



# Pacific Institute for the Mathematical Sciences

Annual Report 2005 | 06



## Mission Statement

The Pacific Institute for the Mathematical Sciences (PIMS) was founded and is maintained by the five main universities in Western Canada (Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, and University of Victoria). In 2005 the University of Washington joined this group of Canadian universities, thereby extending PIMS' influence into the United States.

PIMS' objectives are:

- Promoting research in mathematics;
- Strengthening ties and collaboration between mathematical scientists in the academic community, in the industrial and business sector, and in government;
- Enhancing education and training in mathematical sciences, and broadening communication of mathematical ideas; and
- Creating strong mathematical partnerships and links within Canada and with organizations in other countries, focusing on Pacific Rim nations.

PIMS has a close partnership with the Mathematical Sciences Research Institute (MSRI), and the Mathematics of Information Technology and Complex Systems (MITACS). The Universities of Lethbridge, Northern British Columbia, and Regina are affiliates.

In its nine years of existence, PIMS has developed numerous ways in which to fulfil the objectives set by its founding universities. These include Collaborative Research Groups, various Scientific, Education, and Industrial activities, the Banff International Research Station (BIRS), and Postdoctoral Fellowships. As the Director of PIMS, I am committed to continuing in this direction, as well as exploring other ways in which PIMS can contribute to mathematics, science, and education.

Ivar Ekeland  
PIMS Director

## Message from the Director



**Ivar Ekeland, PIMS Director**

In 2005-06, the Pacific Institute for the Mathematical Sciences (PIMS) has continued to expand the scope of its mathematical research and collaboration, through our ties with mathematicians in Canada and the United States, with international organizations, and with industry.

PIMS' dedication to collaborative mathematical research continues to show results. In 2005-06, five new Collaborative Research Groups (CRG) began operations, while five others wrapped up their activities. Our Postdoctoral Fellowships programme attracted bright mathematical minds to the PIMS universities. Our seminars and conferences brought together mathematicians from North American and internationally, to develop mathematical research and strengthen ties between researchers.

Our international reach expanded dramatically in 2005-06. PIMS signed agreements with the Centre for Mathematical Modeling in Chile (CMM) and with the National University of Mexico (UNAM), which puts PIMS at the centre of mathematical and applied mathematical research in Latin America. PIMS and MSRI initiated a meeting at BIRS that became the founding meeting of the Pacific Rim Mathematical Association. PRIMA is an association of mathematical sciences institutes, departments and societies from around the Pacific Rim, established with the aim of promoting and facilitating the development of the mathematical sciences throughout the Pacific Rim region.

In 2006 and beyond, we will build on our scientific and industrial ties, as PIMS enters its 10<sup>th</sup> year of mathematical excellence.

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## PIMS (News)

### INTERNATIONAL PARTNERSHIPS

In October, 2005, PIMS took a major international initiative. Together with the Mathematical Sciences Research Institute (MSRI), PIMS invited the major mathematical sciences institutes from around the Pacific Rim to attend a meeting at the Banff International Research Station (BIRS). There were over 30 participants, and it was decided to create a network, the Pacific Rim Mathematical Association (PRIMA), which now has 43 members in Canada, the United States, Chile, Mexico, Australia, New Zealand, China and Hong Kong, Japan, South Korea and Singapore. A general agreement was made to develop student and faculty exchanges (under the general principle that the home institute pays for travel and the host institute pays for accommodation), and creating PRIMA programmes and events and the general PRIMA congresses, the first of which will be held July 13-17, 2009, at the University of New South Wales in Sydney, Australia. PRIMA is a natural conduit for bringing international students and researchers to Canada, and for accessing foreign expertise.

