

# Pacific Institute for the Mathematical Sciences

*Central Academic Building, PIMS-UA Site Office*



*Mathematical Sciences Building, PIMS-UC Site Office*



*PIMS Central & UBC Site Office*



*East Academic Annex, PIMS-SFU Site Office*



*Clearihue Building, UVic Site Office*



*University of Washington Campus, PIMS-UW Site Office*



*Max Bell Building & Corbett Hall, Banff Centre, home of BIRS*

## Institute Report 2002/03



# The Pacific Institute for the Mathematical Sciences

## Our Mission

The Pacific Institute for the Mathematical Sciences (PIMS) was created in 1996 by the community of mathematical scientists in Alberta and British Columbia and in 2000, they were joined in their endeavour by their colleagues in the State of Washington. PIMS is dedicated to:

- Promoting innovation and excellence in research in all areas encompassed by the mathematical sciences;
- Initiating collaborations and strengthening ties between the mathematical scientists in the academic community and those in the industrial, business and government sectors;
- Training highly qualified personnel for academic and industrial employment and creating new opportunities for developing scientists;
- Developing new technologies to support research, communication and training in the mathematical sciences.

Building on the strength and vitality of its programmes, PIMS is able to serve the mathematical sciences community as a catalyst in other areas of great importance:

- The communication and dissemination of mathematical ideas; public outreach, mathematical education and training at all school levels;
- The creation of strong mathematical partnerships and links within Canada and organizations in other countries, with a focus on the nations of the Pacific Rim.

## Our Community

PIMS is a partnership between the following organizations and people:

- The six participating universities (Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Victoria, University of Washington) and affiliated Institutions (University of Lethbridge and University of Northern British Columbia).
- The Government of British Columbia through the Ministry of Competition, Science and Enterprise, The Government of Alberta through the Alberta Ministry of Innovation and Science, and The Government of Canada through the Natural Sciences and Engineering Research Council of Canada.
- Over 350 scientists in its member universities who are actively working towards the Institute's mandate. Their disciplines include pure and applied mathematics, statistics, computer science, physical, chemical and life sciences, medical science, finance, management, and several engineering fields.
- Scientists, practitioners and government researchers using mathematical ideas in dozens of companies across Canada and the U.S.
- A large and rapidly growing group of high school and elementary school teachers and educators in Alberta, British Columbia and Washington State.

# From the Chair of the Board

**Hugh Morris, FRSC**

The Pacific Institute for the Mathematical Sciences (PIMS) continues to be one of the most innovative and promising research institutes in the mathematical sciences. I am still as fascinated by the energy, the vitality and the pace that the mathematical scientists of PIMS are putting into their tasks as I was when I became Chair of the PIMS Board of Directors back in 1998.

This year saw the opening of the Banff International Research Station (BIRS) at the end of February. BIRS is destined to provide a tremendous boost for research in the mathematical sciences all over the world.

This annual report represents a compendium of the various activities and programmes organized and supported by PIMS during 2002–03. PIMS not only strives to be a world-class research institute in the mathematical sciences, but also to be prominent in the application of mathematics to industry and in mathematics education at all levels.

Through its Industrial Problem Solving Programme and its Industrial Math Training Programme, PIMS has played a key role in bringing mathematical scientists in academia together with their counterparts in the private sector. This year's Industrial Problem Solving Workshop and Graduate Industrial Mathematics Modelling Camp were highly successful once again.

PIMS continued its involvement in mathematics education. Two issues of *Pi in the Sky* magazine, as well as a poster promoting *Pi in the Sky*, were distributed to schools in Alberta, BC and Washington State. This is just one example of how PIMS is contributing to showing students of all levels how much fun mathematics can be.

This year saw the initiation of the PIMS Collaborative Research Groups programme. These multi-university groups of mathematical scientists will be a pivotal component of the future development of PIMS. I look forward to seeing what these groups achieve.

My warmest congratulations to the director, Dr. Nassif Ghoussoub and to all mathematical scientists and staff of PIMS for their wonderful accomplishments.

As we look forward to next year, there will be some key changes. Dr. Nassif Ghoussoub is stepping down from the position of director, and will be succeeded by Dr. Ivar Ekeland. The institute has been extremely fortunate to have been led by Nassif through its early years to its present level of achievement and acclaim, and we are delighted to have Ivar join us to lead PIMS to its future goals. We wish both of these fine colleagues every success. Dr. Michael Boorman will become Chair of the Board, and I would like to thank him and all the other members of the board for their support, wisdom and enthusiasm over the past five years.



*Hugh Morris, Chair of the PIMS Board of Directors*

# Director's Notes

Nassif Ghoussoub, FRSC

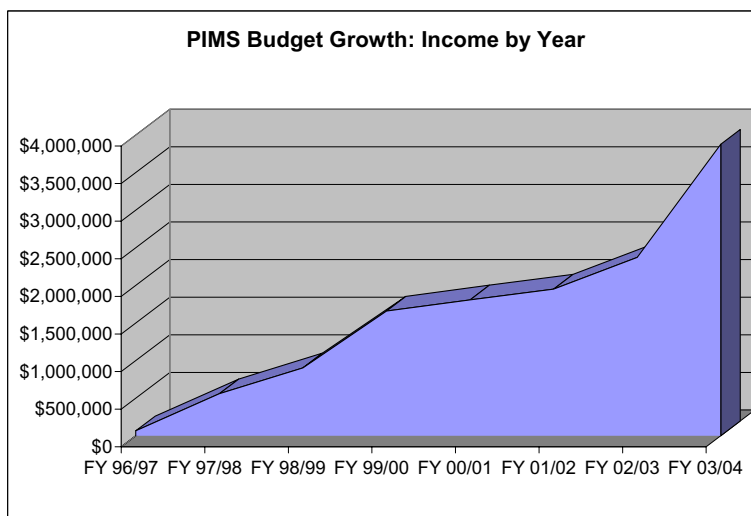
What words can be sweeter to the ears of a departing director than those recently received from a distinguished mathematician at Tuebingen, Germany: *"I am getting the PIMS news regularly and I read them with great enthusiasm. It is absolutely great what Canadians do for Mathematics, absolutely and even more so if measured against population size."*

This is my last annual report as a new PIMS director takes over on September 1, 2003. There is lots to say about the first 7 years of the institute, but how can one briefly summarize so much progress and excitement in these founding years. This self explanatory table—with the undignified look of a chart from a lowly "mutual fund company"—should do the job. On the surface, it only shows variations in cash amounts, but to us in the academic world, these numbers represent the evolution of new scholarly opportunities, the multiplication of postdoctoral support, the increase in training capacity, and our ability as a country to attract scientific talent and to be a focal point for the global R&D effort. This chart—which does not include the industrial contributions—is about our supporting organizations and the steady rise in their level of confidence—and investment—in the institute. It should also be an inspiration to all of us who may have their own dreams of

"giving back", yet daunted by the steep hill to climb. Good things can be done in Canada!

**The unforgettable role of our universities:** Over the years I have often thanked all the scientists who made PIMS a reality. They deserve all the credit. In my last annual report, I would also like to single out the absolutely key role that the PIMS universities played in the success stories that PIMS, MITACS and BIRS represent on the regional, national and international level. The universities have been tremendous in their support and I am deeply grateful for their concerted effort to push the vision forward. Never mind their annual contributions to the enterprise, just look at what they came up with in support, when major incremental steps were in order:

- When the MITACS network moved to Simon Fraser University, the administration there quickly provided the administrative support and research facility for both PIMS and MITACS, and when the latter needed a deputy scientific director to assist Arvind Gupta, SFU created a new faculty position, and judiciously appointed the dynamic and talented John Stockie.
- When the BIRS infrastructure required an additional \$200,000 for a state-of-the-art computing network, both the University of Alberta and the University of Calgary stepped forward and contributed what was needed.
- When the BIRS initiative required a Robert V. Moody for its scientific leadership, the University of Alberta did not hesitate to release him from his regular duties (and supported him) to lead the task.
- When the time came for new leadership at PIMS, the University of British Columbia assertively created two new senior faculty positions for a new director of PIMS and for a deputy, positions that have been filled in an outstanding brain gain for Canada.
- Last but not least, UBC has recently agreed to double the space it had initially provided



to the PIMS central office, and major renovations are to begin very soon. The PIMS research infrastructure can now match those of other world-class institutes.

For these key contributions to the development of the vision, the names of Dick Peter, Gary Kachanovski, Mike Boorman, Michael Stevenson, John Waterhouse, Martin Taylor and Barry McBride, should and will always have the gratitude of the Canadian mathematical community.

**The Banff International Research Station:** What a great first scientific director it had in Robert Moody and what a tremendously successful first year! The scientific world is buzzing about BIRS which hosted in its very first year over 2000 mathematical scientists in 40 workshops, 6 focused research groups, 9 research in teams, 8 week-end workshops, and one industrial graduate modelling camp... and the best is yet to come!

**The new director:** The appointment of Ivar Ekeland by UBC as a Canada Research Chair and his selection as the new PIMS

director by the PIMS Board of directors, is a terrific coup for the Canadian Mathematical community and for PIMS. In a context where scientific and able leadership is often hard to find (and harder to afford), the importance of getting someone like Ivar to Canada, cannot be overstated. We say it again: Ekeland is an outstanding mathematical scientist, an internationally renowned quantitative economist, a dedicated educator, a prolific writer and disseminator of science, a first class administrator, and ... an old friend. We offer him our best wishes as we are convinced that PIMS will reach new heights under his able leadership.

I end on a personal note, by stating my huge appreciation to Tom Brzustowski, Bob Church, Arvind Gupta, Barry McBride and Indira Samarasekera. Over the years, every one of them has, in their own way, given me support, friendship and comfort while on the job. Since I stepped down, they have come forward and shown me a great deal of appreciation, generosity and grace. To them I am grateful.



*A Tribute to Nassif Ghossoub at the MITACS Fourth Annual Conference in Ottawa, May 2003*

*Top left: Don Dawson (Former Director, Fields Institute), Jacques Hurtubise (Directeur, CRM), Nassif Ghossoub (Director, PIMS), Arvind Gupta (Scientific Director, MITACS) and Barry McBride (Provost and VP Academic, UBC)*

*Top right: Don Dawson, Nassif Ghossoub, and Luc Vinet (Provost & VP Academic, McGill University)*

*Bottom left: Ivar Ekeland (UBC), Nassif Ghossoub, and François Lalonde (Université de Montréal)*

*Bottom right: Janet Walden (NSERC), Nigel Lloyd (NSERC), Nassif Ghossoub and Isabelle Blain (NSERC)*

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# PIMS PERSONNEL

## PIMS Management

### Board of Directors

The Board of Directors has final responsibility for all aspects of the PIMS' operation. In particular, the Board ensures fiscal accountability, monitors the operation of the PIMS, and advises the Executive Committee.



Hugh Morris

**Chair of the Board: Dr. Hugh Morris** holds a Ph.D. in Mining Geology from the University of Witwatersrand, Johannesburg, South Africa and has 44 years of experience in the mineral industry. He is a fellow of the Royal Society of Canada and is Chair of the Society's Canadian Global Change Programme.

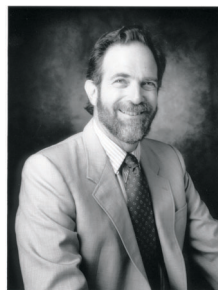
From 1962 to 1979 he held a series of positions with Cominco Ltd. in its Exploration and Mining Departments in several Canadian locations, eventually becoming Director of Exploration for its worldwide activities. In 1979 Dr. Morris became associated with the E & B-Geomex Group of affiliated companies in Calgary, initially as President and Chief Operating Officer of Geomex Minerals Ltd., and in 1981, as President and Chief Executive Officer of E & B Canada Resources Ltd. Following the merger of the E & B-Geomex Group and Imperial Metals Corporation of Vancouver in May 1983, he was appointed Chairman and Chief Executive Officer of Imperial Metals and of three public companies within the Imperial Metals Group. He resigned from these positions in February 1993 to pursue other interests. Currently, he is a mineral industry consultant and board member of six Canadian public companies.

Dr. Morris has demonstrated special interest in national and international scientific and professional associations. He is a member of NSERC's Council, a member of the Standing Finance committee of ICSU, and Chairman of the Board of Directors of the Lithoprobe Project. He is past-president of both the Geoscience Council of Canada and the Geological Association of Canada, and was also Treasurer of the Canadian Geological Foundation from 1987 to 1996. He is a member of the Geological Society of London, the Institute of Mining and Metallurgy, UK, the Canadian Institute of Mining and Metallurgy, the Association of Professional Engineers of BC and a number of other scientific and professional associations.

**Dr. Michael Boorman** received his Ph.D. from University of Nottingham in 1964 and is a professor in the Chemistry Department at the University of Calgary. Currently he is the Dean of Science at the University of Calgary. Dr. Boorman's research activities are in Inorganic Chemistry and in Heterogeneous Catalysis.



Michael Boorman



Bruce Clayman

**Dr. Bruce Clayman** received his Ph.D. in Physics from Cornell University in 1969. He is currently professor of Physics at Simon Fraser University as well as the Vice-President Research. His past administrative duties include Dean of Graduate Studies, President of the Canadian Association for Graduate Studies and of the Ca-

nadian Association of University Research Administrators. He is a member of the Sigma Pi Sigma Physics Honour Society. His research interests include superconductors, impurity states in solids, and layered compounds. He has published over 90 papers in refereed journals and refereed conference proceedings.

**Dr. James Delgrande** is a Professor of Computing Science at Simon Fraser University and he is the former Director of the School of Computing Science. He received his Ph.D. from the University of Toronto in 1985. His research is in formal aspects of knowledge representation in artificial intelligence.



Don Denney

**Dr. Don Denney** received his Ph.D. from the University of Waterloo in 1978 and spent two years as a post-doctoral fellow at the University of Colorado engaged in atmospheric chemistry studies and in developing statistical pattern recognition techniques. He is a Director of PRECARN/IRIS, serving as Board Chair for 1999/2000.

Don has been with Syncrude for 24 years and is currently Manager, Process Automation Services providing process automation support to Syncrude's Mining, Extraction, Utilities and Upgrading operations in Fort McMurray, Alberta. Don's prior experience at Syncrude includes 10 years at Research developing On-Line Sensors and applying Pattern Recognition techniques to data analysis and 8 years as Manager Information Services. His current interest is applying mathematical techniques to determining process unit health and providing advanced warning to process operators to avoid downgrading incidents.

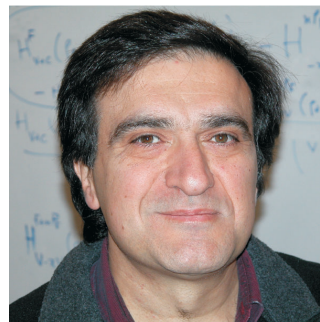
**Mr. Kenneth Foxcroft** served on the board of Directors of Factors Limited, Toronto Dominion Securities (USA) Inc., and of the Ontario Securities Advisory Commission. He has also held the positions of Chairman for Commodity Futures and President for the Forex Association of Canada. Presently, Mr. Foxcroft is the Deputy Chair for TD Securities and EVP, Corporate and Investment Banking, TD Bank.



Kenneth Foxcroft

**Dr. Nassif Ghoussoub**

obtained his Doctorat d'état in 1979 from the Université Pierre et Marie Curie in Paris, France and is currently a Professor of Mathematics at the University of British Columbia. His present research interests are in non-linear analysis, optimization and partial differential equations. He was the recipient of the Coxeter-James prize in 1990, of a Killam senior fellowship in 1992 and has been a fellow of the Royal Society of Canada since 1993.



Nassif Ghoussoub

He was chair of NSERC's grant selection committee for mathematics in 1995-1996 and vice-president of the Canadian Mathematical Society from 1994 to 1996. He was Editor-in-Chief of the Canadian Journal of Mathematics from 1993 to 2002 and is currently on the editorial board of various international journals.

He is the founder Director of PIMS since 1996. He is a founding member of the Board of Directors of MITACS since 1998. He is also the founding Chair of the executive committee of BIRS since 2001.

**Dr. Gary Kachanoski** is the Vice-President (Research) and Professor (Department of Renewable Resources) at the University of Alberta. From 1996-2001 he was Dean, College of Graduate Studies and Research, and Professor at the University of Saskatchewan. He received his B.Sc. (honors Biology 1976) and M.Sc. (Soil Science 1980) from the University of Saskatchewan, and his Ph.D. (Soil Physics 1984) from the University of California, Davis.



Gary Kachanoski

At the University of Saskatchewan he was also appointed Dean, Virtual College of Biotechnology, a university-wide initiative to coordinate teaching and research in the social, ethical, legal, commercial, and science issues related to biotechnology.

From 1985 to 1996 Gary was at the University of Guelph, finishing his appointment there as Chair, Department of Land Resource Science, and Director of Research (Environment and Natural Resources) in the Vice-President (Research) Office. At Guelph he had significant involvement in the planning, coordination, and transfer of research and technology to industry, government, user

groups, and the general public. He was awarded the Distinguished Faculty Extension and Service Award for his work in this area.

Gary continues to have a strong research program with main interests in the physics of water and chemical transport through soil. His past research contributions have been recognized by awards such as Fellow of Soil Science Society of America and Fellow of the Canadian Society of Soil Science. He was President of the Canadian Society of Soil Science in 2001. He has served on the Editorial Boards of the top peer reviewed research journals in his field including the Canadian Journal of Soil Science, Soil Science Society of America Journal, and the European Journal of Soil Science. He has authored over 80 scientific papers in referred journals and over 10 book chapters/sections. His research and technology transfer in soil and water conservation work have been recognized by industry and his peers through a nomination and induction into the Canadian Conservation Hall of Fame by Soil Conservation Canada.



Prabha Kundur

**Dr. Prabha Kundur** holds a Ph.D. in Electrical Engineering from the University of Toronto and has over 30 years of experience in the electric power industry. He is currently the President and CEO of Powertech Labs Inc., the research and technology subsidiary of BC Hydro. Prior to joining Powertech in 1993,

he worked at Ontario Hydro for 25 years and was involved in the planning, design and operation of power systems.

He has served as Adjunct Professor at the University of Toronto since 1979 and at the University of British Columbia since 1994. He is the author of the book *Power System Stability and Control* (McGraw-Hill, 1994), which is the standard modern reference for the subject. He has performed extensive international consulting and has delivered technical courses for utilities and universities around the world.

Dr. Kundur is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE). He is also very active in the Conference Internationale des Grands Reseaux Electriques (CIGRE). He is the recipient of the 1997 IEEE Nikola Tesla Award and the 1999 CIGRE Technical Committee Award.

**Dr. Barry McBride** is currently the Vice-President, Academic and Provost at the University of British. He received his Ph.D. from the University of Illinois (Urbana)

in 1970. He was Department Head of the Microbiology Department at UBC from 1986 to 1989 and Department Head of the Oral Biology Department at UBC from 1981 to 1986. He was the Dean of Science at UBC from 1990 to 1998. He has consulted with Cominco, Energy Mines and Resources Canada, the National Institute of Health, USA and Ventures West. He is a member of many Professional Committees including the Medical Research Council (where he is also on the Executive Committee), the Standing Committee on Manpower (MRC), Scientific Advisory Council - Alberta Council - Alberta Heritage Foundation for Medical Research and the Canadian Institute for Advanced Research - Research Advisory Council. His major area of research is in ecology and pathogenesis of the microbial flora of man with specific reference to pathogens of the mouth.



Barry McBride

**Dr. Edwin Perkins** is Professor of Mathematics at the University of British Columbia where he was first appointed as a postdoctoral fellow in 1979. He did his undergraduate degree at U. of Toronto and obtained his doctoral degree from the U. of Illinois. His research interests in probability include the general theory of processes, Brownian motion, stochastic differential equations and partial differential equations, interacting particle systems, measure-valued diffusions and stochastic models in population genetics.

He has won numerous awards for his research including the Coxeter-James Lectureship (1986), G. de B. Robinson Award (1996) and Jeffery-Williams Prize (2002) (Canadian Math. Society), the Rollo Davidson Prize (1983) (Cambridge U.) and a Steacie Fellowship (1992-93) (NSERC). He is a Fellow of the Royal Society of Canada and the Institute of Mathematical Statistics and presently sits on the editorial Boards of the *Annales de l'Institut Henri Poincare*, *Stochastic Processes and Their Applications* and the *Electronic Journal of Probability*. He has given several invited lectureships including an invited address at the 1994 International Congress of Mathematicians in Zurich.



Edwin Perkins

**Dr. Dennis R. Salahub** assumed the position of is the Vice-President (Research & International) at the University of Calgary on July 1, 2002. Previously, he was the Director General of the Steacie Institute for Molecular Sciences at the National Research Council of Canada in Ottawa, from 1999 until June, 2002. Prior to this he was a Professor of Chemistry at the Université de Montreal from 1976 to 1999, holding a McConnell Chair from 1990.



Dennis Salahub

A native of Alberta, Dr. Salahub has been interested in theoretical and computational chemistry since his undergraduate days in Edmonton and his doctorate at the Université de Montreal. Following postdoctoral studies at Sussex, Waterloo, Johns Hopkins and the General Electric laboratories in Schenectady, New York, he returned to the Université de Montreal and set up an internationally recognized research program in quantum chemistry, specializing in the development of Density Functional Theory and its applications in materials and biomolecular modeling. He has published some 250 research papers, four edited books and has delivered more than 300 invited lectures on the national and international scenes. His students are now occupying important positions in academia, industry and government in several countries. The computer code, deMon, developed in his laboratory is used by researchers around the world.

Dr. Salahub has served the science and innovation communities on a broad front. He was the Program Leader of the Centers of Excellence in Molecular and Interfacial Dynamics (CEMAID) from 1991 to 1994 and a founding member of the Centre de Recherche en Calcul Appliqué (CERCA) in 1991. He has served on NSERC's Grant Selection Committee and twice on the Reallocation Steering Committee for Chemistry (1997, 2001, Chair). He was the lead applicant for an \$18M Canada Foundation for Innovation grant that brought high-performance computing to Quebec in 1998 and was an early proponent of the c3.ca organization which is fostering high-performance computing and networking in Canada. He has been a consultant for industry and the Steacie Institute is currently fostering several incubation and spin-off companies.

At the Steacie Institute, Dr. Salahub shaped research thrusts in nanoscience and technology, bioscience and technology, and optical science and technology, under the banner of the Institute's motto "The fundamental things apply". He contributed to NRC's vision for nanotechnology in Canada and to the founding of the new

\$120M National Institute for Nanotechnology in Edmonton, Alberta.

Dr. Salahub has been the recipient of a CNC-IUPAC Award, the Noranda Award of the Canadian Society for Chemistry and a Killam Research Fellowship. In 1998 he was named as a Fellow of the Royal Society of Canada.

**Dr. Indira V. Samarasekera** is vice president research at the University of British Columbia. She has been a professor in the Department of Metals and Materials Engineering and the Centre for Metallurgical Process Engineering at the University of British Columbia since 1980.

Dr. Samarasekera's expertise in heat transfer and stress analysis has led her to research a number of processes with a major emphasis on the continuous casting and hot rolling of steel, and the growth of single crystals for electronic devices. To facilitate knowledge-transfer to industry, Dr. Samarasekera has participated in short courses on the continuous casting of steel at companies in North and South America, Europe, Asia and South Africa. She was the first incumbent of the Dofasco Chair in Advanced Steel Processing at UBC. Dr. Samarasekera has received the Killam Prize and the McDowell Medal from the University of British Columbia for research excellence. In 1991 she was awarded an E.W.R. Steacie Fellowship by the Natural Sciences and Engineering Research Council of Canada and the B.C. Science Council Award for New Frontiers in Research in 1997. She is a Fellow of the Royal Society of Canada, of the Canadian Academy of Engineering and of CIMM. In 2002 she was appointed an Officer of the Order of Canada

Dr. Samarasekera currently serves on the Board of Directors of Discovery Parks Inc., The Michael Smith Foundation for Health Research, Genome British Columbia, and the Provincial Health Services Authority, and has recently been invited to join the CBIN Board of Directors. She has served as a member of Council of the National Research Council of Canada, the Board of the Children and Women's Health Centre of BC, the BC Research Institute for Children and Women's Health and Aquanet-NCE. Dr. Samarasekera also served as president of the Metallurgical Society of CIM for a year and was on the board for six years. She was student affairs director for The Minerals, Metals and Materials Society of AIME in the U.S.

Dr. Samarasekera obtained a B.Sc. Honours degree in mechanical engineer-



Indira V. Samarasekera

ing from the University of Ceylon in 1974. She spent the following year as a mechanical engineer at the Refinery of the Ceylon Petroleum Corporation and then proceeded to the United States of America as a Hays-Fulbright Scholar, obtaining a M.S. degree in mechanical engineering from the University of California in 1976. She completed a doctorate degree at the University of British Columbia in 1980 under the supervision of Professor J. Keith Brimacombe, O.C.



Martin Taylor

of British Columbia. He was appointed at McMaster in 1974. He was Chair of Geography (1991-1997), founding Director of the Institute of Environment and Health (1991-96), and Acting Vice President Research (1994-1995). His research and teaching interests focus on environmental health and health promotion issues. His ongoing projects include research on the psychosocial effects of environmental contamination and on community-based heart health promotion. He has authored one book and over 100 papers in peer-reviewed journals.

## Scientific Review Panel

The Scientific Review Panel is responsible for:

- The review and selection of scientific programmes and determination of their funding levels
- The selection of PIMS Distinguished Chairs and The PIMS Research Prize.
- Provide advice on longterm scientific planning for PIMS.

Nassif Ghoussoub, Director of PIMS, served as the chair of the Scientific Review Panel. Members of the Panel include the following people:

**Dr. David Brillinger's** research is in statistical inference and applications to stochastic processes. In particular this involves him in statistical methods for random processes and in science and engineering. He has made contributions to the theory and application of statistics in subject

areas including neurophysiology (the analysis of neural spike trains), seismology, and the modelling animal tracks. He is the author of *Time Series Analysis: Data Analysis and Theory*, former editor of the *International Statistical Review*, former President of the Institute of Mathematical Statistics and of the Statistical Society of Canada. He is a member of the American Academy of Arts and Sciences and is a Fellow of the Royal Society of Canada. He received a D.Sc. degree from the University of Western Ontario in 1999 and a D. Math. degree from the University of Waterloo in 2003.



David Brillinger



David Brydges

**Dr. David Brydges** received the PhD in 1976 at the University of Michigan under the direction of Paul Federbush. He held a postdoctoral position at Rockefeller University working for James Glimm. In 1978 he became Assistant Professor at the University of Virginia. He was promoted to Full Professor of Mathematics and Physics in 1981 and became Commonwealth Chair in 1996. In 2001 he was appointed as a Canada Research Chair at the University of British Columbia.

Brydges received the Alfred P. Sloan Research fellowship in 1982. He has given lectures throughout the world including courses in the Troisieme Cycle at Lausanne in 1992, Centre Emile Borel in 1998 and the NachDiplom program at ETH, Switzerland. He is the President of the International Association of Mathematical Physics.

His interests are centred in the renormalization group with applications to quantum field theory, statistical mechanics and probability.

**Dr. Randy Goebel** is currently professor and chair in the Department of Computing Science at the University of Alberta. He received the B.Sc. (Computer Science), M.Sc. (Computing Science), and Ph.D. (Computer Science) from the Universities of Regina, Alberta, and British Co-



Randy Goebel

lumbia, respectively.

Professor Goebel's research is focused on the theory and application of intelligent systems. His theoretical work on abduction, hypothetical reasoning and belief revision is well known, and his recent application of practical belief revision to scheduling and web mining is now having industrial impact. Randy has previously held faculty appointments at the University of Waterloo and the University of Tokyo, and is actively involved in academic and industrial collaborative research projects in Canada, Australia, Europe and Japan.



Ronald Graham

**Dr. Ronald Graham** is the Irwin and Joan Jacobs Professor of Computer and Information Science in the Computer Science and Engineering Department of the University of California at San Diego. He is also currently President of the Mathematical Association of America and has served as the Treasurer of the National Academy of Sciences since 1996. He

was also the President of the American Mathematical Society from 1993 to 1995, and served as Chief Scientist of AT&T Labs until 1999. Graham's academic awards include membership in the National Academy of Sciences, Foreign Honorary Member of the Hungarian Academy of Sciences, Fellow of the American Academy of Arts and Sciences, Fellow of the American Association for the Advancement of Science, Fellow of the Association of Computing Machinery, and recipient of the Polya Prize in Combinatorics, the Euler Medal in Combinatorics, a Lester Ford Award of the Math. Assoc. of America, a Carl Allendorfer Award of the Math. Assoc. of America, and the Leroy Steele Award for Lifetime Achievement from the American Mathematical Society in 2002. He has also served as President of the International Jugglers Association. Graham's current mathematical interests include combinatorics, number theory, graph theory, discrete and computational geometry, design and analysis of algorithms, and applications thereof.

**Dr. Robert V. Moody** is Professor of Mathematics at the University of Alberta. He received his Ph.D. from the University of Toronto in 1966 and spent most of his academic career at the University of Saskatchewan before coming to Alberta in 1989. He is best known for the discovery, independently with V. Kac, and subsequent investigations of the Kac-Moody Algebras, for which he was awarded the 1994-1996 Eugene Wigner Medal jointly with Kac. He has presented both the Coxeter-James Prize Lec-

ture (1978) and the Jeffrey-Williams Prize Lecture (1995) to the Canadian Mathematical Society. He has served nationally on the Scientific Advisory Boards of both the CRM and the Fields Institute, and on the Council of the Academy of Science, Royal Society of Canada. In 2002 he won a Killam prize for "outstanding career achievements".



Robert Moody



Ian Putnam

**Dr. Ian F. Putnam** received his Ph.D. from the University of California at Berkeley in 1985. He was an NSERC University Research Fellow at Dalhousie University before moving to the University of Victoria where he is currently Canada Research Chair in Operator Algebras and Dynamical Systems in the department of mathematics and statistics. He has received the Israel

Halperin Prize and the Andre Aisenstadt prize. He is a Fellow of the Royal Society of Canada.

**Dr. Bob Russell** received the Ph.D. in 1971 at the University of New Mexico under the direction of Lawrence Shampine. In 1971 he became Assistant Professor at Colorado State University and in 1972 he moved to Simon Fraser University. He was promoted to Full Professor in 1981. He has held numerous visiting positions throughout the world, including at Stanford, University of Auckland and Imperial College (as an SERC Fellow).

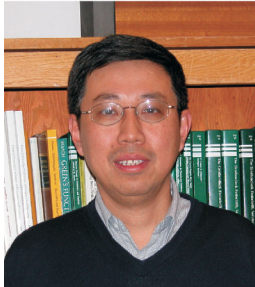


Bob Russell

Russell's travels include as an Invited Scholar at the USSR and Chinese Academies of Science and as a plenary speaker at SIAM's Dynamical Systems Conference in 2000. His journal editorships have included SIAM Journal on Numerical Analysis and SIAM Journal for Scientific Computing. He is a founding member and past Vice President of CAIMS, has served two terms on NSERC's Grant Selection Committee in Computer Science, is on IMACS Board of Directors, and is a Canadian representative for ICIAM.

His field of research is scientific computing, with special emphasis on the numerical solution of PDEs and

ODEs. An interest is in dynamical systems and computational methods which preserve qualitative features of solutions of differential equations. This has recently been in the context of developing mathematical software using adaptive gridding techniques.



Gang Tian

**Dr. Gang Tian** received his Ph.D. from Harvard University in 1988. After positions at Princeton University and the State University of New York at Stony Brook, he went to the Courant Institute of Mathematical Sciences at New York University in 1991 as an associate professor and became a full professor in 1992. He is currently a J. Simons professor at the Massachusetts Institute of Technology. Professor Tian is a recipient of the Alfred P. Sloan research fellowship (1991-1993). He presented a 45-minute invited address at the International Congress of Mathematicians in Kyoto in 1990 and a plenary address at the International Congress of Mathematicians in Beijing in 2002. In 1994, he received the 19th Alan Waterman Award from the National Science Foundation. In 1996, Professor Gang Tian received the Veblen Prize of the American Mathematical Society.



Elizabeth Thompson

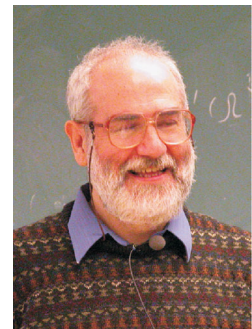
**Dr. Elizabeth Thompson** received a B.A. in Mathematics (1970), a Diploma in Mathematical Statistics (1971), and Ph.D. in Statistics (1974), from Cambridge University. In 1974-5 she was a NATO/SRC post-doc in the Department of Genetics, Stanford University. From 1975-81 she was a Fellow of King's College, Cambridge, and from 1981-5 was Fellow and Director of Studies in Mathematics at Newnham College. From 1976-1985 she was a University Lecturer in the Department of Pure Mathematics and Mathematical Statistics, University of Cambridge. She joined the faculty of the University of Washington in December 1985, as a Professor of Statistics. Since 1988, Dr. Thompson has been Professor also of Biostatistics, and since Spring 2000, she is also an Adjunct Professor in Genetics (now Genome Sciences) at the University of Washington, and an Adjunct Professor of Statistics at North Carolina State University. She served as Chair of the Department of Statistics from 1989-94.

In 1981, she was elected a member of the International

Statistical Institute, and in 1988, she was awarded an Sc.D. degree by the University of Cambridge. In 1994, she gave the R.A. Fisher Lecture at the Joint Statistical Meetings in Toronto. In 1996, she gave the Neyman Lecture (IMS) at the Joint Statistical Meetings in Chicago. In 1998, she was elected a Fellow of the American Academy of Arts and Sciences. In 2001, she received the inaugural Jerome Sacks Award for Cross-Disciplinary Research from the National Institute for Statistical Science, and was also awarded the Weldon Prize, an international prize for contributions to Biometric Science awarded by the University of Oxford.

Dr. Thompson's research interest is in the development of methods for inference from genetic data, and particularly from patterns of genome sharing observed among members of large and large and complex pedigree structures, whether of plants, animals, or humans. Questions of interest range from human genetic linkage analysis to gene extinction in highly endangered species, and from inference of relationship to inferences of the genetic basis of traits. Her current focus is on developing research and education in Statistical Genetics at the University of Washington.

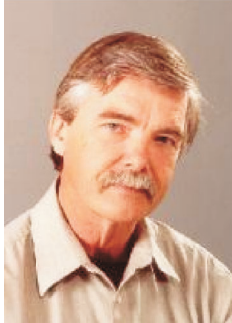
**Dr. Gunther Uhlmann** received the Ph.D. in 1976 at MIT under the direction of Victor Guillemin. He held postdoctoral positions at Harvard, Courant Institute and MIT. In 1980 he became Assistant Professor at MIT and in 1985 he moved to the University of Washington as an Associate Professor. He was promoted to Full Professor in 1987.



Gunther Uhlmann

Uhlmann was awarded the Annual National Prize of Venezuela in Mathematics in 1982. He received the Alfred P. Sloan Research fellowship in 1984 and a John Simon Guggenheim fellowship in 2001. He was named Corresponding member of the Chilean Academy of Sciences in 2001. He has given numerous lectures throughout the world included an invited address at the Portland meeting of the AMS in 1991, the CBMS-NSF lectures on "Inverse Problems and Non-Destructive Evaluation" in 1995, an invited lecture at the International Congress of Mathematicians in Berlin in 1998 and the PIMS distinguished lectures at UBC in 2002.

His current interest is inverse problems in particular inverse boundary value problems and inverse scattering problems. In these problems one attempts to determine internal parameters of a medium by making measurements at the boundary of the medium or by remote observations.



Hugh Williams

**Dr. Hugh Williams** holds the iCORE Chair in Algorithmic Number Theory and Computing at the University of Calgary and is a professor in the Mathematics and Statistics Department at that institution. His main research interests are in computational number theory, cryptography and the design and development of special-purpose hardware devices. His work in computational number theory extends from analyzing the complexity of number theoretic algorithms to the actual implementation and testing of such algorithms.

Dr. Williams has published more than 130 refereed journal papers, 20 refereed conference papers and 20 books or (chapters therein). From 1983–85, he held a national Killam Research Fellowship. He has been an associate editor for *Mathematics of Computation* since 1978 and is also a member of the editorial boards of two other journals. Dr. Williams has also served on the Natural Science and Engineering Research Council (NSERC) Grant Selection Committees for both Computing and Information Science (1972–75) and Pure and Applied Mathematics (1991–94), and chaired the latter from 1993–4. He has also been a member of the Steacie Awards Selection Committee.

**Executive Committee**

The Executive Committee consists of the Director, the five Site Directors, and other members appointed by the Board as required. The Executive is responsible for the day to day management of the PIMS as delegated by the Board.

**Director:** Nassif Ghoussoub (UBC, Math)  
**SFU Site-Dir.:** Manfred Trummer (SFU, Math)  
**UA Site-Dir.:** James Muldowney (UA, Math)  
**UBC Site-Dir.:** Dale Rolfsen (UBC, Math)  
**UC Site-Dir.:** Gary Margrave (UC, Math)  
**UVic Site-Dir.:** Florin Diaconu (UVic, Math)  
**UW Site-Dir.:** S. Paul Smith (UW, Math)

## Executive Committee

**Education and Communication**

**Education Facilitator:** Klaus Hoechsmann (UBC)

## Education and Communication

**Education Facilitator:** Klaus Hoechsmann (UBC)

## Local Committees

The Local Coordinators are indicated by an asterisk.

### University of Victoria:

Kelly Choo  
 David Leeming\*  
 Bill Pfaffenberger

### University of BC:

Andrew Adler\*  
 Phillip Loewen  
 Edwin Perkins

### Simon Fraser University:

Malgorzata Dubiel\*  
 Loki Jorgenson  
 Rina Zaskis

### University of Alberta:

Hans Brungs  
 Ted Lewis\*  
 Andrew Liu

### University of Calgary:

Claude Laflamme  
 Indy Lagu\*

## National Programme Committee of the Canadian Mathematical Sciences Institutes

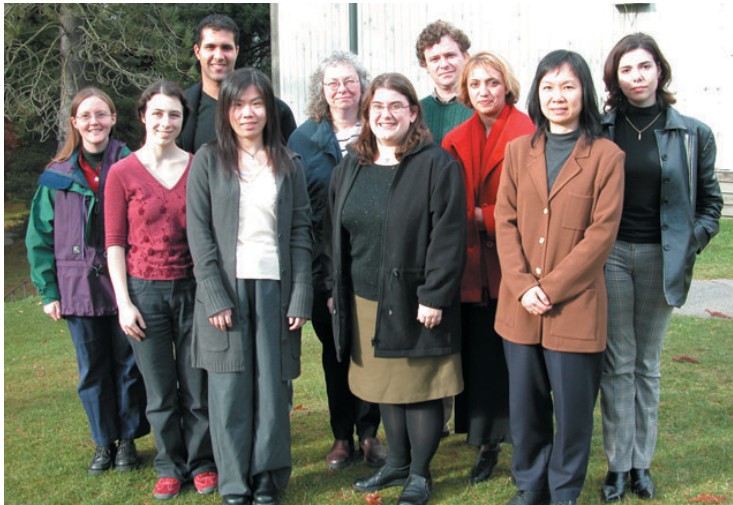
The three Canadian Institutes in the Mathematical Sciences CRM, Fields and PIMS have initiated a new programme for the support of joint activities in the mathematical sciences. This programme is administered by a National Programme Committee, which makes recommendations to the Directors of the three institutes.

The 2002/03 committee consisted of:

**Chair:** Anne Bourlioux (CRM & Université de Montréal)  
 John Harnad (CRM & Concordia University)  
 Bradd Hart (Fields Institute & University of Toronto)  
 Lisa Jeffrey (University of Toronto)  
 Subhash Lele (University of Alberta)  
 Niky Kamran (CRM & McGill University)  
 Dale Rolfsen (PIMS & UBC)  
 David Sankoff (Université de Montréal)



## PIMS Site Personnel



The PIMS Staff (from left to right):  
Heather Jenkins, Jessica Douglas, Derek Bideshi, Fanny Lui, Marian Miles, Andrea Hook, Sandy Rutherford, Dil Bains, Clarina Chan, Olga German

Missing: Kelly Choo, Shirley Mitchell, Shervin Teymouri

### PIMS Main Office

Dr. Nassif Ghossoub, Director  
Dr. Sandy Rutherford, Scientific Executive Officer  
Dr. Klaus Hoechsmann, Education Officer  
Ms. Andrea Hook, PIMS Administrator  
Mr. Derek Bideshi, Programme Coordinator  
Ms. Heather Jenkins, Communications Officer  
Ms. Fanny Lui, Financial Clerk  
Mr. Kelly Choo, Website Administrator  
Mr. Shervin Teymouri, Computer Systems Administrator  
Ms. Clarina Chan, MITACS Administrator

Mr. Shahin Teymouri, Computer Systems Administrator  
Dr. Malgorzata Dubiel, Education Coordinator  
Dr. Nils Bruin, PDF  
Dr. Grace Chiu, PDF  
Dr. Will Galway, PDF  
Dr. Russell Luke, PDF  
Dr. Riste Skrekovski, PDF  
Dr. Janez Ales, MITACS PDF  
Dr. Peter Berg, MITACS PDF  
Dr. Edgardo Cheb-Terrab, MITACS PDF  
Dr. Ronald Ferguson, MITACS PDF  
Dr. Daya Gaur, MITACS PDF  
Dr. Alexander Kononov, MITACS PDF  
Dr. Stefan Langerman, MITACS PDF  
Dr. Snezana Mitrovic-Minic, MITACS PDF  
Dr. Andrew Solomon, MITACS PDF  
Dr. Bettina Speckmann, MITACS PDF  
Dr. Brett Stevens, MITACS PDF

### PIMS at Simon Fraser University

Dr. Manfred Trummer, Site Director  
Ms. Olga German, Administrative Assistant  
Ms. Andrea Kiefner, PIMS/MITACS Receptionist



Manfred Trummer,  
PIMS-SFU Site Director,  
2001-03

Dr. Antal Jarai, PDF  
 Dr. Luis Lehner, PDF  
 Dr. Nathaniel Newland, PDF  
 Dr. Ehud Schreiber, PDF  
 Dr. Xiang Tao, PDF  
 Dr. Yuqing Wang, PDF  
 Dr. Zhenya Yan, PDF  
 Dr. Ana Granados, MITACS PDF  
 Dr. Joern Sass, MITACS PDF

## PIMS at University of Alberta

Dr. Jim Muldowney, Site Director  
 Ms. Shirley Mitchell, Executive Assistant  
 Dr. Ted Lewis, Education Coordinator  
 Dr. Wen Chen, PDF  
 Dr. Christina Cobbold, PDF  
 Dr. Matthias Neufang, PDF  
 Dr. Sumati Surya, PDF  
 Dr. Chuong Tran, PDF  
 Dr. Roman Vershynin, PDF  
 Dr. Hongwei Long, Industrial Collaborative Associate

Dale Rolfsen,  
PIMS-UBC Site Director,  
1997-03



## PIMS at University of Calgary

Dr. Gary Margrave, Site Director  
 Ms. Sharron Kaser, Administrative Assistant  
 Dr. Indy Lagu, Education Coordinator  
 Dr. Peter Hoyer, PDF  
 Dr. Luigi Santocanale, PDF  
 Dr. Tatjana Stykel, PDF  
 Dr. Hugh Geiger, MITACS-PDF  
 Dr. Peter Gibson, MITACS-PDF



Jim Muldowney,  
PIMS-UA Site Director,  
2001-03

## PIMS at University of British Columbia

Dr. Dale Rolfsen, Site Director  
 Dr. Martial Agueh, PDF  
 Dr. Dominic Brecher, PDF  
 Dr. R. Fazio, PDF  
 Dr. Kazuyuki Furuuchi, PDF  
 Dr. Xavier Granier, PDF  
 Dr. Yuri Gusev, PDF

Gary Margrave,  
PIMS-UC Site Director,  
2001-03



## PIMS at University of Victoria

Dr. Florin Diacu, Site Director  
 Ms. Dil Bains, Admin. Assistant  
 Mrs. Timea Halmai, Admin. Assistant (on leave)  
 Dr. David Leeming, Education Coordinator  
 Mr. Kelly Choo, Web Manager  
 Dr. Vladislav Panferov, PDF  
 Dr. Inhyeop Yi, PDF  
 Dr. Joachim Stadel, PDF  
 Dr. Julien Arino, MITACS PDF



Florin Diacu,  
 PIMS-UVic Site Director,  
 1998-03

## PIMS University of Washington

Dr. S. Paul Smith, Site Director  
 Ms. Jessica Baird, Administrative Assistant



S. Paul Smith,  
 PIMS-UW Site Director,  
 2002-03

## University of Lethbridge

Dr. Jorgen Rasmussen, PDF

## Banff International Research Station

Dr. Robert Moody, BIRS Scientific Director  
 Mrs. Andrea Lundquist, BIRS Station Manager  
 Mrs. Amanda Kanuka, BIRS Programme Coordinator  
 Mr. Brent Kearney, BIRS Systems Administrator



The BIRS Staff (from left to right):  
 Brent Kearney, Robert Moody, Andrea Lundquist,  
 Amanda Kanuka

## PIMS Scientific Personnel

### PIMS Distinguished Chairs

#### PIMS Distinguished Chairs for 2002/03

**Donald G. Saari** (University of California, Irvine)  
Site: University of Victoria  
September 2002

**Klaus Schmidt** (University of Vienna and Director, Erwin Schrödinger Institute)  
Site: University of Victoria  
November 2002

**Gunther Uhlmann** (University of Washington)  
Site: University of British Columbia  
November 2002

See page 64 for more information about the PIMS Distinguished Chairs for 2002/03.

