polytechnique where her mathematical genius was discovered, and she was the secret saviour of Gauss, whose life was threatened during Napoleon's invasion. In May, PIMS was treated to a special poster-presentation of Sophie Germain. **Jeni Rae Duschak**, a young American artist who studied mathematics and liberal arts, generously donated her time to produce a beautiful poster for the contest, featuring her illustration of Sophie Germain in an appealing animation-style. Jeni Rae has a website about Sophie's life which includes a biography that she tells as a story illustrated with her drawings. Our discovery of her site led to an enjoyable collaboration which resulted in the special poster. The June contest website includes a profile of Jeni Rae which describes her personal campaign to raise young women's awareness of the importance of mathematics.

The contest for July features **Florence Nightingale**, another remarkable personality. She rejected the privileges of her class and the comforts and security of a conventional lifestyle. Following lengthy struggles with her family, she set out to pursue her training in nursing and eventually led a team of 38 nurses to care for wounded soldiers of the Crimean war. A deeply spiritual person,

Florence Nightingale was also a realist who had a great appreciation and love of mathematics. It was her ability to quantify and visually represent data on public health and social issues which lead to groundbreaking changes and eventually earned her wide public recognition and respect, including the honour of being elected as a fellow of the Royal Statistical Society.

As for **Mathematics is Everywhere**, the present contest attracts a varied audience, with a wide age-span, as well as an expanding geographic range. On the whole, male and female participation is approximately equal. The February winner was **Wayne Matthews**, a 56 year old mathematics instructor at Camosun College in Victoria, BC. He teaches precalculus and calculus and tries to communicate his enjoyment of mathematics to his students. He learnt about the contest from **Pi in the Sky** magazine, and since he enjoys staying active and informed, he decided to enter, and had fun doing so. **Jan Hannemann** was the winner in March. Jan is German, but he is currently living in Vancouver completing his PhD in Computer Science at UBC. He is 27 years old and he also enjoys snowboarding and music. His Diploma from Germany is in Applied Systems Science. He has been following the contests on the website since he first saw the posters last year on Vancouver's public buses.



Florence Nightingale was infuential in the application of statistics.

Please see ***Women*** *page 28.*

Women and Mathematics

Continued from page 27.

Wayne Chevier (29) from Langley, BC, won in April. Wayne is a long-time fan of the PIMS contests and he was also one of the winners last year. He has a wide range of interests including computers, mathematics, sciences, linguistics, science fiction and fantasy, and music. He says that he enjoyed the present contest as he learnt quite a bit about the history of mathematics. The May winner, **Chris Dieterle** is a 15 years old grade 10 student from London Ontario. He is interested in physics, astronomy and (of course) mathematics, as well as music, baseball and long-distance running. He also enjoys reading, especially good mysteries, and good science fiction. He also plans to make a telescope this summer. He found out about the PIMS website and the contest in the fall when he read a little write up about it in the Kitchener Record, the local newspaper. He found the contest interesting and challenging at the same time and plans to continue to participate. **Rebecca Oulton** from Acadia University in Wolfville, Nova Scotia won in June. She is a 20 year old university student in her third year in Mathematics and Statistics with Business. She is currently working for the Mathematics and Statistics Department at Acadia for the summer. She also likes, walking, reading, playing sports, socialising with friends, and spending time with her family. She discovered the contest by chance as she was exploring the PIMS website while searching for interesting links to add to her department's site. In her own words: "I really enjoy these monthly contests and feel that it will increase the awareness of not only mathematics but also the role of women in mathematics. So naturally I have it bookmarked and am looking forward to participating again this month."

Nobel Prize winning theoretical physicist Maria Goeppert-Mayer.

Physicist **Maria Goeppert-Mayer** features on the August poster. She received her doctorate in theoretical physics in 1930 Germany under the tutelage of Max Born. When she moved to the United States with her husband she had to take an unpaid "voluntary" teaching position, and did not hold a paying, full university professorship until she was 53. In 1963, Maria Goeppert-Mayer was awarded the Nobel Prize jointly with Hans Jensen for their work on the shell model of nuclear structure. The award was for the discovery of the magic numbers and their explanation in terms of a nuclear shell model with strong spin-orbit coupling.

PIMS Contact List

Director: Dr. N. Ghoussoub
Admin. Asst: Jacquie Burian
Phone: (604) 822–9328, Fax: 822–0883
Email: director@pims.math.ca

SFU-site Director: Dr. R. Russell
Admin. Asst: Fuyuko Kitazawa
Phone: (604) 268–6655, Fax: 268–6657
Email: sfu@pims.math.ca

UA-site Director: Dr. B. Moodie
Admin. Asst: Shirley Mitchell
Phone: (780) 492–4308, Fax: 492–1361
Email: ua@pims.math.ca

UBC-site Director: Dr. D. Rolfsen
Admin. Asst: Leslie MacFadden
Phone: (604) 822–3922, Fax: 822–0883
Email: ubc@pims.math.ca

UC-site Director: Dr. G. Margrave
Admin. Asst: Marian Miles
Phone: (403) 220-3951, Fax: 282-5150
Email: uc@pims.math.ca

UVic-site Director: Dr. F. Diacu
Phone: (250) 472–4271, Fax: 721–8962
Email: uvic@pims.math.ca

UW-site Director: Dr. T. Toro
Admin. Asst: Mary Sheetz
Phone: (206) 543–1173, Fax: 543–0397
Email: uw@pims.math.ca

Scientific Executive Officer: Dr. A. Rutherford
Phone: (604) 822–1369, Fax: 822–0883
Email: sandy@pims.math.ca

Education Coordinator: Dr. K. Hoechsmann
Phone: (604) 822–3922, Fax: 822–0883
Email: hoek@pims.math.ca

Asst. to the Director: Katrina Soh
Phone: (604) 822–6851, Fax: 822–0883
Email: katrina@pims.math.ca

PIMS/MITACS Website Manager: Kelly Choo
Phone: (250) 472–4927, Fax: 721–8962
Email: chook@pims.math.ca

Computer Systems Manager: Shervin Teymouri
Phone: (604) 822–0410, Fax 822-0883
Email: shervin@pims.math.ca

Computer Systems Manager: Brent Kearney
Phone: (604) 268-6654, Fax: 268-6657
Email: brentk@pims.math.ca

Communications Officer: Heather Jenkins
Phone: (604) 822–0402, Fax: 822–0883
Email: heather@pims.math.ca

PIMS-MITACS Admin. Asst., UBC: Clarina Chan
Phone: (604) 822-0401, Fax: 822–0883
Email: clarina@pims.math.ca

PIMS-MITACS Admin. Asst., UA: Lisa Haraba
Phone: (780) 492-4835, Fax: 492–1361
Email: lharaba@math.ualberta.ca

Newsletter Editors: A. Rutherford and H. Jenkins

*This newsletter is available on the world wide web at **www.pims.math.ca/publications**.*

PIMS is supported by:

- **The Natural Sciences and Engineering Research Council of Canada**
- **The Alberta Ministry of Innovation and Science**
- **The British Columbia Information, Science and Technology Agency**
- **Simon Fraser University**, **University of Alberta**, **University of British Columbia**, **University of Calgary**, **University of Victoria**, **University of Washington**, **University of Northern British Columbia** and **University of Lethbridge**.