In December, 2005, PIMS signed a cooperation agreement with the Centro de Modelamiento Matemático (CMM) at the University of Chile. Similar to Western Canada, Chile has a high degree of economic reliance on natural resources such as fishing, forestry, and mining, which is why CMM joined the PIMS Collaborative Research Group on the Economics and Finance of Climate Risk and Natural Resources. This is a very balanced collaboration: PIMS brings expertise in economics, finance, and operations research, while CMM brings expertise on stochastic optimization and numerical algorithms. Both sides share a strong common ground in mathematics, notably partial differential equations. One three-week summer school was held in Vancouver in the summer of 2006, another is scheduled at BIRS in 2007, and a workshop with several prominent mining companies is scheduled in Santiago in 2007. Several Chilean graduate students now have joint supervision from PIMS and CMM faculty.

In 2006, PIMS signed separate working agreements with two Mexican institutes, the Mathematics Institute at UNAM (March, 2006) and CINVESTAV (September, 2006). This has resulted in closer ties between the Canadian and Mexican mathematical communities (the first joint meeting of the Canadian and Mexican societies was held in Guanajuato in September, 2006, and the second one is scheduled in Vancouver in 2009). As part of this collaboration, a summer school on Algebra was organized by PIMS and UNAM at BIRS in July, 2006, and a meeting in Geometry and Topology took place in Mexico in January, 2007.

### NATIONAL PARTNERSHIP

The University of Regina joined PIMS as an affiliated institution in June, 2005. The PIMS contact at U.Regina is Shaun Fallat, Associate Professor in the Department of Mathematics and Statistics. U.Regina is the third affiliated member of PIMS, joining the University of Lethbridge and the University of Northern British Columbia.





# PIMS Management

## Board of Directors

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

The Board is composed of the PIMS Director and Deputy Director, a Senior Academic Administrator from each PIMS University, mathematical scientists, and representatives from industry and the professional societies.



**Chair of the Board  
(from June, 2005):**

**Brian H. Russell** has spent his career working in all aspects of exploration geophysics. He initially joined Chevron Standard in Calgary in 1976 as a seismic interpreter, subsequently working for Chevron Geosciences in both Calgary and Houston in the areas of seismic processing and research. After leaving Chevron in 1981, Dr. Russell joined Teknica Resources Development in Calgary as a senior geophysicist. In 1983, he moved to Vertias Seismic Ltd. in a research and training position. In 1987, Dr. Russell, together with Dan Hampson, founded Hampson-Russell Software Services Ltd., a company that develops advanced seismic software for the petroleum industry. Since September, 2002, Hampson-Russell has been a wholly owned subsidiary of Veritas DGC Inc., where Dr. Russell is Vice-President.

Dr. Russell is still actively involved in geophysical research and training, and presents courses on seismic technology throughout the world. He holds a B.Sc. Honours in Physics and Geophysics from the University of Saskatchewan and a M.Sc. in Geophysics from the University of Durham, England. He recently completed his Ph.D. in Geophysics at the University of Calgary, where his research involves the application of multivariate statistics and neural networks to the delineation of reservoir parameters using seismic attributes.

Dr. Russell has also been active as a volunteer with several geophysical societies. He was president of the Canadian SEG (CSEG) in 1991, received the CSEG Meritorious Service Award in 1995, the CSEG Medal in 1999, and honorary membership in 2001. With the Society of Exploration Geophysicists (SEG), Dr. Russell served as chairman of the Leading Edge editorial board in 1995, technical co-chairman of the 1996 SEG annual meeting in Denver, and as President of SEG during 1998-99. In 1996, Dr. Russell and Mr. Hampson were jointly awarded the SEG Enterprise Award.

He has been a member of the PIMS Board of Directors since 2004, and Chair since June, 2005.



**Chair of the Board  
(to June, 2005):**

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

He was a member of the PIMS board from 1998 to 2005, and director from 2004 to June, 2005.



**Don Brooks** received his Ph.D. from the University of Oregon in 1971. He held postdoctoral positions at the Weizmann Institute and the University of Cambridge, before coming to UBC in 1974.