### PIMS PDFs for 2002/03

The review panel for the 2002/03 competition was Michael Lamoureux, (Chair, Math, UC), David Brydges (Math, UBC), Leah Keshet (Math, UBC), Richard Lockhart (Stats, SFU), Bryant Moodie (Math, UA) and Frank Ruskey (Comp Sci, UVic).

**Inhyeop Yi:** Dynamical systems and operator algebras.  
Supervised by Ian Putnam (UVic).

**Vladislav Panferov:** PDEs (kinetic theory).  
Supervised by Reinhard Illner (UVic).

**Kazuyuki Furuuchi:** Theoretical physics (string theory).  
Supervised by Gordon Semenoff (UBC).

**Zhenya Yan:** Applied math (soliton theory and nonlinear integral systems).  
Supervised by George Bluman (UBC).

**Xavier Granier:** Computer science (computer graphics).  
Supervised by Wolfgang Heidrich (UBC).

**Ehud Schreiber:** Theoretical physics (quantum field and string theories).  
Supervised by Moshe Rozali, Mark Van Raamsdonk (UBC).

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

**Russell Luke:** Applied math (image processing).  
Supervised by Jon Borwein (SFU).

**Grace Chiu:** Statistics (applications to the life sciences).  
Supervised by Richard Lockhart and Rick Routledge (SFU).

**Riste Skrekovski:** Computer science (graph theory).  
Supervised by Pavol Hell (SFU).

**Wen Chen:** Signal & image processing.  
Supervised by Bin Han and Rong-Qing Jia (U of A).

**Roman Vershynin:** Geometric functional analysis.  
Supervised by Nicole Tomczak-Jaegermann (U of A).

**Christina Cobbold:** Mathematical biology.  
Supervised by Mark Lewis (U of A).

**Chuong Tran:** Applied math (fluid dynamics).  
Supervised by John Bowman (U of A).

**Peter Hoyer:** Algorithmics, data structures, complexity theory and quantum computing.  
Supervised by Richard Cleve (U of C).

**Tatjana Stykel:** Applied math (numerical linear algebra, control theory).  
Supervised by Peter Lancaster (U of C).

# THE BANFF INTERNATIONAL RESEARCH STATION



*The scenic backdrop that greeted visitors to the BIRS inaugural event at the Banff Centre in Banff, Alberta*



Robert Moody, BIRS  
Scientific Director

The Banff International Research Station is a collaborative effort between the Pacific Institute for the Mathematical Sciences (PIMS) and the Mathematical Sciences Research Institute (MSRI). Funding comes from the Canadian government through NSERC (grant to PIMS), the Alberta government through ASRiP (grant to PIMS), the US government through NSF (grant to

MSRI), and from MITACS. The administration of BIRS is performed by PIMS.

BIRS is located in Corbett Hall and the Max Bell Building of The Banff Centre in Banff, Alberta. More than 1700 researchers will attend 5-day workshops, 2-day workshops, research in teams, focused research groups and summer schools over 40 weeks of operation in 2003.

## The BIRS Opening

The inaugural meetings of the Banff International Research Station for Mathematical Innovation and Discovery (BIRS) that took place on February 28–March 1, 2003 in Banff, Alberta.

**Nassif Ghoussoub** (PIMS Director and Chair of the BIRS Executive Committee), **David Eisenbud** (MSRI Director and AMS President), and **Robert Moody** (BIRS Scientific Director) welcomed mathematicians, scientists and supporters of the mathematical sciences from across North America and around the world.

Also present were **Tom Brzustowski** (President, Natural Sciences and Engineering Research Council of Canada), **Isabelle Blain** (Vice President, NSERC), **Arthur Carty** (President, National Research Council of Canada), **Bob Church** (Chair, Alberta Science and Research Authority), **Hon. Victor Doerkson** (Minister of Innovation and Science, Government of Alberta), **Jean-Claude Gavrel** (Director, NCE program), and **William Rundell** (Director, Division Mathematical and Physical Sciences, U.S. National Science Foundation), among 200 other distinguished guests. Local dignitaries included **Mary Hofstetter** (President and CEO, The Banff Centre), **Philip Ponting** (Chair, Board of Governors, The Banff Centre) and **Dennis Shuler** (Mayor, Town of Banff).

Senior administrators from universities across Canada, including **Luc Vinet** (Provost and Vice-Principal Academic, McGill

U.), **Michael Stevenson** (President, SFU), **Harvey Weingarten** (President, U. Calgary), and **Barry McBride** (Vice President Academic and Provost, UBC), showed strong support with their presence.

Members of the PIMS Executive and Board of Directors, the MSRI Academic Sponsors and Board of Trustees, and the MITACS Board of Directors and Research Management Committee were also in attendance.

Many leaders of the Canadian and U.S. mathematical sciences community attended, including **Doug Arnold** (Director, IMA), **Ken Davidson** (Director, Fields Institute), **Jacques Hurtubise** (Director, CRM), **James Ramsay** (President, SSC), **Christiane Rousseau** (President, CMS), **Sam Shen** (President, CAIMS), **Michael Singer** (Acting Director, MSRI) and **Philippe Tondeur** (former Director, Mathematical and Physical Sciences, NSF).

The Scientific Programme, chaired by BIRS Scientific Director **Robert V. Moody** of the University of Alberta, took place in a packed Margaret Greenham Theatre to open the celebrations on Friday afternoon.

Nobel laureate, mathematician and economist **James Heckman** of the University of Chicago spoke on *The Economics & the Mathematics of the Pricing of Quality*. Dr. Heckman was introduced by his long-time collaborator and new Canada Research Chair at UBC, **Ivar Ekeland**.

Next, the audience was treated to a witty lecture entitled *The Chaotic Evolution of Newton's Universe* given by **Donald Saari**, Distinguished Professor of Mathematics and Economics and Director of the Center for Decision Analysis at the University of California, Irvine. Dr. Saari had recently visited the University of Victoria as a PIMS Distinguished Chair. He was introduced by **David Eisenbud**, Director of the Mathematical Sciences Research Institute in Berkeley, CA.

The Scientific Programme concluded with a presenta-



Bob Church, Chair of the Alberta Science and Research  
Authority (ASRA)



Jean-Claude Gavrel (Director NCE Program) and Tom Brzustowski (President, NSERC)

tion by **Jay Ingram**, host of the television science daily @Discovery.ca. His presentation, *A Talk by Someone Who got 68 in Calculus*, ranged from the hilarious to the sombre as he mused on the hopes and expectations of communicating science, especially mathematics, to the general public. Mr. Ingram was introduced by Robert Moody.

The speakers at the banquet were **Nassif Ghoussoub**, **Mary Hofstetter**, **Bob Church**, **Hon. Victor Doerksen**, **David Eisenbud**, **William Rundell** and **Tom Brzustowski**.

Videos of the scientific programme and the banquet speeches are available on the PIMS website at [www.pims.math.ca/birs/opening/Agenda\\_BIRS.html](http://www.pims.math.ca/birs/opening/Agenda_BIRS.html).

Several local high school students and a few members of the media also observed the scientific programme. *MacLean's* magazine printed a feature on BIRS in its March 17, 2003 issue. BIRS was also featured in radio broadcasts and newspaper articles in Ottawa, Edmonton, Banff, and Calgary.

The PIMS Research and Education Prizes for 2002 were presented at the banquet on Friday evening. Videos of speeches during the banquet and the PIMS prizes presentations are available on the PIMS website (see [www.pims.math.ca/birs/opening/Agenda\\_BIRS.html](http://www.pims.math.ca/birs/opening/Agenda_BIRS.html)).



Louise and Nassif Ghoussoub at the BIRS opening



David Eisenbud (Director of MSRI and AMS President)

PIMS, MSRI and MITACS took advantage of the gathering to hold Board, Executive and Management Committee meetings, including the first-ever joint meeting of the three Boards.

## The Scientific Programme of the BIRS Inaugural Meetings

The opening of the Banff International Research Station was ushered in by three distinguished speakers of varying backgrounds. Economist Dr. James J. Heckman, mathematician Dr. Donald Saari, and television producer and host Jay Ingram spoke about the new collaboration between the Mathematical Sciences Research Institute (MSRI) in Berkeley, California, and PIMS at the opening on February 28, 2003.

**James Heckman** is the Henry Schultz Distinguished Service Professor of Economics at the University of Chicago where he has served since 1973. He holds a parallel appointment as Director of Social Program Evaluation at the Harris School of Public Policy at the University of Chicago, and is also a Senior Research Fellow at the American Bar Foundation.

Heckman's research combines both methodological and empirical interests in evaluating the impact of a variety of social programs on the economy and on the society at large. He has also contributed substantially to the literature both in applied and theoretical econometrics. His methodological work on selection bias and on the evaluation of social programs is widely used, as is his research on the analysis of heterogeneity in consumer preferences and in the analysis of longitudinal data. He also has a series of influential papers on the identifiability of broad classes of econometric models.

Heckman has received numerous honors for his research. He is a fellow of the Econometric Society, a member of the

American Academy of Arts and Sciences and of the National Academy of Sciences. He received the John Bates Clark Award of the American Economic Association in 1983 and was awarded the Nobel Prize in Economics in 2000.

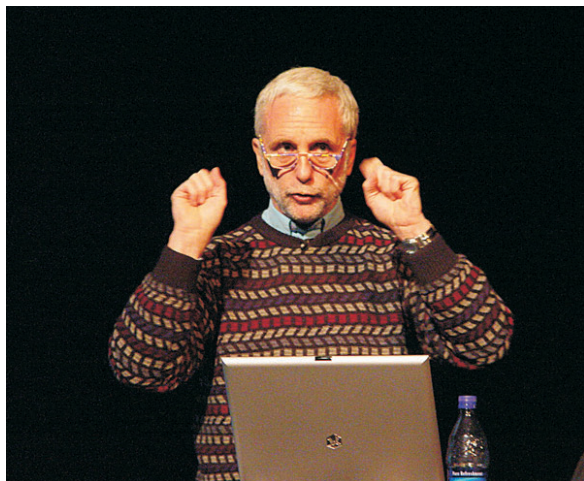
**Don Saari** received his PhD in mathematics from Purdue University and held a post doctoral position in the Yale University Astronomy Department. Until moving to UC at Irvine in July, 2000, Professor Saari was in the mathematics, economics, and applied mathematics departments at Northwestern University where he was the Pancoe Professor of Mathematics and chair of the mathematics department.

His two most recent books (both in 2001) are *Chaotic Elections! A Mathematician Looks At Voting*, American Mathematical Society (AMS), and *Decisions and Elections; Explaining the Unexpected*, Cambridge University Press. Among his editorial positions, he is the Chief Editor of the *Bulletin of the AMS*.

His current research interests centre around applying mathematical notions (primarily from dynamical systems) to decision analysis, voting, mathematical economics, and game theory. And of course, Dr. Saari also has a continued interest in the evolution of the universe, such as the Newtonian N-body problem.

Renowned science broadcaster and writer **Jay Ingram** is a co-host and producer of Discovery Channel's award-winning @discovery.ca, the television world's first and only daily science and nature news magazine. He joined Discovery in November, 1994 and was instrumental in helping shape the program format.

Prior to joining Discovery, Ingram hosted CBC Radio's science program *Quirks And Quarks*, from September 1979 to January 1992. During that time, he earned two ACTRA Awards, including one for Best Host. The program also garnered a variety of Canadian Science Writers' Awards. In 1993, Ingram hosted *The Talk Show*, a CBC Radio series about language which also won a Science in Society Journalism Award. Following that,



Jay Ingram speaker at the BIRS opening



Donald Saari and Nobel Laureate James J. Heckman who both spoke at the BIRS opening

Ingram presented items on the brain for the CBC television show *The Health Show* and contributed regular weekly science features for CBC Newsworld's Canada Live (1993-94). Ingram is also the author of three children's science books, a contributing editor for Owl magazine, and weekly science column contributor for the Toronto Star.

Ingram has been awarded The McNeill Medal and the Sandford Fleming Medal (both for the popularization of science), the Michael Smith Award, and honorary doctor of science degrees from McGill University and Carleton University. He is also a Distinguished Alumnus of the University of Alberta, and was—for the spring semester of 2002—a Distinguished Visiting Journalist at the University of Western Ontario.

## The Location of BIRS

BIRS is located in two adjacent buildings at the Banff Centre: the Max Bell building will have two lecture rooms and several smaller meeting and discussion rooms, and Corbett Hall, which will be entirely taken over by BIRS, will house the living quarters for all BIRS visitors.

## Modes of Operation

### Five-Day Workshops

The fundamental mode of BIRS is the five-day workshop, which runs from Sunday a.m. through to Thursday p.m. Each workshop is devoted to one specific area of high research interest. About 40 expert participants from



### The BIRS Scientific Advisory Board

- Robert V. Moody (Chair, U. Alberta): **Lie Theory and Mathematical Physics**
- Doug Arnold (U. Minnesota): **PDE and Numerical Analysis**
- James Arthur (U. Toronto): **Representation Theory**
- Jennifer Chayes (Microsoft Research): **Complexity theory and Statistical Mechanics**
- Richard Cleve (U. Calgary): **Quantum Computing**
- Ronald Coifman (Yale): **Harmonic Analysis**
- Henri Darmon (McGill): **Number Theory**
- David Gross (UC, Santa Barbara): **Quantum Field Theory and String Theory**
- Peter Gutterop (U. Washington): **Environmental Stats**
- Craig Huneke (U. Kansas): **Algebra**
- Nancy Kopell (Boston University): **PDE and Applied Mathematics**
- Mark Lewis (U. Alberta): **Math Biology and Ecology**
- László Lovász (Microsoft Research): **Combinatorial Optimization, Algorithms and Complexity**
- Jitendra Malik (UC, Berkeley): **Computer Vision**
- Dusa McDuff (SUNY, Stony Brook): **Topology and Symplectic Geometry**
- David Mumford (Brown University): **Machine and Natural Intelligence**
- Robert Myers (McGill and Perimeter Institute): **Superstring Theory and Quantum Gravity**
- Edwin Perkins (UBC): **Probability Theory**
- Nicholas Pippenger (UBC): **Computer Science**
- Ian Putnam (U. Victoria): **Dynamics and Operator Algebras**
- Nancy Reid (U. Toronto): **Statistics**
- Gang Tian (MIT): **Geometry**
- Robert Tibshirani (Stanford): **Data Mining and Computational Statistics**
- Margaret Wright (Courant Institute): **Algorithmic Optimization**
- David Eisenbud (Director, MSRI): **Commutative Algebra, Algebraic Geometry, Computation**
- Nassif Ghoussoub (Director, PIMS): **Non-linear Analysis, PDE**
- Arvind Gupta (Program leader, MITACS): **Combinatorics, Optimization, Complexity Theory**
- Ken Davidson (Director, Fields Institute): **Operator Theory, Nonselfadjoint operator algebras, C\*-algebras**
- Jacques Hurtubise (Directeur, CRM): **Topology, Geometry**

around the world are invited to attend. The objective is to exchange the latest advances in the field and to provide an environment which fosters new collaborations and new ideas, and which provides a forum for lively and vigorous discussion for the latest theories and proposals.

### Two-day Workshops

The normal scheduling of the five-day workshops will leave 2 day periods open (Friday and Saturday) that may be used for a variety of shorter meetings such as Pacific Northwest Seminars and special events.

### Research in Teams

In addition to its ongoing workshops, the station may host teams of 2–4 researchers for periods of 2–4 weeks. This programme will offer individuals from different institutions who are collaborating together, the location and freedom from distraction to concentrate on their research or to finish major projects.

### Focused Research Groups

There will be possibilities to have research collaborative groups in residence together for longer stays (Aspen mode) and some with other formats. A typical configuration might be groups of 10–15 mathematicians each, up to 8 of them being in residence at BIRS for 2–4 weeks. This would provide a good venue for collaborative work for teams of mathematical researchers like those identified and supported by NSF's Focused Research Groups program and NSERC's Collaborative Research Opportunities program.

### Summer Schools

BIRS will run some longer events (10–12 days) in the form of research schools directed principally towards graduate students and postdoctoral fellows.

## The Evaluation of the BIRS 2003 Programme

The Call for Proposals for workshops at BIRS in 2003 was very enthusiastically received, resulting in 108 proposals. The overall level of proposals was outstanding. The various committees were guided by the principle that BIRS has to be inclusive of all the mathematical sciences and that each year its programme should provide a broad sampling of these. Thus the proposals were broken down into some 22 areas, and within each area the proposals were evaluated and compared against each other. The committee then made sure that these were represented and that no area was grossly over- or underrepresented. Not surprisingly many fine proposals were omitted in this process.

The features the committees look for when making their selections were:

- The proposal should be well focused.
- The set of proposed applicants should be realistic and should be logical to the coherence and goals of the workshop.
- The workshop ought to be sufficiently innovative or sufficiently timely that holding it has significant potential to make a difference to the subject.
- The organizers (at least some) should be of recognized stature.
- The proposal should be written carefully, placing the above points clearly in the context of the present state of the subject.

The following points, although not of primary importance, were also considered:

- The committee would like to see each workshop make some effort to involve young and emerging talent in the form of post-docs or advanced graduate students.
- It is always good to keep in mind the appropriate representation of women in the list of participants.
- Priority will be given to those workshops that promote Canada-US research collaboration. Therefore each workshop ideally would have at least one organiser from a Canadian institution and one from an institution in the US.

## The Other Programmes at BIRS

There were also about fifteen proposals for the other aspects of the BIRS programme: Focused Research Groups and Research in Teams. These were all very worthwhile proposals and it was possible to satisfy all these requests, including hosting the Canadian Mathematical Olympiad Team for 2 weeks in the summer of 2003.

## The Review Process

The selection process is a multistage process. All incoming proposals are placed in one master file and all 27 members of the BIRS Scientific Advisory Board (SAB) can provide their written evaluations online about any proposal they wish to comment on.

In addition, each proposal gets reviewed by two members of the SAB, assigned by the Scientific Director according to expertise in the subject area. In some cases, external refereeing was also solicited.

All available information goes to the scientific panels of PIMS (resp., MSRI) who have the responsibility to select 12 (resp., 6) BIRS proposals of interest to their own scientific programmes from this file. The BIRS Scientific Steering Committee finishes off the selection process choosing another 22 workshops, based on the recommendations of its SAB and on the input of the MITACS Scientific Director so that there are at least two weeks of industrially oriented workshops.

## The PIMS Proposals

The PIMS Scientific Review Panel has the responsibility of selecting 12 of the full set of proposals. An appropriate BIRS workshop proposal for the PIMS Scientific Review Panel has to satisfy all criteria of excellence and innovation that are required by the BIRS evaluation process. In addition, they have to be compatible with the PIMS scientific, industrial and educational programmes, as dictated by the provincial funding sources for the institute and of BIRS.

Priority is given to events that fit into other parallel PIMS activities—particularly the Graduate Industrial Modelling Camps, the Periods of Concentration for Collaborative Research Groups, the Thematic Programmes, as well as various educational activities. Beyond that the proposals should also have a strong connection to groups, strengths, or ongoing activities within the PIMS participating universities in Canada and the US.

## BIRS Calendar for 2003

From the 118 proposals that were received the following were selected.

### 2003 Programme for 5-day Workshops

Mar 15–20: **Recent Developments in Superstring Theory**  
Organizers: Jim Bryan, Moshe Rozali, Gordon W. Semenoff, Mark Van Raamsdonk (UBC), Steve Giddings (UC, Santa Barbara), Mikhail Kapranov, Amanda W. Peet (U. Toronto), Andreas Karch (U. Washington), K. Viswanathan (SFU)

Mar 22–27: **Scattering and Inverse Scattering**  
Organizers: Richard Froese (UBC), Gunther Uhlmann (U. Washington)

Mar 29–Apr 3: **Commutative Algebra and Geometry**  
Organizers: Mark Green (IPAM, UCLA), Jürgen Herzog (U.-Gesamthochschule-Essen), Bernd Sturmfels (UC Berkeley)

Apr 5–10: **BIRS Workshop on Noncommutative Geometry**  
Organizers: Alain Connes (IHES), Joachim Cuntz (U. Muenster), George Elliott (U. Toronto), Masoud Khalkhali (U. Western Ontario), Boris Tsygan (Penn State U.)

Apr 12–17: **Quantum Mechanics on the Large Scale**  
Organizers: P.C.E. Stamp (UBC & U. Utrecht), G.A. Sawatzky (UBC), A.J. Leggett (U. Illinois), T. Havel (MIT), S. Popescu (HH Wills Lab, HP Lab), R. Gill (Utrecht U., Eurandom Inst.)

Apr 19–24: **Computational Fuel Cell Dynamics—II**  
Organizers: John Kenna (Ballard Power Systems), Trung Van Nguyen (U. Kansas), Keith Promislow (SFU), Brian Wetton (UBC)

Apr 26–May 1: **The Many Aspects of Mahler's Measure**  
Organizers: David Boyd (UBC), Doug Lind (U. Washington), Fernando Rodriguez Villegas (U. Texas, Austin), Christopher Deninger (U. Muenster)

May 3–8: **Recent Advances in Algebraic and Enumerative Combinatorics**  
Organizers: Richard Stanley, Sara Billey (MIT), Ian

Goulden, David Jackson (U. Waterloo), Curtis Greene (Haverford College)

May 10–15: **Statistical Mechanics of Polymer Models**  
Organizers: Christine E. Soteris (U. Saskatchewan), De Witt Sumners (Florida State U.), Stuart G Whittington (U. Toronto)

May 24–29: **Constraint Programming, Belief Revision, and Combinatorial Optimization**  
Organizer: Randy Goebel (U. Alberta)

May 31–Jun 5: **Symmetry and Bifurcation in Biology**  
Organizers: Martin Golubitsky (U. Houston), William F. Langford (U. Guelph), Ian Stewart (U. Warwick)

Jun 7–12: **Applicable Harmonic Analysis**  
Organizers: Rong-Qing Jia (U. Alberta), Sherman D. Riemenschneider (West Virginia U.), M. Victor Wickerhauser (Washington U.)

Jun 14–19: **Integration on Arc Spaces, Elliptic Genus and Chiral de Rham Complex**  
Organizers: Mikhail Kapranov (U. Toronto), Anatoly Libgober (U. Illinois), François Loeser (ENS)

Jun 21–26: **Point Processes—Theory and Applications**  
Organizers: Peter Guttorp (U. Washington), Bruce Smith (Dalhousie U.)

Jun 28–Jul 3: **Joint Dynamics**  
Organizers: Douglas Lind, Boris Solomyak (U. Washington), Daniel Rudolph (Maryland), Klaus Schmidt (Vienna)

Jul 5–10: **Mathematical Biology: From Molecules to Ecosystems; The Legacy of Lee Segel**  
Organizers: Leah Keshet (UBC), Simon A. Levin (Princeton), Mark Lewis (U. Alberta)

Jul 12–17: **Perspectives in Differential Geometry**  
Organizers: Richard Schoen (Stanford), Gang Tian (MIT), Jingyi Chen (UBC)

Jul 19–24: **Differential Invariants and Invariant Differential Equations**  
Organizers: Niky Kamran (McGill U.), Peter J. Olver (U. Minnesota)

Jul 26–31: **Analysis and Geometric Measure Theory**  
Organizers: Ana Granados (UBC), Hervé Pajot (U. Cergy-Pontoise), Tatiana Toro (U. Washington)

Aug 2–7: **Monge-Ampere Type Equations and Applications**  
Organizers: Alice Chang, Paul Yang (Princeton), Pengfei Guan (McMaster U.)

Aug 9–16: **Localization Behavior in Reaction-Diffusion Systems and Applications to the Natural Sciences** (1/2 workshop)  
Organizers: A. Bernoff (Harvey Mudd College), P. Fife (U. Utah), T. Hillen (U. Alberta), M. J. Ward (UBC), J. Wei (Chinese U., Hong Kong)

Aug 9–16: **Defects and their Dynamics** (1/2 workshop)  
Organizers: Peter W. Bates (Brigham Young U.), Lia Bronsard (McMaster U.), Changfeng Gui (U. Connecticut, UBC)

Aug 16–21: **Current Trends in Arithmetic Geometry and Number Theory**  
Organizers: Imin Chen (SFU), Brian Conrad, Chris Skinner (U. Michigan), Eyal Goren (McGill), Adrian Iovita (U. Washington), Nike Vatsal (UBC)

Aug 23–28: **Computational Techniques for Moving Interfaces**  
Organizers: Randy LeVeque (U. Washington), Robert D. Russell, Steven Ruuth (SFU)

Aug 30–Sep 4: **A Scientific Creative Writing Workshop at BIRS**  
Organizers: Marjorie Senechal (Smith College), Chandler Davis (U. Toronto)

Aug 30–Sep 4: **Locally Finite Lie Algebras** (1/2 workshop)  
Organizers: Yuri Bahturin (Memorial U.), Georgia Benkart (U. Wisconsin), Ivan Penkov (UC Riverside), Helmut Strade (Hamburg U.), Alexander Zaleskii (U. East Anglia)

Sep 6–11: **Regularization in Statistics**  
Organizers: Ivan Mizera (U. Alberta), Roger Koenker (Univ. Illinois-Urbana)

Sep 13–18: **Topology in and around Dimension Three**  
Organizers: Steve Boyer (U. Quebec), Martin Scharlemann (UC Santa Barbara), Abigail Thompson (UC Davis)

Sep 20–25: **Structural and Probabilistic Approaches to Graph Colouring**  
Organizers: Professor Bruce Reed (U. McGill), Paul Seymour (Princeton)

Sep 27–Oct 2: **Stochastic Partial Differential Equations**

Organizers: Martin Barlow, Edwin Perkins (UBC), Krzysztof Burdzy (U. Washington), Robert Dalang (Ecole Polytechnique Fédérale)

Oct 4–9: **Quadratic forms, Algebraic Groups, and Galois Cohomology**  
Organizers: R. Elman, A.S. Merkurjev (UCLA), J. Minac (U. Western Ontario), C. Riehm (McMaster U.)

Oct 11–16: **BANFF Credit Risk Conference 2003**  
Organizers: Tom Astebro (U. Waterloo), Peter Beling (U. Virginia), David Hand (Imperial College), Robert Oliver (UC Berkeley), Lyn Thomas (U. Southampton)

Oct 18–25: **MITACS Theme and Consortia Meetings**  
Organizers: MITACS, Peter Borwein, Evangelos Kranakis, Brian Alspach, Michael Mackey

Oct 25–30: **Current Trends in Representation Theory of Finite Groups**  
Organizers: Jonathan L. Alperin (U. Chicago), Michel Broue (U. Paris VII), Gerald Cliff (U. Alberta)

Nov 1–6: **PIMS Hot Topic: Galaxy Formation; a Herculean Challenge**  
Organizers: Arif Babul (U. Victoria), Julio Navarro (U. Victoria), Jeremiah Ostriker (Cambridge), Tom Quinn (U. Washington), Frank van den Bosch (U. Victoria), Neal Katz (U. Massachusetts)

Nov 8–13: **MSRI Hot Topic: Floer Homology for 3-manifolds**  
Organizers: Yasha Eliashberg (Stanford), Robion Kirby (UBC), Peter Kronheimer (Harvard)

Nov 15–20: **The Interaction of Finite Type and Gromov-Witten Invariants**  
Organizers: Jim Bryan (UBC), David Auckly (Kansas State U.)

Nov 22–27: **Theory and Numerics of Matrix Eigenvalue Problems**  
Organizers: J. W. Demmel (UC Berkeley), N.J. Higham (U. Manchester), P. Lancaster (U. Calgary)

Nov 29–Dec 4: **Nonlinear Dynamics of Thin Films and Fluid Interfaces**  
Organizers: A. L. Bertozzi, R. P. Behringer, T.P. Witelski (Duke U.), R. Almgren, M. C. Pugh (U. Toronto), M. Shearer (NC State U.)

Dec 6–11: **Calabi-Yau Varieties and Mirror Symmetry**  
Organizers: Victor Batyrev (U. Tübingen), Shinobu Hosono

(Tokyo), James D. Lewis (U. Alberta), Bong H. Lian (Brandeis), S.-T. Yau (Harvard), Noriko Yui (Queen's U.), Don Zagier (Max Planck Institut)

Dec 13–18: **p-adic Variation of Motives** (1/2 workshop)  
Organizers: Kevin Buzzard (Imperial College), Robert Coleman (UC Berkeley), Matthew Emerton (Northwestern U.), Eyal Goren (U. McGill)

Dec 13–18: **Coordinate Methods in Nonselfadjoint Operator Algebras** (1/2 workshop)  
Organizers: Allan Donsig (U. Nebraska), Michael Lamoureux (U. Calgary)

## 2003 Programme for Focused Research Groups (FRG), Research in Teams (RIT), Summer Schools (SS) and 2-Day Workshops

March 27–29: **Northwest Functional Analysis Symposium** (2-day workshop)  
Organizers: Michael Lamoureux (U. Calgary), Tony Lau (U. Alberta), Ian Putnam (U. Victoria), Nicole Tomczak-Jaegermann (U. Alberta)

Apr 3–6: **Restricting syzygies of algebraic varieties** (RIT)  
Organizers: David Eisenbud (MSRI), Sorin Popescu (SUNY at Stony Brook), Mark Green (IPAM, UCLA), Klaus Hulek (Fachbereich Mathematik Universitat, Hannover)

Apr 11–12: **Mathfair Workshop** (2-day workshop)  
Organizers: Ted Lewis, Andy Liu (U. Alberta)

Apr 18–26: **Asymptotic Dynamics of Dispersive Equations with Solitons** (RIT)  
Organizers: Tai-Peng Tsai (UBC), Kenji Nakanishi (Nagoya U., Princeton)

Apr 26–May 10: **Topological Orbit Equivalence for Dynamical Systems** (RIT)  
Organizers: T. Giordano (U. Ottawa), C. Skau (Norwegian U. of Science & Technology), I. Putnam (U. Victoria)

Apr 26–May 10: **Field Theory & Cohomology of Groups** (RIT)  
Organizers: A. Adem (U. Wisconsin-Madison), D. Karagueuzian (SUNY at Binghamton), J. Minac (U. Western Ontario)

May 10–24: **Regularity for Hypergraphs** (FRG)  
Organizers: P. Haxell (U. Waterloo), V. Rodl (Emory U.), J. Skokan (U. Illinois, Urbana-Champaign), L. Thoma (U. Rhode Island)

May 15–17: **The regression discontinuity method in economics: theory and applications** (2-day workshop)  
Organizer: Thomas Lemieux (UBC), David Card (Berkeley)

May 17–24: **PIMS Graduate Industrial Mathematics Modelling Camp** (SS)  
Organizers: Rachel Kuske, Ian Frigaard (UBC), Fadil Santosa (IMA), Jack Maki (U. Alberta), Chris Bose (U. Victoria), Huaxiong Huang (York U.)

May 24–Jun 7: **Topology and Analysis: Complementary Approaches to the Baum-Connes and Novikov Conjectures** (FRG)  
Organizers: N. Higson (Penn State U.), J. Kaminker (Indiana U.), S. Weinberger (U. Chicago)

Jun 7–21: **Quantum Algorithms & Complexity Theory** (FRG)  
Organizer: Richard Cleve, John Watrous (U. Calgary), Umesh Vazirani (UC Berkeley)

Jun 21–27: **Preparatory Workshop for the 2003 AMS/MSRI von Neumann Symposium** (SS)  
Organizer: R. Bryant (UC Berkeley)

Jun 28–Jul 10: **2003 Summer IMO Training Camp** (SS)  
Organizer: B. Sands (U. Calgary)

Jul 12–26: **Problems in Discrete Probability** (FRG)  
Organizers: R. Pemantle (Ohio State U.), Y. Peres (UC Berkeley), P. Winkler (Bell Labs, Lucent Technologies)

Jul 26–Aug 16: **Representation Theory of Linearly Compact Lie Superalgebras and the Standard Model** (RIT)  
Organizers: V. Kac (MIT), A. Rudakov (NTNU)

Aug 2–16: **Variance of Quasi-coherent Torsion Cousin Complexes** (RIT)  
Organizers: J. Lipman (Purdue U.), S. Nayak (Harish-Chandra Research Inst.), P. Sastry (U. Toronto)

Aug 16–30: **Invariant Manifolds for Stochastic PDEs** (RIT)  
Organizers: Tomas Caraballo (U. Sevilla), Jinqiao Duan (Illinois Inst. Tech.), Kening Lu (Brigham Young U.), Bjorn Schmalfuss (U. Appl. Sciences, Mereseburg, Germany)

Aug 16–Sep 6: **Local Uniformization and Resolution of Singularities** (RIT)

Organizers: S.D. Cutkosky (U. Missouri-Columbia), F.-V. Kuhlmann (U. Saskatchewan)

Aug 28–30: **Theoretical Physics Institute, University of Alberta Symposium** (2-day workshop)

Organizer: Helmy S. Sherif, Lee Grimard, Frank Marsiglio (U. Alberta)

Sept 4–6: **MITACS-PIMS Health Canada meeting on SARS** (2-day workshop)

Organizer: Jianhong Wu (York U.)

Sep 6–20: **Arithmetic of Fundamental Groups** (FRG)

Organizers: D. Harbater (U. Pennsylvania), F. Pop (U. Bonn)

Sep 18–20: **Canadian Mathematics Chairs Meeting** (2-day workshop)

Organizer: Ted Bisztriczky (U. Calgary), Bob Erdahl (Queen's U.), Yvan Saint-Aubin (Montreal)

Sep 20–Oct 2: **Mathematical Models for Plant Dispersal** (FRG)

Organizers: M. Lewis (U. Alberta), J. Bullock (NERC Centre for Ecology and Hydrology)

October 3–18, 2003: **Modular invariants and NIM-reps** (RIT)

Organizers: Terry Gannon (U. Alberta), Matthias Gaberdiel (ETH Zurich, Switzerland)

Oct 16–18: **West Coast Operator Algebra** (2-day workshop)

Organizers: Berndt Brenken (U. Calgary), Bruce Blackadar (U. Nevada, Reno)

Oct 16–18: **The World Bank Thailand SEQI Project** (2-day workshop)

Organizers: Andy Liu (U. Alberta)

## BIRS Calendar for 2004

### 2004 Programme for 5-day Workshops

Mar 13–18: **Interactions between model theory and geometry**

Organizers: Deirdre Haskell (McMaster U.), Jan Denef (Leuven), Ehud Hrushovski (Hebrew U.), Angus Macintyre (Edinburgh), Anand Pillay (UIUC), Patrick Speissegger (Wisconsin & McMaster U.)

Mar 20–25: **Topology of Manifolds and Homotopy Theory**

Organizers: Ian Hambleton (McMaster U.), Erik Pedersen (SUNY Binghamton), Gunnar Carlsson (Stanford)

Mar 27–Apr 1: **Orthogonal Polynomials; Interdisciplinary Aspects**

Organizers: Jacek Szmigielski (U. Saskatchewan), Percy Deift (Courant Inst. of Mathematical Sciences), Lance Littlejohn, David Sattinger (Utah State U.)

Apr 3–8: **Model Reduction Problems and Matrix Methods**

Organizers: Anne Greenbaum (U. Washington), Gene Golub (Stanford), Jim Varah (UBC)

Apr 10–15: **Analytic and Geometric Aspects of Stochastic Processes**

Organizers: Martin Barlow (UBC), Alexander Grigoryan (Imperial College, London), Elton Hsu (Northwestern U.)

Apr 17–22: **Celestial Mechanics** (1/2 workshop)

Organizers: Florin Diacu (U. Victoria), Donald Saari (UC Irvine)

Apr 17–22: **BIRS Workshop in Creative Scientific Writing** (1/2 workshop)

Organizers: Marjorie Senechla (Smith College), Chandler Davis (U. Toronto)

Apr 24–29: **Microeconometrics of Spatial and Grouped Data**

Organizers: Thomas Lemieux (UBC), David Card (UC Berkeley)

May 1–6: **Mathematical structures in economic theory and econometrics** (1/2 workshop)

Organizers: Ivar Ekeland (UBC), Pierre-Andre Chiappori (U. Chicago)

May 1–6: **Singular Cardinal Combinatorics** (1/2 workshop)  
Organizers: Claude Laflamme (U. Calgary), Matthew Foreman (UC Irvine), Stevo Todorcevic (U. Toronto & CNRS Paris)

May 8–13: **Knots and their Manifold Stories**  
Organizers: Orr Kent (Indiana U.), Tim Cochran (Rice U.), Dale Rolfsen (UBC)

May 15–20: **New developments on variational methods and their applications**  
Organizers: Kung-Ching Chang (Peking U.), Jingyi Chen (UBC), Changfeng Gui (U. Connecticut), Paul Rabinowitz (U. Wisconsin, Madison)

May 22–27: **Mathematical Foundations of Scientific Visualization, Computer Graphics, and Massive Data Exploration**  
Organizers: Torsten Moller, Robert Russell (SFU), Bernd Hamann (UC Davis)

May 29–Jun 3: **Aperiodic Order: Dynamical Systems, Combinatorics, and Operators**  
Organizers: Michael Baake (Institut fuer Mathematik), David Damanik (Caltech), Ian Putnam (U. Victoria), Boris Solomyak (U. Washington)

Jun 5–10: **Semimartingale Theory and Practice in Finance**  
Organizers: Tom Hurd (McMaster U.), Thaleia Zariphopoulou (U. Texas, Austin), Philip Protter (Cornell U.), Lane Hughston (King's College London)

Jun 12–17: **New Horizons in String Cosmology**  
Organizers: James Cline (McGill U.), Robert Brandenberger (Brown U.), Steve Giddings (UC Santa Barbara), Brian Greene (Columbia U.), Rob Myers (Perimeter Institute), Gordon Semenoff (UBC)

Jun 19–Jul 2: **MITACS-PIMS-MSRI Special Program on Infectious Diseases** (2 weeks)  
Organizers: Fred Brauer (UBC), Mark Lewis (U. Alberta), Pauline van den Driessche (U. Victoria), James Watmough (U. New Brunswick), Jianhong Wu (York U), Ping Yan (Health Canada)

Jul 03–Jul 08: **Advances in Complexity Theory**  
Organizers: Valentine Kabanets (SFU), Stephen Cook (U. Toronto), Arvind Gupta (SFU), Russell Impagliazzo (UC, San Diego), Madhu Sudan (MIT), Avi Wigderson (IAS)

Jul 10–15: **Convex Geometric Analysis**  
Organizers: Nicole Tomczak-Jaegermann (U. Alberta), Vitali Milman (Tel Aviv U.), Elisabeth Werner (Case Western Reserve U.)

Jul 17–22: **Modeling Protein Flexibility and Motions**  
Organizers: Walter Whiteley (York U.), Michael Thorpe, Leslie Kuhn (Michigan State U.)

Jul 24–29: **Geometric Evolution Equations**  
Organizers: Christine Guenther (Pacific University), Jingyi Chen (UBC), Bennett Chow (UC San Diego), Klaus Ecker (Freie Universitaet Berlin)

Jul 31–Aug 5: **Conformal Geometry**  
Organizers: Thomas Branson (U. Iowa), Michael Eastwood (U. Adelaide, Australia), McKenzie Wang (McMaster U.)

Aug 7–12: **Stochastic Processes in Evolutionary and Disease Genetics**  
Organizers: Ellen Baake (U. Greifswald), Don Dawson (Carleton U.), Warren Ewens (U. Pennsylvania), Bruce Rannala (U. Alberta)

Aug 14–19: **Statistical Science for Genome Biology**  
Organizers: Jennifer Bryan (UBC), Sandrine Dudoit, Mark van der Laan (UC Berkeley)

Aug 21–26 : **Dynamics, control and computation in biochemical networks**  
Organizers: Brian Ingalls (U. Waterloo), Leon Glass (McGill U.), John Reintz (The University at Stony Brook), Eduardo Sontag (Rutgers U.), Erik Winfree (Caltech)

Aug 28–Sep 2: **Combinatorial Hopf Algebras**  
Organizers: Frank Sottile (U. Massachusetts), Nantel Bergeron (York U.), Louis Billera (Cornell U.), Stephanie van Willigenburg (UBC)

Sep 4–9: **Pluripotential Theory and its Applications**  
Organizers: Len Bos, Alex Brudnyi (U. Calgary), Eric Bedford (U. Indiana), Al Taylor (U. Michigan)

Sep 11–16: **Commutative Algebra: Homological and Birational Theory**  
Organizers: Ragnar-Olaf Buchweitz (U. Toronto), Paul Roberts (U. Utah), Bernd Ulrich (Purdue U.)

Sep 18–23: **Quantum Computation and Information Theory**  
Organizers: John Watrous, Richard Cleve (U. Calgary), Umesh Vazirani (UC Berkeley)

Sep 25–30: **Interaction of Finite Dimensional Algebras with other areas of Mathematics**  
Organizers: Vlastimil Dlab (Carleton U.), Claus Ringel (U. Bielefeld), Leonard Scott (U. Virginia)

**Oct 2–7: Self-Stabilizing Distributed Systems**

Organizers: Lisa Higham (U. Calgary), Anish Arora (Ohio State U.), Faith Fich (U. Toronto), Maurice Herlihy (Brown U.), Ted Herman (U. Iowa)

**Oct 9–14: Free Probability Theory**

Organizers: Alexandru Nica (U. Waterloo), Roland Speicher (Queen's U.), Dan Voiculescu (UC Berkeley)

**Oct 16–21: Braid Groups and Applications**

Organizers: Dale Rolfsen (UBC), Joan Birman (Columbia U.), Patrick Dehornoy (U. Caen), Roger Fenn (U. Sussex), Vaughan Jones (UC Berkeley)

**Oct 23–28: Mathematical Image Analysis and Processing**

Organizers: Mary Pugh (U. Toronto), Selim Esedoglu (UCLA), Sung Ha Kang (U. Kentucky), Jackie Shen (U. Minnesota)

**Oct 30–Nov 4: The Structure of Amenable Systems**

Organizers: George Elliott (U. Toronto), Andrew Dean (Lakehead U.), Thierry Giordano (U. Ottawa), Guihua Gong (U. Puerto Rico), Huaxin Lin, N. Christopher Phillips (U. Oregon)

**Nov 6–11: New Techniques in Lorentz Manifold (1/2 workshop)**

Organizers: Virginie Charette (U. Manitoba), Todd Drumm (Swarthmore College), William Goldman (U. Maryland)

**Nov 6–11: Functional Differential Equations (1/2 workshop)**

Organizers: Jianhong Wu (York U.), Hans-otto Walther (U. Giessen, Germany), John Mallet-paret (Brown U.)

**Nov 13–18: Explicit Methods in Number Theory**

Organizers: Peter Borwein (SFU), H. W. Lenstra (UC Berkeley), P. Stevenhagen (U. Leiden), H. Williams (U. Calgary)

**Nov 20–25: Diophantine Approximation and Analytic Number Theory**

Organizers: Michael Bennett, Greg Martin (UBC), John Friedlander (U. Toronto), Andrew Granville (U. Montreal), Cameron Stewart (U. Waterloo), Trevor Wooley (U. Michigan)

**Nov 27–Dec 2: Mathematical Models for Biological Invasions**

Organizers: Mark Lewis (U. Alberta), Mark Kot (U. Washington), Pauline van den Driessche (U. Victoria)

**Dec 4–9: Generalizations of de Bruijn Cycles and Gray Codes (1/2 workshop)**

Organizers: Brett Stevens (Carleton U.), Joe Buhler (Reed

College), Persi Diaconis (Stanford), Fan Chung, Ronald Graham (UC San Diego), Frank Ruskey (U. Victoria)

**Dec 4–9: Numeracy and Beyond (1/2 workshop)**

Organizers: Klaus Hoechsmann (PIMS), Tony Gardiner (U. Birmingham), Yarom Sagher (U. Illinois), Guenter Toerner (U. Duisburg)

**Dec 11–16: Workshop on Resolution of Singularities, Factorization of Birational Mappings, and Ttoroidal Ggeometry**

Organizers: Kenji Matsuki, Jaroslaw Wlodarczyk (Purdue U.), Dan Abramovic (Boston U.), Edward Bierstone (U. Toronto), Steven Dale Cutkosky (U. Missouri), Pierre Milman (U. Toronto)

## 2004 Programme for Focused Research Groups (FRG), Research in Teams (RIT), Summer Schools (SS) and 2-Day Workshops

**Mar 13–27: Modular invariants and NIM-reps (RIT)**

Organizers: Terry Gannon, Matthias Gaberdiel (Kings College, London, UK)

**Mar 13–27: Cohomogeneity One Manifolds with Positive Sectional Curvature (RIT)**

Organizers: Wolfgang Ziller (U. Pennsylvania), Karsten Grove (U. Maryland), Burkhard Wilking (U. Muenster)

**Mar 18–20: Retreat on Mathematical Ecology and Evolution (2-day workshop)**

Organizers: Mark Lewis (U. Alberta), Ed McCauley (U. Calgary), Michael Doebeli (UBC), Thomas Hillen (U. Alberta), Mark Kot (U. Washington).