Dr. Brooks is professor of Pathology and Laboratory Medicine as well as Chemistry. He is also the Associate Vice-President Research for UBC. His areas of research are biomaterials, microgravity biotechnology, development of blood plasma substitutes and immunodiagnostic techniques. Dr. Brooks has been a member of the PIMS Board of Directors since 2004.



**Don Denney** received his Ph.D. from the University of Waterloo in 1978 and spent two years as a postdoctoral 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. Dr. Denney has been with Syncrude for many 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. His prior experience at Syncrude includes 10 years at Research developing On-Line Sensors and applying Pattern Recognition techniques to data analysis and eight 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. He has been a member of the PIMS Board of Directors since 2000.



**Ivar Ekeland** is the Canada Research Chair in Mathematical Economics at the University of British Columbia. He is a former President of Université Paris Dauphine, and a former Director of the research centres CEREMADE and Institute

Finance-Dauphine.

He has received prizes from the French Academy of Sciences, the French Mathematical Society, and the Belgian Academy of Sciences. He is a foreign member of the Norwegian Academy of Sciences and he holds honorary doctorates from UBC and from the University of Saint-Petersburg for Economics and Finance.

Dr. Ekeland is the founding editor of the "Annales de l'Institut Henri Poincaré-Analyse nonlineaire." He has written several books, which are reflections on, or popularization of, mathematics. For these contributions, Dr Ekeland was awarded the "Prix Jean Rostand" by the Association des Ecrivains Scientifiques de France and the "Prix d'Alembert" by the Société Mathématique de France. He is a regular contributor to the journal "Nature" as well as to the magazine "Pour la Science."

He has been a member of the PIMS Board of Directors since 2003 when he became PIMS Director.



**Haig Farris** practiced as a lawyer with Farris and Company for five years, then moved into financial consulting, co-founding two companies. He is the President of Fractal Capital Corp., a private venture capital company specializing in hi-tech start-ups and resource industry technology companies. In 2001, along with several other UBC graduates, Mr. Farris was named a Pioneer of Innovation by the Vancouver Board of Trade. He was awarded the Bill Thompson Career Achievement Award by the British Columbia Technology Industry Association. Mr. Farris has maintained a consistently high profile in the community as an advocate for UBC and as a champion of science and technology. In the latter role, he has been Chair of the Science Council of BC and a member of the founding Board of Directors for Science World, heading its first two capital campaigns.

Mr. Farris speaks at many conferences, most frequently on the topic of science awareness, venture investing and the management of high-tech companies. He also shared his accumulation of knowledge through an adjunct professorship

at UBC, encouraging entrepreneurship among his students. He currently finances several former students with new technology companies. He was nominated for a UBC Commerce Graduate Teaching Excellence Award in 1996.

His UBC degree is in English and Economics, a reflection of his lifelong interest in the arts as well as in business and the economy. He has served on many community boards, among them the Vancouver Foundation and the Waterfront Theatre. In 1989, he was awarded with the Commemorative Medal of Canada in recognition of his service to the community. Friends laud Mr. Farris's sense of vision and leadership: he leads by example and is living proof that individual attitudes and behaviour can make a difference.

On campus, Mr. Farris served as President of the Alumni Association (1996-1999), was an adjunct professor in the Faculty of Commerce from 1993 to 2003, was chair of Presidents Library Advisory Committee from 1998 to 2006 and sits on the University Industrial Liaison Office, Dean of Science and Cecil Green College advisory committees. In 1997, the university awarded him an Honorary Doctor of Laws degree.

He has been a member of the PIMS Board of Directors since 2004.



**John Hepburn**, Vice-President Research at UBC, was Dean of the Faculty of Science at UBC from 2003-2005. He received his B.Sc. in Chemistry in 1976 from the University of Waterloo, and his Ph.D. in 1980 from the University of Toronto, where his supervisor was Nobel prize winner Dr. John Polanyi.

Following a period as a NATO Fellow at the Lawrence Berkeley Laboratory at the University of California, Berkeley, Dr. Hepburn taught Chemistry and Physics at the University of Waterloo from 1982-2001, chairing the Chemistry Department for two years. In 2001, he became Head of Chemistry at UBC before being appointed Dean of Science in 2003.

He has been a member of the PIMS Board of Directors since October, 2005.



**Ron Irving** is the Interim Dean of the College of Arts and Sciences and a professor in the Department of Mathematics at the University of Washington. Dr. Irving received his undergraduate degree in Mathematics and Philosophy from Harvard College in 1973 and his Ph.D. in Mathematics from MIT in 1977. He joined the faculty of University of Washington in 1980. He is co-founder and executive director of the Summer Institute for Mathematics at University of Washington, a programme that each summer since 2003 has introduced 24 high school students from the Pacific Northwest to the beauty of advanced mathematics. He served as chair of the Department of Mathematics from July, 2001, to June, 2002. In July, 2002, Dr. Irving became Divisional Dean of Natural Sciences at the University of Washington.

He has been a member of the PIMS Board of Directors since December, 2005.



**Gary Kachanoski** was named the Vice-President Research and Professor (Department of Renewable Resources) at the University of Alberta in August, 2001. From 1996-2001, he was

Dean of the College of Graduate Studies and Research and a Professor at the University of Saskatchewan. He received his B.Sc. (Honours 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.

At the University of Saskatchewan, Dr. Kachanoski was the Dean of the 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, Dr. Kachanoski 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.

Dr. Kachanoski continues to have a strong research programme 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.

He has been a member of the PIMS Board of Directors since 2002.



**Mark Lewis** is a Professor at the University of Alberta. He is the Senior Canada Research Chair in Mathematical Biology and directs the Centre for Mathematical Biology. Dr. Lewis obtained his doctorate from the University of Oxford in 1990 in Mathematical Biology. He was a faculty member at the University of Utah until 2001, and has also held visiting and research fellowships at Princeton University and Imperial College, University of London. He is Past President of the Society for Mathematical Biology, and is on the editorial boards for a number of journals including Journal of Mathematical Biology, IMA Journal of Mathematical Medicine and Biology, Ecology and Ecological Monographs. Dr. Lewis has served on a number of advisory boards, including the Journal of Theoretical Biology Advisory Board and Scientific Advisory Board for the Banff International Research Station. His research has been recognized by a Sloan Research Fellowship and a National Young Investigator Award (US NSF).

Dr. Lewis's research is in mathematical biology and ecology, including modelling and analysis of nonlinear PDE and integral models in population dynamics and ecology. Applications, made to case

studies with detailed data and biology, include: wolf territories, elk migration in Yellowstone Park, spatial spread and impact of introduced pest species, and vegetation shift in response to climate change and recolonization of Mount St. Helens.

He has been a member of the PIMS Board of Directors since 2004.



**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 Program. 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 Cominco's 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 Corp. 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. He is currently 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 the Geoscience Council of Canada, a past-president of the Geological Association of Canada, and was also Treasurer of the Canadian Geological Foundations from 1987 to 1996. He is a member of the Geological Society of London, the Institute of Mining and Metallurgy, U.K., the Canadian

Institute of Mining and Metallurgy, a member of the Association of Professional Engineers of British Columbia, and a number of other scientific and professional associations.

He has been a member of the PIMS Board of Directors since 1997, and he is the former chair of the PIMS Board.



**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 the University of Toronto and obtained his doctoral degree from the University 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.

Dr. Perkins has won numerous awards for his research including the G. de B. Robinson Award (1996) and Jeffery-Williams Prize (2002) (Canadian Mathematical Society), the Rollo Davidson Prize (1983) (Cambridge University), a Steacie Fellowship (1992-1993) (NSERC), and the CRM-Fields Prize 2003 (co-winner with John McKay). 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 Poincaré*, *Stochastic Processes and Their Applications*, and the *Electronic Journal* invited address at the 1994 International Congress of Mathematicians in Zurich.