**Mar 25–27: Human Infant Speech Perception and Language Acquisition (2-day workshop)**

Organizers: Janet Werker (UBC), Gary Marcus (NYU), Helen Neville (U. Oregon), Nuria Sebastian-Galles (U. Barcelona), Jacques Mehler (U. Trieste)

**Apr 22–24: Mathfair Workshop (2-day workshop)**

Organizers: Ted Lewis (U. Alberta), Andy Liu (U. Alberta), Tom Holloway (U. Alberta)

**Apr 15–17: PIMS PDF Meeting (2-day workshop)**

Organizer: Manfred Trummer (PIMS)



May 6–8: **Directions in Combinatorial Matrix Theory** (2-day workshop)

Organizers: Shaun Fallat, Steve Kirkland (U. Regina), Hadi Kharaghani (U. Lethbridge), Bryan Shader (U. Wyoming), Michael Tsatsomeros (Washington State U.), Pauline van den Driessche (U. Victoria)

May 13–15: **Decentralized Discrete Event Systems: Structure, Communication and Control** (2-day workshop)

Organizers: Peter Caines (McGill U.), Stephane Lafortune (U. Michigan), Laurie Ricker (Mount Allison U.), Karen Rudie (Queen's U.), John Thistle (U. Waterloo)

May 13–15: **PI in the Sky Retreat** (RIT)

Organizers: Heather Jenkins (PIMS)

May 15–Jun 5: **Maximal functions in Non-commutative Analysis** (RIT)

Organizers: Marius Junge (U. Illinois, Urbana-Champaign), Quanhua Xu (Besancon, France)

May 22–Jun 5: **Geometric Analysis of One and Several Complex Variables** (RIT)

Organizers: Steven Krantz (Washington U. St. Louis), Joseph Cima (U. North Carolina), Ian Graham (U. Toronto), Kang-Tae Kim (Pohang Institute, Korea)

Jun 5–19: **Robust Analysis of Large Data Sets** (FRG)

Organizers: Ruben Zamar (UBC), Stefan Van Aelst (U. Ghent, Belgium)

Jun 17–19: **Adaptive Wavelet and Multiscale Methods for PDEs** (2day workshop)

Organizer: Tony Ware (SFU), Manfred Trummer (SFU), Bin Han (U. Alberta), Micheal Lamouroux (U. Calgary), Elena Braverman (U. Calgary)

Jul 3–10: **Geometry and Deformation Theory of Hyperbolic 3-manifolds** (RIT)

Organizers: Richard Canary (U. Michigan), Jeffrey Brock (Brown/Texas), Kenneth Bromberg (U. Utah), Yair Minsky (Yale)

Jul 10–24: **String Field Theory Camp** (FRG)

Organizers: Gordon Semenoff, Mark van Raamsdonk, Moshe Rozali (UBC)

Jul 15–17: **The Design and Analysis of Computer Experiments for Complex Systems** (2-day workshop)

Organizers: Derek Bingham (Canada Research Chair in Industrial Statistics), Randy Sitter (SFU)

Jul 24–Aug 7: **Stability and Computations for Stochastic Delay Differential Equations** (RIT)

Organizers: Rachel Kuske (UBC)

July 24–Aug 14: **Study of Affine Surfaces with Self-maps of Degree  $> 1$  and the Jacobian Problem** (RIT)

Organizers: R.V. Gurjar (Tata Inst. of Fundamental Research, India), M. Miyanishi (Osaka U.), D.-Q. Zhang (National U.), Peter Russell (McGill U.)

Aug 5–7: **Combinatorial and Algorithmic Aspects of Networking and the Internet** (2-day workshop)

Organizers: Angel Hamel (Wilfrid Laurier), Alex Lopez-Oritz (U. Waterloo), Ian Munro (U. Waterloo), Rajeev Motwani

(Stanford), Andrei Broder (IBM T.J. Watson), Srinivasan Keshav (U. Waterloo)

Aug 7–21: **Competing Species and Predator-Prey Models and Measure-valued Diffusions** (RIT)

Organizers: Edwin Perkins (UBC)

Aug 21–Sept 4: **Kinetic Models for Multiscale Problems** (FRG)

Organizers: Peter Markowich (Wolfgang Pauli Institute Vienna), Lorenzo Pareschi (U. Ferrara, Italy), Jin Shi (U. Wisconsin), Reinhard Illner (U. Victoria)

Aug 26–28: **Theoretical Physics Institute, University of Alberta Symposium** (2-day workshop)

Organizer: Frank Marsiglio (U. Alberta).

Sep 5–18: **Geometry and Analysis on Cauchy Riemann Manifolds** (RIT)

Organizers: John Bland (U. Toronto), Tom Duchamp (U. Washington), Charlie Epstein (U. Pennsylvania), Jack Lee (U. Washington)

Sep 18–25: **Research on Stochastic Models for the Web Graph and Other Scalefree Networks** (RIT)

Organizer: Jeannette Janssen (Dalhousie), Anthony Bonato (Wilfrid Laurier)

Sep 30–Oct 2: **ABCW Workshop in Numerical Analysis** (2-day workshop)

Organizers: Manfred Trummer (SFU), Steve Ruuth (SFU), Randy LeVeque (U. Washington), Tony Ware (U. Calgary), Chen Greif (UBC)



# I. COLLABORATIVE RESEARCH GROUPS

As part of its second phase of development, PIMS is embarking on a plan that will create and support collaborative multi-university teams of mathematical scientists. These Collaborative Research Groups (CRGs) will pool talent across universities to form world-class research groups that will generate and sustain the scientific programme of PIMS in the years to come.

The research programmes of these groups will be supported through a new PIMS programme that supports concentrated activities in 5–10 research areas each year. This programme, run on a competitive basis, will support multi-site activities of selected CRGs over a 1–2 year period of concentration.

Upcoming Areas of Concentration: 2003–05

**String Theory**

**Scientific Computing**

**Number Theory**

**Mathematical Ecology and Evolution**

**Topological Dynamics**

Upcoming Areas of Concentration: 2004–06

**Topology and Knot Theory**

**Probability and Statistical Mechanics**

## What is a PIMS CRG?

The CRGs typically consist of researchers with a common research interest and with a common desire to collaboratively develop some aspects of their research programmes. Groups may already be organizing joint seminars and workshops, making joint PDF appointments, or developing joint graduate training programmes. However, with the resources and organizational structure of PIMS they will be able to do considerably more.

The CRGs act as a vehicle for networking between universities. They effectively integrate the mathematical sciences community at the various PIMS universities into the scientific infrastructure of PIMS. They will build on already existing joint efforts and links between the researchers of Western Canada and the US Pacific Northwest thereby opening up a new era of scientific collaborations between the two countries. They will also assume scientific leadership at the Banff Station and some will have the potential to lead industrial projects through the MITACS network.

The CRGs will create critical mass that will substantially enhance training programmes at all levels. The pooling of PIMS support with other sources and the joint planning of resource allocation will allow the CRGs to support a large number of PDFs and graduate students and will create new research opportunities for these young scientists, including exchanges, joint supervision, and summer schools.

The CRGs directly address the problems of retention and recruitment of faculty. They are a venue for new faculty to get plugged into a larger community, they give young faculty an effective network to build their research programme, and they enhance the attractiveness of the universities.

PIMS has identified 32 potential CRGs within its community, spanning five broad areas of research to which PIMS is committed: Fundamental Mathematics, Applied and computational Mathematics, Mathematical Biology and Medicine, Statistical Sciences and Theoretical Computer Science. While some are already well established and structured, in most cases they are just forming. Each CRG, which consists of 10–15 Canadian and US researchers, are to be jointly coordinated by at least 3 senior researchers representing various PIMS sites.

## Periods of Concentrated Activities for the CRGs

The Periods of Concentration are designed to promote and support longer term, multi-event, multi-site coordinated activities of competitively selected CRGs, in tandem with their national and international collaborators and visitors. Every year, the PIMS Scientific Review Panel will select on a competitive basis, up to 5 areas of research from those proposed by existing or developing CRGs. The selected areas will be the focus of much of the institute's programme over a 1–2 year period of concentrated activities that will be delivered through the selected CRGs. Thus, at any given time, as many as 10 CRGs may be leading the PIMS scientific enterprise. Proposals can vary greatly according to the needs of the particular group and may combine a number of existing PIMS activities. During its period of concentration, a CRG can expect to receive priority for:

- Thematic programmes and mini-programmes
- PIMS postdoctoral fellowships
- Pacific Northwest mini-conference series
- 5-day workshops at BIRS
- Focussed workshops at host universities
- Intensive two week graduate courses
- Distinguished chairs & long term visitors
- Graduate students exchanges
- Graduate & senior undergrad schools
- Industrial training camps
- International collaborations
- Research fellowships for teaching relief

With this support, a CRG can plan to gather a significant portion of the world's experts in its focus topic for periods of intense collaboration. The fruits of such intensity can be expected to persist for many years and to be exponentially greater than the results of more normal activity levels.

In due course, all 32 of the PIMS CRGs recognized so far would be given the benefit of a period of concentration. This approach should dramatically increase the effectiveness of the PIMS research programme by making its facilities and its opportunities available to all CRGs on a periodic basis.

## Expected Impact of the Periods of Concentration

A targeted and coordinated, yet inclusive grass-roots approach of this form will present a new and innovative way for the institute to drive and stimulate research and will result in a significant impact on the research excellence of its activities. The programme's extended time scale, its multi-event nature and its cross-university character together distinguish it from any other institute programme. Its implementation will allow PIMS to achieve several of its goals. It will:

- Provide new ways of having its scientific programmes driven by its member scientists: The programme will help elicit proposals for thematic summers, miniprogrammes, BIRS events, and distinguished scholars as part of the application process. These programmes will have strong local interest and will encourage grass-roots generation and longterm planning of activities with a much more inclusive and flexible format than standard thematic programmes.
- Foster multi-site interactions and collaborations: The programme will continue to build the inter-site collaborative nature of the PIMS community and will alleviate the problems of interconnection inherent in large geographical separations between the PIMS sites. It creates a context through which researchers can collectively profit from the opportunities created by PIMS, BIRS and the MITACS network.
- Create new research opportunities and enhance training: The periods of concentration will allow for the planning of a series of advanced graduate courses at any one site with the participation of students from multiple PIMS universities. The Western Dean's agreement allows graduate students at any Western Canadian university to take courses, for credit, at any Canadian PIMS university. The result will be new opportunities for PIMS graduate students and a larger audience for PIMS and visiting scientists. This will directly lead to a vigorous graduate student exchange programme.
- Support existing collaborative research groups and foster new groups: The periods of concentration will help to strengthen groups and give them a vehicle for long-range planning of research and advanced education activities. As well it will encourage and empower isolated groups or smaller ones at one university by bringing them into larger

collaborative teams.

- Effectively facilitate Canada-US collaborations: The programme will effectively integrate the mathematical sciences community at the U. of Washington into the operations of the institute. It will allow the 12 groups of Canadian and US researchers that are currently organizing the PNW Seminars to develop further their collaborative activities, and allow other groups to launch these types of activities. The programme will also provide researchers with the means to play a leadership role on the national and international level.
- Attract additional support for research: Periods of concentration will provide departments and universities with a mechanism for granting teaching and administrative releases to the scientists involved. Such programmes can also be developed in collaboration with other organizations and institutes, hence multiplying the opportunities.

## Areas of Concentration: 2003–05

### String Theory

Recently, the concentration of research manpower in string theory and closely related fields in the communities associated with PIMS has reached a critical size so that it now has the potential to be a major player in the international research community. The purpose of this Period of Concentration in String Theory is to galvanize this group of researchers into a leading research unit. The members of this group already have a formal structure as a PIMS Collaborative Research Group. The Period of Concentration on String Theory gives this Group the resources to carry on a strong research programme at PIMS, to form a pan-Canadian network with the emerging groups at the University of Toronto and the Perimeter Institute and to communicate and collaborate with other string theory research groups worldwide.

The aim is to incubate significant original research in string theory and those areas of physics and mathematics that are influenced by string theory. The Period of Concentration will contribute by educating researchers on the latest developments in the field, encouraging and enhancing their research activity and providing a ready venue for dissemination of their results.

## Scientific Activities 2003

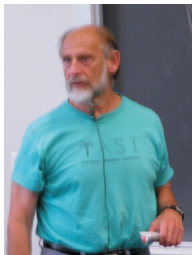
### Frontiers of Mathematical Physics Summer School on Strings, Gravity and Cosmology PIMS-UBC, July 14-25, 2003



Vijay  
Balasubramanian (U.  
Pennsylvania)



David Kutasov  
(U. Chicago)



Leonard Susskind  
(Stanford)

*Frontiers in Mathematical Physics (FMP)* was organized as a summer school this year. The school was concentrated on the interface between gravity, cosmology and string theory. This is an active research area in string theory, and the school was designed to prepare the students for active research in this field. By choosing a particular section of string theory, the school was fairly comprehensive in the topics covered, providing both elementary introduction to the subject matter and ending with reviews of recent literature. The organizers were **Taejin Lee** (APCTP), **John Ng** (TRIUMF, UBC), **Moshe Rozali** (UBC), **Alexander Rutherford** (PIMS) and **Gordon W. Semenoff** (UBC). The first week of the school was dedicated to introducing the basic tools of string theory. Those include the basic technical tools of (perturbative and non-perturbative) string theory and quantum field theory, and some of their applications. Basics of cosmology were covered in preparation for the second week. The second week of the school covered more advanced topics, by and large developments of the last year or two (or in some cases

the last week or two). These included recent developments in matrix models, Liouville theory, cosmic singularities and much more. Among those were the excellent lectures of **Ashoke Sen**, PIMS Distinguished Chair in String Theory.

The full list of speakers is:

**Vijay Balasubramanian** (UPenn): *Time and String Theory*

**Micha Berkooz** (Weizmann Institute): *Cosmic Singularities in General Relativity and String Theory*

**Robert Brandenberger** (Brown): *Basics of Cosmology for String Theorists*

**Michael Dine** (UC, Santa Cruz): *String Phenomenology*

**Simeon Hellerman** (Stanford): *Supersymmetric Gauge Theories*

**David Kutasov** (U. Chicago): *Little String Theory*

**Yuri Makeenko** (ITEP, Moscow): *Large N Gauge Theories*

**Volker Schomerus** (Saclay): *Strings in Exact Non-Compact Backgrounds*

**Ashoke Sen** (Harish-Chandra Institute): *Tachyon Dynamics in Open String Theory*

**Matthew Strassler** (U. Washington): *Confinement and String Theory: The Duality Cascade and its Applications*

**Leonard Susskind** (Stanford): *deSitter Space*

**Richard Szabo** (Heriot-Watt): *Perturbative String Theory*

**Mark Van Raamsdonk** (Stanford/UBC): *Introduction to AdS/CFT*

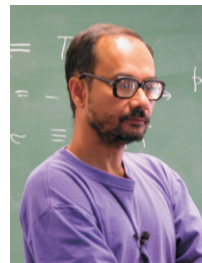
**Don Witt** (UBC): *QFT in Curved Space*

**Piljin Yi** (KIAS): *Low Energy Dynamics of Unstable D-Branes*

We were fortunate to have a group of 88 very enthusiastic and dedicated students. Student seminars were given at the end of the day, and were well-attended. The lectures were very interactive, resulting in interesting discussions during the breaks. The students should now be able to start making their own contributions to the field.

The next Frontiers in Mathematical Physics Summer School will be on Particles, Fields and Strings, and it will be held in early August 2004.

### Ashoke Sen, PIMS Distinguished Chair, UBC



Ashoke Sen (Harish-Chandra Institute)

As part of the FMP programme UBC hosted Ashoke Sen as a PIMS Distinguished Chair. Professor Sen is one of the most influential string theorists in the world, leading the recent effort aimed at understanding tachyon dynamics in open string theory, one of the most active research areas in string theory. This was the topic of his 5 lectures in Vancouver.

Professor Sen was educated in India, and Obtained his PhD from State University of New York at Stony Brook. He completed postdoctoral appointments in SLAC (Stanford) and Fermilab (Chicago). He joined the faculty of the Tata institute in Mumbai in 1988, and the Harish-Chandra research institute in Allahabad in 1995.

### Pacific Northwest String Seminar PIMS-UBC, November 15–16, 2003

The meeting is cosponsored by PIMS and the Pacific Institute for Theoretical Physics.

The speakers were:

**Dominic Brecher** (UBC)  
**Michael Gutperle** (UCLA)  
**Shamit Kachru** (Stanford University)  
**Andreas Karch** (University of Washington)  
**Albion Lawrence** (Brandeis University)  
**Hiroshi Ooguri** (Caltech)  
**Stephen Shenker** (Stanford University)  
**Matthew Strassler** (U. Washington)

### PNW String Seminar on Mathematical Aspects of Open-Closed String Dualities U. Washington, December 4–5, 2003

The organizers are Mina Aganagic, Charles Doran, Andreas Karch and Matthew Strassler (U. Washington).

This seminar was supported by PIMS, the Milliman Fund at the UW Department of Mathematics, the U.S. Department of Energy, and the Dean of the UW College of Arts and Sciences.

The external speakers include **Adrian Clingher** (Stanford), **Ezra Getzler** (Northwestern), **Sergei Gukov** (Clay/Harvard), **Kentaro Hori** (Toronto), **Ken Intriligator** (UCSD), **Amer Iqbal** (Harvard) and **Melissa Liu** (Harvard).



Participants of the BIRS Workshop on Recent Developments in Superstring Theory

### BIRS Workshops

BIRS Workshop on Recent Developments in Superstring Theory, 5-Day Workshop, March 15–20, 2003

New Horizons in String Cosmology, 5-Day Workshop, June 12–17, 2004

String Field Theory Camp, Focused Research Group, July 10–25, 2004

### Members of the CRG

#### PIMS PDFs of the CRG

UBC: Dominic Brecher, Kazuyuki Furuuchi and Ehud Schreiber

#### Faculty of the CRG

Leaders: Gordon Semenoff (UBC), Eric Woolgar (U. Alberta)

SFU: K. Viswanathan

U. Alberta: B. Campbell, V. Frolov, T. Gannon, D. Page

UBC: K. Behrend, J. Bryan, M. Choptuik, M. Van Raamsdonk, M. Rozali,

K. Schleich, W. Unruh, D. Witt

U. Lethbridge: M. Walton

U. Toronto: A. Peet

U. Washington: A. Karch

Perimeter Institute: R. Myers, L. Smolin

APCTP: T. Lee



Gordon Semenoff (UBC), co-leader of the CRG on String Theory



Eric Woolgar (UA), co-leader of the CRG on String Theory

The String Theory CRG webpage is at [www.pims.math.ca/CRG/string/](http://www.pims.math.ca/CRG/string/). Further information and a preliminary list of activities for 2004–05 may be found there.

## Scientific Computing

The major goal of this period of concentration is to develop the group's common research programmes and to promote research in scientific computing and increase related interdisciplinary collaboration within the region. In addition, this period of increased activity in scientific computing provides a focus to kickstart and solidly establish SFU's Centre for Scientific Computing (CSC). The majority of the activity of this concentration period will take place at the PIMS sites at SFU, UW and UBC and at BIRS. The organizers are committed to organizing a number of activities which bring in the other PIMS sites as well.

A special feature of this period of concentration is the promotion of a multidisciplinary approach to the subject and the inclusion of important research topics such as the earth and atmospheric sciences.

### Scientific Activities 2003

#### Workshop on Numerical Linear Algebra and Applications

PIMS-UBC, August 4–8, 2003

This workshop was organized by Chen Greif (UBC). It featured two short courses, and a mixture of survey talks and advanced talks.

The short courses were accessible to non-experts, and slides from these courses are available on the web page. The short course speakers were:

**Alison Ramage** (Strathclyde University): *An Introduction to Iterative Solvers and Preconditioning Techniques*

**Eldad Haber** (Emory U): *PDEs and Optimization*

The other speakers were:

**Uri Ascher** (UBC): *On the modified conjugate gradient method in cloth simulation*

**Xiao-Wen Chang** (McGill U.): *Numerical linear algebra in the Global Positioning System*

**Edmond Chow** (Lawrence Livermore National Lab): *A survey of incomplete factorization preconditioners*

**Iain Duff** (RAL and CERFACS): *The symbiosis of direct and iterative methods for solving large sparse systems & Solving large industrial problems in electromagnetics at CERFACS*

**Gene Golub** (Stanford): *Numerical So-*



Alison Ramage  
(Strathclyde)



Eldad Haber  
(Emory)

*lution for Solving Least Squares Problems with Constraints*

**Anne Greenbaum** (U. Washington): *Polynomial Numerical Hulls of Jordan Blocks and Related Matrices*

**Chen Greif** (UBC): *Techniques for solving indefinite linear systems*

**Misha Kilmer** (Tufts U.): *Numerical Methods for Ill-Posed Problems*

**Scott MacLachlan** (U. Colorado): *Solving PDEs with Multigrid Methods*

**Carl Meyer** (North Carolina State U.): *Updating Markov Chains*

**Peyman Milanfar** (UC, Santa Cruz): *Applications of Numerical Linear Algebra to Imaging Inverse Problems*

**Esmond Ng** (Lawrence Berkeley National Lab): *Computational Challenges in Electron Microscopy of Macromolecules*

**Michael Overton** (NYU): *Optimizing Matrix Stability*

**David Watkins** (Washington State U.): *Hamiltonian and Symplectic Lanczos Processes*

See <http://www.pims.math.ca/science/2003/numerical/>.

#### Pacific Northwest Numerical Analysis Seminar U. Washington, October 4, 2003

This year's speakers were:

**Marsha Berger** (NYU)

**William Ferng** (Boeing)

**Jonathan Goodman** (NYU)

**Boualem Khouider** (UVic)

**Ian Mitchell** (UBC)

**Michel Pettigrew** (UW)

**Yun-Qiu Shen** (WWU)

#### PIMS Distinguished Series in Scientific Computing at UBC

This is a new distinguished speaker series, comprising six talks by world leading experts, and spanning a wide variety of topics in scientific computing. It is organized by **Uri Ascher** and **Chen Greif** (Computer Science, UBC). The series is taking place at UBC in September 2003–January 2004. Additional support is being provided by NSERC grants of the organizers and by the Institute of Applied Mathematics at UBC.

The lectures are:

**Heinz W. Engl** (Industrial Mathematics Institute, Johannes Kepler Universität, Austria): *Iterative Regularization of Nonlinear Inverse Problems*

**Pat Hanrahan** (Computer Science, Stanford U.): *Why is Graphics Hardware so Fast? Implications for Scientific Computing*

**Tom Hou** (Applied Mathematics, CalTech): *Multiscale*





Andy Wathen (Oxford)

*Modelling and Computation of Flow in Heterogeneous Media*  
**Jorge Nocedal** (Electrical & Computer Engineering, Northwestern U.): *The New Faces of Nonlinear Optimization*

**Christoph Schwab** (Applied Mathematics, ETH, Switzerland): *Wavelet algorithms for asset pricing under Levy Processes*

**Andy Wathen** (Oxford U. Computing Lab): *Preconditioning in Scientific Computation*

Please see [www.pims.math.ca/science/2003/scicomp/](http://www.pims.math.ca/science/2003/scicomp/).



CRG on Scientific Computing group leaders (*clockwise from top left*): **Steve Ruuth** (CRG Coordinator, SFU), **Manfred Trummer** (SFU), **Chen Grief** (UBC), **Randy Leveque** (U. Washington), **Elena Braverman** (U. Calgary) and **Yanpin Lin** (U. Alberta).

## BIRS Workshops

Computational Fuel Cell Dynamics, 5-Day Workshop, April 19–24, 2003

Computational Techniques for Moving Interfaces, 5-Day Workshop, August 23–28, 2003

Mathematical Foundations of Scientific Visualization, Computer Graphics and Massive Data Exploration, 5-Day Workshop, May 22–27, 2004

## Members of the CRG

### PIMS PDFs of the CRG:

SFU: Jian-Jun Xu

UBC: Jianying Zhang

### Faculty of the CRG:

Coordinator: Steve Ruuth (SFU)

CRG Leaders: Elana Braverman (U. Calgary), Chen Grief (UBC), Randy Leveque (U. Washington), Yanpin Lin (U. Alberta), Steve Ruuth (SFU), Manfred Trummer (SFU)  
 SFU: R. Choksi, M.C. Kropinski, T. Möller, D. Muraki, K. Promislow, B. Russell, S. Ruuth, L. Trajkovic, M. Trummer, J. Verner, R. Zahar.

U. Alberta: Y. Lin, J. Macki, P. Minev, Y.S. Wong

UBC: U. Ascher, O. Dorn, S. Dunbar, I. Frigaard, A. Peirce, B. Seymour, B. Shizgal, J. Varah, M. Ward, B. Wetton, M. Yedlin

U. Calgary: T. Ware, R. Westbrook

U. Victoria: P. van den Driessche, D. Olesky

U. Washington: L. Adams, C. Bretherton, J. Burke, D. Durran, A. Greenbaum, G. Hakim, N. Kutz, R. LeVeque, R. O'Malley, P. Schmid  
 Ballard Corp: R. Bradean, J. Kenna  
 Boeing Corp: M. Epton, S. Filipowski, J. Lewis  
 Quadrus Financial Technologies: S. Reddy



Participants of the Computational Techniques for Moving Interfaces BIRS Workshop

The Scientific Computing CRG webpage is [www.pims.math.ca/CRG/scientific/](http://www.pims.math.ca/CRG/scientific/). Further information and a list of activities for 2004–05 may be found there.

## Number Theory

Number theory is one of the oldest, deepest and most vibrant branches of modern mathematics. It centrally incorporates some of the most sophisticated and profound mathematical ideas that have been developed (witness the recent proof of Fermat's Last Theorem) and yet remains broadly useful in many areas of pure and applied mathematics. Indeed, it is remarkable how often number theory comes to bear both in other areas of mathematics and in applications. A notable recent example is cryptography and internet security whose protocols are based on number theoretic problems.

Number theory is particularly strong in Canada with the PIMS Number Theory Group featuring prominently. The PIMS Number Theory Group is large and well distributed in the PIMS Universities. It has a number of prominent senior world-class researchers leading a group of richly talented young mathematicians. The recent influx of new number theorists into several PIMS universities has created an exciting working group.

All areas of Number Theory will be dealt with in this concentration period, including computational and arithmetic aspects.

### Scientific Activities 2003

#### 7th Annual PNW Number Theory Conference U. Washington, April 5–6, 2003

This conference was organized by **Ralph Greenberg** and **Joe Buhler** with support from the University of Washington Milliman Fund, the Number Theory Foundation, Reed College, and PIMS.

The speakers were:

**Michael Bennett** (UBC): *Perfect Powers from Progressions*

**Joe Buhler** (Reed College): *The Probability that a  $p$ -adic Polynomial Splits*

**Cheewhye Chin** (UC, Berkeley): *Lafforgue's Work on the Langland's Correspondence over Function Fields*

**Stephen Choi** (SFU): *Small Prime Solutions for Quadratic Equations with Five Variables*

**Henry Cohn** (Microsoft): *Horosphere Packings*

**Karl Rubin** (Stanford): *Kolyvagin Systems*

About 40 people attended the conference, including graduate students and faculty members from universities in the Pacific Northwest and as far as the University of Chicago. The lectures covered a diverse set of topics in number theory.

#### Mahler Measure of Polynomials Simon Fraser University, June 2–29, 2003

The PIMS summer program on *Mahler Measure* was funded by PIMS with support from Simon Fraser University. There were a total of 50 faculty members, postdoctoral fellows, graduate and undergraduate students from various universities and countries including Canada, US, France, Italy, Australia, Austria and Greece. The keynote speaker for this program was **Jeffrey Vaaler**, a PIMS Distinguished Chair visiting Simon Fraser University. Before his lectures series, there was a short graduate course, taught by **Stephen Choi** (SFU) and **Mike Mossinghoff** (Davidson College), serving as a preparation for the lecture series and later talks in the program. **David Boyd** (UBC) gave two talks on *Multivariable Mahler measure*. The program ended with a workshop in the last week of June. In the workshop 18 speakers gave talks on different aspects of Mahler measure. A student session was also organized throughout the whole program to encourage graduate students to present current work to the participants. Almost all the participating students gave talks in this student session. Most of the slides and notes of the talks from this program are on the PIMS website <http://www.pims.math.ca/science/2003/mahler/>.

The Invited Speakers were:

**Iskander Aliev** (Technische U. Wien): *Decompositions of Integer Vectors and Some Related Problems*

**Arthur Baragar** (UNLV): *Vector Heights on Surfaces*

**Jason Bell** (U. Michigan): *Cohen-Macaulay Rings and Polynomials with Real Zeros*

**Marie José Bertin** (U. Paris, Pierre et Marie Curie): *Mahler's Measures of Calabi-Yau's Varieties: Examples*

**David Boyd** (UBC): *Explicit Formulas for Multivariable Mahler's Measure; Mahler's Measure and Hyperbolic Manifolds*

**Edward Dobrowolski** (The College of New Caledonia)

**Tamas Erdelyi** (Texas A & M)

**Lenny Fukshansky** (U. Texas, Austin): *Small Zeros of Quadratic Forms with Linear Conditions*

**Kevin Hare** (UC, Berkeley): *Gaps in the Spectra of Pisot Numbers*

**Angel Kumchev** (U.T, Austin): *On Waring-Goldbach Problem*

**Matilde Lalin** (U. Texas, Austin): *Examples of Mahler Measures as Special Values of the Riemann Zeta Function and L-Series*

**Friedrich Littmann** (UIUC, UBC, SFU): *Entire Extremal Majorants*

**Michael Mossinghoff** (Davidson College): *Computational Aspects of Problems on Mahler's Measure; Mahler's Measure of Polynomials with Odd Coefficients*

**Nathan Ng** (U. Montréal): *Mean Values of L-functions*



Participants of the The Many Aspects of Mahler's Measure Workshop

**Clay Petsche** (U. Texas, Austin): *The Height of Algebraic Units in Local Fields, and Lehmer's Problem; The Quantitative Distribution of Galois Orbits of Small Height*

**Chris Pinner** (Kansas State U.): *Some Bounds for Complete Exponential Sums*

**Igor E. Pritsker** (Oklahoma State U.): *Gelfond-Schnirelman Method in Prime Number Theory*

**Georges Rhin** (U. Metz): *Integer Transfinite Diameter and Polynomials of Small Mahler Measure*

**Chris Sinclair** (U. Texas, Austin): *Heights of Polynomials, Asymptotic Estimates and the Mellin Transform; The Distribution of Mahler's Measures of Reciprocal Polynomials*

**Jeff Vaaler** (U. Texas, Austin): *Mahler's Measure and the Number of Irreducible Factors of a Polynomial, Mahler's Measure and the ABC Inequality, The Distribution of Values of Mahler's Measure, Estimates for the Number of Algebraic Numbers of Fixed Degree and Bounded Height*

**Carlo Viola** (U. Pisa): *Birational Transformations and the Arithmetic of Euler's Integrals*

**Qiang Wu** (U. Metz): *An Effective Algorithm to Compute the Integer Transfinite Diameter and Some Applications*

### Jeffrey Vaaler, PIMS Distinguished Chair, SFU

**Jeffrey Vaaler** (University of Texas, Austin) was a PIMS Distinguished Chair at Simon Fraser University in June 2003. His four talks were part of the *Mahler Measure of Polynomials Conference*. Vaaler's lecture series was videotaped and will be put on the PIMS website in the near future.

### PIMS Number Theory Day SFU Harbour Centre, December 5, 2003

This meeting is being organized by Michael Bennett (UBC), Peter Borwein (SFU), David Boyd (UBC), Imin

Chen (SFU) and Stephen Choi (SFU).

The Invited Speakers are **Valentin Blomer** (Toronto), **Alina Cojocaru** (Princeton), **Benjamin Green** (PIMS), **Friedrich Littmann** (PIMS), **Nathan Ng** (Montreal), **Robert Osburn** (Queen's U.) and **Christopher Rowe** (PIMS).

### BIRS Workshops

The Many Aspects of Mahler's Measure, 5-Day Workshop, April 26–May 01, 2003

Current Trends in Arithmetic Geometry and Number Theory, 5-Day Workshop, August 16–21, 2003

Explicit Methods in Number Theory, 5-Day Workshop, November 13–18, 2004

Diophantine Approximation and Analytic Number Theory, 5-Day Workshop, November 20–25, 2004

### Members of the CRG

#### PIMS PDFs of the CRG:

SFU: Ron Ferguson, William Galway, Alexa van der Waall  
UBC: Ben Green, Friedrich Littman, Christopher Rowe

#### Faculty of the CRG:

Group Leaders: Peter Borwein (SFU), David Boyd (UBC)  
SFU: I. Chen, S. Choi, P. Lisonek  
U. Alberta: J. D. Lewis  
U. Calgary: R. Guy, J. P. Jones, R. Mollin, R. Scheidler, H. Williams  
UBC: M. Bennett, W. Casselman, R. Gupta, I. Laba, G. Martin, N. Vatsal  
U. Washington: R. Greenberg, A. Iovita, N. Koblitz, B. Solomyak  
Other institutions: A. Akbary (U. Lethbridge), E. Dobrowolski (College of New Caledonia), M. Klassen (DigiPen Inst. Tech.), K. Lauter (Microsoft)



Peter Borwein (SFU), co-leader of the CRG on Number Theory



David Boyd (UBC), co-leader of the CRG on Number Theory

The Number Theory webpage is at [www.pims.math.ca/CRG/number/](http://www.pims.math.ca/CRG/number/). Further information and a preliminary list of activities for 2004–05 may be found there.

## Mathematical Ecology and Evolution

As the current revolution in biological information progresses, there is a well recognized need for new quantitative approaches and methods to solve problems in ecology. One challenge is to model complex ecological systems—systems which depend upon a myriad of inputs, but often with incomplete details regarding the inputs.

The primary goal of this period of concentration is to develop and strengthen the synergistic interactions between mathematics and ecology in PIMS universities.

Areas of mathematical ecology research at PIMS universities include: nonlinear population dynamics, spatially structured populations, adaptive dynamics, model selection and validation and inverse methods, stochastic models for populations, and scaling laws—from individuals to populations.

### Scientific Activities 2003

#### 2<sup>nd</sup> Annual PIMS Mathematical Biology Summer Workshop University of Alberta, April 30–May 9, 2003

The Centre for Mathematical Biology (CMB), University of Alberta, hosted its 2<sup>nd</sup> Annual PIMS Mathematical Biology Summer Workshop entitled *Mathematics of Biological Systems*. The aim of this 10-day workshop was to introduce undergraduate mathematics students to mathematical modeling and analysis applied to real biological systems.

The instructors were **Gerda de Vries**, **Thomas Hillen**, **Mark Lewis**, **Frithjof Lutscher** (all from the University of Alberta), and guest instructor **Pauline van den Driessche**



Participants of the 2<sup>nd</sup> Annual PIMS Mathematical Biology Workshop

(University of Victoria). There was further assistance provided by volunteer graduate students, postdoctoral fellows, and staff.

Twenty-two students came to the workshop from 14 different universities across Canada and the United States, many on their own funding. More than half of the attendees were women.

The workshop was 10 days in length and consisted of a combination of classroom instruction, computer lab sessions, pen and paper exercises, guided group project work, and project presentations. Communication between and among workshop participants and instructors was promoted through scheduled breaks and social events.

For the second consecutive year, the PIMS Mathematical Biology Summer Workshop received extremely positive feedback. Instructors are planning the 3<sup>rd</sup> Annual PIMS Workshop to be held May 4–14, 2004. The present structure of the workshop is very effective and requires little alteration. Instructors are also revising a book for publication that was used as the text for the present workshop and will be used for future workshops. This text is to be published by the Society for Industrial and Applied Mathematics.

#### Bryan Grenfell, PIMS Distinguished Chair

**Bryan Grenfell** of the University of Cambridge was the PIMS Distinguished Chair in Mathematical Ecology in September 2003. He gave five lectures with two at the University of Alberta, one overview lecture at UBC, and two more lectures at the University of Calgary. These lectures were videotaped and will be made available on the web.



Bryan Grenfell  
(U. Cambridge)

Notes from his talks will also be made available.

His talks were entitled:

- *Comparative dynamics of childhood microparasitic infections and the impact of vaccination*
- *Waves, sparks and wavelets: measles in space and time*
- *Childhood infections in space and time*
- *Dynamics and evolution of pathogens*
- *Dynamics and control of foot and mouth disease*

For more information please see [www.pims.math.ca/science/2003/distchair/grenfell/](http://www.pims.math.ca/science/2003/distchair/grenfell/).

From November 20 until December 13 **Brian Sleeman** (U. Leeds) will visit the University of Alberta as an Endowment Fund for the Future Distinguished Visitor. Brian is a world leading expert in applied mathematics, in particular the mathematical modelling of angiogenesis in tumor growth. He gives a series of four lectures in Edmonton, one talk in Calgary, and one in Saskatoon.

In November 2003 **Pauline van den Driessche** (U. Victoria) is visiting the Centre for Math Biology at U. Alberta. She will be doing research with PIMS PDF **Joanna Renclawowicz**.

### BIRS Workshops

Mathematical Biology: From molecules to ecosystems; The legacy of Lee Segel, 5-day Workshop, July 5–10, 2003

Mathematical Models for Plant Dispersal, Focused Research Group, September 20–October 2, 2003

Retreat on Mathematical Ecology and Evolution, 2-day Workshop, March 18–20, 2004

Mathematical Models for Biological Invasions, 5-day Workshop, November 27–December 2, 2004



Clockwise from top left: Co-organizers of the Math Ecology and Evolution CRG Michael Doebeli (UBC), Mark Lewis (U. Alberta), Edward McCauley (U. Calgary), and CRG Coordinator Thomas Hillen (U. Alberta)

### Members of the CRG

#### PIMS PDFs of the CRG:

U. Alberta & U. Calgary: Frithjof Lutschern

U. Alberta & U. Victoria: Joanna Renclawowicz

#### Faculty of the CRG:

Coordinator: Thomas Hillen (U. Alberta)

Co-organizers: Michael Doebeli (UBC), Mark Lewis (U. Alberta), Edward McCauley (U. Calgary)

SFU: E. Palsson, B. Roitberg

U. Alberta: M. Boyce, H. Freedman, S. Lele, M. Li, J. Roland, J. So

UBC: F. Brauer, L. Keshet, D. Schluter

U. Calgary: S. Richards

U. Victoria: P. van den Driessche

U. Washington: J. Anderson, C. Bergstrom, D. Grunbaum, R. Hilborne, M. Kot



Participants of The legacy of Lee Segel Workshop at BIRS

The webpage for this CRG is at [www.pims.math.ca/CRG/ecology/](http://www.pims.math.ca/CRG/ecology/). Further information and a list of activities for 2004–05 may be found there.

## Dynamics and Related Topics

The study of dynamical systems has had a long and distinguished history in mathematics. This study has ranged from applications involving differential equations and information theory, to more theoretical work focusing on systems with topological or algebraic structure. In the past few decades this field has grown dramatically, and completely new directions have opened up.

Due to the diversity of the researchers in this CRG a wide range of topics will be covered including operator algebras, the dynamics of biological systems, and aperiodic order theory.

### Scientific Activities 2002

#### Aperiodic Order, Dynamical Systems, Operator Algebras and Topology University of Victoria, August 4–8, 2002

This workshop was devoted to recent developments in the area of aperiodic tilings and quasi-crystals. In particular, the participants discussed contributions from diverse fields such as operator algebras, topology, K-theory and foliated spaces, as well as ergodic theory and diffraction. The number of talks was limited so as to allow informal discussion.

It was organized by **Jean Bellissard** (U. Toulouse), **Johannes Kellendonk** (U. Cardiff) and **Ian Putnam** (U. Victoria).

The speakers were:

**Michael Baake** (U. Greifswald): *Mathematical Diffraction Theory and Model Sets*

**Marcy Barge** (Montana State U.): *The Topology of One-dimensional Tiling Spaces*

**Laurent Bartholdi** (UC, Berkeley): *Tilings and Groupoids Acting on Rooted Trees*

**Bob Burton** (Oregon State U.): *Dynamic Systems with Evenly Spread Out Orbits*

**Claire Anantharaman-Delaroche** (U. Orléans): *Amenable Groupoids. Examples and Applications*

**Thierry Fack** (U. Lyons I): *Introduction to Cyclic Cohomology*

**Franz Gähler** (ITAP U. Stuttgart): *Cohomology of Quasiperiodic Tilings*

**Franz Gähler** (ITAP U. Stuttgart): *Modelling Aperiodic*

*Solids: Concepts and Properties of Tiling and their Physical Interpretation*

**Jean-Marc Gambaudo** (U. Bourgogne, Dijon): *Delone Sets, Tilings and Solenoids: from Finitetranslation Type to Finite Isometry Type*

**Thierry Giordano** (U. Ottawa): *Affable Equivalence Relations and Orbit Structure of Cantor Minimal Systems*

**Chaim Goodman-Strauss** (U. Arkansas): *Triangle Tilings and Regular Productions*

**John Hunton** (U. Leicester): *New Models and Methods for Tiling Spaces*

**Jerry Kaminker** (IUPUI): *Index Theory on Foliated Spaces and Applications*

**Alex Kumjian** (U. Nevada, Reno): *Actions of  $Z^k$  Associated to Higher Rank Graphs*

**Daniel Lanz** (TU-Chemnitz): *Uniform Ergodic Theorems on Delone Dynamical Systems and Applications*

**Jeong-Yup Lee** (U. Alberta): *Consequences of Pure Point Diffraction Spectra for Discrete Point Sets*

**N. Christopher Phillips** (U. Oregon): *The Structure of the  $C^*$ -algebras of Free Minimal Actions of  $Z^d$  on the Cantor Set*

**Charles Radin** (U. Texas, Austin): *Aperiodicity: Lessons from Various Generalizations*

**Lorenzo Sadun** (U. Texas, Austin): *When Size Matters: the Effect of Geometry on 1-D Tiling Dynamics*

**Klaus Schmidt** (U. Vienna): *Shifts of Finite Type, Wang Tilings and Fundamental Cocycles*

**Claude Schochet** (Wayne State U.): *Life After K-theory*

**Robert Williams** (U. Texas, Austin): *Tiling Spaces as Cantor Set Fiber Bundles*

#### Alexander Helemskii, PIMS Distinguished Chair, University of Alberta

The 2003 holder of the PIMS Distinguished Chair in Dynamics at the University of Alberta was Alexander Ya Helemskii of Moscow State University. He arrived in Edmonton on July 11 and stayed till August 13. Besides giving a series of four lectures as PIMS Distinguished Chair, he participated in the 16<sup>th</sup> International Conference on Banach Algebras (Banach Algebras and their Applications, July 27 to August 9—another PIMS sponsored event), where he chaired a workshop on his speciality: topological homology.

His lecture notes may be downloaded from [www.pims.math.ca/publications/distchair/](http://www.pims.math.ca/publications/distchair/).

**BIRS Workshops**

Northwest Functional Analysis Symposium, 2-Day Workshop, March 27–29, 2003

Coordinate Methods in Nonselfadjoint Operator Algebras, 5-Day Workshop, December 13–18, 2003

Aperiodic Order: Dynamical Systems, Combinatorics, and Operators, 5-Day Workshop, May 29–June 3, 2004

**Members of the CRG****Faculty of the CRG:**

Group Leaders: Douglas Lind (U. Washington), Ian Putnam (U. Victoria)

U. Alberta: A. Lau, R. Moody, V. Runde, A. Weiss

U. Calgary: B. Brenken, M. Lamoureux, I. Nikolaev

U. Victoria: C. Bose, R. Edwards, M. Laca, J. Phillips

U. Washington: M. Einsiedler, C. Hoffman, D. Lind, S. Rohde, B. Solomyak, S. Tuncel

Visitors and other contributors: M. Boyle (Maryland), C. Denninger (Muenster), W. Parry (Warwick), D. Rudolph (Maryland), K. Schmidt (Vienna)

The Dynamics & Related Topics webpage is at [www.pims.math.ca/CRG/dynamics/](http://www.pims.math.ca/CRG/dynamics/). Further information and a preliminary list of activities for 2004–05 may be found there.



Ian Putnam (U. Victoria), co-leader of the CRG on Dynamics and Related Topics



Douglas Lind (U. Washington), co-leader of the CRG on Dynamics and Related Topics

**Upcoming Areas of Concentration: 2004–06****Topology and Knot Theory**

The PIMS community has an active group of researchers in topology and related fields. Their research may be roughly divided into two major themes: geometric and algebraic. Among the geometric issues being studied by PIMS topologists are the classification of manifolds (particularly in dimension 3 and 4), group actions on Riemann surfaces, knot theory and its applications, and relating 3-manifold topology to relativity theory. A sample of the contributions in algebraic topology are: application of algebraic topology to robotics, developing equivariant minimal models in homotopy theory, applying subtle algebraic properties of projective spaces and bundles to solve classical problems in quadratic forms and combinatorics. Because of their geographic separation and diversity of interests, this community of scientists is particularly well-served by forming a collaborative research group.

**BIRS Workshops**

Topology of Manifolds and Homotopy Theory, 5-day Workshop, March 19–24, 2004

Knots and their Manifold Stories, 5-day Workshop, May 7–12, 2004

Braid Groups and Applications, 5-day Workshop, October 15–20, 2004

Cascade Topology Seminar, 2-day Workshop, 2004

**Members of the CRG****Faculty of the CRG:**

Group Leaders: George Peschke (U. Alberta), Dale Rolfsen (UBC), Laura Scull (UBC), Peter Zvengrowski (U. Calgary)

U. Alberta: J. Timourian

UBC: J. Bryan, K. Lam, D. Sjerve

U. Calgary: K. Varadarajan

U. Washington: E. Babson, E. Devinatz, M. Freedman, S. Mitchell, J. Palmieri, J. Segal

The Topology & Knot Theory CRG webpage is at [www.pims.math.ca/CRG/topology/](http://www.pims.math.ca/CRG/topology/).



Clockwise from top left: George Peschke (U. Alberta), Dale Rolfsen (UBC), Laura Scull (UBC), and Peter Zvengrowski (U. Calgary), the group leaders of the CRG on Topology and Knot

## Probability and Statistical Mechanics

Much of the original motivation for the study of spatially interactive stochastic systems came from stochastic models in statistical physics. An intensive area of recent research centers around the idea that complex local dynamics can lead to a small number of well-understood continuum models upon space-time rescaling. When the underlying system is at or near criticality the limit invariably seems to be closely related to super-Brownian motion.

Other local interactions arising in models for competing species, predator-prey systems or symbiotic branching lead to more complex stochastic models which behave locally like superprocesses but with branching, migration and drift coefficients which depend on the current state of the system. Two challenging and related topics are therefore:

I. The development of a general theory of interactive superprocesses and in particular methods to characterize

## COLLABORATIVE RESEARCH GROUPS

these processes and study their properties.

II. The use of such models in mathematical ecology and evolution.

### BIRS Workshops

BIRS Workshop on Statistical Mechanics of Polymer Models, May 10–15, 2003 at BIRS

BIRS Workshop on Stochastic Partial Differential Equations, September 27–October 2, 2003 at BIRS.

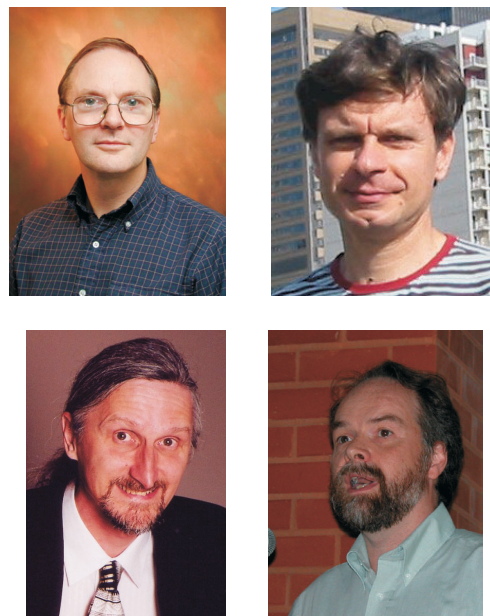
BIRS Workshop on Analytic and Geometric Aspects of Stochastic Processes, April 10–15, 2004 at BIRS.

Stability and Computations for Stochastic Differential Delay Equations, Research in Teams, July 24–August 7, 2004, BIRS

Participants: **Salah Mohammed** (Southern Illinois University), **Evelyn Buckwar** (Humboldt University), **Tony Shardlow** (Manchester), **Rachel Kuske** (UBC)

Competing Species and Predator-Prey Stochastic Models, Research in Teams, August 2004, BIRS

Participants: **Rick Durrett** (Cornell U.), **Leonid Mytnik** (Technion), **Ed Perkins** (UBC)



Clockwise from top left: David Brydges (UBC), Chris Burdzy (U. Washington), Ed Perkins (UBC), and Byron Schmuland (U. Alberta), group leaders of the CRG on Probability and Statistical Mechanics.



## Members of the CRG

### Faculty of the CRG:

Group Leaders: David Brydges (UBC),  
Chris Burdzy (U. Washington), Ed  
Perkins (UBC), Byron Schmuland  
(U. Alberta)

U. Alberta: M. Kouritzin

UBC: M. Barlow, J. Feldman,  
A. Holroyd, V. Limic, G. Slade, J. Walsh

U. Saskatchewan: C. Soteris,  
R. Srinivasan

U. Washington: Z.-Q. Chen, B. Erickson,  
C. Hoffman, L. Korf, S. Rohde

Microsoft Research: C. Borgs, J. Chayes,  
O. Schramm, D. Wilson

Other Institutions: D. Dawson (McGill),  
R. van der Hofstad (Eindhoven)



Participants of the BIRS Workshop on Statistical Mechanics of Polymer Models

The Probability & Statistical Mechanics

CRG webpage is at [www.pims.math.ca/CRG/probability/](http://www.pims.math.ca/CRG/probability/).

Further information and a preliminary list of activities for  
2004–05 may be found there.



## II. THEMATIC PROGRAMMES



**The Asymptotic Geometric Analysis Thematic Programme** organising committee: Vitali Milman (Tel Aviv), Nicole Tomczak-Jaegermann (University of Alberta) and Gideon Schechtman (Weizmann Institute). Missing from photo Nassif Ghoussoub (PIMS and UBC) and Robert McCann (University of Toronto).

Participants of the **PASI on PDEs, Inverse Problems and Non-linear Analysis** in Chile. The PASI was part of the **2003 PIMS Thematic Programme on Inverse Problems and Applications**.



## Theme 2002 (A): Asymptotic Geometric Analysis

*Asymptotic Geometric Analysis* is concerned with the geometric and linear properties of finite-dimensional convex bodies, especially with the asymptotics of various quantitative parameters as the dimension of the underlying space tends to infinity. The techniques here combine geometric, analytic, probabilistic and combinatorial methods. The main directions of study are:

- *Convex Geometric Analysis* including problems from Classical Convexity and Isomorphic Geometry.
- *Asymptotic Combinatorics* including questions in Complexity Theory and Computational Geometry.
- Certain aspects of *Statistical Physics* that deal with “Threshold” and “Phase Transition” phenomena.

The main probabilistic tools used are deviation inequalities and the concept of concentration of measure phenomenon, which in fact is an isomorphic form of isoperimetric type inequalities. Measure Transport methods and related PDEs have provided new and powerful Geometric Inequalities of Brunn-Minkowski and Brascamp-Lieb type as well as novel approaches to Log-Sobolev and Talagrand-type inequalities. The subject is also connected with quantized functional analysis via important estimates for the distribution of eigenvalues and norms of random matrices, as well as with some aspects of free and quantum information theories, operator spaces and non-commutative  $L_p$  spaces.

### Scientific Committee:

**Vitali Milman** (Co-chair, Tel Aviv)  
**Nicole Tomczak-Jaegermann** (Co-chair, U. Alberta)  
**Nassif Ghoussoub** (PIMS and UBC)  
**Robert McCann** (University of Toronto)  
**Gideon Schechtman** (Weizmann Institute)

### Programme:

**Conference on Convexity and Asymptotic Theory of Normed Spaces,**

PIMS-UBC, July 1–5, 2002

**Concentration Period on Measure Transportation and Geometric Inequalities,**

PIMS-UBC, July 8–12, 2002

**Conference on Phenomena of Large Dimension,**

PIMS-UBC, July 14–23, 2002

**Focused Research Groups on Random Methods and High Dimensional Systems,**

PIMS-UBC, July 24–August 5, 2002

**Conference on Non-commutative Phenomena and Random Matrices,**

PIMS-UBC, August 6–9, 2002

**Conference on Banach Spaces,**

PIMS-UBC, August 12–15, 2002

The goal of this thematic programme is to bring together some areas of Mathematics and Computer Science which are dealing with asymptotic behaviour of different parameters when the dimension, or a number of other relevant free parameters, increases to infinity .

Asymptotic geometric analysis is concerned with the geometric and linear properties of finite-dimensional convex bodies, especially with the asymptotics of various quantitative parameters as the dimension of the underlying space tends to infinity. This field is multidisciplinary in nature, typically combining geometric, analytic, probabilistic and combinatorial methods.



Fields medalist  
Jean Bourgain (IAS)

This Thematic Programme brought together over 220 senior experts, young researchers, post-docs and advanced Ph.D. students from mathematics and computer science. Represented among the programme of speakers were laureates of many different honours and prizes, such as the Fields Medal, Nevanlinna Prize, Wolf Prize, Salem Prize, Ostrowski Prize, and many others. The flavour of the Workshop may be felt

from the following examples of speakers and directions (in broad categories and listed in every group alphabetically). Many more talks in every direction were, in fact, given.

One-hundred and ten of the lectures in the programme were taped and are available in both streaming realvideo and MP3 format. This provided an online resource to conference participants, by allowing them to review previous lectures throughout the programme. To provide a resource to the mathematics community at large, we have now made entire collection of taped lectures available from the main Thematic Programme web page given above and from the PIMS online lecture archive, <http://www.pims.math.ca/video>.

For the complete list of participants and lectures please see the Thematic Programme web page, <http://www.pims.math.ca/aga>.

The main directions of study were convex geometric analysis (asymptotic theory of convex bodies and normed spaces), some problems of discrete mathematics (one may call it asymptotic combinatorics) including problems of complexity theory, and some problems of statistical physics. A number of lectures were also given on closely connected subjects in probability and nonlinear PDEs arising in convex analysis and geometric inequalities.

The programme was strongly connected thematically with many of the lectures illustrating the crossover between these fields. Most of the participants took advantage of this by attending a number of the sessions in the programme.

Additional support for this Thematic Programme was provided by the CRC grant of Nicole Tomczak-Jaegermann, by the NSF conference grants of Erwin Lutwak and Ted Odell, and by Microsoft.

## Conference on Convexity and Asymptotic Theory of Normed Spaces PIMS-UBC, July 1–5, 2002

**Organizers:** Erwin Lutwak (Warsaw) and Alain Pajor (Marne-La-Vallée)

The programme opened with the Conference on Convexity and Asymptotic Theory of Normed Spaces. Lasting one week, from July 1–5, this conference featured lectures on classical convexity theory, Radon transforms and Fourier methods in convexity, asymptotic theory of high dimensional convex bodies, geometric functional inequalities, probabilistic methods in Convexity, and isoperimetric-type inequalities.

The following lectures in the conference were taped and are available from <http://www.pims.math.ca/video>:

**Keith Ball** (U. College London): *Convolution Inequalities in Convex Geometry*

**Mohammad Ghomi** (U. South Carolina): *A Survey of Some Recent Convexity Results and Problems in Classical Differential Geometry*

**Peter Gruber** (Technische U.): *Optimal Quantization*

**Erwin Lutwak** (Polytechnic U.):  *$L_p$ -curvature*

**Vitali Milman** (Tel Aviv): *Are Randomizing Properties of any Two Convex Bodies Similar?*

**Gideon Schechtman** (The Weizmann Institute): *Non Linear Type and Pisier's Inequality*

**Rolf Schneider** (U. Freiburg): *Mixture of Convex Bodies*



AGAs participants enjoying a reception at PIMS

## Concentration Period on Measure Transportation and Geometric Inequalities PIMS-UBC, July 8–12, 2002

Organizer: Robert McCann (U. Toronto)

The second week of the Thematic Programme was devoted to the Concentration Period on Measure Transportation and Geometric Inequalities. The focus was on transportation of measure methods and their applications, including concentration of measure phenomenon, geometric functional inequalities (Brascamp-Lieb, Sobolev, entropy, Cramer-Crao and the like), and probabilistic methods. This concentration period was organized with a slightly lighter lecture schedule to allow ample time for extensive informal discussions between lectures.

The following lectures were taped:

**Shiri Artstein** (Tel Aviv): *Entropy increases at every step*  
**Keith Ball** (U. College London): *Entropy growth for sums of IID random variables*

**Franck Barthe** (U. Marne-la-Vallée): *Optimal Measure Transportation\**

**Gordon Blower** (Lancaster): *Almost sure weak convergence and concentration for the circular ensembles of Dyson*

**Christer Borell** (Chalmers U.): *On risk aversion and optimal terminal wealth*

**Yann Brenier** (CNRS): *Density and current interpolation*

**Jose A. Carrillo** (U. de Granada): *Asymptotic behaviour of fast diffusion equations*

**Jochen Denzler** (U. Tennessee): *Fast Diffusion to self-similarity: complete spectrum, long-time asymptotics and numerology*

**Michel Ledoux** (U. Toulouse): *Measure Concentration, Transportation Cost, and Functional Inequalities*

**Robert McCann** (U. Toronto): *Nonlinear diffusion to self-similarity: spreading versus shape via gradient flow*

**Vitali Milman** (Tel Aviv): *Geometric inequalities of hyperbolic type*

**Assaf Naor** (Microsoft Corporation): *Entropy jumps in the presence of a spectral gap*

**Roland Speicher** (Queen's): *Free probability and free diffusion*

**Van Vu** (UC, San Diego): *Concentration of non-Lipschitz functions and combinatorial applications*

**Qinglan Xia** (Rice): *Optimal paths related to transport problems*

## Conference on Phenomena of Large Dimensions PIMS-UBC, July 14–23, 2002

Organizers: Vitali Milman (Tel Aviv), Michael Krivilevich, Laszlo Lovasz (Microsoft Research) and Leonid Pastur (U. Paris VII)

The main topics covered in the lectures were different phenomena observed in complexity theory, asymptotic combinatorics, asymptotic convexity, statistical physics and other theories of very high parametric families (or large dimensional spaces).

The following lectures were taped:

**Noga Alon** (Tel Aviv U.): *(n, d, λ)-graphs in Extremal Combinatorics*

**Imre Barany** (U. College London): *Sylvester's Question, Convex Bodies, Limit Shape*

**Franck Barthe** (U. de Marne la Vallee): *Transportation versus Rearrangement*

**Alexander Barvinok** (U. Michigan): *How to Compute a Norm?*

**Noam Berger** (UC, Berkeley): *Phase Transition for the Biased Random Walk on Percolation Clusters*

**Christian Borgs** (Microsoft Research): *Phase Transition in the Random Partitioning Problem*

**Jean Bourgain** (IAS): *New Results on Green's Functions and Spectra for Discrete Schroedinger Operators*

**Yann Brenier** (CNRS): *On Optimal Transportation Theory*

**Mei-Chu Chang** (UC, Riverside): *Recent Results in Combinatorial Number Theory*

**Jennifer Chayes** (Microsoft Research): *Graphical Models of the Internet and the Web*

**Marianna Csornyei** (U. College London): *Structure of null sets and related problems of geometric measure theory*

**Apostolos Giannopoulos** (Crete): *Random Sections and Random Rotations of High Dimensional Convex Bodies*

**Efim Gluskin** (Tel Aviv U.): *On the Sections of Product Spaces and Related Topics*

**Jeong Han Kim** (Microsoft Research): *The Poisson Cloning Model for Random Graphs with Applications to k-core Problems, Random 2-SAT, and Random Digraphs*

**Gil Kalai** (Hebrew U.): *Results and Problems around Borsuk's Conjecture*

**Ravindran Kannan** (Yale): *Random Submatrices of a Given Matrix*

**Yoshiharu Kohyakuwa** (U. San Paulo): *The Regularity Lemma for Sparse Graphs*

**Michael Krivelevich** (Tel Aviv U.): *Algorithmic Applications of Graph Eigenvalues and Related Parameters*

**Izabella Laba** (UBC): *Tiling Problems and Spectral Sets*

**Rafal Latała** (Warsaw U.): *Some Estimates of Norms of Random Matrices (non iid case)*

**Laszlo Lovasz** (Microsoft Research): *Discrete Analytic Functions and Global Information from Local Observation*

**Colin McDiarmid** (Oxford U.): *Concentration and Random Permutations*

**Vitali Milman** (Tel Aviv U.): *Some phenomena of large dimension in Convex Geometric Analysis*

**Assaf Naor** (Microsoft): *Metric Ramsey-Type Phenomena*

**Krzysztof Oleszkiewicz** (Warsaw U.): *On a Non-symmetric Version of the Khinchine-Kahane Inequality*

**Leonid Pastur** (U. Pierre & Marie Curie): *Some Large Dimension Problems of Mathematical Physics*

**Bruce Reed** (McGill U.): *Crayola and Dice: Graph Colouring via the Probabilistic Method*

**Andrzej Rucinski** (Adam Mickiewicz U.): *Ramsey Properties of Random Structures*

**Mark Rudelson** (U. Missouri): *Distances between Sections of Convex Bodies*

**Shmuel Safra** (Tel Aviv U.): *Probabilistically Checkable Proofs (PCP) and Hardness of Approximation*

**Gideon Schechtman** (The Weizmann Institute):  $l_p^n$ ,  $1 < p < 2$ , well embed in  $l_1^{an}$ , for any  $a > 1$

**Miklos Simonovits** (Hungarian Academy of Science): *Introduction to the Szemerédi Regularity Lemma*

**Gordon Slade** (UBC): *The Percolation Phase Transition on the  $n$ -cube*

**Mikhail Sodin** (Tel Aviv U.): *Zeros of Random Analytic Functions*

**Alexander Soshnikov** (UC, Davis): *On the Largest Eigenvalue of a Random Subgraph of the Hypercube*

**Benjamin Sudakov** (Princeton U.): *On the Ramsey- and Turan-type Problems*

**Stanislaw Szarek** (U. Paris VI): *On Pseudorandom Matrices*

**Nicole Tomczak-Jaegermann** (U. Alberta): *Families of Random Sections of Convex Bodies*

**Van Vu** (UC, San Diego): *Divide and Conquer Martin-gales and Thin Waring Bases*

**Avi Wigderson** (IAS): *Expander Graphs - where Combinatorics and Algebra Compete and Cooperate*

## Focused Research Groups on Random Methods and High Dimensional Systems PIMS-UBC, July 24–August 5, 2002

**Organizers:** Vitali Milman (Tel Aviv) and Nicole Tomczak-Jaegermann (U. Alberta)

Participants took advantage of this period to discuss previous lectures in the programme and to work in new directions. Furthermore, Gideon Schechtman (Weizmann Institute) and Alexander Litvak (U. Alberta) each organized an informal series of lectures during this period.

The following lectures were taped:

**Keith Ball** (U. College London): *There are infinitely many irrational values of the zeta function at the odd integers*

**Jean Bourgain** (IAS): *New Results on Green's Functions and Spectra for Discrete Schroedinger Operators*

**Yehoram Gordon** (Haifa): *Applications of zonoids to Asymptotic Geometric Analysis*

**Izabella Laba** (UBC): *The Kakeya conjecture (Parts 1, 2)*

**Rolf Schneider** (Freiburg): *Stability of uniqueness results for convex bodies*

**Rolf Schneider** (Freiburg): *Minkowski's existence theorem and some applications*

**Alexander Soshnikov** (Davis): *Random Matrices: Gaussian Unitary Ensemble and Beyond (Parts 1–3)*

## Conference on Non-commutative Phenomena and Random Matrices PIMS-UBC, August 6–9, 2002

**Organizers:** Gilles Pisier (U. Paris VI and Texas A & M) and Stanislaw Szarek (U. Paris VI and Case Western Reserve)

Topics addressed in this conference related to the distribution of eigenvalues of random matrices, norms of such matrices, some aspects of free and quantum information theories, quantized functional analysis and operator spaces, and non-commutative  $L_p$  spaces.

The following lectures were taped:

**David Blecher** (Houston): *Noncommutative  $M$ -structure and the interplay of algebra and norm for operator algebras*

**Edward Effros** (UCLA): *Operator spaces as “quantized” Banach spaces*

**Alexander Gamburg** (Stanford): *Random Matrices and Magic Squares*

**Kenley Jung** (Berkeley): *Free Entropy Dimension and Hyperfinite von Neumann algebras*

**Marius Junge** (Urbana): *The central limit procedure for noncommuting random variables and applications*

**Franz Lehner** (Graz): *A Good formula for noncommutative cumulants*

**Christian Le Merdy** (Besançon): *Holomorphic functional calculus and square functions on non-commutative  $L_p$ -spaces*

**Alexandru Nica** (Waterloo):  *$A_2$ -point functions for multi-matrix models, and non-crossing partitions in an annulus*

**Eric Ricard** (Paris 6): *Hilbertian Operator spaces with few completely bounded maps*

**Haskell Rosenthal** (Austin): *Can non-commutative  $L^p$  spaces be renormed to be stable?*

**Zhong Jin Ruan** (Urbana): *On Real Operator Spaces*

**Mary Beth Ruskai** (Lowell): *The Role of Maximal  $L_p$  Bounds in Quantum Information Theory*

**Alexander Soshnikov** (UC, Davis): *Determinantal Random Point Fields*

**Roland Speicher** (Queen's U., Kingston): *Maximization of free entropy*

**Quanhua Xu** (U. de Franche-Comté): *On the maximality of subdiagonal algebras*

## Conference on Banach Spaces PIMS-UBC, August 12–15, 2002

**Organizers:** Bill Johnson (Texas A & M) and Ted Odell (U. Texas, Austin)

The programme closed with the Conference on Banach Spaces. Unfortunately, personal circumstances required Bill Johnson to cancel his participation at the last minute and his presence was greatly missed. This conference focused on the asymptotic theory of Banach spaces and other applications of local theory to the geometry of infinite dimensional Banach spaces.

The following lectures were taped:

**George Androulakis** (U. South Carolina): *The method of minimal vectors*

**Yoav Benyamini** (Technion): *An introduction to the uniform classification of Banach spaces*

**Vassiliki Farmaki** (Athens U.): *Baire-1 functions and spreading models*

**Tadek Figiel** (Polish Academy of Sciences): *Selecting unconditional basic sequences*

**Mark Hoffman** (U. Missouri): *The Banach envelope of Paley-Wiener type spaces  $E_p$  for  $0 < p < 1$*

**Alexander Koldobsky** (U. Missouri-Columbia): *Fourier analytic tools in the study of sections and projections of convex bodies*

**Tamara Kuchurenko** (U. Missouri): *Weak topologies and properties that are fulfilled almost everywhere*

**Joram Lindenstrauss** (Hebrew U.): *On Frechet differentiability of Lipschitz functions, parts I and II*

**Narcisse Randrianantoanina** (Miami U.): *Weak type inequalities for non-commutative martingales*

**Thomas Schlumprecht** (Texas A & M U.): *How many operators do there exist on a Banach space?*

**Lior Tzafriri** (Hebrew U.):  *$\lambda_p$  sets for some orthogonal systems*

**Vaclav Zizler** (U. Alberta): *Sigma shrinking Markushevich bases and Corson compacts*



## Theme 2002 (B): Selected Topics in Mathematical and Industrial Statistics

Statistical models became, in the late 20th century extremely complex and high dimensional. One goal is to identify opportunities and challenges for model development and criticism and to begin to outline approaches to assessment of complex models. This requires bringing together leading practitioners and philosophers of scientific, Bayesian and frequentist modelling statistics with leading researchers in model assessment, validation and goodness-of-fit.

*Robust Statistics* and Statistical Computing deal with methods designed for processing large data sets of uneven quality, such as databases with outliers, gross errors or missing data. One focus is on the efficient computation of robust estimates using very large data sets.

*Design and Analysis of Experiments* are at the heart of the statistical sciences. Yet—unlike the designs originating from agricultural problems developed by Sir Ronald Fisher in the 1920's—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.

### Programme Organizers:

**Charmaine Dean** (SFU)  
**Peter Guttorp** (U. Washington)  
**Chris Field** (Dalhousie)  
**R. H. Zamar** (UBC)  
**Randy Sitter** (SFU)  
**Agnes Herzberg** (Queen's)

### Programme:

**International Conference on Robust Statistics**  
 UBC, May 12–18, 2002

**3rd MITACS Annual General Meeting: Statistics for Large Scale Industrial Modelling**  
 UBC, Vancouver, May 23–25, 2002

**Design and Analysis of Experiments**  
 Vancouver, July 14–18, 2002

**PIMS-MITACS Workshop on Filtering Theory and Applications**  
 Edmonton and Jasper, July 25–30, 2002

## International Conference on Robust Statistics (ICORS 2002) UBC, May 12–18, 2002

**Organizers:** Luisa Fernholz (Temple U.), Ursula Gather (Dortmund), Chris Field (Dalhousie) and R. H. Zamar (UBC)

This conference was a forum for new developments and applications of robust statistics and statistical computing. Experienced researchers and practitioners, as well as younger researchers, came together to exchange knowledge and to build scientific contacts.

The conference touched upon many different aspects of data analysis in a fashion which integrates theoretical and applied statistics. One focus was the efficient computation of robust estimates using very large data sets.

Nearly 100 researchers from 10 different countries participated in ICORS 2002, which was hosted by PIMS and jointly sponsored by PIMS, MINERVA Research Foundation (USA) and SBF 475 at University of Dortmund (Germany).

ICORS 2002 was then followed up by a weekend Workshop on Computational Robustness hosted by PIMS and cosponsored by NSF.

The videos of the following lectures are available from <http://www.pims.math.ca/icors2002/>.

**Claudia Becker** (U. Dortmund): *Dimension Reduction and Nonparametric Regression: A Robust Combination*

**Tadeusz Bednarski** (U. Zielona Gora): *Robust Inference for the Cox Model*



The organizers of ICORS: Chris Field (Dalhousie), Luisa Fernholz (Temple U.) and R. H. Zamar (UBC). Missing from photo: Ursula Gather (Dortmund).

**Graciela Boente** (U. Buenos Aires): *Robust Estimators in Partly Linear Models*

**David Brillinger** (UC, Berkeley): *John Tukey and “Troubled” Time Series Data*

**Christophe Croux** (U. Leuven): *On the Bianco-Yohai Estimator for High Breakdown Logistic Regression*

**Laurie Davies** (U. Essen): *Breakdown and Groups*

**Peter Filzmoser** (Vienna Tech): *Robust Factor Analysis*

**Xuming He** (U. Illinois at Urbana-Champaign): *Straight Talks about Robust Methods*

**Karen Kafadar** (U. Colorado): *Statistical Analysis of Microarray Data from Affymetrix Gene Chips*

**Ricardo Maronna** (U. Nacional de La Plata): *Approaches to Robust Multivariate Estimation Based on Projections*

**Doug Martin** (U. Washington and Insightful): *Robust Statistics in Portfolio Optimization*

**Stephan Morgenthaler** (Ecole Polytechnique Fédérale de Lausanne): *The Multihalver*

**Raymond Ng** (UBC): *Robust Space Transformations for Distance-based Outliers*

**David Rocke** (UC, Davis): *Multivariate Outlier Detection and Cluster Identification*

**Elvezio Ronchetti** (U. Geneva): *Resistant Parametric and Nonparametric Modelling in Finance*

**Peter Rousseeuw** (U. Antwerp): *Robustness Against Separation and Outliers in Binary Regression*



International Conference on Robust Statistics (ICORS 2002) participants during their excursion to Capilano. ICORS was part of the 2002 Thematic Programme on Selected Topics in Mathematical and Industrial Statistics.

**Matias Salibian-Barrera** (Carleton U.): *Estimating the  $p$ -values of Robust Tests for the Linear Model*

**Arnold J. Stromberg** (U. Kentucky): *Computational Issues in Robust Statistics*

**David Tyler** (Rutgers U.): *High Breakdown Point Multivariate  $M$ -Estimation*

**Jane-Ling Wang** (UC, Davis): *Semiparametric Random Effects Models for Longitudinal Data*

**Doug Wiens** (U. Alberta): *Robust, Sequential Design Strategies*

**Victor Yohai** (U. Buenos Aires): *High Breakdown Point Robust Regression with Censored Data*

**Julie Zhou** (U. Victoria): *Robustness Issues for Confidence Intervals*

### 3rd MITACS Annual General Meeting: Statistics for Large Scale Industrial Modelling, UBC, May 23–25, 2002

**Organisers:** Arvind Gupta (MITACS), Nassif Ghossoub (PIMS), Ken Davidson (Fields Institute) and Jacques Hurtubise (CRM).

The 3rd MITACS Annual General Meeting brought together over 350 students, researchers and industrial representatives from across Canada and the United States. The participants enjoyed a range of activities that included lectures, a poster and demo exhibition and competition, administrative meetings and social gatherings.



The plenary speakers at MITACS AGM, clockwise from top left: Ron Graham (UC, San Diego), Anil Jain (Michigan State), Gilbert Strang (MIT)

The AGM Exhibition commenced on Thursday morning, when students and post-docs began mounting over 70 posters and demos. Eight posters earned prizes, which consisted of plaques and cash awards. Three companies generously sponsored the first place prizes: Object Technology International, Inc.; StemCell Technologies Inc.; and Alcatel.

Indira Samarasekera (VP Research, UBC) gave the opening address of the welcoming reception at UBC's Museum of Anthropology. The conference banquet had in attendance Arthur Carty (President, NRC) and Philippe Tondeur (Director, Division of Mathematical Sciences, NSF). Both Carty and Tondeur gave talks that emphasized the importance of mathematical research to society at large.

The plenary speakers were:

**Ron Graham** (UC, San Diego): *Guessing Secrets*

**Anil Jain** (Michigan State): *Fingerprint Matching*

**Gilbert Strang** (MIT): *Filtering and Signal Processing*

### Design and Analysis of Experiments, Coast Plaza Suites Hotel, Vancouver, July 14–18, 2002

**Organizers:** 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 followup 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.

The purpose of the PIMS Workshop on Design and Analysis of Experiments (DAE 1) was to begin a series of workshops to provide support and encouragement to junior researchers in the field of design and analysis of experiments, and to stimulate interest in topics of practical relevance to science and industry. In the summer of 2000, researchers from North America and abroad in the area of experimental design, including a large group of young talented new researchers, attended the First Midwest Conference for New Directions in Experimental Design in Columbus, Ohio organized by Angela Dean at Ohio State University, Kathryn Chaloner at the University of Minnesota, Dibyen Majumdar at the University of Illinois Chicago and Dennis Lin at Penn State University. This workshop had a focus on applications of design in industry and was well received. It was sponsored by the National Science Foundation, the Ohio State University and Executive Jet Corp with a small award from Stat-Ease. A discussion group reached consensus that a series of similar workshops should be held every 2 or 3 years at different locations in North America. DAE 1 is the first workshop in this series in Canada. The bulk of its sponsorship came from PIMS with an additional contribution from Graduate Studies at SFU.

The next workshop in the series is being organized by Angela Dean, Kathryn Chaloner and Dibyen Majumdar and will be held in Chicago in 2003 (New Directions in Experimental Design, DAE2003, May 15-18, Chicago), with focus on medical applications. There was a roundtable discussion during the DAE 1 workshop in Vancouver to discuss general future structure and to determine interest among volunteers to host and organize the next in the series, following Chicago. This resulted in a commitment from researchers at Los Alamos National Laboratories to host DAE 3 in 2005 in Sante Fae, NM. Thus the PIMS support for this initial endeavour appears to have achieved its goal. An infrastructure and framework was established for a continuing such series at locations throughout North America to be held about every 2 years.

The DAE 1 workshop itself was a huge success. The invited speakers, the invited poster presenters and the attendees represented precisely the cross-section of young junior researchers and experienced world leaders in areas of both design and analysis of experiments that was hoped for. Visitors travelled from various sites in Canada and the US, as well as from Belgium, Sweden, Germany, the Netherlands, Italy, the United Kingdom, New Zealand and Taiwan; and represented both academia and industry. The talks and posters included such wide-ranging topics as Computer Intensive Methods for Design Selection, De-

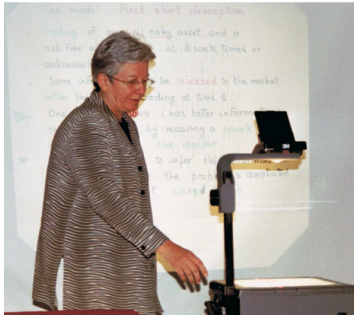
sign of Experiments in Bioinformatics, Drug Discovery and Marketing, Mathematical Theory of Design Construction and Bayesian Analysis of Designed Experiments, and represented leading research in these areas.

The Invited Speakers were:

**Sabyasachi Basu** (Boeing)  
**Scott Beattie** (Eli Lilly)  
**Ching-Shui Cheng** (UC Berkeley)  
**Shaowei Cheng** (Academia Sinica, Taiwan)  
**Abdel El-Shawaari** (National Water Research Institute)  
**Valeri Fedorov** (Smith Kline)  
**Paul Green** (Wharton School, Penn State)  
**Mike Hamada** (Los Alamos National Labs)  
**Joel Huber** (Wharton School, Penn State)  
**David Hunter** (Penn State)  
**Stephen Jones** (Boeing)  
**Abba Krieger** (Wharton School, Penn State)  
**Warren Kuhfeld** (SAS Institute)  
**Raymond Lam** (GlaxoSmithKline)  
**Nhu Le** (BC Cancer Agency)  
**Robert Mee** (U. Tennessee-Knoxville)  
**Saumen Mandal** (U. Manitoba)  
**Max Morris** (Iowa State)  
**Bill Notz** (Ohio State)  
**Greg Piepel** (Pacific Northwest Labs-Battelle)  
**Giovanni Pistone** (Politecnico di Torino)  
**Shane Reese** (Brigham Young)  
**Louis-Paul Rivest** (Laval U.)  
**Kirti Shah** (U. Waterloo)  
**Bikas Sinha** (U. Waterloo)  
**John Stufken** (Iowa State)  
**Winson Taam** (Boeing)  
**Boxin Tang** (Memphis State)  
**Randy Tobias** (SAS Institute)  
**Ben Torsney** (University of Glasgow)  
**Joe Voelkel** (Rochester Institute of Technology)  
**Marcia Wang** (U. Waterloo)  
**C.F. Jeff Wu** (U. Michigan)  
**Huaiqing Wu** (Iowa State)  
**Don Ylvisaker** (UCLA)  
**Kenny Ye** (SUNY-Stony Brook)  
**Hongquan Xu** (UCLA)  
**Hongtu Zhu** (U. Victoria)  
**Lei Zhu** (GlaxoSmithKline)  
**Jim Zidek** (UBC)

## PIMS-MITACS Workshop on Filtering Theory and Applications Edmonton and Jasper, July 25–30, 2002

**Organisers:** Robert Elliott (U. Calgary), Michael Kouritzin (U. Alberta), Tom Kurtz (U. Wisconsin-Madison) and Hongwei Long (U. Alberta)



Nicole El Karoui  
(Ecole Polytechnique)

Filtering theory is an active and current research field attracting many probabilists. In particular, there is increasing interest in applying filtering theory to real-world problems in areas such as mathematical finance, target detection and tracking,

communication networks, pollution tracking, weather prediction, traffic management, and search and rescue. The main goal of the Conference was to bring current problems and theory together, benefiting all researchers, especially those new to filtering theory.

The four keynote speakers were:

**Nick Duffield** (AT&T): talk series entitled *Revealing the Detail in Network Measurements*

**Tyrone Duncan** (U. Kansas): talk series entitled *Fractional Brownian Motion and Applications*

**Gopi Kallianpur** (U. North Carolina): talk series entitled *Lectures on Nonlinear Filtering Theory*

**Nicole El Karoui** (Ecole Polytechnique): talk series entitled *Pricing and Hedging Financial Products with Partial Information*

They are outstanding experts in their fields. Their lectures focused on the most recent development of filtering theory and applications to communication net-



Gopi Kallianpur  
(U. North Carolina)

work and mathematical finance. There were many established researchers from five continents, who presented their recent and most exciting research accomplishment in the conference and exchanged their ideas with other participants. The conference attracted students and postdoctoral researchers from universities across



Tyrone Duncan (U. Kansas)

North America, which will encourage future research activity in Canada. The conference benefited from industrial participants including AT&T, Lockheed Martin and Raytheon, who showed great interests in the conference and indicated desire to have more interaction and collaboration with scientists from academic institutions. We believe that the conference helped to advance the scientific development of filtering theory and its applications as well as offer benefits to industry.

The meeting was held at the University of Alberta from July 25–27 and was concluded in Jasper, Alberta from July 28–30.

The conference was cosponsored with the University of Alberta and the Applied Mathematics Institute of the University of Alberta.

The Invited Speakers included:

- D. Blount** (Arizona State)
- A. Budhiraja** (U. North Carolina)
- H. Chan** (U. Alberta)
- P. Del Moral** (Toulouse)
- R. Elliott** (U. Alberta)
- W. Engler** (Vision Smart)
- D. Kenway** (Vision Smart)
- V. Krishnamurthy** (U. Melbourne)
- H. Long** (U. Alberta)
- M. Kouritzin** (U. Alberta)
- M. Prefontaine** (U. Alberta)
- B. Remillard** (HEC, Montreal)
- W. Sun** (U. Alberta)
- A. Tsoi** (U. Missouri, Columbia)
- F. Viens** (Purdue)
- P. Wiebe** (U. Alberta)
- Xun Yu Zhou** (Chinese U. Hong Kong)

## Theme 2003: Inverse Problems and Applications

Inverse problems are problems in which the goal is to find material or biological properties of objects or information about the objects' surrounding environment which cannot be measured directly or it is not desirable to do so. These problems arise in many areas of applications including geophysics, medical imaging, remote sensing and non-destructive evaluation of materials. During the last twenty years or so there have been remarkable developments in the mathematical theory of inverse problems. These developments together with the enormous increase in computing power and new powerful numerical methods have made it possible to make significant progress on increasingly more realistic and difficult inverse problems. The purpose of the Thematic Programme was to bring together mathematicians and practitioners to work on these problems. A series of workshops on inverse problems were held at different locations, during the year 2003, emphasizing these different applications. Several of these activities were sponsored jointly by PIMS and the NSF.

**Gunther Uhlmann** was the coordinator of the PIMS thematic year.

Please see [www.pims.math.ca/inverse/](http://www.pims.math.ca/inverse/) for more information.

### Scientific Committee:

**Gunther Uhlmann** (Coordinator, U. Washington)

**Richard Froese** (UBC)

**Nassif Ghoussoub** (PIMS)

**Michael Lamoureux** (U. Calgary)

**Gary Margrave** (U. Calgary)

**Jim Morrow** (U. Washington)

### Programme:

**Pan-American Advanced Studies Institute (PASI) on PDE, Inverse Problems and Nonlinear Analysis,**  
Centro de Modelamiento Matemático (CMM),  
Universidad de Chile, January 6–19, 2003

**BIRS workshop on Scattering and Inverse Scattering,**  
BIRS, Banff, March 22–27, 2003

**Seismic Wave Simulation and Seismic Imaging: A PIMS Summer School,**  
U. Calgary, July 14–18, 2003

**PIMS Geophysical Inversion Workshop,**  
U. Calgary, July 20–25, 2003

**Workshop on Inverse Problems and Medical Imaging,**  
PIMS-UBC, August 4–8, 2003

## PASI on PDE, Inverse Problems and Non-Linear Analysis Centro de Modelamiento Matemático, Universidad de Chile, Santiago, Chile, January 6–19, 2003

**Organizers:** Rafael Benguria (Universidad Católica de Chile), Carlos Conca (U. Chile), Nassif Ghoussoub (PIMS and UBC), Raul Manasevich (U. Chile), Wei-Ming Ni (U. Minnesota), Gunther Uhlmann (U. Washington) and Michael Vogelius (Rutgers)

The Pan-American Advanced Studies Institute (NSF) are funded by the US NSF and DOE. The PASI is modelled on the NATO Advanced Studies Institute. Canadian participation in the PASI in Chile was supported by PIMS.

The PASI on Partial Differential Equations (PDE), Inverse Problems (IP) and Non-Linear Analysis (NLA) was held at the Centro de Modelamiento Matemático (CMM), Facultad de Ciencias Físicas y Matemáticas, Universidad de Chile. The interaction between PDE, IP and NLA has produced remarkable developments in the last couple of decades or so. One of the main objectives of the PASI was to bring many of these developments to advanced graduate students, postdocs and other scientists in the Americas interested in these fields and their applications. Another important objective of the PASI was to foster international cooperation throughout the Americas by bringing different areas of expertise in PDEs, IP and NLA in one event. More than 160 participants mainly from several countries of the Americas participated in this unique workshop.

During the first week of the PASI there were a series of minicourses given by **Jean-Bernard Baillon** (U. Chile), **Jerome Busca** (U. Paris IX), **Luis Caffarelli** (UT, Austin), **F. Alberto Grunbaum** (Berkeley), **Maarten de Hoop** (Colorado School of Mines), **Peter Kuchment** (Texas A&M), **Yan Yan Li** (Rutgers) and **Michael Vogelius** (Rutgers). During the second week the workshop focused on recent developments in the interaction between IP, NLA and PDE.

## BIRS Workshop on Scattering and Inverse Scattering BIRS, March 22–27, 2003

**Organizers:** Richard Froese (UBC) and Gunther Uhlmann (U. Washington)

In the fields of scattering and inverse scattering theory techniques of microlocal analysis, including the use of eikonal equations and of complex geo-

metrical optics solutions to Schrödinger and other equations, have led to substantial progress in recent years.

Despite close mathematical connections between the fields of scattering and inverse scattering there has not always been a strong interaction between these fields. Part of the rationale of this workshop was to bring together workers who might not ordinarily interact, but could benefit from sharing ideas. The 40 participants took full advantage of this opportunity.

Scattering theory seeks an understanding of spectral phenomena for noncompact manifolds. There has been a recent focus in this subject on what is now termed geometric scattering, which amounts to the study of scattering on classes of noncompact complete manifolds with regular structures at infinity. Several of the lectures were concerned with questions about the smooth parametrization of the continuous spectrum by functions on some ideal boundary, the structure of the scattering matrix as an operator on this ideal boundary, and the study of resonances, which are poles of the meromorphic continuation of the resolvent. There are many subtle connections between these objects and the geometry of the underlying manifold.

Inverse scattering is how we obtain a large part of our information about the world. An everyday example is human vision: from the measurements of scattered light that reaches our retinas, our brains construct a detailed three-dimensional map of the world around us. Dolphins and bats are able to do the same thing from listening to scattered sound waves.

The inverse scattering problems discussed in the workshop included the determination of the interior structure of the Earth by measuring the travel times of seismic waves, and the inverse quantum scattering problem which attempts to determine the inner structure of the atom and its constituents from studying the scattering when materials are bombarded with particles. Another important inverse scattering problem discussed in the workshop is reflection seismology which uses the reflection of seismic waves to locate oil deposits. Inverse obstacle scattering is used in radar and sonar and several of the lecturers dealt with this topic.



Participants in workshop on Scattering and Inverse Scattering at BIRS

## Seismic Wave Simulation and Seismic Imaging: A PIMS Summer School

### University of Calgary, July 14–18, 2003

**Organizers:** Gary Margrave (U. Calgary) and Len Bos (U. Calgary)

The first part of this summer school examined real seismic data, and several mathematical models for the forward problem (the simulation of seismic waves) were presented. Wave equations and their solutions were explored. Essential mathematical techniques such as Greens functions, Kirchhoff diffraction theory, and ray theory were developed and examined.

In the second part, these concepts and tools were applied to develop the prototypical approaches to the seismic imaging problem. The Born and Kirchhoff approximations were shown to lead to direct schemes for the estimation of subsurface reflectivity that are the basis for modern imaging techniques. The strengths and weaknesses of these techniques were examined and a survey of more advanced, emerging methods was presented. Emphasis was placed on understanding the assumptions and limitations of each technique.

The instructors at this summer school were:

**Len P. Bos** (Math & Statistics, U. Calgary)

**Robert J. Ferguson** (Jackson School of Geosciences, Geological Sciences, U. Texas, Austin)

**Gary F. Margrave** (Geology & Geophysics, U. Calgary)

## PIMS Geophysical Inversion Workshop

### University of Calgary, July 20–25, 2003

**Organizers:** Gary Margrave (U. Calgary), Martijn de Hoop (Colorado State of Mines), and William (Bill) Symes (Rice U.)