He has been a member of the PIMS Board of Directors since 1997.



**B. Mario Pinto** was born in Colombo, Sri Lanka, and received his B.Sc. degree in Chemistry and Ph.D. from Queen's University. Dr. Pinto served as Chair of the Chemistry Department from 1999-2004, and is currently Vice-President Research, at Simon Fraser University. Dr. Pinto received the 1992 Horace S. Isbell Award of the American Chemical Society, the 1993 Merck Frosst Award of the Canadian Society for Chemistry (CSC), and the 2002 Bernard Belleau Award of the CSC. He is a Fellow of the Chemical Institute of Canada, and was elected to the Academy of Sciences of the Royal Society of Canada in 2003. Dr. Pinto is a pioneer in the field of chemical biology having developed novel NMR/molecular modelling protocols for protein structure determination and the study of ligand topographies essential for drug and vaccine design. He was recently awarded a patent for his breakthrough on the effect of glycosidase inhibitors as novel therapeutic agents for Type 2 diabetes, which has proven effective in lowering blood glucose levels in rats. He is founder of Mimos Therapeutics Inc. He has been a member of the PIMS Board of Directors since 2004.



**Dennis R. Salahub** was appointed 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 that, he was a Professor of Chemistry at the University of Montreal from 1976 to 1999, holding a McConnell Chair from 1990.

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 University of Montreal. Following postdoctoral studies at Sussex, Waterloo, Johns Hopkins and the General Electric laboratories in Schenectady, New York, he returned to the University of Montreal and set up an internationally recognized research programme in quantum

chemistry, specializing in the development of Density Functional Theory and its applications in materials and biomolecular modelling. 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 now occupy 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 \$18-million 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 fosters high-performance computing and networking in Canada. He has been a consultant for industry.

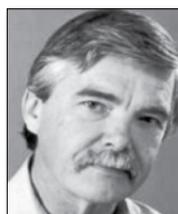
At the Steacie Institute, Dr. Salahub shaped research thrusts in nanoscience and technology, bioscience and technology, and optical science and technology, under the banner of the Institute's motto "The fundamental things apply". He contributed to NRC's vision for nanotechnology in Canada and to the founding of the new \$120-million National Institute for Nanotechnology in Edmonton.

His current term on the PIMS Board of Directors began in 2005, and he also served on the PIMS Board in 2003-04.



**Martin Taylor** moved to University of Victoria in July, 1998, to be the University's first Vice-President Research, as well as being a Professor in the Geography Department. He has a B.A. in Geography from the University of Bristol (U.K.), and an M.A. and Ph.D. from the University of British Columbia. He was appointed at McMaster

in 1974. He was Chair of Geography (1991-97), 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. He has been a member of the PIMS Board of Directors since 1998.



**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. 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 1993-94. He has also been a member of the Steacie Awards Selection Committee.

He has been a member of the PIMS Board of Directors since 2004.

## Scientific Review Panel

### The Scientific Review Panel is responsible for:

- Reviewing and selecting scientific programmes and determination of their funding levels;
- Selecting PIMS Distinguished Chairs and the PIMS Research Prize; and
- Providing advice on long-term scientific planning for PIMS.



**Alejandro Adem** is a Professor of Mathematics at UBC. In 1982 he received his B.S. from the National University of Mexico, and in 1986 he received his Ph.D. from Princeton University, under

Bill Browder. After holding a Szegő Assistant Professorship at Stanford University and spending a year at the Institute for Advanced Study in Princeton, he joined the faculty of the University of Wisconsin in 1990, and remained there until he joined the University of British Columbia in 2004. Dr. Adem has held visiting positions at the ETH-Zurich, the Max Planck Institut in Bonn, the University of Paris VII and XIII, and most recently at Princeton University.

Dr. Adem's mathematical interests vary widely over topics in algebraic topology, group cohomology and related areas. He has given over 150 invited lectures; however, his toughest assignment was preparing a lecture for the celebrated Bourbaki Seminar in Paris. His monograph "Cohomology of Finite Groups" (jointly written with R. James Milgram) was published as a Springer-Verlag Grundlehren (Volume 309) in 1994, and a second edition appeared in 2005.

Dr. Adem served as Chair of the Department of Mathematics at the University of Wisconsin-Madison, during the period 1999-2002. He was awarded an NSF Young Investigator Award in 1992, a Romnes Faculty Fellowship in 1995 and a Vilas Associate Award in 2003. He is an editor for *the Memoirs and Transactions of the American Mathematical Society*. He is currently

co-chair of the Scientific Advisory Committee for the Mathematical Sciences Research Institute in Berkeley.

In 2004, Dr. Adem was appointed Canada Research Chair in Algebraic Topology at UBC and, on Jan. 1, 2005, he became the Deputy Director of PIMS.

He has been an ex-officio member of the PIMS SRP since 2005.



**David Brillinger's** research is in statistical inference and applications to stochastic processes. In particular, this involves 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 of animal tracks. He is the author of "Time Series Analysis: Data Analysis and Theory" and former editor of the International 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.

He was a member of the PIMS SRP from 1999 to June, 2005.



**David Brydges** received his Ph.D. 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 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.

Dr. Brydges received the Alfred P. Sloan Research fellowship in 1982. He has given lectures throughout the world including courses in the Troisième Cycle at Lausanne in 1992, Centre Emile Borel in 1998, and the NachDiplom programme 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.

He has been a member of the PIMS SRP since 2002.



**Anne Condon** is a Professor in the Department of Computer Science at the University of British Columbia and is the NSERC/General Motors Chair for Women in Science and Engineering for British Columbia and Yukon. She received her Ph.D. (1987) from the University of Washington, and B.Sc. (1982) from University College, Cork, Ireland. Her Ph.D. thesis on game-like computational models won an ACM Distinguished Dissertation award. She also received an NSF National Young Investigator Award (1992) and an NSF Visiting Professorships for Women Award (1996) to support her work.

Dr. Condon's research focuses on the power of randomness in computation. Through classification of randomized and nondeterministic complexity classes, her work has led to improved understanding of what types of intractable problems can be approximated and/or computed efficiently, notably PSPACE-hard problems and also problems in

probabilistic planning. Dr. Condon also works on computational prediction of RNA secondary structure, and on verification of cache coherence protocols.

She has been a member of the PIMS SRP since 2005.



**Carl de Boor** is a Professor Emeritus in Mathematics and Computer Science at the University of Wisconsin-Madison. He won the 2003 U.S. National Medal of Science. An expert in

numerical analysis, Dr. de Boor is the author of more than 150 papers and four books. He has earned world recognition for his work on spline functions, mathematical expressions that describe free-form curves and surfaces. In particular, Dr. de Boor developed simpler approaches to complex spline calculations, a contribution that revolutionized computer-aided geometric design. His work is now routinely applied in a range of fields that rely on precise geometry, including the use of special effects in films, and in the aircraft and automotive industries.

Dr. de Boor grew up in East Germany and came to the United States in 1959. He received a doctorate from the University of Michigan in 1966 and joined the University of Wisconsin-Madison faculty in 1972. Until 2003, Dr. de Boor was the Steenbock Professor of Mathematical Sciences and the P.L. Chebyshev Professor of Mathematics and Computer Sciences. He was awarded the John von Neumann Prize by SIAM in 1996. In 1993 he was elected to the National Academy of Engineering, and in 1997 to the National Academy of Sciences. Dr. de Boor is a member of the Deutsche Akademie der Naturforscher (1998) and a foreign member of the Polish Academy of Sciences (2000). He holds honorary doctorates from Purdue University (1993) and the Technion in Israel (2002).

He has been a member of the PIMS SRP since 2005.