The University of Calgary campus was the setting for more than eighty mathematicians, physicists, and geophysicists from around the world, who gathered to discuss geophysical inversion in theory and practise.

There were ten invited speakers and twenty-three contributed papers which made for a very full agenda. In addition, there were more than forty non-presenting registered attendees and many more people dropped in for the occasional presentation. The strong linkage between the subject matter and the business interests of the Calgary oil and gas exploration community bolstered workshop attendance. Though there were more geophysicists than mathematicians in attendance, there were some very well known people in the latter category, while many of the former were effectively applied mathematicians. Many graduate students were also present and some of these had stayed over from the Seismic Imaging Summer School of the previous week.

There were many presentations on the mathematics of wave propagation and the implied inverse problem, which is often called seismic imaging. Seismic imaging is a central theme in geophysical inversion and is a rapidly moving field. Fourier integral operators and pseudodifferential operators were found in numerous presentations suggesting that many researchers are finding these operators useful in seismic inversion. Another common theme in seismic inversion is the recognition that the inversion operation can also be formulated as a generalized Radon transform. In addition to papers on the seismic reflection problem, there were also a variety of papers dealing with the inverse traveltime problem and other aspects of kinematics. Finally, there were several more general presentations on inverse theory that were not limited to seismological data.

The general atmosphere of the workshop was informal and congenial. Many presentations elicited a lively exchange of ideas. The two social events, an opening





barbeque and a dinner in the latter part of the week, were well attended. In the end, there were many expressions of gratitude to PIMS for funding the event and a general desire to have another meeting in a few years.

The invited speakers were:

**Norman Bleistein** (Colorado School of Mines): *Seismic Modelling, Migration and Inversion: From String Construction to Theory to Computer Implementation*

**Michael Bostock** (UBC):

*Inverse scattering of teleseismic wavefields*

**Hans Duistermaat** (U. Utrecht): *Fourier integral operators as a tool to take care of the high frequency part of waves*

**Louis Fishman** (MDF International previously at NRL): *One-Way Wave Equation Modeling in Seismo-Acoustic Wave Propagation and Inversion*

**Rob van der Hilst** (Massachusetts)

**Larry Lines** (U. Calgary): *Geophysical Inversion - Provehito in Altum!*

**Doug Oldenburg** (UBC): *Inversion for applied geophysics: Applications to mineral exploration*

**Mauricio Sacchi** (U. Alberta): *Regularized Least-squares Migration/Inversion*

**Christiaan Stolk** (Ecole Polytechnique): *The determination of medium discontinuities by migration: results from microlocal analysis*

**Gunther Uhlmann** (U. Washington): *The inverse kinematic problem*



Participants of the workshop on Inverse Problems and Medical Imaging at PIMS-UBC

This workshop was sponsored in collaboration with the US National Science Foundation.

The workshop focused on recent developments in medical imaging, particularly the advances in mathematics which have allowed for significant enhancement of widely used imaging techniques such as x-ray tomography, magnetic resonance imaging, and ultrasonic imaging. Mathematical developments in emerging medical imaging modalities were also surveyed. The more than 70 participants included physicians, physicists and mathematicians directly involved in the mathematical and practical aspects of medical imaging.

Several of the lectures described relatively recent medical modalities which might improve on the earlier detection and diagnosis of breast cancer. These new imaging methods are non-invasive and they all provide for more detailed information than given by standard x-ray mammography about different properties of breast tissue. For instance, electrical impedance tomography images the electrical conductivity of tissue by making voltage and current measurements at the boundary of the body.

## Workshop on Inverse Problems and Medical Imaging PIMS-UBC, August 4–8, 2003

**Organizers:** John Schotland (Chair, Biomedical Engineering, U. Pennsylvania), Richard Albanese (Armstrong Research Lab, Brooks AFB), Tom Budinger (Biomedical Engineering, Berkeley), David Isaacson (Rensselaer Polytechnical Institute), Amir Gandjbakhche (National Institute of Health) and Gunther Uhlmann (University of Washington).



John Schotland (U. Penn) and Gunther Uhlmann (U. Washington), two of the organizers of the Workshop on Inverse Problems and Medical Imaging.

Breast tumours have a much larger conductivity than surrounding tissue. Transient elastography uses information given by shear ultrasound waves to measure the breast tissue hardness or elasticity. In optical tomography one sends infrared light through breast tissue to locate and quantify regions of oxygenated and deoxygenated hemoglobin. This might help detect early tumour growth and characterize the stage of a tumour by learning about its vascular makeup.

The invited speakers were:

**Simon Arridge** (UCL): *Reconstruction Methods in Optical Tomography and Applications to Brain Imaging*

**Yoram Bresler** (UIUC): *Fast Hierarchical Algorithms for Tomography*

**Thomas Budinger** (UC Berkeley): *How Medical Science will Benefit from Mathematics of Inverse Problems*

**Emmanuel Candes** (Cal Tech): *New Multiscale Thoughts on Limited-Angle Tomography*

**Scott Carney** (UIUC): *Computed Imaging for Near-Field Microscopy*

**Anna Celler** (UBC): *Inverse Problems and Nuclear Medicine*

**Rolf Clackdoyle** (U. Utah): *Reconstruction from Truncated Fanbeam and Parallel-Beam Projections*

**Mathias Fink** (ESPCI): *Transient Elastography and Supersonic Shear Imaging*

**Amir Gandjbakhche** (NIH, USA): *Effects of Target Non-localization on the Contrast of Optical Images: Lessons for Inverse Reconstruction*

**Frederick Greensite** (UC Irvine): *Multivariate Inverse Problems*

**David Isaacson** (RPI): *Progress and Problems in Electrical Impedance Imaging*

**Matti Lassas** (Rolf Nevalinna Institute, Finland): *Inverse scattering problem with a random potential*

**Brian Litt** (UPenn): *Predicting Epileptic Seizures From Intracranial EEG*

**Joyce McLaughlin** (RPI): *Interior Elastodynamics Inverse Problems: Recovery of Shear Wavespeed in Transient Elastography*

**Michael Miller** (Johns Hopkins University): *Image Analysis Models in Computational Anatomy*

**Frank Natterer** (U. Muenster): *3D Emission Tomography Via Plane Integrals*

**Joseph O'Sullivan** (Washington U., St. Louis): *Information Geometry, Alternating Minimizations, and Transmission Tomography*

**George Papanicolau** (Stanford): *Imaging in Clutter*

**Sarah Patch** (GE Medical Systems): *Thermoacoustic Tomography - An Inherently 3D Generalized Radon Inversion Problem*

**Todd Quinto** (Tufts): *Limited Data Tomography in Science and Industry*

**Yoram Rudy** (Case Western Reserve U.): *ECGI: A Noninvasive Imaging Modality for Cardiac Electrophysiology and Arrhythmias*

**John Schotland** (UPenn): *Tomography and Inverse Scattering with Diffuse Light*

**Meir Shinnar** (UMDNJ): *Inversion of the Bloch Equation*

Some of the talks were videotaped and may be watched in RealVideo format from the web page [www.pims.math.ca/science/2003/inverse/](http://www.pims.math.ca/science/2003/inverse/)

## Optimal Transportation and Nonlinear Dynamics Workshop PIMS-UBC, August 11–15, 2003

**Organizers:** Michael Cullen (UK Meteorological Office), Lawrence C Evans (UC, Berkeley), and Wilfrid Gangbo (Georgia Tech) and cosponsored by their NSF Focused Research Group.

The conference commenced with an survey lecture by **Robert McCann** (U. Toronto) on *Optimal Transportation: The Lay of the Land*, and featured special sessions organized by **Felix Otto** (U. Bonn) about *Analyzing Gradient Descent Models in Physical Systems* and **Michael Cullen** on *Atmospheric Dynamics and Scientific Computation* problems from optimal transport theory.



Wilfrid Gangbo (Georgia Tech), an organizer of the Optimal Transportation and Nonlinear Dynamics Workshop

A minicourse on *Hessian and Curvature Equations* was given by **John Urbas** (Australian National University). These second-order elliptic PDEs arise in geometric and optimization problems, but are fiendishly difficult to analyse due to nonlinearities which result from replacing the Laplacian operator in Poisson's equation with the Hessian determinant or (in 3 dimensions and higher) other elementary symmetric functions of the Hessian's eigenvalues.

The conference was a successful sequel to the *Transport me to Toronto!* workshop held at the Fields Institute in August 2001.

The invited lecturers were:

**Jean-David Benamou** (INRIA): *Numerical Resolution of an "Unbalanced" Mass Transport Problem*

**Guy Bouchitte** (U. Toulon et du Var): *Asymptotic of Optimal Location Problems*

**Yann Brenier** (U. Nice Sophia-Antipolis): *Displacement of 2D Vector Fields and 3D Electromagnetism*

**Peter Constantin** (U. Chicago): *Diffusive Lagrangian Transformations*

**Mike Cullen** (U. Reading): *Fast Algorithm for the Monge-Kantorovich Problem (joint work with Purser)*

**Jean Dolbeault** (U. Paris IX - Dauphine): *Direct Entropy Methods*

**Mikhail Feldman** (U. Wisconsin): *Lagrangian Solutions of 3D Semigeostrophic Equations in Physical Space*

**Jim Feng** (U. Massachusetts Amherst): *Large Deviations, Hamilton-Jacobi and Mass Transport*

**Nassif Ghoussoub** (UBC, PIMS): *A Unifying Framework for Geometric Inequalities*

**Lorenzo Giacomelli** (U. di Roma "La Sapienza"): *A Variational Approach to Lubrication Approximation*

**Bernd Kawohl** (U. Köln): *Symmetries in Anisotropic Media*

**David Kinderlehrer** (Carnegie Mellon U.): *Diffusion Mediated Transport: Can We Understand Motion in Small Systems?*

**Robert McCann** (U. Toronto): *Optimal Transportation: The Lay of the Land*

**John Norbury** (Oxford)

**Adam Oberman** (U. Texas): *Exact Solution to the Semigeostrophic Equations in Elliptical Domains*

**Vladimir Oliker** (Emory U.): *Fermat's Principle and Mass Transport Problem*

**Felix Otto** (U. Bonn): *A Transportation Problem in Type I Superconductors*

**Max von Renesse** (U. Bonn): *Robust Lower Ricci Bounds by Optimal Transportation*

**Ian Roulstone** (U. Reading): *Semigeostrophic Theory on The Sphere*

**Giuseppe Savaré** (U. degli Studi Pavia): *Gradient Flows in Wasserstein Spaces*

**Andrei Sobolevskii** (Observatoire de la Cote D'Azur): *Reconstruction of the Early Universe by a Monge-Ampere-Kantorovich Mass Transportation Method*

**John Urbas** (Australian National U.): *Minicourse on Regularity and Estimates for Hessian and Curvature Equations*

**Xu-Jia Wang** (Australian National U.): *Light Reflection and Optimal Transportation*

Some lectures were videotaped and may be watched in RealVideo format from the web page [www.pims.math.ca/science/2003/inverse/](http://www.pims.math.ca/science/2003/inverse/).



### III. CORE SCIENTIFIC PROGRAMMES



The participants in the 2002 Frontiers in Mathematical Physics Workshop on Brane Worlds and Supersymmetry.

Gunther Uhlmann (U. Washington) and Nassif Ghoussoub (PIMS, Director). Gunther Uhlmann was a PIMS Distinguished Chair in November 2002 at UBC.



## PIMS Mini-Programmes

Mini-programmes are more focused events than the thematic programmes and span a shorter period of time. They place the focus on having fewer formal lectures and more opportunities for active collaborative work between the participants, who typically stay for the duration of the programme.

### Frontiers in Mathematical Physics Workshop on Brane Worlds and Supersymmetry, UBC, July 22–August 2, 2002

**Organizers:** John Ng (TRIUMF, Chair), Andreas Karch (University of Washington), Taejin Lee (APCTP), Moshe Rozali (UBC), Alexander Rutherford (PIMS) and Gordon Semenoff (UBC).

Held at the Department of Physics and Astronomy, UBC, this two-week workshop featured a variety of talks on topics ranging from fundamental questions in superstring theory and supersymmetry to the cosmological implications of brane world models and higher dimensional physics. Brane world models suggest that the observable universe is a domain wall (the word brane derives from membrane) in a higher dimensional universe. These models have been proposed as a possible solution to the hierarchy problem, which asks why in the standard model of particle physics the hierarchy of mass scales that is observed in nature can occur.

The standard model of particle physics is a complicated nonlinear dynamical system. In such systems, predictions of dimensional numbers like particle masses tend to be of the same size, the size of the largest input parameter. In nature, there is a distribution of different masses,

from massless particles like the photon and the very light particles like the electron or neutrino to the mass scale which describes gravitational interactions, a factor of  $10^{20}$  heavier. Previous to these new ideas, the only solution of this hierarchy problem was to invoke symmetries. In fact, supersymmetry—a hypothetical and as yet unobserved symmetry whose transformations mix fermionic and bosonic particles—was needed. These new ideas about extra dimensions give a radical new alternative solution of the hierarchy problem. This solution is so compelling that it has been the focus of intense theoretical particle physics research over the past few years.

The new ideas about extra dimensions have also led to a revolution in our thinking about the role of gravity in particle physics. Gravity was previously thought to be important to the interactions of elementary particles only at extremely short distance scales, 10–34 centimetres, or in processes involving extremely high energies, far beyond the reach of any conceivable experiments. In most of the extra dimension scenarios, gravity becomes an important player in particle physics modelling.

Some of the extra dimension scenarios use superstring theory to quantize gravity and predict that superstring excitations should be observable at much lower energies than was previously thought. The elementary particles seen so far would be the lowest energy excitations of superstrings. The next excited states would occur at energies not much higher than the masses of already observed particles. This has the exciting consequence that these new ideas are testable by present and imminent experiments. For example, the existence of extra dimensions modifies the gravitational interaction at short distances. If objects are close together, gravity would no longer have the Newtonian inverse square dependence on distance but would have a different power depending on the total number of dimensions of spacetime. There are now several new experiments dedicated to testing the laws of gravity at the micron level.

Lectures were given by:

**Alessandro D'Adda** (INFN, Torino): *Gauge Theories of the Symmetric Group in the Large N Limit*

**Ignatios Antoniadis** (CERN): *Physics with Large Extra Dimension* (2 lectures)

**Cliff Burgess** (McGill): *Fixing Runaway Moduli*

**Kiwoon Choi** (KAIST): *Radius-dependent Gauge Coupling Renormalization in AdS5*

**Keith Dienes** (Arizona): *Shape Versus Volume: Rethinking the Properties of Large Extra Dimensions and Solving the Hierarchy Problem without SUSY or Extra Dimensions: an Alternative Approach*

**Bogdan Dobrescu** (Yale): *Universal Extra Dimension*

**Andreas Karch** (Washington): *Adding Flavour to ADS/CFT*

**Emanuel Katz** (Washington): *Little Higgses*

**Noboru Kawamoto** (Hokkaido): *Twisted Superspace and Dirac-Kaehler Fermions*

**Hyung Do Kim** (KIAS): *Deconstructing Warped Gauge Theory and Unification*

**C.S. Lam** (McGill): *What Can Neutrino Oscillation Tells Us About the Possible Existence of an Extra Dimension?*

**Y.S. Myung** (Inje University): *Limitation of Cardy-Verlinde Formula on the Holographic Description of Brane Cosmology*

**Erich Poppitz** (Toronto): *Instanton Effects in 5d Theories and Deconstruction*

**Konstantin Savvidis** (Perimeter Institute): *A New Non-commutative Field Theory*

**George Savvidy** (National Research Center, Demokritos): *Conformal Invariant String with Extrinsic Curvature Action*

**Gordon Semenoff** (UBC): *Nonplanar Corrections to PP-wave Strings*

**Mikhail Shifman** (Minnesota): *Cosmological Constant Problem in Infinite Volume Extra Dimensions: a Possible Solution and Topological Effects in our Brane World From Extra Dimensions*

**Henry Tye** (Cornell): *Brane World Cosmology: From Superstring to Cosmic Strings*

**Neal Weiner** (Washington): *Supersoft Supersymmetry Breaking*

The programme was organized so that there was the opportunity for extensive discussion between the lectures. The lectures were videotaped and are available in real video and MP3 format from [www.pims.math.ca/science/2002/fmp](http://www.pims.math.ca/science/2002/fmp).

This workshop was the sixth of the annual workshops in the Frontiers in Mathematical Physics series. It was co-sponsored by PIMS, the Perimeter Institute for Theoretical Physics and the Asia Pacific Center for Theoretical Physics.

## Distinguished Chairs

PIMS has established a programme of Distinguished Chairs, which serves to host eminent researchers in the mathematical sciences for extended visits at the PIMS sites. The researchers will have the opportunity to collaborate with colleagues at the PIMS universities and to give a series of lectures on their work.

### PIMS Distinguished Chairs for 2002/03

**Donald G. Saari** (University of California, Irvine)  
Site: University of Victoria  
September 2002

**Klaus Schmidt** (University of Vienna and  
Director, Erwin Schrödinger Institute)  
Site: University of Victoria  
November 2002

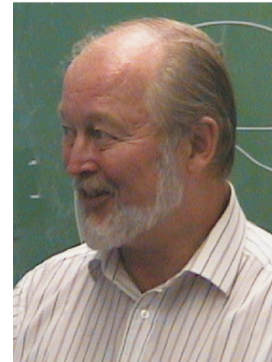
**Gunther Uhlmann** (University of Washington)  
Site: University of British Columbia  
November 2002

In September 2002, **Donald Saari** delivered a series of five lectures at the University of Victoria as a PIMS Distinguished Chair. Don is a Distinguished Professor of Mathematics and Economics and Director of the Center for Decision Analysis at the University of California, Irvine, and the former Arthur and Gladys Pancoe Professor of Mathematics and Professor of Economics at Northwestern University. He is recognized for his important contributions to the theory of dynamical systems and to the social sciences.

In his research Don uses mathematical models to analyze a wide variety of social phenomena: politics, markets, and intra-organizational behaviour. He made signifi-

cant advances in celestial mechanics, in which Saari's conjecture—proposed in 1970 and now a landmark in the field—is still unsolved. Don is a member of the National Academy of Sciences.

His UVic lectures were intended to a broad general audience, showing how interesting mathematics is generated by questions coming from the social sciences.



Donald Saari

*Mathematical Social Sciences, an Oxymoron?* presented how basic questions from the social sciences lead to new mathematics or new uses of mathematics. The talk emphasized how hidden symmetries influence everyday decision making.

*Singularity Theory and Departmental Discussions* dealt with simple models of basic decision theory, connecting it with singularity theory and with some unresolved questions from the n-body problem of celestial mechanics.

*Evolutionary Game Theory; Examples and Dynamics* explained why dynamical systems are becoming an important tool for handling the new area of evolutionary game theory. The conclusions for game theory can be surprising. The impact for dynamical systems is that new structures are found.

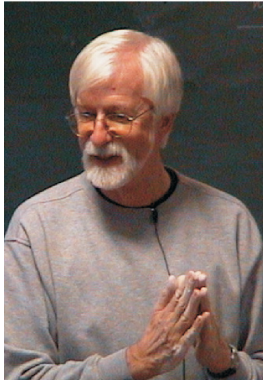
*Chaotic Dynamics of Economics* refuted Adam Smith's invisible hand theory through a careful mathematical examination, which showed that chaos is more likely than stability in economics models.

*Dynamics, Symmetry, and the Social Sciences* concluded the lecture series by showing other uses of dynamics and symmetry in understanding basic concerns coming from the social sciences. One of the issues discussed was Arrow's theorem and a new way of interpreting it.

The lectures were widely attended by faculty, PDFs, graduate and undergraduate students from the mathematics and the economics departments, visitors from other



universities, and several members of the general public. Long and interesting discussion followed after every talk. This has been a highly rewarding experience for all those who attended. A video recording of the lectures and a written version of the notes are available on PIMS's website.



Klaus Schmidt

During November 2002 **Klaus Schmidt**, who is a Professor at the Mathematics Institute of the University of Vienna, and the Director of the Erwin Schrödinger Institute for Mathematical Physics, gave series of five talks at the University of Victoria.

The talks were about *Algebraic  $Z^d$ -actions* and covered the following topics:  $Z^d$ -actions by automorphisms of compact abelian groups: general theory, higher order mixing, homoclinic points and the symbolic representations of algebraic  $Z^d$ -actions, and rigidity properties.

Klaus Schmidt was the winner of the 1993 Ferran Sunyer i Balaguer Prize.

He was a founding editor of the journal *Ergodic Theory and Dynamical Systems* and is a member of the Austrian Academy of Sciences.

At the start of November 2002 **Gunther Uhlmann** (University of Washington) gave three two-hour talks at UBC. The topics were *inverse boundary* and *inverse scattering* problems. Inverse boundary problems are a class of problems in which one seeks to determine the internal properties of a medium by performing measurements along the boundary of the medium. These inverse problems arise in many important physical situations, ranging from geophysics to medical imaging to the non-destructive evaluation of

materials. The appropriate mathematical model of the physical situation is usually given by a PDE (or a system of such PDEs) inside the medium. The boundary measurements are then encoded in a certain boundary map, usually called the Dirichlet-to-Neumann (DN) map. The inverse boundary problem is to determine the coefficients of the PDE inside the medium from knowledge of the boundary map. In inverse scattering problems, in which the observations are made far from the medium, the information is encoded in the scattering amplitude. The inverse scattering problem is to determine the medium properties from this information.

The first two lectures discussed the prototypical example of an inverse boundary problem, the inverse conductivity problem, also called electrical impedance tomography, whose mathematical formulation is due to A. P. Calderón. In this case the DN map is the voltage to current map; that is, the map assigns to a voltage potential on the boundary of a medium the corresponding induced current flux at the boundary of the medium. The inverse problem is to recover the electrical conductivity of the medium from the DN map. Gunther Uhlmann discussed the role of complex geometrical optics solutions in solving this inverse problem.

The first part of the last lecture described a solution of the inverse scattering problem at a fixed energy in dimension three or larger by reducing the problem to the study of the set of Cauchy data for the Schrödinger equation for a large ball. In the second half it was discussed recent progress on an inverse boundary problem arising in geophysics and rigidity questions in Riemannian geometry. The problem is to determine a Riemannian metric on a compact Riemannian manifold with boundary by measuring the lengths of geodesics (travel times) joining points of the boundary.

The lectures series by Donald G. Saari, Klaus Schmidt and Gunther Uhlmann may be watched in real video format at [www.pims.math.ca/video/mini/](http://www.pims.math.ca/video/mini/).

## Pacific Northwest Seminar Series

These are annual or biannual meetings that bring together various regional groups of mathematicians in areas represented by strong communities in British Columbia, Alberta, Washington, Oregon and Northern California. Some of the scientific goals of PIMS, e.g. promoting communication and interactions among mathematical scientists, are served by ad hoc organizations formed in Western Canada and the U.S. Pacific Northwest. The PNW meetings form the backbone of the PIMS Collaborative Research Groups.

### November 9, 2002 at University of Victoria:

Organizers: Frank Ruskey (chair), Jing Huang, Gary MacGillivray and Wendy Myrvold (U. Victoria).

The speakers were:

**Andrzej Proskurowski** (U. Oregon): *Width Parameters of Graphs and Discrete Optimization Problems*

**Branko Grunbaum** (U. Washington): *Polyhedra: Combinatorial and Geometric*

**Jozef Siran** (Slovak University of Technology): *Links Between Graph Theory, Group Theory, Geometry, Riemann Surfaces, and Galois Theory*

### PNW Algebraic Geometry Seminar

**Organizers:** Jim Bryan (UBC), James Carrell (UBC) and Sandor Kovacs (U. Washington).

#### October 20, 2002 at Western Washington U:

There were three speakers at this meeting:

**Bill Fulton** (Michigan):

**Tom Graber** (UC, Berkeley): *Generalizations of Tsen's Theorem*

**Karen Smith** (Michigan): *A Non-vanishing Conjecture of Kawamata and the Core of an Ideal*

### Combinatorial Potlatches

Combinatorial Potlatches have been held for many years at various locations around Puget Sound and southern British Columbia, and are an opportunity for combinatorialists in the region to gather informally for a day of invited talks and conversation.

### PNW Geometry Seminar

The Pacific Northwest Geometry Seminar (PNGS) is a regional meeting for geometers of all kinds. It is held at least twice during the academic year, rotating among UBC, Oregon State U., U. Oregon, Portland State U., U. Utah and U. Washington.

#### Joint Meeting of the PNW Geometry Seminar and the Cascade Topology Seminar, May 11-12, 2002 at U. Washington:

Roughly 60 people attended this meeting, mostly from Washington, Oregon, and British Columbia. Individually, the PNW Geometry Seminar and the Cascade Topology Seminar are regular, regional meetings for geometers and topologists, respectively. This joint meeting provided a good setting for the usual interactions within each group, but also interactions between the groups. The meeting also received funding from the National Science Foundation. The talks were designed so as to be accessible to the entire audience, and they were well-received. This was reflected in the broad participation in the problem sessions following the talks. Topics for talks included information theory, gauge theory, conformal field theory, and rational homotopy theory. The following people spoke:

**John Baez** (UC Riverside): *Categorified Gauge Theory*  
**Dan Christensen** (Western Ontario): *Quantized Geometry via Representation Theory*  
**Ralph Cohen** (Stanford): *Duality Phenomena in Loop Spaces and Conformal Field Theory*  
**Megan Kerr** (Wellesley): *A Study of Homogeneous Einstein Metrics*  
**Laura Scull** (UBC): *Rational Equivariant Homotopy*  
**Deane Yang** (Polytechnic University): *Geometry, Analysis, and Information Theory*

## Western Canada Linear Algebra Meeting (W-CLAM)

**Organizing Committee:** Shaun Fallat, Steve Kirkland (U. Regina), Hadi Kharaghani (U. Lethbridge), Peter Lancaster (U. Calgary), Dale Olesky, Pauline van den Driessche (U. Victoria) and Michael Tsatsomeros (Washington State U.).

W-CLAM is a biannual sequence of meetings on linear algebra and related fields; previous meetings have been held in Regina, Lethbridge and Kananaskis. The objective is to foster research in linear algebra and its applications. While the primary purpose of W-CLAM is to enable researchers (including graduate students) from Western Canada to get together to present current work and to exchange ideas, the meeting is open to anyone.

### May 10–11, 2002 at University of Regina:

This meeting received financial support from the National Programme Committee, the University of Regina Conference Fund, and the University of Regina Faculty of Science. WCLAM 2002 featured 18 talks by speakers from Canada, the United States and Germany. The lectures covered a range of research areas associated with linear algebra, include matrix theory, operator theory, graph theory, applied mathematics, numerical analysis and combinatorics. The list of speakers included two winners of the Hans Schneider prize, which is given out every three years by the International Linear Algebra Society for outstanding contributions to research in linear algebra.

In addition to the contributed talks, the meeting featured lectures from three invited speakers:

**Jane Day** (San Jose State)  
**Ludwig Elsner** (Universität Bielefeld)  
**Chris Godsil** (Waterloo)

## PNW Number Theory Seminar

### April 20–21, 2002 at PIMS-SFU:

The sixth annual PNW Number Theory Meeting had about 40 participants primarily from Washington, Oregon, Alberta and BC. The invited speakers were:

**Kristin Lauter** (Microsoft): *Curves Over Finite Fields and Applications to Cryptography*  
**Greg Martin** (UBC): *Inequities in the Shanks-Rényi Prime Number Race*

**Carl Pomerance** (Bell Labs): *Mersenne Numbers*  
**Mark Sheingorn**: *Geometric Resonances in the Hall Ray of the Discrete Portion of the Markoff Spectrum*

**Fernando Rodriguez Villegas** (Texas, Austin): *Periods, L-functions and Hyperbolic Manifolds*

**Hugh Williams** (U. Calgary): *Computing Certain Invariants in Real Quadratic Number Fields*

### November 2, 2002 at Western Washington U:

The speakers at this meeting are:

**Bisi Agboola** (U. Santa Barbara): *Galois Structure, Galois Representations and Metrised Line Bundles*

**Will Galway** (PIMS-SFU): *The Pseudoprimes Below  $2^{64}$*

**Jim Mailhot** (U. Washington): *Selmer Groups of Elliptic Curves with  $p$ -Isogenies*

## PNW Numerical Analysis Seminar

### September 28, 2002 at University of Victoria:

This meeting was organised by Dale Olesky (U. Victoria). The speakers were:

**Mike Foreman** (Institute of Ocean Sciences, Victoria): *Modelling Tidal Resonance and Tidal Power Around Vancouver Island*

**John Fyfe** (Canadian Centre for Climate Modelling and Analysis): *Numerical Methods in Climate Research*

**Joerg Gablonsky** (Boeing): *Effective Parallel Optimization of Expensive Functions*

**John Gilbert** (MIT Laboratory for Computer Science and UC, Santa Barbara): *Graph Algorithms in Numerical Linear Algebra: Past, Present and Future*

**Chen Greif** (UBC): *On the Solution of Indefinite Linear Systems*

**Tom Hogan** (Boeing): *Fitting Position, Direction and Curvature with a  $C^2$  Quartic Spline*

**Volker Mehrmann** (Technical University Berlin): *Numerical Methods for Model Reduction and the Control of Partial Differential Equations*

## West Coast Optimization Seminar

The West Coast Optimization Meeting takes place twice each year, and alternates between Vancouver and Seattle. In Vancouver, PIMS, CECM and the math departments at UBC and SFU share the hosting duties, with local contacts Jonathan M. Borwein and Philip D. Loewen. In Seattle, UW/Math and UW/Applied Math contribute the organizational personnel: R. T. Rockafellar and J. V. Burke do most of the work. The meetings involve an informal get-together for social and technical discussions on Friday evening, followed by a series of talks on Saturday. Speakers are drawn from the considerable body of optimization talent now gathered in the six PIMS partner sites and Washington State University; a featured guest from outside is also usually invited.

### May 3–4, 2002 at SFU:

The spring session of the West Coast Optimization Meeting was well-attended, with over thirty participants. There were seven 45-minute technical presentations and a short theoretical talk, covering the full spectrum of theory, implementations, and applications of continuous optimization. The session concluded with a small group discussion, led by Tamas Terlaky, of the prospects for stimulating and structuring a nationwide collaboration in optimization. Speakers:

**Jonathan Borwein** (SFU): *Differentiability of Monotone Functions on Separable Banach Space*

**James V. Burke** (UW): *Gauss's Approach to the Variational Analysis of Functions of the Roots of Polynomials*

**Asen Dontchev** (Mathematical Reviews): *The Many Faces of the Condition Number Theorem*

**Oliver Dorn** (UBC): *A Level Set Method for Shape Reconstruction in Medical and Geophysical Imaging*

**Marian Fabian** (Czech Academy of Sciences): *Topological and Sequential Normal Compactness*

**Gabor Pataki** (North Carolina): *On the Closedness of the Linear Image of a Closed Convex Cone*

**Tamas Terlaky** (McMaster): *Interior Point Methods: Dynamic Update and Self-Regularity*

**Paul Tseng** (UW): *Signal Denoising by Maximum Likelihood Estimation with  $l_1$ -penalty*

## PNW PDE Seminar

### May 23–25, 2002 at Washington State University, Pullman:

This meeting was held in honor of John R. Cannon's 65th birthday. The invited speakers covered a wide range of topics including inverse and ill-posed problems, free boundary problems, PDEs arising in the life sciences, PDEs arising in financial mathematics and numerical analysis of PDEs.

It was organized by Robert Dillon, Alex Khapalov, V.S. Manoranjan and Hong-Ming Yin (Washington State University).

The speakers were: **Kumud S. Altmayer** (U. Wisconsin, Whitewater), **Sergei Avdonin** (U. Alaska), **Emmanuele DiBenedetto** (U. Vanderbilt), **John Chadam** (U. Pittsburgh), **Eduardo Chappa** (U. Washington), **Paul DuChateau** (Colorado State), **Robert Dillon** (Washington State), **Jim Douglas** (Purdue), **Long Lee** (U. Washington), **Zhilin Li** (North Carolina State), **Gary Lieberman** (Iowa State), **Yanping Lin** (U. Alberta), **Shuqing Ma** (U. Alberta), **Jodi Mead** (Boise State), **Karthik Ramaseshan** (U. Washington), **William Rundell** (Texas A&M), **Thomas Seidman** (U. Maryland, Baltimore), **Ralph Showalter** (UT, Austin), **Takashi Suzuki** (Osaka), **Emily Tian** (Wright State), **Gunther Uhlmann** (U. Washington), **David Wollkind** (Washington State) and **Hong-Ming Yin** (Washington State).

## PNW Probability Seminar

This seminar is organized by the probability groups at the UBC, U. Washington and Oregon State U. It usually attracts 25–30 participants and gives the various groups a chance to interact with each other. As these are among the strongest probability groups in North America it has been easy to attract outstanding scientists as speakers. This is also a good way for these groups to share many of the visiting scientists with the other sites.

**Scientific advisory committee:** Martin Barlow (UBC), Richard Bass (UW), Chris Burdzy (UW), Ed Perkins (UBC) and Ed Waymire (OSU).



Martin T. Barlow (UBC), Scott Sheffield (Microsoft Research) and Hao Wang (U. Oregon), PNW Probability Seminar speakers.

### October 19, 2002 at University of Washington:

The speakers were:

**Martin T. Barlow** (UBC): *Random Walks on Supercritical Percolation Clusters*

**Scott Sheffield** (Microsoft Research): *Crystal Facets and the Amoeba*

**Hao Wang** (U. Oregon): *A Class of Interacting Superprocesses*

## PNW Statistics Group

This is a biannual meeting.

### April 12, 2002 at UBC:

The Spring 2002 meeting included 44 participants, with good representation from various institutions and excellent participation by graduate students. The main speaker was:

**Ying MacNab** (Health Care and Epidemiology, UBC and Centre for Community Health and Health Evaluation Research, BC Research Institute for Children's and Women's Health): *Statistical Modeling Issues in Hospital Performance Comparison Studies: the Neonatal Health Services in Canada Project*

## Cascade Topology

This is a twice-yearly seminar which rotates among the universities of the US Pacific Northwest, and western Canada. Its purpose is to gather topologists of the region, and present lectures on recent progress in the field, at an informal weekend meeting. The meetings are informal and friendly, and a special effort is made to encourage participation by graduate students by providing their housing cost.

### Joint Meeting of the PNW Geometry Seminar and the Cascade Topology Seminar, May 11–12, 2002 at U. Washington:

See page ???.

### November 2–3, 2002 at UBC:

The 29th meeting of the Cascade Topology Seminar was organized by Kee Lam and Dale Rolfsen (UBC). Speakers:

**David Gillman** (UCLA): *The Best picture of Poincare's Homology Sphere*

**Ian Hambleton** (McMaster): *Homotopy Self-equivalences of 4-manifolds*

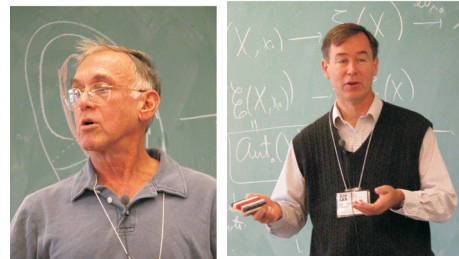
**Vaughan Jones** (UC Berkeley): *Skein Theory in Knot Theory and Beyond*

**Dev Sinha** (U. Oregon): *New Perspectives on Self-linking*

**Catherine Webster** (UBC): *Cryptography and the Braid Groups*

**Sergey Yuzvinsky** (U. Oregon): *Topological Robotics; Topological Complexity of Projective Spaces*

All these lectures were taped and can be watched by going to [www.pims.math.ca/video/meetings/](http://www.pims.math.ca/video/meetings/).



Clockwise from top left: David Gillman (UCLA), Ian Hambleton (McMaster), Vaughan Jones (UC Berkeley), Sergey Yuzvinsky (Oregon), Dev Sinha (Oregon) and Catherine Webster (UBC).

## PIMS Lecture Series

PIMS lectures series include:

- IAM-PIMS Joint Distinguished Lecture Series in Applied Mathematics
- PIMS-MITACS Mathematical Finance Seminar
- PIMS-Shell Lunchbox Lecture Series
- PIMS String Theory Seminar
- PIMS Centre for Scientific Computing Seminar
- PIMS Centre for Mathematical Biology Seminar

### IAM-PIMS Joint Distinguished Colloquium Series

This series of seminars is co-hosted by the Institute for Applied Mathematics at UBC and PIMS.

#### 2002/03 Series

**Gordon E. Swaters** (University of Alberta): *Dynamics of Abyssal Ocean Currents*, October 7, 2002

**David Chandler** (University of California): *Transition Pathways in Complex Systems: Throwing Ropes Over Rough Mountain Passes, in the Dark*, October 28, 2002

**Ulf Dieckmann** (The International Institute for Applied Systems Analysis, Laxenburg): *Spatial Complexity in Ecol-*



**Organizer:**  
Bernie Shizgal  
(Director of the IAM)

*ogy and Evolution*, December 2, 2002

**Parviz Moin** (Stanford University): *Turbulence and its Computation*, January 13, 2003

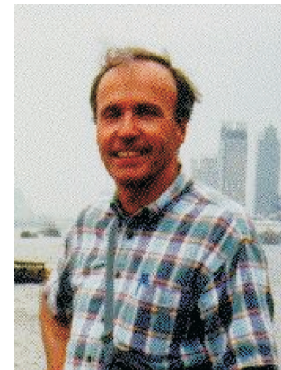
**Leon Glass** (McGill University): *Dynamics of Genetic Networks*, January 27, 2003

**Lloyd N. Trefethen** (Oxford University): *Fast Accurate Solution of stiff PDE*, March 17, 2003

These lectures were taped and are available at [www.pims.math.ca/video/dist/](http://www.pims.math.ca/video/dist/).

### PIMS-MITACS Mathematical Finance Seminars

In conjunction with research activities of MITACS, PIMS hosts a series of talk on recent work in financial mathematics.



**Organizer:**  
Ulrich Haussmann  
(Math, UBC)

#### Seminars for 2002/03

**Rik Blok** (Centre for Applied Ethics, UBC): *Statistical Properties of Financial Timeseries*, May 28, 2002

**Joern Sass** (PIMS and UBC): *Portfolio Optimization Under Partial Information: The Drift Process as Continuous Time Markov Chain*, July 11, 2002

**Satish Reddy** (Quadrus Financial Tech. Inc.): *Introduction to Options and their Valuation*, September 20, 2002

**Costis Skiadas** (Northwestern U.): *Optimal Lifetime Consumption-Portfolio Strategies Under Trading Cone Constraints and Recursive Preferences*, October 4, 2002

**Gabriel Mititica** (student): *Introduction to Collateralized Debt Obligations*, October 10, 2002

**Gillian Clegg** (UBC): *Introduction to Mortgage-Backed Securities*, October 24, 2002

**Alex Schied** (Humboldt U. & UBC): *Variational Problems for Capacities Arising in Risk Theory*, November 13, 2002

**Jean-Marie Dufour** (U. Montreal): *Testing Mean-variance Efficiency in CAPM with Possibly Non-Gaussian Errors: an Exact Simulation-based Approach*, November 28, 2002

**Ali Lazrak** (UBC): *Revisiting Treynor and Black (1973): An Intertemporal Model of Active Portfolio Management*, January 30, 2003

**Umüt Cetin** (Cornell University): *Liquidity Risk and Arbitrage Pricing Theory*, March 4, 2003

**Alexander Melnikov** (University of Alberta): *On the Pricing of Life-Insurance Contracts Based on Risky Assets*, March 20, 2003

**Antonin Settari** (U. Calgary): *Mathematics of Coupled Reservoir and Geomechanical Modeling*, May 21, 2002

**Ian Frigaard** (UBC): *Advances in Understanding Well-construction Fluid Mechanics: Cementing Flows and Turbulence*, June 13, 2002

**Richard Churchill** (Hunter College, CUNY): *Fermat's Last Theorem*, August 6, 2002

**Len Bos** (U. Calgary): *Fitting Surfaces to Data*, September 23, 2002

**Christian Jacob** (U. Calgary): *Design by Evolution The Art and Science of Genetic Computer Programming*, October 22, 2002

**Tony Ware** (U. Calgary): *Changing Your Point of View: Modern Fourier Analysis and Other Techniques for Seeing Data in a New Light*, November 18, 2002

**Edward S. Krebes** (U. Calgary): *Seismic Waves in a Layered Earth*, December 12, 2002

**Peter Lancaster** (U. Calgary): *From Quadratic Equations to Transfer Functions*, January 23, 2003

**Melvin J. Hinich** (University of Texas): *Detecting Random Modulated Cycles*, February 11, 2003

**Richard Cleve** (U. Calgary): *Quantum Algorithms*, March 11, 2003

## PIMS-Shell Lunchbox Lecture Series

PIMS is presenting a series of lectures at the Shell Centre in downtown Calgary. These lectures, given by experts from the PIMS Universities, focus on mathematical techniques and applications relevant to the oil and gas industry and demonstrate the utility and beauty of applied mathematics. The talks are aimed at a general audience. Attendance may qualify for APEGGA Professional Development Hours.



**Organizer:**  
Gary Margrave  
(U. Calgary)

The lectures in 2002/03 were:

**Rita Aggarwala** (U. Calgary): *Designing Better Industrial Experiments*, April 16, 2002

## PIMS String Theory Seminar

This is a series of lectures on String theory held approximately once per week at PIMS-UBC.



**Organizer:** Mark Van Raamsdonk (UBC)

The 2002/03 seminars included:

**Kirk Buckley** (UBC): *Superconducting Strings in High Density QCD*, November 8, 2002

**Hong Liu** (Rutgers): *Strings in Time-Dependent Orbifolds*, November 22, 2002

**Y. Frishman** (Weizmann Institute): *Meson-Baryon Scattering in 2-dimensional QCD*, February 28, 2003

## PIMS-MITACS Centre for Scientific Computing Seminar for



**Organizer:**  
Bob Russell  
(CSC Director)

### 2001/02

The 2002/03 seminars were:

**Dale Durran** (U. Washington): *Wave Propagation in Quadratic-Finite-Element Approximations to Hyperbolic Equations*, April 5, 2002

**Koorosh Nikfetrat** (BCIT): *Three Dimensional Viscous Incompressible Flow Simulations Using Helpholz Velocity Decomposition*, April 12, 2002

**Rajan Dassan and Brad Bondy** (Genus Capital Management): *Investment Problems: Mathematics and Computation*, April 19, 2002

**Alex Kurganov** (Tulane): *Smoothness Indicator for Adaptive Algorithms*, May 17, 2002

**Chris Budd** (U. Bath): *Can an Adaptive Method Live with a Symplectic Method and Still be Friends?*, May 17, 2002

**Lubomir Bakule** (Academy of Sciences of the Czech Republic): *Decentralized Control of Large Scale Systems*, May 23, 2002

**Christopher P. Silva** (Academy of Sciences of the Czech Republic): *Chaos, Fractals, and Wavelets in Communications & Signal Processing*, June 7, 2002

**JF Williams** (U. Bath): *Exactly Self-similar Blow-up in Higher Order Semilinear Parabolic Equations*, August 2, 2002

**Ioanis Nikolaidis** (U. Alberta): *On the Use of Transmission Power Control for Energy-efficiency MANET Services*, August 22, 2002

**Satish Reddy** (Quadrus Financial Tech. Inc.): *Introduction to Options and their Valuation*, September 6, 2002

**S. J. Paddison** (Los Alamos National Lab): *Multi-scale Modeling of Proton Conduction in the Electrolyte of a PEM Fuel Cell*, September 13, 2002

**Andrey Pavlov** (SFU): *Homeownership as a Constraint*

*on Asset Allocation*, September 20, 2002

**Jose-Leonel Torres** (U. Michoacan): *Biological Power Laws and Darwin's Principle*, September 25, 2002

**Michael Ward** (UBC): *The Stability and Dynamics of Localized Patterns for a Reaction-Diffusion System*, September 27, 2002

**Chen Greif** (UBC): *On the Solution of Indefinite Linear Systems*, October 4, 2002

**Eirikur Palsson** (UBC): *Exploring the Interplay of Cell-adhesion and Chemotaxis on Cell Sorting Using a 3-D Model*, October 11, 2002

**Walter Craig** (McMaster): *Traveling Water Waves*, October 21, 2002

**Brad McNeny** (SFU): *A Stepwise Procedure for Detecting Recombination Breakpoints with Application to HIV-1 Molecular Sequences From an Individual*, October 25, 2002

**Richard O. Moore** (SFU): *Importance Sampling Applied to Simulations in Optical Communications*, November 1, 2002

**Bastiaan J. Braams** (Courant): *The Computational Complexity of the Hartree-Fock Approximation in Quantum Chemistry*, November 29, 2002

**John M. Stockie** (University of New Brunswick): *Parametric Resonance in Immersed Elastic Boundaries*, January 24, 2003

**Sinai Robins** (Temple University): *Texture Maps in Image Processing and Their Links to Analytic Number Theory and Combinatorial Geometry*, January 31, 2003

**Jeff Orchard** (SFU): *Number Crunching in Medical Imaging: Combining Coupled Problems to Get Better Solutions*, February 7, 2003

**P.N. Shivakumar** (University of Manitoba): *Mathematical and Computational Aspects of Infinite Matrices and Their Applications*, February 14, 2003

**Youngsuk Lee** (University of Wisconsin): *Stability of Rossby Waves in the Beta-plane Approximation*, February 21, 2003

**Rachel Kuske** (UBC): *Stochastic Dynamics in Models Sensitive to Noise*, March 7, 2003

**Nick Trefethen** (Oxford University): *Spectrally Accurate Solutions in Unusual Geometries*, March 14, 2003

**Jinchao Xu** (Pennsylvania State University): *Multilevel Adaptive Methods for Partial Differential Equations*, March 14, 2003

**Weizhang Huang** (University of Kansas): *Variational Mesh Adaptation*, March 21, 2003

**Eusebius Doedel** (Concordia University): *Continuation of Periodic Solutions in Conservative Systems with Application to the N-Body Problem*, March 21, 2003



## PIMS Centre for Mathematical Biology Seminar

**Organizer:**  
Mark Lewis  
(University of  
Alberta)



The 2002/03 seminars were:

**Alex Mogilner** (UC Davis): *How Nematode Sperm Crawl*, September 9, 2002

**Rebecca Tyson** (Okanagan University College): *A Minimal Mechanism of Bacterial Pattern Formation*, November 4, 2002

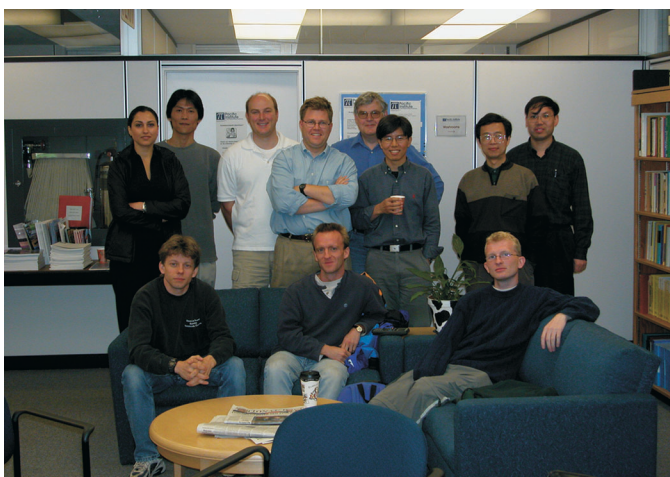
**Marc Roussel** (University of Lethbridge): *Irregularly Switched Dynamical Systems: Synchronization and Enhanced Wave Propagation*, January 13, 2003

**Bill Fagan** (Maryland University): *Rarity and Spatial Scale in Desert Fishes: Quantifying the Linkage Between Fragmentation and Extinction Risk Across Species*, February 3, 2003

**Sandy Anderson** (Dundee University): *Mathematical Modelling of Solid Tumour Growth: Angiogenesis and Invasion*, February 24, 2003



### III. GENERAL SCIENTIFIC EVENTS



The participants of the **1<sup>st</sup> PIMS-MITACS Crystal Growth Workshop**. Shown standing from left to right are San Arjoriandi (UBC), Wenxiang Zhu (Penn State), Colin Carrew (Firebird), Ian Frigaard (UBC), Bill Micklethwaite (Firebird), Huaxiong Huang (York University), Dong Liang (York University), Shuqing Liang (York University). Sitting from left to right are C. Sean Bohun (Penn State), Tim Myers (University of Cape Town) and Matt Bolton (UBC). Missing are Carl Ollivier-Gooch (UBC), Brian Seymour (UBC) and John Stockie (University of New Brunswick).

Shui-Nee Chow with some of his former PhD students at the **Americas V Conference**. This conference took place in Alberta in July 2002.



## Extra-Thematic Scientific Workshops

Its unique structure allows PIMS to move quickly to produce and promote the latest advances in the mathematical sciences and involve PIMS' scientists in them. Rather than centering all its scientific activities around a few topics for an entire academic year, thus tying up resources and limiting participation, PIMS also runs shorter, more intensive programmes to emphasize rapidly developing areas. The flexibility of this structure improves communication between PIMS' members and the larger scientific community, resulting in better trained personnel and establishing vigorous dialogue between the mathematical sciences and the other disciplines.

This section describes the extra-thematic scientific activities of the institute. Each workshop has its own organizing committee and they are mostly held in the various PIMS sites. The selection and funding decisions are made by the Scientific Review Panel.

### PIMS-MITACS Crystal Growth Workshop PIMS-UBC, May 26, 2002

One of the recent MITACS research collaborations involves modelling the industrial manufacturing of crystals. Led by Dr. Huaxiong Huang, the project is entitled "*Mathematical and Computational Modelling of Semi-Conductor Manufacturing Processes*". The main goal of the project is to improve semiconductor manufacturing through scientific modelling. Many of the group participants, the author included, were first introduced to a portion of this problem by Bill Micklethwaite of **Firebird Semiconductor** at the **5<sup>th</sup> PIMS Industrial Problem Solving Workshop** held in June 2001 at the University of Washington in Seattle.

The group consists of a handpicked international collection of researchers with a variety of backgrounds and ex-

perience. This last May the group met for the inaugural PIMS-MITACS crystal growth workshop that took place at UBC.

### 2<sup>nd</sup> Canadian Conference on Nonlinear Solid Mechanics, SFU, June 19–23, 2002

**Organisers:** Elena M. Croitoro (Co-Chair, University of Victoria), Cecil Graham (Co-Chair, SFU), R. Choksi (SFU), M. Epstein (U. Calgary), M. S. Gadala (UBC), J. B. Haddow (U. Victoria), T. B. Moodie (U. Alberta), N. Rajapakse (UBC), P. Schiavone (U. Alberta) and D. J. Steigmann (UC, Berkeley).

Canadian Conferences on Nonlinear Solid Mechanics (CanCNSM) provide an international forum for communicating recent and projected advances in various areas of Nonlinear Solid Mechanics and Materials, to assemble researchers working on common themes from complementary perspectives, and to provide an opportunity for direct information exchange among delegates from academia, research laboratories, and industry. The framework of CanCNSM Conferences is truly multidisciplinary.

The plenary speakers were:

**E. N. Dvorkin** (Centre for Industrial Research, Buenos Aires): *Finite Element Models in the Steel Industry: Modeling of Production Processes*

**R. Fosdick** (University of Minnesota): *Steady, Structured Shock Waves: Thermoelastic Materials*

**P. Podio-Guidugli** (University of Rome Tor Vergata): *Concepts and Problems in Dynamic Micromagnetics*

**A. P. S. Selvadurai** (McGill University): *Second-Order Elasticity for Axisymmetric Torsion: A Spheroidal Coordinate Formulation*

**J. R. Willis** (University of Cambridge): *Some Recent Developments in the Analysis of Composite Materials*

## Americas V Conference, Edmonton, July 7–12, 2002

**Organisers:** Michael Li (Co-Chair, Alberta), Kening Lu (Brigham Young), Konstantin Mischaikow (Georgia Tech.), James Muldowney (Co-Chair, Alberta) and Jianhong Wu (York).

The Americas Conference in Differential Equations and Non-linear Dynamics is a biennial series that was established in 1994 as a joint initiative of four major research centres in South and North America: The Center for Dynamical Systems and Nonlinear Studies (CDSNS) at Georgia Institute of Technology, USA, the Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas (IIMAS) at Universidad Nacional Autónoma de México (UNAM), Mexico, the Instituto de Matemática Pura e Aplicada (IMPA), Brazil, and Fundayacucho, Venezuela, with an initial objective of fostering close collaborations and exchanges among researchers in this scientific field among the four countries.

The series was developed as a forum for the dissemination of scientific accomplishments in the Americas and for the creation of new opportunities for collaboration in dynamical systems. It has grown into one of the major international opportunities in this area. The first four conferences were held in Taxco, Mexico (1994), Aguas de Lindoia, Brazil (1996), Atlanta, USA (1998) and Mérida, Venezuela (2000).

Americas V had 120 participants from 9 Americas countries (Canada, USA, Mexico, Brazil, Venezuela, Colombia, Chile, Argentina and Peru) as well as from Asia and Europe. The conference was dedicated to Professor Shui-Nee Chow (Georgia Tech and University of Singapore) on his sixtieth birthday. Shui-Nee along with a handful of others such as Jack Hale (USA), Gilberto Flores (Mexico) and Hildebrando Rodriguez (Brazil) have been active for many years in the development of scientific exchanges in the Americas especially at the graduate level.

The plenary lectures were delivered by: **Alfonso Castro** (Colombia, USA), **Jorge Cossio** (Colombia), **Robert Gardner** (USA), **Tomas Gedeon** (USA), **Jack Hale** (USA), **Mark Lewis** (Canada), **Hugo Leiva** (Venezuela), **Kening Lu** (USA), **John Mallet-Paret** (USA), **Antonmaria Minzoni** (Mexico), **Raúl Manásevich** (Chile), **Peter Polacik** (USA), **Hildebrando Rodrigues** (Brazil), **George Sell** (USA), **Jorge Sotomayor** (Brazil), **Jianhong Wu** (Canada) and **Yingfei Yi** (USA).

An innovation at this conference was the PIMS Posters at Americas V which was a web-based poster session. A prize of \$1000 for the best graduate student poster was shared by German Jesus Lozada Cruz (from Peru, studying for his PhD at Universidade de São Paulo, Brazil) and Horacio Gomez-Acevedo (from Mexico, studying for his PhD at U of A, Canada). The Selection Jury for the graduate student posters

was Raúl Manásevich (Chile), Gilberto Flores (Mexico) and Jianhong Wu (Canada).

## Co-Sponsored Computer Science Conferences, Edmonton, July–August 2002

Over a three-week period in July–August 2002, PIMS, the University of Alberta together with the City of Edmonton had the honour of hosting the following eight prominent international conferences. Each of these conferences represents a field with sophisticated mathematics and fascinating intellectual challenges. In addition, each is addressing useful, important real-world problems.

### IDEAS'02, International Database Engineering and Applications Symposium, Edmonton, July 17–19, 2002

An international forum for discussion of the problems of engineering database systems involving not only database technology but the related areas of information retrieval, multimedia, human machine interface and communication. More information can be found on <http://database.cs.ualberta.ca/ideas02>.

### CanDB'02, 3<sup>rd</sup> Annual Canadian Database Workshop, Edmonton, July 22, 2002

A biannual workshop grouping Canadian academics in databases to discuss their current research and research issues. <http://db.cs.ualberta.ca/candb/>.

### KDD'02, The 8<sup>th</sup> ACM SIGKDD International Conference on Knowledge Discovery and Data Mining Conference, Edmonton, July 23–26, 2003

The largest international conference in Knowledge Discovery and Data Mining, see [www.acm.org/sigs/sigkdd/kdd2002/](http://www.acm.org/sigs/sigkdd/kdd2002/).

### CG'02, 3<sup>rd</sup> International Conference on Computers and Games, U. Alberta, July 25–27, 2002

A major international forum for researchers and develop-

ers interested in all aspects of artificial intelligence in computer game-playing. For more information see [www.cs.ualberta.ca/cg2002](http://www.cs.ualberta.ca/cg2002).

**AAAI/IAAI'02,  
18<sup>th</sup> National Conference on Artificial  
Intelligence, 14<sup>th</sup> Innovative Applications of  
AI Conference,  
Edmonton, July 28–August 1, 2002**

The pre-eminent conference in Artificial Intelligence, for more information see [www.aaai.org/Conferences/National/2002/aaai02.html](http://www.aaai.org/Conferences/National/2002/aaai02.html).

**UAI'02,  
18<sup>th</sup> Conference on Uncertainty in Artificial  
Intelligence,  
U. Alberta, August 1–4, 2002**

The primary international forum for presenting new results on the use of principled methods for reasoning under uncertainty within intelligent systems. For further information see [www.cs.ucla.edu/uai02/](http://www.cs.ucla.edu/uai02/).

**SARA'02,  
Symposium on Abstraction, Reformulation  
and Approximation,  
Kananaskis, August 2–4, 2002**

The fifth Symposium on Abstraction, Reformulation and Approximation (SARA) was held at Kananaskis Mountain Lodge, Kananaskis Village, Alberta (Canada), August 2–4, 2002. SARA's aim is to provide a forum for intensive interaction among researchers in all areas of AI with an interest in the different aspects of AR&A techniques.

SARA'02 was the most successful of the five meetings held so far. Fifty-one researchers attended from countries around the globe and twenty of the attendees were Ph.D. students. There were three invited technical talks, 14 technical presentations selected on a peer-review basis, and 14 presentations of “late breaking results” in a lively poster session. The proceedings of the meeting are published under the title *Abstraction, Reformulation and Approximation* as volume 2371 in Springer's LNAI series (Lecture Notes in Artificial Intelligence). Many details about the meeting, including some of the presentations made, are available through the conference's web page: [www.cs.ualberta.ca/~holte/SARA2002/](http://www.cs.ualberta.ca/~holte/SARA2002/)

SARA-02 is an affiliate of the American Association for Artificial Intelligence (AAAI), and as such received free advertising through AAAI and a very generous grant for supporting student attendance. NASA's Ames Research Center provided financial support for two of the invited

speakers. The University of Alberta provided a conference grant. PIMS handled the pre-registration of all attendees.

The next SARA will be run by Jean-Daniel Zucker of the Université Paris VI (Pierre & Marie Curie) in Paris, France. For more information, contact **Jean-Daniel.Zucker@lip6.fr**.

**ISMB'02,  
10<sup>th</sup> International Conference on Intelligent  
Systems for Molecular Biology,  
Edmonton, August 3–7, 2002**

The largest international conference in bioinformatics and computational biology. For more information see [www.cs.ualberta.ca/ismb02/](http://www.cs.ualberta.ca/ismb02/).

**Aperiodic Order, Dynamical  
Systems, Operator Algebras and  
Topology,  
U. Victoria, August 4–8, 2002**

**Organisers:** Jean Bellissard (Toulouse), Johannes Kellendonk (Cardiff), Ian Putnam (Victoria).

The workshop was devoted to recent developments in the area of aperiodic tilings and quasi-crystals. In particular, the participants discussed contributions from diverse fields such as operator algebras, topology, K-theory and foliated spaces, as well as ergodic theory and diffraction. Experts from these different fields were brought together to share their knowledge.

The speakers and titles were:

**Claire Anantharaman-Delaroche** (Université d'Orléans): *Amenable Groupoids. Examples and Applications*

**Michael Baake** (Universität Greifswald): *Mathematical Diffraction Theory and Model Sets*

**Marcy Barge** (Montana State University): *The Topology of One-dimensional Tiling Spaces*

**Laurent Bartholdi** (UC, Berkeley): *Tilings and Groupoids Acting on Rooted Trees*

**Bob Burton** (Oregon State): *A Dynamical Approach to Constructing Sequences in the Unit Cube which are Well Dispersed*

**Thierry Fack** (Université de Lyons I): *Introduction to Cyclic Cohomology*

**Franz Gähler** (ITAP, Universität Stuttgart): *Modelling Aperiodic Solids: Concepts and Properties of Tilings and their Physical Interpretation and Cohomology of Quasiperiodic Tilings*

**Jean-Marc Gambaudo** (Université de Bourgogne, Dijon): *Delone Sets, Tilings and Solenoids: From Finite Transla-*

*tion Type to Finite Isometry Type*

**Thierry Giordano** (U. Ottawa): *Affable Equivalence Relations and Orbit Structure of Cantor Minimal Systems*

**Chaim Goodman-Strauss** (U. Arkansas): *Triangle Tilings and Regular Productions*

**John Hunton** (U. Leicester): *New Models and Methods for Tiling Spaces*

**Jerry Kaminker** (I.U.P.U.I.): *Index Theory on Foliated Spaces and Applications*

**Alex Kumjian** (U. Nevada, Reno): *Actions of  $Z^k$  Associated to Higher Rank Graphs*

**Jeong-Yup Lee** (U. Alberta): *Consequences of Pure Point Diffraction Spectra for Discrete Point Sets*

**Daniel Lenz** (TU-Chemnitz): *Uniform Ergodic Theorems on Delone Dynamical Systems and Applications*

**N. Christopher Phillips** (U. Oregon): *The Structure of the  $C^*$ -algebras of Free Minimal Actions of  $Z^d$  on the Cantor Set*

**Charles Radin** (U. Texas, Austin): *Aperiodicity: Lessons from Various Generalizations*

**Lorenzo Sadun** (U. Texas): *When Size Matters: the Effect of Geometry on 1-D Tiling Dynamics*

**Klaus Schmidt** (U. Vienna):

**Claude Schochet** (Wayne State): *Life After  $K$ -theory*

**Robert Williams** (U. Texas, Austin): *Tiling Spaces as Cantor Set Fiber Bundles*

## Physics Conference in Honour of K. S. Viswanathan's Contribution to Theoretical Physics, PIMS-SFU, September 19–20, 2002

**Organisers:** A. DeBenedictis (Langara), P. Matlock (SFU), W. Mueck (Naples), R. Parthasarathy (Chennai, India), R. Rashkov (Sofia, Bulgaria) and Y. Yang (SFU)

The speakers at this conference were:

**A. Das** (SFU)

**D. Horvat** (U. Zagreb, Croatia): *Hypernuclear Potentials and Axial Vector and Vector Meson Degrees of Freedom*

**T. Lee** (Kangwon National University, Korea): *String Field Theory and Tachyon Condensation*

**R. Parthasarathy** (Institute of Mathematical Science, India): *Abelianisation of Wilson Loops of Non-Abelian Gauge Theory*

**P. Matlock** (SFU): *Butterfly Tachyons*

**R. Rashkov** (Sofia University, Bulgaria): *On the Static/time-dependent Tachyon States in Vacuum String Field Theory and Their Relevance to Cosmology*

**G. Semenoff** (UBC): *Aspects of AdS/CFT*

**Y. Yang** (SFU)

## PIMS-ASRA Industrial Workshop: Mathematical Prediction of Sound Transmission Through Composite Lightweight Walls Seminar, ATCO Noise Management, Calgary, November 7, 2002

**Organisers:** Daryl Caswell (University of Calgary), Liming Dai (U. Regina), Dave Nichols and Salem Hertel (ATCO Noise Management).

This seminar was conducted by David Quirt and Alfred Warnock (Acoustics, Institute of Research in Construction, NRC).

The seminar consisted of six presentations:

*Airborne Sound Transmission Through Walls and Floors*

*Flanking Transmission—Typical performance, and concepts for modelling*

*Modelling Airborne Sound Transmission Through Walls and Floors Floor and Wall Assemblies—Using Regression to Predict TL*

*Predicting Flanking Transmission in Wood Framed Construction*

*Sound Transmission Through Concrete Block Wall Systems*

## Co-Sponsored Computer Science Activities, Vancouver, November 16–23, 2002

**Local Organizer:** Arvind Gupta (MITACS)

Four premier events in theoretical computer science were held at the Delta Pinnacle hotel in Vancouver. In total more than 500 participants came from around the world took part in one or more activities.

## Workshop on Algorithms and Models for the Web-Graph, November 16, 2002

**Organisers:** Bela Bollobas (Memphis and Cambridge), Andrei Broder (IBM T. J. Watson, Chair), Guido Caldarelli (U. di Roma), Fan Chung Graham (UC San Diego), Alan Frieze (CMU), Lee Giles (Penn State), Jon Kleinberg (Cornell), Ravi Kumar (IBM Almaden), Michael Mitzenmacher (Harvard), Christos Papadimitriou (UC Berkeley), Prabhakar Raghavan (Verity Inc), Andrew Tomkins (IBM Almaden) and Eli Upfal (Brown).

The 1st Workshop on Algorithms and Models for the Web-Graph (WAW) was very successful. There were 9 contributed talks, 3 invited talks, and a panel, and the final tally was 76

participants, probably half of which were students.

The invited speakers were:

**F. Chung, L. Lu and V. Vu** (UC, San Diego): *Eigenvalues of Random Power Law Graphs*

**R. Stata** (UC, Santa Cruz): *Building Web-scale Web Graphs From Real Data*

**M. Mitzenmacher** (Harvard): *A Brief History of Generative Models for Power Law and Lognormal Distribution*

The event was co-sponsored by MITACS, PIMS, IBM, and Overture.

### Foundations of Computer Science Tutorial, November 16, 2002

This tutorial attracted 200 participants. The three speakers that were chosen to present tutorials on topical issues were:

**Oded Goldreich** (Weizmann Institute of Science): *Zero-Knowledge*

**Eva Tardos** (Cornell): *Approximation Algorithms*

**Salil Vadhan** (Harvard): *Randomness Extractors*

### IEEE Foundations of Computer Science (FOCS) Conference, November 16–19, 2002

**Programme Committee:** Dorit Aharonov (Hebrew U), Maria Luisa Bonet (UPC, Barcelona), Bernard Chazelle (Chair, Princeton & NEC Research), Edith Cohen (AT&T Labs), Lance Fortnow (NEC Research), Anna Gal (UT Austin), Venkatesan Guruswami (UC Berkeley & U Washington), Piotr Indyk (MIT), Ravi Kannan (Yale), Claire Kenyon (U Paris-Sud), Yuval Rabani (Technion), Tal Rabin (IBM Research), Omer Reingold (AT&T Labs), Ronitt Rubinfeld (NEC Research), David B. Shmoys (Cornell), Dan Spielman (MIT) and Emo Welzl (ETH, Zürich).

The 43rd Annual Symposium on Foundations of Computer Science (FOCS 2002) had close to 350 participants, much higher than the usual 200–250 at past FOCS conferences. More than 250 papers were submitted out of which 74 were selected for presentation. The highlight was a traditional Chinese banquet at the Imperial Chinese Restaurant.

The IEEE Computer Society Technical Committee on Mathematical Foundations of Computing, MITACS, SFU, PIMS, Microsoft Hewlett-Packard and QCI were all sponsors of the event.

### International Symposium on Symbolic and Algebraic Computation (ISAAC), November 20–23, 2002

**Organizers:** Binay Bhattacharya (SFU), Prosenjit Bose (Carleton), Arvind Gupta (SFU) and Tiko Kameda (SFU).

The 13<sup>th</sup> Annual International Symposium on Algorithms and Computation (ISAAC) attracted 120 participants with

substantial representation from Asian countries. There were 54 papers presented from 164 submissions.

The three plenary speakers were:

**Luc Devroye** (McGill): *Random Tries*

**János Pach** (Courant Institute): *Monotone drawings of planar graphs*

**Nicholas Pippenger** (UBC): *Expected Acceptance Counts for Finite Automata with Almost Uniform Input*

The sponsors of ISAAC were MITACS, PIMS, SFU, HP, QCI, and Bajaj.

### Alberta Conference on Industrial Organization, U. Calgary, November 29–30, 2002

**Organisers:** Aidan Hollis (U. Calgary) and Andrew Eckert (U. Alberta).

Competition policy is the means through which national governments control the behaviour of firms to ensure that consumers receive a low price and yet investors receive a fair return on their investment. This workshop explored several different aspects of competition policy by drawing on examples from specific industries (such as gasoline and automobiles) in which there is systematic useful data, and by theoretical modelling applied to explore problems such as competition in the patent system and competition in industries with upgrades.

The speakers at this conference were:

**John Boyce** (U. Calgary): *Novelty ad Usefulness in Patents*

**Jeffrey Church** (U. Calgary): *Competitive Upgrades*

**Andrew Eckert** (U. Alberta): *Retail Gasoline Price Cycles and Cross-Sectional Price Dispersion*

**Robin Lindsey** (U. Alberta): *Predatory Pricing in Differentiated Products Retail Markets*

**Moez Kilani** (Universite du Centre a Sousse, Tunisia): *Price and Product Line Competition in Automobile Markets*

### Special Functions in the Digital Age, SFU, January 23–24, 2003

The workshop was cosponsored by the Centre for Experimental and Constructive Mathematics and the Pacific Institute for the Mathematical Sciences. It was organized by Professor Jonathan Borwein (SFU).

This meeting was motivated by the large number of recent developments in computational techniques for special



functions, and to take advantage of the visit to SFU by professor Daniel Lozier from NIST, where the Digital Library of Special Functions Project is being developed. The idea was to hold a meeting with a small number of participants, to exchange information, gather opinions and relate a number of different projects going on, including some at CECM.

The meeting happened in an informal and friendly atmosphere, with excitement about the opportunity of hearing about the different projects, and included the following talks:

**David Jeffrey** (University of Western Ontario): *Elementary Functions in an Automatic Symbolic Context, Part I: Inverse Functions and the Unwinding Number*

**Rob Corless** (UWO): *Elementary Functions in an Automatic Symbolic Context, Part II: Closure, Continuity and Correctness*

These two talks discussed the current limitations of computer algebra systems with regards to inverse functions, as well as the possible use of the unwinding number to tackle these problems.

**Edgardo Cheb-Terrab** (UERJ Brazil, CECM and Maplesoft): *Special functions & Maple*

This talk presented a large number of new special function developments happening in the Maple system. The presentation focused on a new network of routines for relating special functions and for computing differential polynomial forms for non-polynomial objects, as well as on the “Function Advisor” Maple project: an interactive computational assistant with respect to mathematical functions.

**Victor Adamchik** (Carnegie-Mellon University): *The Multiple Gamma Function: Theory, Computation and Applications*

Victor Adamchik discussed the theory of the Multiple Gamma function, illustrating its use in edge problems in exact integration of special functions. He showed how this function can also be used in numerical evaluation algorithms and presented benchmarks showing that these algorithms perform significantly better than those available in current computer algebra systems.

**Dan Lozier** (NIST): *Digital Library of Special Functions (DLMF) Technical Issues*

The popular Abramowitz and Stegun Handbook of Mathematical Functions was first published in 1964. It remains a technical best-seller and is among the most widely cited of all mathematical reference compendia. But the Handbook is increasingly out-of-date. Lozier presented an ongoing project at the National Institute of Standards and Technology (NIST) to develop a Digital replacement for it with impressive computational features; this is expected to be available on the internet and so become a major resource of math reference data for special functions and their applications.

**Jon Borwein** (CECM, SFU): *Experiments in Mathematics*

Closing the meeting, Jon Borwein, from CoLab, CECM, SFU, presented a thorough and lively talk on experiments in computational mathematics, with varied philosophical and historical insights regarding the subject, its evolution and its future.

## Seminar on Stochastic Processes, University of Washington, March 27–29, 2003

This conference attracted about 100 participants, mainly from the United States, but also from countries as diverse as Algeria, Colombia, Germany and Hungary. About one half of the participants were junior people: recent graduates and even advanced graduate students. The conference followed the format of the previous conferences in the same series. See <http://www.math.yorku.ca/Probability/ssparch.html> for the history of the conference. Only five one-hour invited talks were given by the top experts in probability theory. All other sessions were devoted to short informal talks. Every participant had a chance to present his or her most favourite recent result or an interesting open problem. Both senior mathematicians and junior researchers actively participated in the informal sessions. Ample time was left for discussions in small groups.

The main speakers and their lecture titles were:

**Ioannis Karatzas** (Columbia U.): *Some Stochastic Optimization Problems in Mathematical Finance*

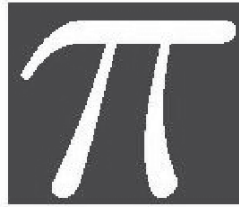
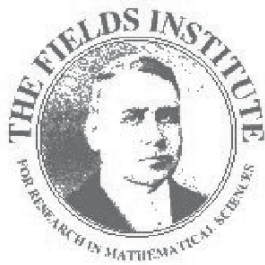
**Wenbo Li** (U. Delaware): *Large Deviations for Intersection Local Times*

**Russ Lyons** (Indiana U. and Georgia Tech): *Stationary Determinantal Processes (Fermionic Lattice Gases)*

**Carl Mueller** (U. Rochester): *Some Wave Equations with Noise*

**Balint Toth** (Budapest U. of Technology & Economics): *Between Equilibrium Fluctuations and Eulerian Scaling*

Some more information related to the event, including a few photographs, can be found at <http://www.math.washington.edu/~burdzy/SSP2003/index.shtml>. The conference was sponsored by the Institute of Mathematical Statistics and was financially supported by PIMS, the Milliman Fund at the Department of Mathematics, at the University of Washington, a VIGRE grant at the University of Washington, the National Science Foundation, the University of Washington, College of Arts and Sciences at the University of Washington and the Graduate School at the University of Washington. A big portion of the conference budget was spent on travel grants for junior researchers, women, minorities, and participants with no grants.



## National Programme Committee

In 1999 the three Canadian Institutes in the Mathematical Sciences, CRM, Fields and PIMS, initiated a new programme for the support of joint activities in the mathematical sciences. This programme is administered by a National Programme Committee, which makes recommendations to the Directors of the three institutes. The mandate includes:

- Allocating funds provided by the three institutes to support conferences and workshops in the mathematical sciences across Canada. These are primarily activities that fall outside of the main purview of the three institutes, or that would benefit from joint institute funding.
- Allocating funds for the support of activities that are held at the meetings of the three Canadian mathematical science societies: Canadian Mathematical Society (CMS), Canadian Applied and Industrial Mathematical Society (CAMS), Statistical Society of Canada (SSC).
- Assist the National Societies in supporting graduate students to attend these scientific meetings and coordinating annually the organization of three Institute Sessions to be held at the meetings of the Canadian Mathematical Society.
- Coordinating international programmes and other ventures where it is advantageous for the three Institutes to act as a whole.

The six member committee consists of the Deputy Directors and one member of the scientific advisory panel at each institute.

A call for proposals is made annually with submitted proposals considered semi-annually (September 15 and March 15). Primary administrative responsibility for the programme rotates between the three Institutes on an annual basis. Submissions are made to the Deputy Director of the institute administering the programme in that year. In 2001–02 the Committee approved the following slate of scientific activities:

### Activities 2002/03:

#### Western Canada Linear Algebra Meeting

University of Regina, May 10–11, 2002

Contact: Steve Kirkland (U. Regina)

#### PIMS Sessions at the SSC Annual Meeting

McMaster University, May 26–29, 2002

Contact: Bruce Smith (Dalhousie University)

#### 5<sup>th</sup> Americas Conference on Differential Equations and Nonlinear Dynamics

University of Alberta, July 07–12, 2002

Contacts: Michael Li and James Muldowney (U. Alberta)

#### Formal Power Series and Algebraic Combinatorics 2002

University of Melbourne, July 8–12, 2002

Organizer: Nantel Bergeron (York U.)

#### Nonlinear Dynamical Systems with Applications

Memorial U. Newfoundland, July 15–18, 2002

Organizers: H. Brunner and X. Zhao (Memorial U.)

#### AARMS Summer School

Memorial University of Newfoundland,

July 22–August 16, 2002

Organizer: Hermann Brunner (Memorial U.)

#### 14<sup>th</sup> Annual Canadian Conference on Computational Geometry (CCCG02)

University of Lethbridge, August 12–14, 2002

Contact: Stephen Wismath (U. Lethbridge)

#### International Workshop on Polynomial Identities in Algebra,

Memorial University of Newfoundland,

August 29–September 3, 2002

Organizer: Hermann Brunner (Memorial U.)

#### APICS 2002 Special Session on Ring Theory

Mount Allison University, October 18–20, 2002

Organizers: M. Beattie (Mount Allison U.), M. M. Parmenter (Memorial U.) and R. J. Wood (Dalhousie U.).

**Numerical Analysis, Scientific Computing and Computational Applied Mathematics**

St. Francis Xavier University, October 20–21, 2002

Organizer: Hermann Brunner (Memorial U.)

**CMS Winter Meetings**

Ottawa, December 8–10, 2002

Organizer: Graham Wright (CMS)

**30<sup>th</sup> Annual Meeting of the  
Statistical Society of Canada  
McMaster University,  
May 26–29, 2002**

The 30th Annual Meeting of the Statistical Society of Canada (SSC) was held on May 26–29, 2002, on the campus of McMaster University, in Hamilton, Ontario. The conference was generously supported by grants from the National Program Committee (NPC) of the CRM, Fields and PIMS, and McMaster University.

This meeting was an unequivocal success, with 379 registered participants. There were three workshops held:

- i) *Design and Analysis of Cluster Randomization Trials* by **A. Donner** (U. Western Ontario) and **N. Klar** (Cancer Care Ontario)
- ii) *Design and Analysis of Computer Experiments for Engineering* by **J. Sachs** (Duke University) and **W. Welch** (U. Waterloo)

- iii) *Handling Missing Data* by **K. Nobrega** and **D. Haziza** (Statistics Canada)

There were 46 scientific sessions in total, plus a poster session. Topics ranged from theoretical probability, inference, and stochastic processes to applied sessions on environmental issues, statistical genetics, and statistics and governmental policy.

Thanks in no small part to the funding from the NPC, the meeting included a large number of internationally known speakers. The particular speakers whose funding was wholly or partially covered by the grant from NPC, by session, were:

- i) *Probability*: **Ilie Grigorescu** (U. Miami)
- ii) *Statistical Inference*: **Chris Klaassen** (U. Amsterdam) and **William Strawderman** (Rutgers U)
- iii) *Statistics for Microarray Data Analysis*: **Michael Newton** (U. Wisconsin, Madison) and **Terry Speed** (UC, Berkeley)
- iv) *Statistics and Brain Mapping*: **Pedro Valdes-Sosa** (Cuban Neuroscience Center) and **Moo Chung** (U. Wisconsin, Madison)
- v) *Statistics and Public Policy*: **Miron Straf** (National Academy of Sciences)
- vi) *Split Plot Experiments in Industry*: **Robert McLeod** (PhD student at U. Manitoba)
- vii) *New Research Findings in Analysis Methods for Survey Data*: **Christian Boudreau** (PhD student at U. Waterloo)

The complete programme is available on the web at [www.mscs.dal.ca/~bsmith/ssc2002/program.html](http://www.mscs.dal.ca/~bsmith/ssc2002/program.html).

# The National Program on Complex Data Structures

## Members of the Program Committee

**Jamie Stafford** (Director of the NPCDS, U. Toronto)

**David Bellhouse** (University of Western Ontario)

**Richard Cook** (University of Waterloo)

**Paul Gustafson** (UBC)

**Mike Hidioglou** (Statistics Canada)

**Nancy Reid** (University of Toronto)

**Randy Sitter** (Simon Fraser University)

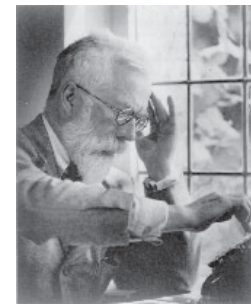
**Ed Susko** (Dalhousie University)

**Louis-Paul Rivest** (Universite Laval)

The National Program was conceived as a model for a national network in the Statistical Sciences in partnership with Canada's three Mathematical Sciences Institutes. The program was funded by NSERC during the recently completed reallocations exercise and received funding for four years for a total of \$687,000 with an additional \$200,000 committed to the program by the Institutes. **Jamie Stafford** (U. Toronto) is the Director of the National Program and chairs its Scientific Committee. The Scientific Committee and the Institute Directors are working intensively to establish what is expected to be a very successful program.

The broad goal of the program is to foster nationally coordinated projects with substantial interactions with the large community of scientists involved in analysis of complex data sets, and to establish a framework for national networking of research activities in the statistical community. The original proposal targeted the development and application of statistical methods for the analysis of data

obtained from complex survey sample designs and longitudinal biological, epidemiological and medical studies. More specific objectives of the program include the development of collaborations between university and extra-university researchers, and the provision of training for graduate students in important scientific areas through these collaborations.



Fisher, the father of modern statistics

The working plan for 2003 is to promote collaborative research opportunities in thematic areas through two inaugural workshops/projects. One is in complex survey data analysis for population health and social science, and the other is in statistical genomics/bioinformatics. In partnership with the National Program and Statistics Canada, the project on complex survey data has successfully sought further support from MITACS and has established research positions for students.

The National Program is a unique opportunity to advance the statistical sciences in Canada and its success depends crucially on the active involvement of statisticians and scientists from a variety of sectors across the country. Those interested in providing input on important directions for the program are welcome to do so by contacting Jamie Stafford. Information about the program may be found at [www.pims.math.ca/NPCDS/](http://www.pims.math.ca/NPCDS/).

## V. INDUSTRIAL PROGRAMME



The participants of the 6<sup>th</sup> PIMS Industrial Problem Solving Workshop beside the PIMS facility at

### PIMS/MITACS Industrial Partners:

Advanis	IBM T. J. Watson Research Center	Precision Biochemicals
Amber Computer Systems	ICBC	Prestige Telecommunications
APPEGA	Imperial Oil	Progas
Ballard Power Systems Inc.	In Silico	Quatronix Media
Barrodale Computing	Insightful	Searle
Bayer Inc.	Itres Research Ltd.	Shaw Cable
BC Cancer Research Center	Kinetek Pharmaceuticals Inc.	Siemens Research
BC Hydro	Lockheed Martin Tactical Defense Systems	Simons International Copr.
BioTools	Math Resources Inc.	SmithKline BeeCham Pharma
Canadian Cable Labs	MathSoft	Sperry-Sun
Canadian Marconi	MacMillan Bloedel Ltd.	Soundlogic
Charles Howards & Associates	McMillan-McGee	StemCell Technologies Inc.
Chemex Labs	MDSI	StemSoft Software Inc.
Computer Modeling Group	Menex Technologies	Stentor
Corel Corporation	Merak	Stern Stewart & Co.
Crystar Research Inc.	Michelin	Sun Microsystems
Diagnostic Engineering Inc.	NALCO Canada Inc.	Syncrude
Dynapro	NORTEL Networks	Telecom Research Labs
Eastman Kodak	Novacor	Telus
Enbridge	Pacific Forestry Centre	TransAlta
FinancialCAD Corporation	PanCanadian Petroleum Ltd.	Veritas DGC
Firebird Semiconductors	Petro Canada	VisionSmart
Galdos Systems	Progas	Vortek Industries Ltd.
Hughes Aircraft	Powerex	Waterloo Maple Inc.
Husky Oil	Powertech Labs Inc.	Worker's Compensation Board

# Industrial Problem Solving Programme

The format of the **Industrial Problem Solving Workshops** is mainly based on the Oxford Study Group Model, in which problems of relevant and current interest to the participating companies are posed to the workshop participants by experts from industry. The participating graduate students and academics will spend five days working on the problems and the results will be published in the workshop's proceedings. The advantages for participating students and academics are:

- The challenge of applying one's skills to new and relevant problems directly applicable to industry.
- The opportunity for continued collaboration with the workshop's academic and industrial participants.
- Help PIMS and mathematics in general, by showing businesses and governments the tangible benefits of supporting the mathematical sciences.

## 6<sup>th</sup> PIMS Industrial Problem Solving Workshop (IPSW 6) University of British Columbia, May 27–31, 2002

### Organizers:

Jack Macki (U. Alberta)  
Chris Bose (U. Victoria)  
Randy LeVeque (U. Washington)  
Huaxiong Huang (York U.)  
Marc Paulhus (U. Calgary)  
Manfred Trummer (SFU)  
Ian Frigaard (UBC)

### Industrial Participants:

Capital Health  
McMillan-McGee Corp  
Precix Advanced Cutting Technologies  
RBC Financial Group  
Semiconductor Insights  
Shell Canada  
Talisman Energy

## **PIMS Industrial Problem Solving Workshop (IPSW 6)** **University of British Columbia,** **May 27–31, 2002**

About 100 people registered for this year's **Industrial Problem Solving Workshop (IPSW)**, including the 60 graduate students who had taken part in the graduate modeling camp the week before. Faculty from as far away as South Africa, Finland and China 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 found on the website, [www.pims.math.ca/industrial/2002/ipsw/](http://www.pims.math.ca/industrial/2002/ipsw/), and proceedings papers are now being written by each group.

### **Workshop Problems:**

**Mathematically Surface Matching of Maps of the Human Torso:** **Edmond Lou** represented **Capital Health of Edmonton** and brought a problem involving automating the process of analysis data from a 3D laser scanner that is used to diagnose patients with scoliosis. The current process, although good, relies on many manual user steps to complete the analysis. The team was able to show how some standard (and some not so standard) image processing techniques could be used to fully automate the data analysis process. Further, Capital Health was interested in knowing if it was necessary to use the physical marker points that they currently place on the patient's back before the scanning process. The team was convinced, after looking at a large amount of sample data, that the information given by the marker points could not be retrieved mathematically from the data, and hence are necessary.

**Combined Inversion of Seismic and Magnetotelluric for Gas Exploration in the Canadian Foothills:** **Kai Meunzer** from **Shell Canada** came to the workshop with an inverse problem: Given seismic and magnetotelluric data, can we determine geological properties of the Canadian foothill? After some discussion on the background materials of both seismic and magnetotelluric methodologies, the team realized that the best approach was to construct a simple one-dimensional 3-layer model to test a hybrid seismic-magnetotelluric approach by minimizing the weighted least square errors of both seismic and magnetotelluric data. Even though the team worked on this project was the smallest,

each participant brought considerable expertise from various areas. With the help of Doug Oldenburg, (an expert in geophysical inverse problems), Yongji Tan, (an expert in inverse problems), and with the help of two graduate students, it was found that the hybrid method works better than either seismic or magnetotelluric approaches. This was only true if appropriate weight functions were chosen. Kai Meunzer was very satisfied with the progress made during the workshop and some follow-up work after the workshop has provided further insight into the problem.

**How to create the composite image of an integrated circuit:** **Edward Keyes of Semiconductor Insights** was interested in an algorithm to automatically stitch a large number of images of an integrated circuit together in order to reconstruct the image of the entire circuit itself. This problem attracted a large number of participants who quickly broke into teams to test the many different approaches that were suggested. The most straightforward approach, based on least-squares was implemented and tested during the week and was found to be a significant improvement over the current method. Other approaches, based on graph theory, simulated annealing and linear programming also showed a great deal of promise. It is clear that once the smoke clears the company will have an algorithm that is a significant improvement over the current techniques.

**Resistance Monitoring:** Appearing in his second IPSW, **Bruce McGee of MacMillan-McGee** presented the following scenario. One method of recovering soil contaminants is to electrically heat the soil with various electrodes inserted into wells in the ground. By injecting water into certain electrode locations and pumping fluids out of the remaining locations, the contaminants are slowly removed. If the contaminants are actually removed, as is intended, this process should change the resistivity of the soil as it progresses. For this reason, departures from the characteristic evolution of resistivity are of particular interest. The workshop participants were given the inverse problem of find the actual resistivity, given the response curve of the current, (or indeed any other measurable data). Failing this, was it possible to localize where in the domain any changes in resistivity occurred? Because of the size of the group (7 faculty and 9 graduate students), various aspects of the problem were investigated. To understand the forward problem a sequence of one and two-dimensional models were constructed to determine (i) the time evolution of the temperature field when cold water is injected and (ii) the sensitivity of the model to small localized changes in the resistivity. These preliminary investigations illustrated that an internal transition layer is generated during the propa-

gation of the shock of injecting cold water, which persists in the steady state. Furthermore, the measured voltage between the electrodes is much more sensitive than the outflow fluid temperature to localized resistivity changes. Using these forward models as justification, the temperature field was neglected for the inverse problem and an attempt was made to implement the generalized sensitivity theorem in a square domain with a localized resistance anomaly at its centre. By combining the computed voltage field in the domain without the anomaly with a series of voltage measurements obtained with the anomaly in place, a picture of where the anomaly was located was built up. Work continues on the problem specifically in extending the analysis of the inverse problem to a simple layered medium. Investigations to increase the resolution of the inverse problem using an analytic Green's function and finite difference rather than finite element methods are ongoing. Bruce McGee was quite pleased with the progress made on the problem and anticipates a predictive model that can be used onsite. In Bruce's words, "It's all good!"

**Price Pseudo-Variance, Pseudo-Covariance, Pseudo-Volatility, and Pseudo Correlation Swaps—In Analytical Close Forms:** **Ritchie He** of the **RBC Financial Group** presented a challenge to compute the closed form solutions to some very complex "pseudo" statistics. The team for this problem consisted almost entirely of graduate students, most of whom were new to financial mathematics. Nevertheless, the result was achieved and we look forward to seeing the full solution presented in the report.

**Seismic inverse problem in anisotropic, inhomogeneous media:** In the areas of petroleum exploration and reservoir engineering, geoscientists use concepts from seismology to image the subsurface and determine essential rock-physics properties. Experimental conditions are typically in the form of a seismic survey whereby measurements are made of a seismic wave traveling between source and receiver. **Talisman Energy** presented an inverse seismic ray problem that sought to incorporate recent technological advances in the determination of elastic moduli. In particular, with the development of three-component geophones it is now possible to measure particle displacement associated with a seismic wavefront at depth. Such an experiment, whereby sources are located at the surface and geophones are placed within the earth, is called a VSP, (vertical seismic profile). It was hoped that pairing particle displacement (i.e., polarization angle) with recorded traveltimes would lead to an in situ inversion for elastic moduli requiring only a single source/receiver pair. Using concepts of asymptotic ray theory and continuum mechanics the team was able to formulate a system of eight non-linear equations that could be solved for the elastic moduli that were sought. Unfortunately, with the introduction of experimental errors, the system proved highly unstable and had to be abandoned. However, with the introduction of some further, yet not overly restrictive, assumptions, the team went on to formulate a new system of four non-linear equations. Initial follow up work suggests the new formulation is reasonably stable under experimental conditions.



## Industrial and Scientific Training Activities

### Basic Components of Programme:

**The PIMS Graduate Industrial Mathematics Modeling Camp:** Graduate students from Canadian universities come to learn various aspects of high-level techniques for solving industrial mathematics problems. The camp prepares them for the PIMS Industrial Problem Solving Workshop: **The PIMS Summer School in Industrial Fluid Dynamics:** The participants attend a comprehensive series of graduate-level lectures and are also 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.

**The IAM-CSC-PIMS School in Industrial Mathematics for Senior Undergraduates** shows students how the mathematics they are learning can be useful. Faculty mentors lecture on various industrial problems to all the participants. Subsequently, the students have the option of choosing one or more problems to work on during the three-day workshop.

**The PIMS-MITACS-COE Undergraduate Industrial Case Study Workshop** giving students in their senior year the opportunity to compete in a 3-day industrial case study competition.

**The Industrial Workshops and Mini-courses** with topics of interest to both industry and academia serve to disseminate newly developed mathematical tools that can be of use in industry. The workshops are more interactive than the mini-courses.

**5<sup>th</sup> PIMS Graduate Industrial Math Modeling Camp**  
SFU, May 18–23, 2002

**Coordinator:** Marc Paulhus (U. Calgary)

**4<sup>th</sup> PIMS Fluid Dynamics Summer School**  
PIMS at U. Alberta, July 28–August 9, 2002

**Organizer:** B. R. Sutherland (U. Alberta)

**1<sup>st</sup> PIMS Mathematics of Biological Systems Summer Workshop**

University of Alberta, May 11–19, 2002

**Organizer:** Mark Lewis (U. Alberta)

**PIMS-MITACS-COE Undergraduate Industrial Case Study Workshop**

COE at UBC, May 25–27, 2002

**Organizers:** M. Puterman (Commerce and Business Admin, UBC) and Stephen Jones (COE, UBC)

**IAM-CSC-PIMS Senior Undergraduate Math Modeling Workshop**

UBC and SFU, February 15-16, 2003

**Organizers:** Manfred Trummer (SFU) and Bernie Shizgal (IAM)

## 5<sup>th</sup> PIMS Graduate Industrial Math Modeling Camp Simon Fraser University, May 18–23, 2002

**Organizers:** Jack Macki (U. Alberta), Chris Bose (U. Victoria), Randy LeVeque (U. Washington), Huaxiong Huang (York U.), Marc Paulhus (U. Calgary), Manfred Trummer (SFU) and Ian Frigaard (UBC).

At the 5<sup>th</sup> Annual Graduate Industrial Math Modelling Camp (GIMMC) camp 60 graduate students from all over Canada, the US and even some from as far as Europe cut their teeth on some problems in Industrial Mathematics presented by prestigious academic mentors.

**Brett Stevens** (Carleton University) presented a problem in software testing. The idea was to apply combinatorics and statistical design to devise the best possible set of tests for a piece of abstract software. The students worked very hard devising combinatorial coverings of the space of possible input parameters.

**Tim Myers** (University of Cape Town) presented a problem on heating an airplane wing in order to evaporate water before it freezes. His students made great progress in modelling and solving this challenging thin film problem.

**Chris Budd** (University of Bath) presented a problem where you use a prod to test for the freshness of fish. His students were challenged into building a mathematical model the fish prods response and attempting to infer what information on the freshness of the fish could be retrieved from the data.

**Yongji Tan** (Fudan University, Shanghai) presented a problem applicable to the oil and gas industry. The students were asked to investigate the results of a well log tool that measures the resistivity in the surrounding structure. The students learned a great deal about finite element methods.

**Alexander Melnikov** (University of Alberta) came with some problems in financial mathematics. His problem attracted the largest number of students who were interested in learning about hedging and option in both complete and incomplete market settings.

**Petra Berenbrink** (SFU) brought her students right to the very edge of research in the complex area of routing in ad-hoc networks. The students came up with many new approaches and some counter-examples to this very difficult problem.

**Brian Wetton** (UBC) challenged the students with a very complex problem in modelling a protein membrane of

a fuel cell. His students did an excellent job of solving some very difficult mathematics.

This year the students had a unique opportunity to present the results of the week's work in the form of a poster at the MITACS-AGM.

## 4<sup>th</sup> PIMS Fluid Dynamics Summer School, PIMS-U. Alberta July 28–August 9, 2002

**Organizers:** B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

A knowledge of the dynamics of fluids is the starting point to understanding such diverse fields of study as aerodynamics, weather forecasting, ventilation, lubrication and turbulence. Fluid flows can be described by mathematical equations but these cannot be solved except in special circumstances. Instead scientists solve the equations numerically or use the results of laboratory experiments to guide their intuition in finding solutions.

In its dedication to the training of highly qualified personnel, each year the PIMS sponsors a fluid dynamics summer school at the University of Alberta. The two week long event is attended by graduate students and senior undergraduates from around the world. Each morning the participants attend lectures on a broad range of topics including waves and turbulence, convection, physical oceanography and climate modelling. The afternoons are spent gaining hands-on experience running numerical simulations and performing laboratory experiments which are designed to complement the lectures and which are adapted from the lecturers' current research. At the end of the school the students give presentations based on the results of their work.



2002 Fluid Dynamics Summer School participants.

There are two other annual fluid dynamics summer schools in the world, one at the University of Cambridge, England and the other at Woods Hole Oceanographic Institution, MA, USA. The PIMS Fluid Dynamics Summer School is unique in its emphasis on computational fluid dynamics and computer-aided laboratory measurements. Indeed, with its modern computational resources and its concentration of expertise in experimental and numerical fluid dynamics, the U. Alberta is one of the few institutions in the world capable of running a school which simultaneously exposes participants to theory, numerical and experimental methods.

The summer school was fully attended by eighteen participants from Canada, England, Germany and the United States. Core lectures were given by John Bowman (Turbulence Modelling), Andrew Bush (Climate Modelling), Peter Mineev (Computational Fluid Dynamics), Bryant Moodie (Wave Theory), Bruce Sutherland (Stratified Flows) and Paul Myers (Physical Oceanography).

The four invited lecturers were:

**John Allen** (U. Oregon): *Coastal Oceanography*

**John Bush** (MIT): *Geophysical Plumes*

**Jean-Luc Guermond** (LIMSI, U. Paris, Orsay): *Large Eddy Simulations*

**Peter Rhines** (U. Washington): *Overtuning Circulations in the Oceans and Atmospheres and Mountainous Flows in Rotating Fluids: Vorticity Dynamics, Form Drag and Induced Circulation*

Please see <http://fdss.math.ualberta.ca>.

## 1<sup>st</sup> PIMS Mathematics of Biological Systems Summer Workshop University of Alberta, May 11–19, 2002

**Organizer:** Mark Lewis (U. Alberta)

From May 11–19, 2002, the Centre for Mathematical Biology (CMB) offered the 1<sup>st</sup> annual PIMS Mathematical Biology Summer Workshop entitled **Mathematics of Biological Systems**. Our aim was to introduce undergraduate mathematics students to mathematical modeling and analysis applied to real biological systems. Instructors were Gerda de Vries, Thomas Hillen, Mark Lewis, and Michael Li, all from the University of Alberta. There was further assistance provided by volunteer graduate students, postdoc fellows, and staff (Robert Bechtel, Andrew Beltaos, Gustavo Carrero, Christina Cobbold, Tomas de Camino-Beck, Lisa Haraba, Annemarie Pielaat, Shirley Mitchell).

We received applications from almost 40 students from



The participants of the 1<sup>st</sup> PIMS Mathematical Biology Summer Workshop

all over North America. In the end, 26 students came to the workshop from 14 different Universities across Canada and the United States, many on their own funding. More than half of the attendees were women.

The workshop was 8 days in length and was a combination of classroom instruction, computer lab instruction and exercises, guided group project work, and project presentations.

The extremely positive feedback that was received, in combination with the large number of applicants and participants, has led us to pursue the workshop as an annual event. We strongly believe the exchange of ideas and knowledge that occurred between students will be carried back to their home universities and that the program will grow in popularity over the years to come.

## PIMS-MITACS-COE Undergraduate Industrial Case Study Workshop Centre for Operations Excellence, UBC, May 25-27, 2002

**Organizers:** Martin Puterman and Stephen Jones (UBC)

Sixteen undergraduate students in commerce, engineering, business, physics, mathematics, statistics, and computer science were invited from across Canada to meet industry executives and renowned academics, and to explore graduate study opportunities, and to work in teams to solve challenging business problems.

The focus of the workshop was a real-world case study competition, culminating with teams presenting their findings to industry executives and academics on May 27.

Universities represented in the workshop were UBC, SFU, U. Alberta, U. Calgary, McGill and Mount Allison.

Workshop judges Glen Darou (COE Director, Industry), Carol Leacy (Vice President, Systems and Process Integration, Mark Anthony), Bernard Lamond (Professor and Director, Department of Operations and Systems, Université Laval) and Maurice Queyranne, (COE Director, Academic) were presented with outstanding presentations from the workshop teams. All participants were awarded with certificates and COE sweatshirts for their excellent work over the weekend. Team four, composed of Derrick Chung (McGill), Amir Motamedi (McGill), Igor Naverniouk (UBC), and Philip Seo (UBC), was honored with the prize for “Best Overall Case Analysis and Presentation”.

This workshop was 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 see the web page [www.pims.math.ca/industrial/2001/uicsw](http://www.pims.math.ca/industrial/2001/uicsw).

## IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop UBC and SFU, February 15–16, 2003

**Organizers:** Manfred Trummer (SFU) and Bernie Shizgal (IAM)

The 2003 IAM-CSC-PIMS Undergraduate Math Modelling Workshop held during the weekend of February 15–16, 2003 was a great success. Ten of the very best undergraduate mathematics students in Canada, and one from the Washington State participated in the workshop.

The workshop was organized by PIMS along with the Institute of Applied Mathematics (IAM) at UBC and

the PIMS Centre for Scientific Computing (CSC) at SFU.

Faculty mentors first outlined each of the applied problems to all the participants. The students then chose one of the problems to work on each day. Lectures on each of the problems were presented by the mentors in which the tools for the modelling and analysis of the problem were developed. The mentors then helped the students develop the models and answer the questions posed. The workshop culminated with presentations by each of the groups working on the problems.

The problems the students looked at were:

### Image Restoration using PDE-based Methods

*Mentor: Chen Greif (CS, UBC)*

In many applications there is a need to produce a clean image out of a given blurred, noisy input image. This situation occurs, for example, for satellite or space-shuttle images that get contaminated while being broadcast to earth.

Denosing and deblurring those images involves a non-trivial numerical inversion operation, which needs to be implemented using sensible and robust mathematical models, in order to accomplish high-quality results.

In this project the students looked at a few image restoration methods that are based on partial differential equations (PDEs) and applied the methods to reconstruct images.

### Optimal Scheduling Policies in Networks with Multi-task Servers

*Mentor: Rachel Kuske (Math, UBC)*

In this project the students developed models for queueing networks in which “customers” may return to a server with requests for different tasks or “jobs”. Examples of such systems occur in manufacturing processes and design of



The IAM-CSC-PIMS Undergraduate Modelling Workshop participants at SFU

disk controllers. In semi-conductor device manufacture, where there are many steps in the manufacturing process, the same machine is used for several of these steps. Similarly, disk controllers are dedicated processors for efficient reading and writing data to a hard disk; the efficiency depends on implementing efficient algorithms for storage, so that writing data results in an additional service request for applying the smart algorithm.

Students built simple models which illustrate the bottleneck problems described above. By viewing these models as sub-networks in a larger network, the team developed optimal priorities for job processing in these small sub-networks, as a basis for constructing an overall optimal policy.

### **Characterization of Internet Traffic and its Impact on Network Performance**

*Mentor: Ljiljana Trajkovic (CS, SFU)*

Traditional queuing theory techniques based on Poisson traffic models were essential for the development of telephone networks. Today's multimedia applications produce complex traffic patterns that result from the statistically multiplexed data, voice, image, and video patterns. For networks carrying such diverse applications, traditional traffic models have proved inadequate and incapable of capturing essential characteristics of the traffic patterns. Internet traffic characterization work has only recently been shown to be promising due to the presence of the traffic "invariants" detected in traffic traces.

In such an environment, computer simulation and empirical techniques play an important role in understanding networks' behavior. The use of genuine traffic traces to simulate loss in packet networks such as Internet were described. Simulation results indicate that underlying transport protocols and time scales are essential for understanding loss behavior in packet networks.

### **Pedestrian Flow and Cellular Automata**

*Mentor: Peter Berg (MITACS Postdoc, SFU)*

Recently, pedestrian flow has received much attention in the mathematical modeling community, e.g. in simulations of emergency exits, subway pedestrian traffic and handling large crowds.

Essentially, there are three different ways of modeling such discrete stochastic 2-D systems of interacting "particles": deterministic continuum models, deterministic discrete models and cellular automata. So far, only cellular automata models allow for the inclusion of stochastic effects and are an easy method for numerical simulation.

Some features of pedestrian flow and how they are modelled were presented. The students worked in a team to simulate pedestrian counter-flow along a long thin stretch using Matlab. They observed the phase transition from individual free walking to lane formation, an organized form of flow. This is an exciting example of how unpredictable individuals can become organized without any leader's decision or other obvious causes.

## MITACS: A Network of Centers of Excellence in the Mathematical Sciences



**Mathematics of Information Technology and Complex Systems (MITACS)** is one of the three Networks of Centers of Excellence (NCE) created in 1998. The MITACS NCE is a joint venture of the three Canadian mathematical sciences institutes: the Centre de Recherches Mathématiques, the Fields Institute in Mathematical Sciences and the Pacific Institute for the Mathematical Sciences. MITACS harnesses mathematical power for the benefit of the Canadian economy. The network brings together more than 150 researchers at 22 Canadian universities with more than 70 Canadian industrial, medical, and financial organizations. The network comprises 23 projects addressing problems in five sectors of the Canadian economy, including two new projects funded in 2000.

The creation of the MITACS network provides an exceptional opportunity for the mathematical sciences community to develop a large scale systematic programme for research, HQP training and the development of partnerships with key business, industrial and health care sectors across the country.



Arvind Gupta, MITACS Programme Leader

### 3<sup>rd</sup> MITACS Annual General Meeting: Statistics for Large Scale Industrial Modelling, UBC, May 23-25, 2002

This meeting was part of the **PIMS Thematic Programme on Selected Topics in Mathematical and Industrial Statistics**.

See the chapter on *Thematic Programmes*.

## MITACS Projects at PIMS

There are 31 ongoing MITACS projects across the country in five themes: Biomedical Research, Commercial Research, Information Technology Research, Manufacturing Research, and Trading and Finance Research. Here are the currently 14 projects coordinated by PIMS:

### Biomedical Research

#### Biomedical Models of Cellular and Physiological Systems in Health and Disease

**Leader:** Dr. L. Keshet (Math, UBC)

**Members:** Dr. G. de Vries (Math, UA), Dr. D. Finegood (Kinesiology, SFU), Dr. R. Miura (Math, UBC), Dr. J. Piret (Biotech Lab, Chemical Eng, Bioresource Eng, UBC), Dr. E. Puil (Pharmacology, UBC) Dr. D. Schwarz (Research Director, Dept of Surgery, UBC), Dr. C. Shaw (Ophthalmology, UBC), Dr. Y. Xian Li (Math, UBC) Dr. M. Mackey (Math, McGill)

**Industrial Affiliates:** Bayer Inc., InSilico Biosciences, Kinetek Pharmaceuticals, Precision Biochemicals, StemCell Technologies, SmithKline Beecham, BC Cancer Research Center.

### Mathematical Modelling in Pharmaceutical Development

**Leader:** Dr. J. A. Tuszyński (Physics, U. Alberta)

**Members:** Dr. G. de Vries (Math, U. Alberta), Dr. G. A. Dumont (Elec. & Computer Engg., UBC), Dr. M. Klobukowski (Chemistry, U. Alberta), Dr. B. MacLeod (Anaesthesia, Pharmacology & Therapeutics, UBC), Dr. J. Muldowney (Math, U. Alberta), Dr. K. Rubenson (CHET, Education, UBC), Dr. J. Samuel (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. Y. Tam (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. D. Wiens (Stats Centre, U. Alberta), Dr. D. Bevan, Dr. D. Quastel, Dr. C. Ries, Dr. M. Sutter, Dr. M. Walker, Dr. J. Wright

**Industrial Affiliates:** Drs. Y.K. Tam and D. Ridgway (Kinetana), Dr. R.R. Koganty (Biomira, Inc.), Mr. Willaim Gough (Universal Dynamics Technologies), Dr. Michael J. Ellison (Institute for Biomolecular Design), Dr. John Samson (MACI and Physics, U. Alberta), %Dr. M. Huzmezant (M.I.H. Consulting Group), Dr. W. de Brouwer (Starlab, Belgium)

**Other Affiliates:** Canadian-European Research Initiative on Nanostructure (Belgium), Drs. P.L. Christiansen and E. Mosekilde (Inst. of Math. Modeling, Danish Technical University), Dr. Y. Engelborghs (Biomolecular Dynamics, K. U. Leuven), Dr. M. Kimmel (Stats, Rice University), Jim Laukes (Psychology, U. Arizona), Dr. E. Unger (Molecular Biotechnology, Jena, Germany)

## Commercial Research

### Facility Location Optimization

**Leaders:** Dr. Binay Bhattacharya (CS, SFU) and Dr. David Kirkpatrick (CS, UBC).

**Members:** P. Bose (CS, Carleton U.), J. Han (CS, SFU), P. Hansen (Ecole des Hautes Etudes Commerciales/GERAD), J. M. Keil (CS, U. Saskatchewan), R. Ng (CS, UBC), T. Shermer (CS, SFU), J. Snoeyink (CS, UBC), G. Toussaint (CS, McGill U.)

**Industrial Affiliates:** Webdispatchers.

### The Mathematics of Resource Allocation and Scheduling

**Leader:** L. Hafer (CS, SFU)

**Members:** B. Alspach (Math & Stats, SFU), J. M. Bourjolly

(Concordia), W. Cunningham (C & O, U. Waterloo), L. Goddyn (Math & Stats, SFU), A. Gupta (CS, SFU), P. Hell (CS and Math & Stats, SFU), R. Krishnamurti (CS, SFU), W. Pulleyblank (Director, Math. Sciences, T.J. Watson Labs, IBM), M. Queyranne (Manag. Sci, UBC)

**Industrial Affiliates:** Amber Systems, HA Simons, IBM, Prestige Telecommunications

### Probabilistic Mathematical Models for Complex Industrial Systems

**Leader:** M. Puterman (Commerce, UBC)

**Members:** D. Atkins (Commerce, UBC), J. Bookbinder (Waterloo), H. Chen (Commerce, UBC), M. Gendreau (Université de Montréal), S. Jones (Commerce, UBC), B. Lamond (Université Laval), T. McCormick (Commerce, UBC), J. McGill (Queen's U.), M. Queyranne (Commerce, UBC).

**Industrial Affiliates:** TELUS, Canadian Airlines International, Workers Compensation Board of BC.

### Searching Networks

**Leader:** Dr. Brian Alspach (U. Regina)

**Members:** Gena Hahn (Montreal), Denis Hanson (Regina), Richard Nowakowski (Dalhousie)

## Information Technology Research

### Mathematical Methods for Modeling, Verification and Testing in Information Technology

**Leader:** Dr. Bruce Kapron (CS, U. Victoria)

**Members:** M. Cheng (CS, U. Victoria), J. Delgrande (CS, SFU), M. Greenstreet (CS, UBC), A. Hu (CS, UBC), P. Panangaden (CS, McGill)

**Industrial Affiliates:** Nortel Networks

### Prediction in Interacting Systems (PINTS)

**Leader:** Dr. Mike Kouritzin (Math, U. Alberta)

**Members:** D. Blount (Math, Arizona State University), J. Bowman (Math, U. Alberta), P. Del Moral (Université Paul Sabatier, France), D. Dawson (Fields), E. Gombay (Math, U. Alberta), A. Heunis (Engineering, Waterloo), T. Kurtz (Math, Wisconsin-Madison), J. Macki (Math, U. Alberta), L. Miclo (Université Paul Sabatier, France), B. Remillard (École des Hautes Études Commerciales), J. Xiong (Math, U. Alberta)

**Industrial Affiliates:** Acoustic Positioning Research Inc., Lockheed Martin Canada, Lockheed Martin Naval Electronics & Surveillance Systems, VisionSmart

## Quantum Computing

**Leader:** Dr. Richard Cleve (UBC)

**Members:** M. Mosca (C&O, Waterloo), J. Watrous (CS, Calgary), C. Crapeau (CS, McGill), R. Flamme (Physics, Waterloo), D. Lidar (Chemistry, Toronto) A. Tapp (CS, McGill), W. Unruh (Physics, UBC)

## Symbolic Analysis

**Leader:** Dr. Peter Borwein (Math & Stats, SFU)

**Members:** F. Bergeron (Math, Universit'e de Qu'bec `a Montr'eval), J. Borwein (Math & Stats, SFU), R. Corless (Math, UWO), S. Devitt (Waterloo Maple Inc), D. Jeffrey (Math, UWO), L. Jorgenson (Math & Stats, SFU), M. Lamoureux (Math & Stats, U. Calgary), M. Monagan (Math & Stats, SFU), J. Stafford (Math, UWO), S. Watt (Math, UWO)

**Industrial Affiliates:** Math Resources, Sun Microsystems, Waterloo Maple

## Towards Interactive Data Mining

**Leader:** Dr. Raymond Ng (UBC)

**Members:** L. Lakshmanan (CS, UBC) A. Wagner (CS, UBC) R. Zamar (Stats, UBC) R. Miller (CS, Toronto) J. Rosenthal (Stats, Toronto) K. Sevcik (CS, Toronto)

## Manufacturing Research

### Mathematical Modeling and Scientific Computation

**Leader:** B. Wetton (Math, UBC)

**Members:** R. Bradean (PDF, Math, SFU) L. Bridge (Graduate student, Math, UBC) R. Choksi (Math & Stats, SFU), R. Haynes (Graduate student, Math, SFU) H. Huang (Math, York U.), N. Kouzniak (PDF, Math, UBC) M. C. Kropinski (Math & Stats, SFU), D. Liang (PDF, Math, York) M. Liang (Graduate student, Math, UBC) A. Novruzi (PDF, Math, UBC) A. Peirce (Math, UBC), K. Promislow (Math & Stats, SFU), B. Russell (Math & Stats, SFU), S. Ruuth (Math, SFU) B. Seymour (Math, UBC), J. Stockie (PDF, Math, SFU) M. Ward (Math, UBC), R. Westbrook (Math & Stats, U. Calgary)

**Industrial Affiliates:** Ballard Power Systems, Powertech Labs, Vortek Industries

### Pseudo-differential Operator Theory in Seismic Imaging

**Leaders:** Dr. Michael Lamoureux and Dr. Gary Margrave (University of Calgary)

**Members:** R. Aggarwala (Math, U. Calgary), W. Allegretto

(Math, U. Alberta), J. Bancroft (Geophysics, U. Calgary), P. Binding (Math, U. Calgary), K. Bude (Math, Washington), A. Calvert (Earth Sciences, SFU), P. Lancaster (Math, U. Calgary), L. Lines (Geophysics, U. Calgary), E. Nyland (Physics, U. Alberta), M. Sacchi (Physics, U. Alberta), M. Slawinski (Mechanical Eng, U. Calgary), J. Sniatycki (Math, U. Calgary), G. Uhlmann (Math, Washington), D. R. Westbrook (Math, U. Calgary)

**Industrial Affiliates:** Chevron Petroleum Technology Company, Veritas DGC Inc, Consortium for Research in Elastic Wave Exploration Seismology

## Trading and Finance Research

### Modeling, Trading and Risk in the Market

**Leader:** U. Haussmann (Math, UBC)

**Members:** M. Barlow (Math, UBC), J. Friedman (Math, UBC), A. Lari-Lavassani (Math, U. Calgary), A. Peirce (Math, UBC), J. Walsh (Math, UBC)

**Industrial Affiliates:** Financial CAD, Powerex Corporation, Transalta

## PIMS affiliated MITACS Postdoctoral Fellows 2002

1. Janez Ales, Simon Fraser University
2. Peter Berg, Simon Fraser University
3. Edgardo Cheb-Terrab, Simon Fraser University
4. Ronald Ferguson, Simon Fraser University
5. Daya Gaur, Simon Fraser University
6. Alexander Kononov, Simon Fraser University
7. Stefan Langerman, Simon Fraser University
8. Snezana Mitrovic-Minic, Simon Fraser University
9. Andrew Solomon, Simon Fraser University
10. Bettina Speckmann, Simon Fraser University
11. Brett Stevens, Simon Fraser University
12. Rong Ding, University of British Columbia
13. Marek Labecki, University of British Columbia
14. Stan Maree, University of British Columbia
15. Joern Sass, University of British Columbia
16. Rong Zhu, University of British Columbia
17. Hugh Geiger, University of Calgary
18. Peter Gibson, University of Calgary
19. Julien Arina, University of Victoria



## VI. MATHEMATICS EDUCATION PROGRAMME

Victoria elementary school students playing the Set Game at **Math Mania**.



Participants of the 2003 Esso-CMS-PIMS Summer Math Camp for High School students outside East Academic Annex at SFU.

## Initiatives for K–12 Students

PIMS continues to provide fun and innovative education activities for elementary and high school students. These include mathematics competitions and math fairs.

### Activities for Elementary Schools

The following activities took place for elementary school students in 2002/03.

#### Math Mania

Math Mania is part of PIMS “Alternative Math Education” programme where Faculty and Staff from the PIMS Universities present “fun” methods for teaching math and computer science to children (and adults!) using games and art. It takes place at elementary schools in Victoria BC. Typically included in the presentations are soap bubble demonstrations, constellations as 2D networks, geometry and paper, The Set Game, a binomial probability experiment using pennies, and exciting geometrical models from straws and paper. Other demonstrations involve chess games, parallel algorithms of network sorts, and recursive methods in mathematical puzzles. These events attract around 300 students and parents each evening.

The enthusiastic volunteers who participated in these events included James Andersen, Peter Anderson, Kathy Beveridge, Charlie Burton, Jeff Campbell, Kelly Choo, Mike Crowle, Florin Diacu, Malgorzata Dubiel, Rod Edwards, Irina Gavrilova, Mike Fellows, Denton and Marilyn Hewgill, Elies Hoepner, Reinhard Illner, David Leeming, Shaun Pack, Jan and Paul Nienaber, Elena Prieto, Geoff Schmidt, Pauline van den Driessche and Julie Zhou.



The activity “A Sorting Network.”

The Math Mania events in 2002/03 were:

- January 30, 2002: **Oaklands Elementary School, Victoria**
- May 28, 2002: **Lampson Street Elementary School, Victoria**
- October 9, 2002: **Happy Valley Elementary School, Victoria**
- January 28, 2003: **George Jay Elementary School, Victoria**
- May 28, 2003: **St. Michaels University Junior School, Victoria**
- October 28, 2003: **Frank Hobbs Elementary, Victoria**

#### MathClick Workshops

MathClick workshops are full-day mathematics immersion experiential events for students in grades 5–7. They are not only for the mathematically talented; in fact, the main intention is to awaken children’s latent talent and interest by showing them that mathematics can be also playful and intriguing. Students in these workshops engaged in a genuine mathematical inquiry in a very encouraging environment that promoted a feeling of surprise

and ample opportunity for success.

Klaus Hoechsmann (PIMS Education Facilitator) and one of the workshop instructors co-authored the mathematical content for the workshop programme. The workshops were taught by Edel Vo and Natasa Sirotic from Collingwood School and assisted by Wendy Dorn from the Burnaby School District and Janet Martin, a graduate student at the UBC Faculty for Education.

The 2002 MathClick workshops took place on August 27 and 30. The students all went home with certificates of participation.

Judy Dalling, the parent of 2001 MathClick participant Eleanora, attests that this single-day workshop can be truly transformational and can dazzle a child to the extent of completely reconditioning her or him for success in mathematics. She wrote, *“Last August I enrolled my 10 year-old daughter Eleanora in the one day MathClick workshop. Her record at elementary school was poor in all areas. In Grade 5 math, socials and science she had a C average, and getting her to complete assignments was impossible. After taking the MathClick workshops her attitude completely changed. She realized that she was capable of much greater things. She has not missed one day of school this year, and she has replaced the C's on her report card with A's. When asked, Eleanora credits these changes to your encouragement in the workshop. Thanks you for helping her realize her potential. What a difference a day can make!”*

## Activities with High School Students

The PIMS education panel organizes a number of events aimed at high school students. Here we describe one such event. The two sections that follow this one, Mathematics Competitions and PIMS Math Fair Programme, highlight many other PIMS activities for high school students.

### Junior High Math Nights

These biannual events are organised by Dr. Peter Zizler of Mount Royal College, Calgary. From October–November, 2002 on six consecutive Tuesdays, students, parents and teachers at Mount Royal College were provided with the opportunity to engage in mathematical exploration. The emphasis of these evenings was to dispel the myths that mathematics is a set of facts innate to certain indi-

viduals and that mathematics is not an experimental discipline.

Discussions took place under the following titles:

**Facts About Five:** This evening was a potpourri of topics about the number five, including 5 by 5 magic squares, Pentagonal numbers, Tessalation of the plane using various polygons including pentagons, compass and straight-edge constructions, and Ramsey theory.

**Map Colouring:** This evening the question of how many colours are needed to colour a planar map was asked and also applications to some scheduling problems were investigated.

**Sorting out Sorting:** Sorting algorithms, their benefits, and their drawbacks were discussed.

**The Secret of NIM:** This evening, analysing NIM and similar games with a view towards developing winning strategies was the topic.

**Nothing But 0's and 1's:** This evening an exploration of number systems with different bases was on the agenda.

## Mathematics Competitions

Traditionally, mathematics skill and interest can be uncovered in students by exposure to challenging mathematical exams and contests. PIMS sponsors Alberta and BC participation in a number of such national and international competitions.

### CMS Regional Math Camps

To identify and nurture future members of the Canadian team for the International Mathematical Olympiad, the CMS, Esso and PIMS sponsor this yearly event to which students in grades 8–10, as well as exceptional elementary grade students, are invited based on merit. Topics in Combinatorics, Number Theory, Algebra and Geometry are covered at the difficulty level of the Olympiad. This is part of a long-range goal of the CMS to develop mathematical talent in Canadian students to compete on the world stage.

### 2002 Esso-CMS-PIMS Summer Math Camp, SFU, July 2–5, 2002

The second Esso-CMS-PIMS Summer Math Camp for High School students took place July 2–5, 2002, at the SFU-PIMS Site in the East Academic Annex.

Twenty-five students from schools across the Lower Mainland were selected to participate in the camp, out of almost 50 nominations sent by their teachers. For four days they participated in exciting and challenging activities organized by the SFU faculty and graduate students. Two guest speakers were invited as well: **Lily Yen** (Capilano College) and **Branko Curgus** (Western Washington University).

### 2002 Esso-CMS-PIMS Summer Math Camp, University of Alberta, August 14–20, 2002

The annual Alberta Math Camp alternates between the U. Alberta and U. Calgary. This is the second time that it was held at the U. Alberta. The event is sponsored by ESSO and CMS, with additional support from the Faculty of Science at the U. Alberta, PIMS, the Edmonton Public School Board, and the Mathematical Council of the Alberta Teachers Association. The camp organizers were **Ted Lewis** and **Andy Liu**.

The camp is intended for students from grades 7–10. Twenty-four campers from Alberta and two campers from outside the province stayed in the Lister Hall Residence Complex for its duration. There were also three day students from Edmonton who attended.

The morning programme consisted of a three-hour workshop centered on a lecture. **Andy Liu** gave a lecture on Coding, **Hans Brungs** spoke about The History of Mathematics, **Edit Gombay** talked about Probability, **Sudarshan Sehgal** gave a lecture on Number Theory, **Dragos Hrimiuc** spoke about Diophantine Equations, and **Volker Runde** gave a lecture on The Banach-Tarski Paradox.

The afternoon programme was a mixture of academic and extracurricular activities. On Sunday, the students wrote a three-hour contest. On Monday, the camp visited the Odysium, the former Edmonton Space Science Centre. The students were divided into groups for a team contest on Tuesday. On Wednesday, the camp visited a cornfield maze just outside Edmonton. Prof. Andy Liu offered an exhibition of part of his puzzle collection on Thursday. On Friday, the well-known magician, Jon Charles, gave a special performance at the camp.

The evenings were largely spent in the residence for social activities. The students were supervised by Mr. Gilbert Lee and Mrs. Joyce Pon, the mother of one of the campers. On Wednesday, after the cornfield maze, the camp visited West Edmonton Mall. On Thursday, the students had an eat-in consisting mainly of pizzas. On Friday, a banquet was held at the China Palace Seafood Restaurant.

## Alberta High School Mathematics Competition

The Alberta High School Mathematics Competition is an annual two part competition taking place in November and February of each school year.



There are book prizes for the first part, and cash prizes and scholarships for the second part.

The first part of the 47<sup>th</sup> Alberta High School Mathematics Competition was written on November 19, 2002 by 948 students representing 43 schools from Alberta. The competition consisted of 16 multiple choice questions. Although part I serves as a gateway to part II, the book prizes are substantial, with the total value exceeding \$1200.

There was one perfect paper, by Robert Barrington Leigh from Old Scona Academic High School. This year also featured several competitors from junior high school who fared very well.

Part II of the Alberta High School Mathematics Competition was written on February 5, 2003 by 75 students representing 26 schools.

The awards dinner, which is sponsored by PIMS, was held on March 29 in Edmonton.

For a list of top finishers, please see the website [www.math.ualberta.ca/~ahsmc](http://www.math.ualberta.ca/~ahsmc).

## PIMS Elementary Grades Mathematics Contest

The annual **PIMS Elementary Grades Math Contest (ELMACON)** is open to students in Grades 5–7. It provides an opportunity for them to experience mathematics as an exciting sport. The contest is modelled after the successful MathCounts competitions. However, there are some important differences, because it is aimed at younger students, many of whom will likely “graduate” to



2002 Grade 5 ELMACON winners (l-r) Jeffrey Choi, Aram Ebtekar, Juno Jung.

MathCounts once they get to high school. There they will learn to work collaboratively in the Team Round, which has here been replaced by a Problem Solving Round. The latter not only relieves the competitive pressure for a while, but also affords an opportunity for learning some mathematics in a state of heightened awareness

and motivation. The other rounds are designated Sprint, Target, and Countdown, each with their own special characteristics.

The 4<sup>th</sup> ELMACON took place on May 25, 2002. It was organized 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. 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 events.

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. The top 10 from the first two rounds went on to the Countdown round where the students “duelled” starting with the 9<sup>th</sup> and 10<sup>th</sup>. The winner of that contest then went on to “duel” with the 8<sup>th</sup> place holder. So the person who ranked 10<sup>th</sup> had the potential of winning the contest by beating the 9 people ahead of him/her one by one. The duelling consisted of answering math questions against the clock and sounding a buzzer. Eventually an overall winner was found.

The top ten finishers in each grade 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 donated by Sharp.

The 2002 ELMACON had a total of 229 competitors. There were 67, 80 and 82 children in grades 5, 6 and 7 respectively. The top 10 winners were:

**Grade 5:** 1. Juno Jung (Nelson), 2. Aram Ebtekar (Glen), 3. Jeffrey Choi (John T Errington), 4. Karen Bennie Ho



2002 Grade 6 ELMACON winners (l-r) Daniel Park, Jimmy He, Alarica Tang.

(Oppenheimer), 5. Nikita Zouev (Lynn Valley), 6. Jeffrey Yeh (Vancouver Montessori), 7. Sophie Ji-Soo Kwak (Canyon Heights), 8. Veronika Dikoun (Maywood Community), 9. Phil Chang (Simon Fraser), 10. Yanga Zhu (Eric Langton).

**Grade 6:** 1. Alarica Tang (Kitchener), 2. Jimmy He (Pinewood), 3. Daniel Park (Kwayhquitlum Middle), 4. Bryan Huang (Osler), 5. Yuan Liang (Pitt River Middle), 6. Silviu Toderita, 7. Sherwin Kwan (Seaforth), 8. Jonathan Zhang (Oppenheimer), 9. Hank Duan (Maple Creek Middle), 10. Simon T. H. Tseng (Chantrell Creek).

**Grade 7:** 1. James Chen (John T Errington), 2. Arthur da Silva (St. Paul's), 3. Anthony Chuang (Maple Lane), 4. Sebastian Crema (Boundary Community), 5. Jerome Li (Kwayhquitlum Middle), 6. Steven Karp (Kitchener), 7. Jeffrey Hsiung (Emily Carr), 8. Kevin Xiao (Confederation Park), 9. Mulin Yang (University Hill), 10. Javin Chen (Thunderbird).



2002 Grade 7 ELMACON winners (l-r) Anthony Chuang, Arthur da Silva, James Chen.

## PIMS Math Fair Programme

Math Fairs are particularly suitable for students in Grades 7–12 who are looking for longer term projects to get a feel for the adventure of a self-directed exploration.

PIMS supports math fairs as part of the Greater Vancouver Regional Fair and the Calgary Youth Science Fair, as well as running its own Forever Annual Mathematics Exhibition in Vancouver and numerous math fairs in Alberta.

### The Concept of a Math Fair

Unlike, say, sports or music, mathematics does not offer many extracurricular activities in school, except for various kinds of contests, which—for all their admirable motivating qualities—stress just one side of mathematics: the quick grasp. And yet, most mathematical work could be more aptly likened to a marathon than to a sprint. The steadfast persevering quest, so vital to the subject, is minimally represented in the school environment.

The use of science fairs as a vehicle for popularising and teaching mathematics might eventually prove to be a way of filling this void. It is still in its infancy—the wheel has not yet been invented. Mathematics is traditionally not a showy subject. When we get a problem to work on, we retreat into a corner like a squirrel with a nut and come back into the light of day only when we have cracked it. Sure enough, we need some time for quiet concentration. But must it be unrelieved solitary confinement? There ought to be a better way—and preparing projects for public display might help push us in the right direction.

The projects usually fall under one of the following three headings, although many will present a mixture of two or even all three of them.

**Original Research:** There are lots and lots of open problems in mathematics. However, most of them lie on the outskirts which can only be reached by air. Since the field is so old, most of the rocks near the centre have been turned over more than once, so finding something really new there is a very lucky break. Nevertheless it happens now and again—and, hey, you never know!

**Applications:** There is an inexhaustible supply of problems of all shapes and sizes in science, in technology, and even in the arts. Many of them are close to home. The challenge here is to tease out the interesting ones (say, the geometry of rose petals) and not get bogged down in mere routine (like counting them) or too engrossed in extraneous activities (like smelling them).

**Exposition:** Again and again it happens that somebody

gives an old hat a brand-new twist—and most of the time, a new insight comes with it. There are hundreds of ready made proofs of the Pythagorean Theorem, but some people are still rolling their own. The area of the regular dodecagon inside a unit circle (3 square units) had been known for many centuries before recent beautiful proofs were found.

Whichever flag it sails under, a project should always aim at engaging the visitors' minds, not only their eyes. In this connection, a low-tech, homespun implementation is sometimes more successful than a glitzy computerized one—which might impress without enlightening, unless special care is taken.

### BC Science Fair Foundation

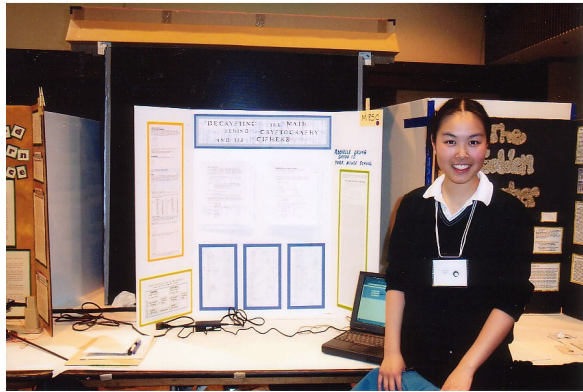
At the Greater Vancouver Regional Fair (GVRSF) PIMS supplies judges, mathematical expertise, and prizes. PIMS initiated the inclusion of a Mathematical Sciences exhibit category within the existing Science Fairs, which are organized and administered by the Science Fair Foundation of British Columbia. PIMS is committed to informing and involving mathematics teachers, giving presentations and workshops to groups of students, helping and providing assistance to students that have undertaken mathematics projects, judging the projects, and supplying the monetary awards.

Projects are judged as gold, silver or bronze based on a point system.

The 2002 Math Fair project took place this year amidst the teachers' job action. Despite this obstacle, ten projects were entered in the Computational and Mathematical Sciences category at the 2002 Greater Vancouver Regional Science Fair (GVRSF) and of these, two were selected to



Gabrielle Arden with her project, *Forecasting Weather with Neural Networks*.



Rochelle Leung with her project, *Deciphering the Math Behind Cryptography and its Ciphers*.

attend the Canada-Wide Science Fair held in Saskatoon, Saskatchewan in May 2002. These students were Gabrielle Arden of Burnaby South Secondary School and Rochelle Leung of York House School (pictured).

PIMS presented the following awards:

**First: Rochelle Leung** (York House): *Deciphering the math behind cryptography and its ciphers*

**Second: Gabrielle Arden** (Burnaby South Secondary): *Forecasting weather with neural networks*, **Frank Sun** and **Winnie Ho** (Windermere Secondary): *Matrices and cryptology*, **Harvey Zhang** (Burnaby North Secondary): *Inscribed triangles in circles and ellipses*

**Third: Pearly Trinh** and **Elaine Lee** (Windermere Secondary): *RSA algorithm cryptology*, **Galina Meleger** and **Kathryn Cheng** (York House): *The golden number*

The first prize winner received \$200, the second prize winners \$100 each, and the third prize winners \$50 each.

Considering there were only ten projects entered in the Computational and Mathematical Sciences category, it is noteworthy that the GVRSF judges selected two of these projects as part of the top ten projects at the entire science fair.

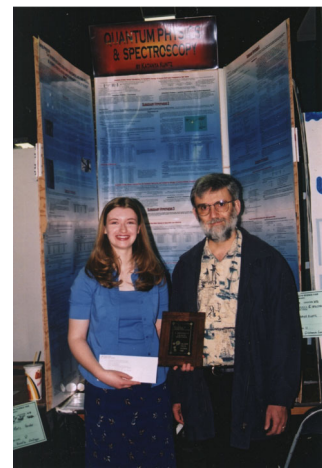
PIMS contributed \$2500 travel money to send the two winners to Saskatoon.

At the Canada-Wide Science Fair, Gabrielle Arden won a Gold Medal and a \$2000 scholarship to the University of Western Ontario in the Intermediate Computational and Mathematical Sciences category, and Rochelle Leung won a Bronze Medal and a \$1000 scholarship to the University of Western Ontario in the same category.

## Calgary Youth Science Fair

In 2002 PIMS provided a prize at the Calgary Youth Science Fair. The prize consisted of \$100 and a plaque awarded for Secondary project making major use of mathematics in the project.

At this year's Calgary Youth Science Fair, which took place on April 10–13, 2002, the PIMS award went to **Katanya Kuntz**, a grade 11 home schooler from Alberta Distance Learning. Her project was called *Quantum Physics and Spectroscopy*. The objective of the project was to learn more about Quantum Physics and to test mathematical models of the atom (the Bohr theory and the Quantum theory) for their accuracy in predicting and explaining the atomic universe. Her Unified Hypothesis was “Spectroscopic signatures, other atomic characteristics, and atomic phenomena can be accurately predicted and explained by a mathematical model of the atom.” She concluded that the Quantum theory is the best known model (so far) that is extremely accurate in predicting and explaining the atomic universe.



Katanya Kuntz & Gary Margrave (PIMS Site Director, U. Calgary) in front of Katanya's project.

## Forever Annual Mathematics Exhibition (FAME)

The fifth Annual FAME took place at S.J. Willis Educational Centre on April 10, 2002. A total of 120 students participated in the events, with 20 elementary entries, 13 junior entries and 20 senior entries. Twelve students won Distinction Awards (score 90+/100). The winning schools (in terms of scores for the top 3) were Fairburn (elementary) and Lansdowne (junior and senior). Some of the topics chosen this year were: Optical illusions, Tower of Hanoi, The average sleeper, Numbers that make you go hmm, History of math in South America, Codes and ciphers, and Catapults and What is the fourth dimension? FAME is sponsored by PIMS, BCAMT, Greater Victoria Teacher Association and School District #61. The event was organized by mathematics teachers Betty Doherty of Lansdowne and Wendy Swonnell of Lambrick Park.

## Elementary Math Fairs in Alberta

The Math Fairs in elementary schools in the Edmonton area are gaining in popularity. Initiated upon requests by schools, and supported mainly by PIMS and the Edmonton Public School Board, the Math Fairs were held in previous years at Our Lady of Victories, Parkallen Elementary, and Terrace Heights Schools. The Edmonton Math Fairs are unique in that all students in the school participate. This event is about problem solving, not winning and losing. The schools themselves play a major role in the planning and thus the format can vary from school to school. In some Math Fairs, Education students from the University of Alberta were available to help, primarily by providing a “model” for a Math Fair that students can emulate in planning their own event. The extensive involvement of students in planning, staging and participating in the Math Fair may be one of the secrets of its success.

Prior to the Math Fair, students choose or are given problems to work on. They work in small groups to solve the problem and subsequently create a tabletop display. On the day of the Math Fair, spectators are invited to tackle the problem, with hints and guidance provided by students in charge. The displays are not poster sessions. Rather, the students are actively involved in the presentations.

### PIMS/U. Alberta Math Fair, November 5, 2002

Just under seven hundred elementary and junior high students from twenty-five schools visited the PIMS/U. Alberta Math Fair on Tuesday November 5, 2002. This all day event was sponsored by PIMS and presented



Students enjoying activities at the March 2003 PIMS/University of Alberta Math Fair



Discussing a problem at the March 2003 PIMS/University of Alberta Math Fair

by the Math 160 students of Venera Hrimiuc and Ted Lewis, and was held in Dinwoodie Lounge in the Student Union Building. At the same time, Andy Liu ran a problem solving session for the children (which he dubbed the “math unfair”). The students spent about 2–2.5 hours at the event, splitting their time between the math fair and the problem solving session.

### PIMS/U. Alberta Math Fair, March 3, 2003

On Friday March 7, 2003 the Math 160 students of Venera Hrimiuc presented a second PIMS/U of A Math Fair. Just under 500 enthusiastic students visited the fair, from Grade 3 to Grade 9. At the math fair, the children could try their hand at solving many math puzzles, and were guided in their endeavours by the university students.

A new component has been added to the popular event. As well as applying their talents to the puzzles, the visitors also played a mathematical game. Their opposition was provided by 40 U of A student volunteers, both graduate and undergraduate. Each university student played against a dozen children in a setting somewhat like simultaneous chess. Any visitor who won a game was invited to challenge Andy Liu. The game is most commonly known “hare and hounds”, and it is rumoured that Andy never loses. Because of this, the games component of the math fair has been dubbed the “Math Unfair”.



**That's a Good Problem!, Math Fairs in Calgary**

*That's a Good Problem!* is a collaborative project of PIMS, the Galileo Educational Network (GENA), and Mount Royal College in Calgary. It is based on the highly successful math fairs organised by Ted Lewis (PIMS Education Coordinator, University of Alberta). Teams of teachers from several Calgary-area schools were invited to a half-day workshop. The focus of the workshop was on teaching mathematics through explorations and investigations by working through a number of mathematical explorations, suggestions for introducing explorations to other teachers, organising and promoting a school math fair.



Having fun learning math with a frog game.

The teachers returned to their schools armed with Ted Lewis' excellent booklet on how to run a math fair. Sharon Friesen of GENA and Indy Lagu (PIMS Education Coordinator, Calgary) made visits to the schools to work with the teachers and students before the math fairs.

After the math fairs, the teachers were invited for another half-day workshop to talk about problem solving, what worked and what did not with their fairs, and future steps. Many of the teachers admitted that they were worried about how successful their math fair would be, but none were disappointed, and all thought of the math fair as an unqualified success. The many parents who attended the math fairs were also quite impressed.

In all, seven schools participated, and all expressed an interest in repeating a math fair.

The math fairs took place on the following dates:

- April 19, 2002: **C. Ian McLaren School, Black Diamond**
- May 16, 2002: **Glendale Elementary School**
- May 22, 2002: **Nellie McClung Elementary School**
- June 6, 2002: **Red Deer Lake Elementary School**

Half-day workshops were also held with teachers about the math fairs.

More information about the math fairs (including lots of photographs) can be found at [www.galileo.org/math/sumtalk/index.html](http://www.galileo.org/math/sumtalk/index.html).

Dr. Friesen and Dr. Lagu are planning to involve 10 or 12 new schools in the project next year.



Some of the math fair projects at Erin Woods Elementary.

## Initiatives with K-12 Teachers

With new mathematics curricula being developed across Western Canada, PIMS scientists have found considerable demand for teacher training and retraining. Teachers are also interested in exchanging ideas with academics.

### PIMS Conferences on Changing the Culture

Organized by M. Dubiel (SFU), P. Hagen (Westwood Elementary), K. Heinrich (SFU), B. McAskill (BC Ministry of Education), E. Perkins (UBC), these conferences are intended to forge closer ties between the mathematics community, mathematics teachers and the industry. Erasing barriers between these communities and looking for common ground is an essential step in any attempts at changing the mathematics culture.

#### Changing the Culture V, SFU Harbour Center, April 26, 2002

The Fifth Annual Changing the Culture conference took place April 26, 2002 at the SFU Harbour Centre campus. The conference was attended by 78 participants: Teachers from all levels, from elementary through university; student teachers and graduate students in mathematics and math education.

The theme of this year's conference was *Rigour and Intuition in Mathematics*. Two plenary speakers: Ed Barbeau, a mathematician from the University of Toronto, and Brent Davis, a Canada Research Chair in Education

at the University of Alberta in Edmonton, presented their views on understanding mathematics and the respective roles of intuition and logic in the process of achieving it.

A lively panel discussion, chaired by Klaus Hoechsman (PIMS), addressed the topic in the afternoon. Lin Hammill (Kwantlen University College), Christine Stewart (SFU), Günter Törner (German Mathematical Society, DMV) and Kirsten Urdahl-Serr (School District 42, Maple Ridge), presented their views on the subject.

The participants were offered a choice of 3 workshops to enrich their experiences:

**Sue Haberger** (Centennial Secondary School): *The Moment of Proof*, which described methods and tricks she has developed and successfully used over the years to make students appreciate the need for rigour.

**Natasa Sirotic** (Collingwood School): *"Proofs" of Fallacies*, or how to spot problems in seemingly flawless reasoning.

**David Lidstone** (Langara College): *Intuition in Problem Solving*, which invited participants to test their mathematical intuition in a series of challenging problems.

### Teacher Association Meetings

Annual meetings of teacher associations provide an important venue for connections between PIMS researchers and school teachers. PIMS participated in the big 2002 October meetings of the British Columbia Association of Mathematics Teachers (BCAMT). PIMS had a display table there which was organised by Janet Martin and Wendy Nielsen.

## Initiatives for Undergraduate Students

### PIMS Graduate Weekends

This annual PIMS programme is unique in Western Canada, providing a forum in which talented undergraduates can preview and select the speciality which best suits their interests and ability. The payoff is many-faceted: Groups and laboratories are populated with better-matched students, students get the programmes they really want, and the strength of Western Canada's mathematical sciences is promoted.

### PIMS Graduate Studies Information Week Universities of Calgary and Alberta, January 7-11, 2003

For the last several years PIMS has sponsored an annual Graduate Studies Information Week. The objective is to recruit top undergraduate students from across Canada to enrol in graduate studies in mathematics, statistics and computing science at the PIMS universities.

This year's PIMS Graduate Studies Information Week was held in Calgary and Edmonton from January 7–11. The event was funded by PIMS and the two host universities.

The 25 students arrived in Calgary on the afternoon of Tuesday, January 7, and a welcoming reception was held that evening. Then all day Wednesday and Thursday morning, the visiting students had a full programme that included information sessions about graduate studies in the Department of Mathematics and Statistics and in the Department of Computer Science.

They had opportunities to talk to faculty members and graduate students about their research interests. The students were also given a tour of the campus. Representatives of other PIMS universities who met the students and made presentations about their programmes were Chris Bose (University of Victoria) and Randy Sitter (Simon Fraser Univer-



Enjoying the reception at the PIMS 2003 Graduate Studies Information Week.

sity). A farewell banquet was held on Wednesday evening at the University Club.

When the students arrived in Edmonton they attended a welcoming banquet hosted by the Vice-President (research). The students were welcomed by Acting Dean of Science Gregory Taylor and by Associate Dean of Graduate Studies and Research Ellen Macdonald.

On Friday morning students were addressed by BIRS Scientific Director Robert Moody on the nature of graduate studies and research in the mathematical sciences and by Jin Hoover on the types of mathematical problems being considered by computing scientists. They then heard 40-minute presentations by representatives of PIMS universities. They heard about UBC programmes from David Brydges. Simon Fraser University was represented by Imin Chen and Steven Ruuth and Lorna Stewart. Yau Shu Wong represented the University of Alberta.

At noon, following the formal presentations, all local graduate students and faculty in math, statistics and computing science were invited to meet the guests for lunch in the Department of Mathematical and Statistical Sciences.

For the afternoon students followed individual itineraries that had been prepared for them based on their expressed interests (in universities, programmes etc). They took campus and facility tours and/or had individual or small group meetings with PIMS graduate programme representatives and



Discussing graduate studies.

with local scientists and graduate students.

The event concluded with a farewell supper at the Heritage Lounge. Students expressed their excitement and interest in the experience and most of them declared their intention to apply for admission to one or more graduate programmes at a PIMS university.

### **1<sup>st</sup> PIMS Mathematics of Biological Systems Summer Workshop University of Alberta, May 11-19, 2002**

Organizer: Mark Lewis (U. Alberta)

(See chapter on *Industrial & Scientific Training Programme*.)

### **PIMS-MITACS-COE Undergraduate Industrial Case Study Workshop Centre for Operations Excellence at UBC, May 25-27, 2002**

Organizers: M. Puterman (Commerce and Business Admin, UBC) and Stephen Jones (COE, UBC).

(See chapter on *Industrial & Scientific Training Programme*.)

### **IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop UBC and SFU, February 15-16, 2003**

Organizers: Manfred Trummer (SFU) and Bernie Shizgal (IAM)

(See chapter on *Industrial & Scientific Training Programme*.)

## Initiatives for Graduate Students

### Graduate Industrial Math Modelling Camps

Each spring PIMS sponsors a five-day workshop for graduate students on industrial mathematical modelling. The goal of the Graduate Industrial Math Modelling Camp (GIMMC) is to provide experience in the use of mathematical modelling as a problem solving tool for graduate students in mathematics, applied mathematics, statistics, and computer science.

GIMMC is one of two components of the annual PIMS Industrial Forum. The other component is the Industrial Problem Solving Workshop. At this workshop, industrial and academic mathematicians work together to solve particular problems posed by industrial sponsors. Graduate students who are accepted to the Mathematical Modelling Camp are also invited to this Workshop.

Students work together in teams, under the supervision of invited mentors. Each mentor poses a problem arising from an industrial or engineering application and guides his or her team of graduate students through a modelling phase to a resolution. At the end of the workshop, reports are presented and a written summary of conclusions is made available for distribution.

Outstanding graduate students at both the Masters and PhD levels in the fields of mathematics, applied mathematics, statistics, and computer science, or related disciplines, are invited to apply.

### 5th PIMS Graduate Industrial Math Modelling Camp Simon Fraser University, May 18-23, 2002

Organizer: Mark Paulhus (U. Calgary)

(See chapter on *Industrial Training Programme*.)

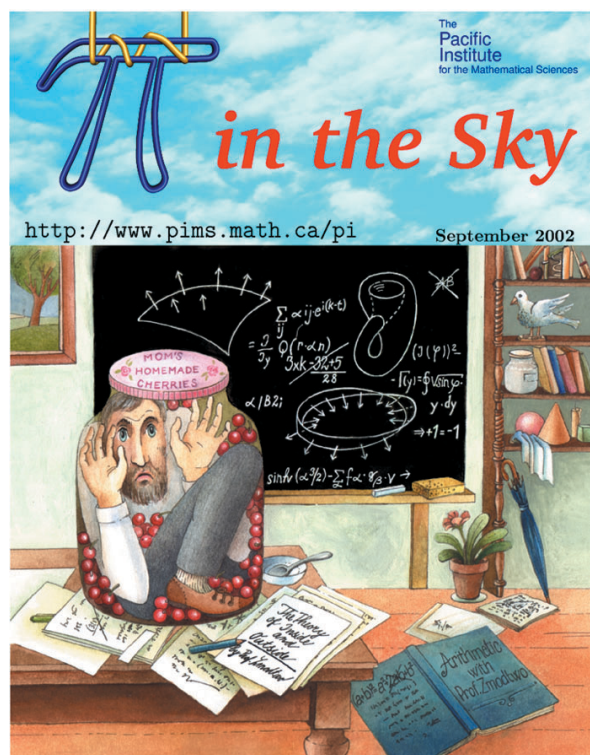
### 4th PIMS Summer School in Fluid Dynamics PIMS at the University of Alberta, July 28-August 9, 2002

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

(See chapter on *Industrial Training Programme*.)



## VI. COMMUNICATION OF THE MATHEMATICAL SCIENCES



While studying the work of Möbius, Prof. Zmodtwo discovers the importance of signs.

The fifth issue of *Pi in the Sky* magazine. The cover was specially created by Czech artist Gabriela Novakova according to an original idea by George Peschke, and the meaning of the scene is explained in the article “Oops!!! Just what happened to Prof. Zmodtwo?”

## Pi in the Sky

*Pi in the Sky* is a mathematical magazine targeted at the Junior and Senior High School students and educators. *Pi in the sky* is produced by mathematicians at the University of Alberta, for distribution across the BC, Alberta and Washington State. This popular semi-annual publication promotes all aspects of the mathematical sciences. The first 5 issues are available online through the PIMS website. The Editors in Chief are Nassif Ghoussoub (PIMS Director) and Wieslaw Krawcewicz (U. Alberta). John Bowman, also from U. Alberta, is the Associate Editor. The rest of the editorial Board consists of Peter Borwein (SFU), Florin Diacu (U. Victoria), Klaus Hoechsmann (UBC), Michael Lamoureux (U. Calgary) and Ted Lewis (U. Alberta).

The purpose of *Pi in the Sky* is to promote mathematics, establish direct contact with teachers and students, increase the involvement of high school students in mathematical activities, and promote careers in the mathematical sciences.

This journal, aimed at the average student, has the following objectives:

- promote meaningful and exciting mathematics;
- inform students and teachers about mathematical sciences;
- increase participation of students in math related activities;
- encourage girls to get involved in mathematical sciences;
- establish a dialog between students, teachers and academics;
- promote new and/or innovative teaching methods;
- change any negative stereotype image of math.

## The September 2002 Issue of Pi in the Sky Magazine

The fifth issue of the *Pi in the Sky* came out in September 2002. The *Math & Astronomy* section features *Solar Eclipses: Geometry, Frequency, Cycles* by Hermann Koenig. Read a biography of female mathematician Emmy Noether by Volker Runde. *From Rabbits to Roses: A Geometric Mystery Story* by Klaus Hoechsmann is the continuation of the mystery series *The Rose and the Nautilus*. Other articles include *Student's Workshop: Polyhedra with Six Vertices* by Richie Ng, *Mathematics of the Past* by Garry Kasparov, and *Decoding Dates from Ancient Horoscopes* by Wieslaw Krawcewicz. Another article is about Gibbon, Malthus, and the Ancients.

## The March 2003 Issue of Pi in the Sky Magazine

The sixth issue of the PIMS educational magazine **Pi in the Sky** came out in March 2003. The cover was specially created by Czech artist Gabriela Novakova. The scene depicted was inspired by the article *Gambling with Your Future—Knowing the Probabilities* by Garry J. Smith and Byron Schmuland, which features in the magazine.

The Magic of Numbers section features *Divisibility of Prime Numbers* by Edwin D. Charles and Jeremy B. Tatum.

The Math Strategies section contains the article *Inequalities for Group Folding and Groups Unfolded* by Andy Liu, which explains “Scientific Origami”.

Other articles include *On the Dynamics of Karate* by Florin Diacu, *Be Careful with that Axe, Eugene* by Thomas Hillen, *Leonard Euler* by Alexander and Alina Litvak, *Vedic Mathematics* by Jeganathan Srisikandarajah, *Mathematics in Today's Financial Markets* by Alexandar Melnikov, and *Am I Really Sick?* by Klaus Hoechsmann.

*Pi in the Sky* continues to be distributed to schools in British Columbia, Alberta and Washington State as well as to individuals across North America who have requested a copy.

This issue and all the previous issues are available for download on the website [www.pims.math.ca/pi/](http://www.pims.math.ca/pi/).





## The PIMS Math Fair Booklet

PIMS published the math fair booklet by **Ted Lewis** (PIMS Education Coordinator, U. Alberta) in the Spring. This is a major new resource for teachers and others interested in math fairs for schools. It is based on the experience of the author and his colleagues over the past few years. It is a rich source of guidelines to organizing math fairs, and to finding suitable problems puzzles and challenges.

The booklet is available for free download in pdf format suitable for laser printing. Hard copies may be purchased from PIMS University of Alberta for a nominal fee (US\$10.00 for shipping and handling in North America, US\$15.00 elsewhere).

### From the Introduction: the math fair booklet by Ted Lewis

Everybody knows what a science fair is. Students find projects to work on, they prepare posters and demonstrations, the public is invited to come and see what they have done, and a panel of judges awards prizes for projects that are deemed to be the best.

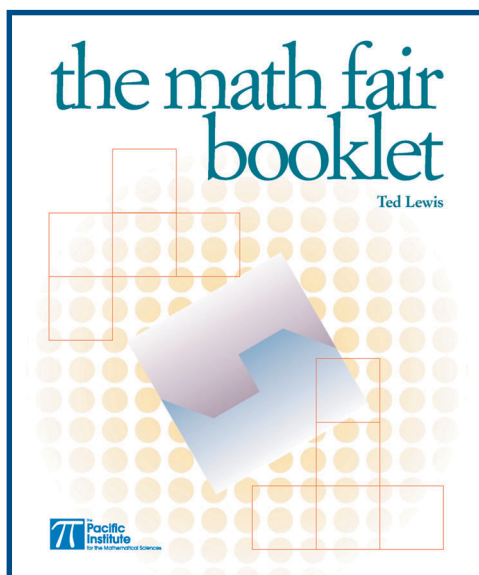
A math fair is similar, but two important differences set our concept apart. Although mathematics is extremely diverse, our math fairs concentrate on just one aspect of the subject, namely problem solving, and our fairs are officially non-competitive, so there are no awards or prizes. We have chosen to focus on problem solving for several reasons. It is one activity that is common to most of mathematics, it is frequently an explicit part of the mathematics curriculum and it encourages skills in students that

can be applied in all areas of their lives.

The problems in this booklet are ones that young students can solve and truly understand with a reasonable amount of work. They will not need a broad educational background, but the problems are not simple and most will have to think before solving them. The same is true about the people who visit the math fair even though they may be adults or students from higher grades. When the participants present their problems, they will discover that the visitors need help to work through the solutions, and the presenters will gain the satisfaction and confidence that comes from helping more talented or older persons.

The interaction between the participants and the viewers at a problem-based math fair can have a profound effect on the poise, confidence, communication skills and patience of the participants. The reason for our second difference, that the math fair be officially non-competitive, is so that all students are encouraged to participate and benefit. If some students feel they have little chance of winning they may decline to join in or not put in a full effort.

Even if a math fair is officially non-competitive, informal competition does occur. The participants quickly recognize who among them are good problem solvers, who can explain things well, whose presentations have the best artwork, and which displays attract the most visitors. But this sort of competition is friendly and constructive, and frequently leads to co-operative efforts among the participants. The focus on problem solving and the lack of formal awards are the key parts to our concept of a math fair for children, but otherwise there are many opportunities to creatively adapt the concept to a particular situation. We hope you will find this booklet useful in organizing your own math fair and are looking forward to hearing from you about your experiences.



## The PIMS Magazine

### Scientific Articles that appeared in the PIMS Magazine in 2002-03:

- Volume 6.2: *Is Economic Theory True?*  
by **Ivar Ekeland** (U. Paris-Dauphine)
- Volume 7.1: *Algebraic  $Z^n$  Actions*  
by **Klaus Schmidt** (University of Vienna and Erwin Schrödinger Institute)

- Volume 7.1: *Numerical Construction of Spacetimes* by Luis Lehner (Louisiana State University)

## PIMS Offers Lectures via Streaming Video over the Internet

PIMS now has over 2000 lectures available over the internet using on-demand streaming video and audio. The lectures are available at [www.pims.math.ca/video](http://www.pims.math.ca/video).

There are videos of the lectures in Realvideo format and high resolution JPEG images of the speaker's slides, when possible. MP3 files are also available for listening to for many of the lectures.

The library is divided into five main sections:

- Ceremonies and Meetings
- Seminar Series and Distinguished Lectures
- Thematic Programmes, Conferences and Workshops
- Minicourses
- Educational Activities

The videos that were added in 2002-03 include the following:

### Ceremonies and Meetings

- *PIMS Awards Ceremony 2001*, Vancouver, December 1, 2001
- *Announcement Ceremony for the Banff International Research Station*, The Banff Centre, Banff Alberta and The National Science Foundation, Washington, DC, September 24, 2001
- *Opening Ceremonies and Banquet of the 2001 Canada-China Mathematics Congress*, UBC, August 20, 2001

### Seminar Series and Distinguished Lectures

### MITACS Annual General Meeting, UBC, May 23-25, 2002

- **Gilbert Strang** (MIT), *Filtering and Signal Processing*
- **Ron Graham** (UC, San Diego), *Guessing Secrets*
- **Anil K. Jain** (University of Michigan), *Fingerprint Matching*



The cover of the PIMS Magazine, Fall 2002 issue



The cover of the Spring 2003 issue of the PIMS Magazine

### IAM-PIMS 2001–02 Joint Distinguished Colloquia, UBC

• **Eva Tardos** (Cornell University), *Approximation Algorithms and Games on Networks*

• **Adam Arkin** (UC, Berkeley), *Signal Processing in Cellular Regulatory Networks: Physical Models, Formal Abstractions and Applications*

• **Russel Cafilisch** (UCLA), *Modeling and Simulation for Epitaxial Growth*

• **Joel H. Ferziger** (Stanford University), *Numerical Simulation of Turbulence*

• **David Gottlieb** (Brown University), *Spectral Methods for Discontinuous Problems*

• **Philippe R. Spalart** (Boeing, Seattle), *Detached-Eddy Simulation*



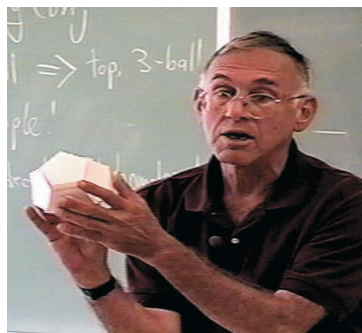
Eva Tardos (Cornell University), IAM-PIMS Distinguished Colloquia speaker

### Distinguished Lectures

• **Ivar Ekeland** (Université Paris-Dauphine), *Systems of Nonlinear PDEs arising in economic theory*, UBC, March 22, 2002

• **David Gillman** (UCLA), *Odd embeddings on lens spaces*, UBC, May 31, 2001

• **Douglas Arnold** (Director, IMA, Minnesota), *Colliding Black Holes and Gravity Waves: A new Computational Challenge*, UBC, May 16, 2001



David Gillman (UCLA) gave a PIMS Distinguished Lecture at UBC

• **David Eisenbud** (Director, MSRI), *Chow Forms and Resultants—old and new*, UBC, April 12, 2001

### Thematic Programmes, Conferences and Workshops

**Thematic Programme on Asymptotic Geometric Analysis, PIMS at the UBC, July 1–August 15, 2002**

100 lectures are available!

**International Conference on Robust Statistics, UBC, May 13–17, 2002**

23 lectures are available!

**PNW String Theory Seminar, PIMS at the UBC, March 8–10, 2002**

10 lectures are available!

### Minicourses

#### Minicourses by PIMS Distinguished Chairs

**Michael Shelley** (Courant Institute), PIMS Distinguished Chair, Simon Fraser University, November–December, 2001

- *Computing Free Boundary Problems in Moving Fluids* (lecture 1)
- *Computing with Surface Tension, and Discovering Singularities* (lecture 2)
- *Pattern Formation in Fluid Dynamics: Fluid Dynamics meets Materials Science* (lecture 3)
- *Why do Flags Flap?* (lecture 4)
- *Bending in the Wind: Elasticity and Drag Reduction* (lecture 5)

**Vladimir Turaev** (National Center of Scientific Research, France), PIMS Distinguished Chair, U. of Calgary, July–August, 2001

- *Torsion of chain complexes* (lecture 1)
- *Mehler's Formula and the Renormalization Group* (lecture 2)
- *Euler structures and refined torsions* (lecture 3)
- *The torsion function of 3-manifolds* (lecture 4)
- *Properties of the torsion function* (lecture 5)

## Educational Activities

### **PIMS Changing the Culture 2002, SFU Harbour Centre, April 26, 2002**

- **Ed Barbeau** (Mathematics, University of Toronto), *Symbiosis: Intuition and Rigour*
- **Brent Davis** (Education, University of Alberta), *Rigour : Mathematics : : Intuition : Teaching ... And Vice Versa*

Ed Barbeau (University of Toronto), a speaker at PIMS Changing the Culture 2002



## VIII. PIMS PRIZES 2002



The 2002 PIMS Research Prize went to Changfeng Gui, now at the University of Connecticut after having spent several years at UBC.



The 2002 PIMS Education Prize was awarded to Ted Lewis. Math Fairs are the brainchild of Ted Lewis, the PIMS Education Coordinator at the University of Alberta.

The PIMS Research Prize selection committee for 2002 was chaired by **Robert Moody**, the Scientific Director of BIRS. The committee members were **Gunther Uhlman** (U. Washington), **Gang Tian** (MIT), **David Brillinger** (Berkeley), **Randy Goebel** (U. Alberta), **Ian Putnam** (U. Victoria), **Hugh Williams** (U. Calgary) and **Bob Russell** (SFU).

The **2002 PIMS Research Prize** went to **Changfeng Gui**, now at the University of Connecticut after having spent several years at the University of British Columbia.

Gui is one of the leading researchers of his generation in the field of nonlinear partial differential equations. He is truly exceptional in his capacity to successfully tackle the most difficult problems in this central area of mathematics.

Two recent results of Gui were cited by the committee for the award.

The first is his proof of the existence of high energy solutions for a class of nonlinear Neumann problems. This analysis is relevant to the study of pattern formation in biology, confirming computer simulations that indicate the existence of multi-peak solutions.

The second is his solution, with his collaborators, of the De Giorgi Conjecture about the transition profile in the Allen-Cahn model for anti-phase transitions, in several important space dimensions. Since its formulation by De Giorgi in 1978, this conjecture has attracted the efforts of many leaders in the field of partial differential equations. In a 1998 paper with Nassif Ghoussoub, Gui proved this conjecture in 2 dimensions. More recently, they have also established this conjecture in dimensions 4 and 5 under symmetry conditions.

In a continuation of this work, Gui together with Martin Barlow at UBC and Richard Bass at Connecticut have completely solved the Gibbons conjecture in all dimensions. To accomplish that, they first prove a general Liouville theorem for harmonic functions associated with non-uniform elliptic operators in divergence form. This type of Liouville theorem is itself groundbreaking, important, and quite difficult.

With his collaborators Gui has made fundamental contributions to the study of multiple phase dynamics by establishing rigorously the existence of basic configurations near multi-junctions and non-trivial transition layers for vector-valued Allen-Cahn systems.

He has also done important work in understanding the stability and blow-up phenomena of nonlinear heat equations and porous media equations, in classifying the coexistence states of Lotka-Volterra competition system.

Gui and his collaborator Wei also settled the issue of the best constant in the Moser-Aubin-Onofri inequality for radially symmetric functions on the 2-dimensional sphere.

Gui has devoted himself to some of the most difficult problems in nonlinear partial differential equations. For his success in solving these problems, he is richly deserving of the PIMS Research Prize.

The **2002 PIMS Education Prize** was awarded to **Ted Lewis**.

Math Fairs are the brainchild of Ted Lewis, the PIMS Education Coordinator at the University of Alberta. The idea has evolved over a lifetime of passionate commitment to the provision of quality mathematics courses for teacher trainees and outreach to schools.

The Math Fair is similar in many ways to a science fair. Two important differences set the concept apart. Math fairs concentrate on the problem solving aspect of mathematics, and the fairs are officially non-competitive, so there are no awards or prizes. While the problems are accessible to children, they are uncompromisingly non-trivial and adults usually are also intrigued and challenged by them.

Lewis realized early on that an efficient way of delivering the concept to the schools was to concentrate on training teachers to organize fairs in their schools and districts. The most important vehicle for this is MATH 160, a mathematics course for students in teacher training in Elementary Education at the University of Alberta. This non-required course was in trouble due to low enrolment. Since the introduction of the math fairs unit it has grown to two over-subscribed sections of 60–90 students each and is now very popular. This is important from several points of view, not least in that it has gone a long way to allay ‘math anxiety’ among these student teachers who would later communicate that feeling to their pupils.

The practicum portion of the course involves the organization of a math fair for invited schools. These fairs are held on campus and competition among schools to participate is keen. Because of space limitations, participation is usually limited to about 650 students. The schools in turn are expected to later organize their own math fair with support from PIMS for the purchase of problem solving resource materials. An added benefit is the heightened awareness among teachers of PIMS as a resource.

Another important vehicle for the promotion of math fairs has been the organization of model fairs at teachers’ conventions.

A valuable resource for the math fairs became available when Lewis' *The Math Fair Booklet* was designed and produced with private funding and printed by PIMS last year. It is a very high quality publication available at nominal cost in hard copy and soon as a free download from the web.

Of course Lewis has not been alone in this endeavor. Colleagues Andy Liu from the University of Alberta and Indy Lagu from Mount Royal College in Calgary have collaborated actively in the development of the concept from the beginning along with a host of former students who have now joined the teaching profession. By now thousands of students across Alberta have participated in Math Fairs. The home departments and institutions of these individuals must also be recognized

along with PIMS for their support of the school projects.

Another essential partner for the past four years has been the Alberta Science and Research Authority (ASRA) whose funding for PIMS education outreach activities in Alberta has been indispensable. The energy of this partnership of creative individuals and organizations would not have been so readily and effectively tapped without ASRA.

The 2002 PIMS Education Prize selection committee members were the PIMS Site Directors: **Manfred Trummer** (SFU), **Jim Muldowney** (U. Alberta, Chair), **Dale Rolfsen** (UBC), **Gary Margrave** (U. Calgary) and **Florin Diacu** (U. Victoria).





## Appendix: Financial Report

The information in this appendix outlines the income and expenses of PIMS for the fiscal year April 1, 2002 to March 31, 2003. PIMS activities are supported by ongoing base funding from the following partners:

- The member institutions (Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Victoria and University of Washington) and affiliated institutions (University of Lethbridge and University of Northern British Columbia).
- The government of Canada through the Natural Sciences and Engineering Research Council.
- The government of Alberta through the Alberta Ministry of Innovation and Science (Alberta Science and Research Authority).
- The government of British Columbia through the Ministry of Competition, Science and Enterprise (Science and Information Technology Agency).

PIMS also received substantial contributions from 58 industrial partners (to March 31, 2003) for its industrial programmes and for the PIMS-affiliated MITACS industrial collaborative research projects.

### Income for 2002-03

The total income received by PIMS in the 2003 fiscal year is listed in Table 1. Each founding university makes an annual cash contribution equivalent to one full-time faculty position at their university at the time of the founding of PIMS. The universities also make considerable in-kind contributions of office space, computer labs, and infrastructure, in addition to releasing personnel from teaching duties in order to provide scientific leadership to the Institute.

**SFU:** Simon Fraser University made a cash contribution of \$75,000 to the PIMS operating budget. In-kind support in the form of a 4000-square foot research facility is estimated to be \$150,000 per annum.

**UA:** The University of Alberta made a cash contribution of \$70,000 to the PIMS operating budget, and a one-time cash contribution of \$100,000 for the purchase of computer infrastructure at the Banff International Research Station. In-kind support in the form of office space is estimated to be \$60,000 per annum.

**UBC:** The University of British Columbia made a cash contribution of \$135,000 to the PIMS operating budget. In-kind support in the form of a 4800-square foot research facility is estimated to be \$150,000 per annum. In addition, the university provides services to PIMS (financial accounts, e.g.) at an estimated value of \$30,000 per annum.

**UC:** The University of Calgary made a cash contribution of \$61,000 to the PIMS operating budget, and a one-time cash contribution of \$100,000 for the purchase of computer infrastructure at the Banff International Research Station. In-kind support in the form of office space is estimated to be \$60,000 per annum.

**UVic:** The University of Victoria made a cash contribution of \$60,000 to the PIMS operating budget. In-kind support in the form of office space is estimated to be \$60,000 per annum.

**UW:** The University of Washington provided in-kind support for administration and scientific leadership estimated at \$10,000 USD (\$15,000 CAD). Direct expenses incurred at the site office are estimated to be \$7,000 USD (\$10,000 CAD).

**ULeth:** The University of Lethbridge, an affiliated institution of PIMS, made a cash contribution of \$5,000.

**UNBC:** The University of Northern British Columbia, an affiliated institution of PIMS, made a cash contribution of \$5,000.

**MITACS:** The MITACS NCE makes an annual contribution to PIMS to cover the direct expenses of PIMS in providing administration and infrastructure support to the PIMS-affiliated MITACS projects, and for networking activities, theme meetings and workshops.

PIMS Total Income: April 1, 2002 - March 31, 2003

<b>Source</b>	<b>Carry-forward</b>	<b>Income 02/03</b>	<b>Operating Funds</b>	<b>In-Kind Support</b>
NSERC	\$75,538	\$630,000	\$705,538	
BC (CSE/ISTA)	\$13,958	\$197,500	\$211,458	
BC (NCE)	\$25,214	\$47,892	\$73,106	
Alberta (ASRA)	\$52,117	\$400,000	\$452,117	
Universities	(\$19,447)	\$0	(\$19,447)	
SFU		\$75,000	\$75,000	\$150,000
UAlberta		\$170,000	\$170,000	\$60,000
UBC		\$135,000	\$135,000	\$180,000
UCalgary		\$161,000	\$161,000	\$60,000
UVictoria		\$60,000	\$60,000	\$60,000
ULethbridge		\$5,000	\$5,000	
UNBC		\$5,000	\$5,000	
UWashington		\$0	\$0	\$25,000
MITACS	\$46,863	\$157,000	\$203,863	
Other**	\$60,625	\$203,661	\$264,286	
<b>Total</b>	<b>\$254,868</b>	<b>\$2,247,053</b>	<b>\$2,501,921</b>	<b>\$535,000</b>

\*\* Does not include industrial contributions to PIMS activities or PIMS/MITACS projects.

<b>Total Operating Funds</b>	<b>\$2,501,921</b>
<b>Reserve Fund</b>	<b>\$100,000</b>
<b>Industrial Funds Received (PIMS/MITACS)</b>	<b>\$459,864</b>
<b>Total Funds At-Hand</b>	<b>\$3,061,785</b>
<b>Total In-Kind Support</b>	<b>\$535,000</b>

Table 1

## Industrial Funding

PIMS receives substantial industrial funding in support of its programmes, in particular, the PIMS prizes, various industrial workshops, seminar series and industrial collaboration postdoctoral and graduate student fellowships. PIMS also manages the industrial funds provided by vari-

ous companies in support of the thirteen MITACS collaborative projects associated with PIMS. A summary of the industrial funding received to March 31, 2003 is given in Table 2.

## PIMS and PIMS-MITACS Industrial Funds

Project	Company	Before March/02	April/02-March/03	Total to March/03
Project 1	IBM	\$30,000	\$0	\$30,000
	MDSI	\$25,000	\$0	\$25,000
	StemSoft	\$34,500	\$0	\$34,500
Project 2	Quatronix	\$15,000	\$0	\$15,000
	Sound Logic	\$25,000	\$0	\$25,000
	Webdispatchers.com	\$25,000	\$0	\$25,000
Project 3	Waterloo Maple	\$139,750	\$36,000	\$175,750
	Workfire Development Corp.	\$20,000	\$0	\$20,000
Project 4	FinancialCAD	\$88,750	\$10,250	\$99,000
	Powerex	\$62,000	\$0	\$62,000
	TransAlta	\$42,000	\$0	\$42,000
Project 5	CREWES	\$10,000	\$0	\$10,000
	Imperial Oil	\$15,000	\$15,000	\$30,000
	C&C Systems Limited	\$10,000	\$0	\$10,000
Project 6	NORTEL	\$120,000	\$0	\$120,000
Project 7	Kinetek	\$15,000	\$0	\$15,000
	SmithKline Beecham	\$160,000	\$0	\$160,000
	In Silico	\$77,556	\$0	\$77,556
	StemCell	\$5,000	\$0	\$5,000
	Bayer	\$10,000	\$0	\$10,000
Project 8	VisionSmart	\$7,473	\$0	\$7,473
	Lockheed Martin	\$98,789	\$0	\$98,789
	Acoustic Positioning Research	\$20,000	\$4,000	\$24,000
Project 9	Canadian Airlines	\$87,000	\$0	\$87,000
	BCTel	\$43,500	\$0	\$43,500
	Telus	\$43,500	\$0	\$43,500
	Workers' Compensation Board	\$134,750	\$47,750	\$182,500
	Vancouver International Airport	\$53,875	\$23,875	\$77,750
Project 10	Powertech	\$20,000	\$0	\$20,000
	Ballard Power System Inc.	\$366,000	\$127,500	\$493,500
Project 11	Organon Canada	\$20,000	\$0	\$20,000
	Starlab	\$8,141	\$0	\$8,141
	Kinetana	\$35,400	\$0	\$35,400
	National Institute of Health	\$5,941	\$0	\$5,941
	Cybercell	\$20,000	\$0	\$20,000
Project 12	Insightful	\$23,814	\$0	\$23,814
	iCapture (McDonald Research Lab)	\$0	\$12,500	\$12,500
Project 13	Monsanto Company	\$2,920	\$0	\$2,920
	Merak	\$2,000	\$0	\$2,000
	Charles Howard & Associates	\$1,000	\$0	\$1,000
Project 14	Imperial Oil	\$4,000	\$0	\$4,000
	McMillan-McGee	\$2,000	\$0	\$2,000
	Michelin	\$2,889	\$0	\$2,889
	Stern Stewart & Co.	\$2,889	\$0	\$2,889
Project 15	Firebird Semiconductors	\$2,000	\$0	\$2,000
	Algorithmics	\$2,000	\$0	\$2,000
	IBM	\$1,974	\$0	\$1,974
	Microsoft	\$3,011	\$0	\$3,011
	Dept. of National Defence (CSE)	\$2,000	\$0	\$2,000
	AEC Oil & Gas	\$2,000	\$0	\$2,000
Project 16	Firebird Semiconductors	\$23,000	\$0	\$23,000
Project 17	Toronto Dominion	\$20,000	\$0	\$20,000
Project 18	MathSoft	\$21,708	\$0	\$21,708
Project 19	Vortek	\$10,000	\$0	\$10,000
Project 20	Schlumberger (Etudes & Productions)	\$48,000	\$48,000	\$96,000
Project 21	Schlumberger (Cambridge)	\$20,000	\$10,000	\$30,000
Project 22	NORTEL/StatCar	\$12,604	\$0	\$12,604
Project 23	Galdos Systems	\$15,000	\$0	\$15,000
Project 24	Capital Health	\$0	\$2,000	\$2,000
	McMillan-McGee	\$0	\$2,000	\$2,000
	RBC Risk Management	\$0	\$2,000	\$2,000
	Semiconductor Insights	\$0	\$2,000	\$2,000
	Shell Canada	\$0	\$2,000	\$2,000
	Talisman Energy	\$0	\$2,000	\$2,000
	Project 25	Microsoft Research	\$0	\$7,531
Project 26	Sun Microsystems	\$0	\$105,458	\$105,458
	<b>Total</b>	<b>\$2,118,734</b>	<b>\$459,864</b>	<b>\$2,578,598</b>

Table 2

## Other Contributions

Table 3 outlines the cash operating budget of PIMS for funds flowing through PIMS accounts at the various sites. Additional contributions in support of PIMS researchers and events are estimated below.

**University Infrastructure:** PIMS has offices at all five Canadian member institutions. Computational facilities, infrastructure and administrative support are provided. The PIMS central office at UBC is housed in a 4,800 sq ft facility that accommodates up to 40 researchers, plus a seminar room and reading room. The PIMS-SFU site office is housed in a 4,000 sq ft facility that accommodates up to 20 researchers, plus a seminar room.

**BC-NCE Infrastructure Support:** Only the BC-NCE infrastructure award held at the PIMS central office at UBC is listed in Tables 1 and 3. In addition, an award is made to PIMS and MITACS at SFU for infrastructure support. These funds are made available through the Vice Presidents, Research at UBC and SFU to support federal NCE activities.

**MITACS Projects:** The majority of the industrial funds listed in Table 2 go to support the PIMS-affiliated MITACS projects. The NCE matching funds provided by MITACS for these projects are not listed, however, these funds are managed by PIMS.

**Sun Microsystems:** Sun Microsystems provided a one-time corporate contribution of more than \$100,000 in discounts and donated equipment for the Banff International Research Station. This contribution is of special note in the list of industrial income.

**Additional Support for Industrial PDFs:** The PIMS contributions to industrial postdoctoral fellowships (\$10-\$20K each) are matched (one-to-one) by the corresponding industrial partners. These funds are usually paid as salary directly to the postdoctoral fellow and are not reported here.

**Additional Support for Scientific PDFs:** The PIMS contributions to scientific postdoctoral fellowships (\$18K each) have been at least matched (minimum \$18K contribution) by individual research grants and by teaching stipends from the PDF's department.

**Conference Support:** Most PIMS conferences receive additional financial support in the form of registration fees, contributions from the research grants of organizing committee members, and/or cosponsorship with other organizations.

**Corporate Support:** Industrial partners or corporations sometimes contribute to official receptions and banquets connected to scientific and industrial activities. Shell Canada provides lunch and meeting space for the Lunchbox Lectures in Calgary, for example.

**Industrial Support:** Many industrial outreach events, in particular, the *Graduate Industrial Math Modelling Camp and Industrial Problem Solving Workshop* (among many others) are partially supported by direct and indirect contributions from the industrial participants.

**Education Support:** Most education activities of PIMS are cosponsored by schools, university departments, provincial ministries of education, and professional societies.

PIMS Summary of Expenditures: April 1, 2002 - March 31, 2003

<b>Expense Category</b>	<b>Budgeted</b>	<b>Actuals</b>	<b>Over/Under</b>
Site Offices	\$222,217	\$206,694	\$15,523
Scientific Personnel	\$122,500	\$115,168	\$7,332
Central Office	\$370,000	\$336,631	\$33,369
Special Events	\$490,458	\$417,635	\$72,823
Industrial Outreach*	\$375,000	\$255,959	\$119,041
Education Programmes	\$144,317	\$124,483	\$19,834
Scientific Activities	\$597,324	\$541,636	\$55,688
PIMS Postdoctoral Fellows**	\$348,000	\$294,594	\$53,406
<b>Total Expenses</b>	<b>\$2,669,816</b>	<b>\$2,292,800</b>	<b>\$377,016</b>

\* *Figures include neither industrial funds nor MITACS projects*\*\* *Figures include neither industrial PDFs nor matching funds*

<b>Source</b>	<b>Operating Funds</b>	<b>Budgeted</b>	<b>Actuals</b>	<b>Carry-forward</b>
NSERC	\$705,538	\$668,846	\$558,658	\$146,880
BC (CSE/ISTA)	\$211,458	\$335,000	\$320,685	(\$109,227)
BC (NCE)	\$73,106	\$55,000	\$53,448	\$19,658
Alberta (ASRA)	\$452,117	\$471,000	\$304,851	\$147,266
Universities	\$591,553	\$537,500	\$505,531	\$86,022
MITACS	\$203,863	\$219,000	\$202,157	\$1,706
Other	\$264,286	\$403,470	\$347,471	(\$83,185)
<b>Total Expenses</b>	<b>\$2,501,921</b>	<b>\$2,689,816</b>	<b>\$2,292,800</b>	<b>\$209,121</b>

Table 3







*The Banff Centre from the air. Photo courtesy of Robert Piché.*

**The Pacific Institute for the Mathematical Sciences is sponsored by:**

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