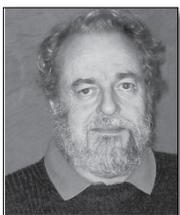


**Ivar Ekeland** is the Canada Research Chair in Mathematical Economics at the University of British Columbia. He is a former President of Université Paris Dauphine, and a former Director of the research centres CEREMADE and Institute Finance-Dauphine.

He has received prizes from the French Academy of Sciences, the French Mathematical Society, and the Belgian Academy of Sciences. He is a foreign member of the Norwegian Academy of Sciences and he holds honorary doctorates from UBC and from the University of Saint-Petersburg for Economics and Finance.

Dr. Ekeland is the founding editor of the “Annales de l’Institut Henri Poincaré-Analyse nonlineaire.” He has written several books, which are reflections on, or popularization of, mathematics. For these contributions, Dr Ekeland was awarded the “Prix Jean Rostand” by the Association des Ecrivains Scientifiques de France and the “Prix d’Alembert” by the Société Mathématique de France. He is a regular contributor to the journal “Nature” as well as to the magazine “Pour la Science.”

He has been an ex-officio member of the PIMS SRP since 2003.



**John Friedlander** is one of the world’s foremost analytic number theorists, and is a recognized leader in the theory of prime numbers and L-functions. He received his B.Sc. from the

University of Toronto in 1965, an M.A. from the University of Waterloo in 1966, and a Ph.D. from Penn State in 1972. He was a lecturer at MIT in 1974-76, and has been on the faculty of the University of Toronto since 1977, where he served as chair during 1987-91. He has also spent several years at the Institute for Advanced Study where he has collaborated with E. Bombieri and many others.

Dr. Friedlander is a Fellow of the Royal Society of Canada (1988), an invited lecturer at the 1994 ICM in Zurich, and he delivered the CMS Jeffery-Williams Lecture in 1999. He has contributed

significantly to mathematics in other ways, especially in Canada, through his role at NSERC (Mathematics GSC, 1991-94), as Mathematics Convenor of the Royal Society of Canada (1990-93), and as a Council Member (1989-95) and Scientific Advisory Panel Member (1996-2000) of the Fields Institute. He has served on the Editorial Board of the Canadian Journal of Mathematics and the Canadian Mathematics Bulletin. He has been a member of the PIMS SRP since 2005.



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

Dr. 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.

He has been a member of the PIMS SRP since 2002.



**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 served as the President of the Mathematical Association of America during 2003-04, and has served as the Treasurer of the National Academy of Sciences. He was the President of the American Mathematical Society from 1993-95, and served as Chief Scientist of AT&T Labs until 1999.

Dr. Graham’s academic awards include membership in the National Academy of Arts and Sciences, Fellow of the America Association for the Advancement of Science, and Fellow of the

Association of Computing Machinery. He is the recipient of the Polya Prize in Combinatorics, the Euler Medal in Combinatorics, a Lester Ford Award of the Mathematical Association of America, a Carl Allendorfer Award of the Mathematical Association of America, and the Leroy Steele Award for Lifetime Achievement from the American Mathematical Society in 2002. He served as President of the International Jugglers Association. Dr. Graham's current mathematical interests include combinatorics, number theory, graph theory, discrete and computational geometry, design and analysis of algorithms, and applications thereof.

He was a member of the PIMS SRP from 1996 to June, 2005.



**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 André Aisenstadt prize. He is a Fellow of the Royal Society of Canada.

He has been a member of the PIMS SRP since 1999.



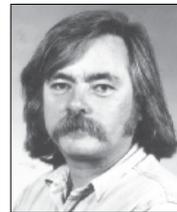
**Nancy Reid** is University Professor of Statistics at the University of Toronto. She received her Bachelor of Mathematics in 1974 from the University of Waterloo, her M.Sc. in 1976 from the University of

British Columbia, and her Ph.D. in 1979 from Stanford University. She held an academic appointment at the UBC from 1980-86 and has held visiting appointments at Imperial College, London, Harvard University and the University of Texas at Austin. She has served as President of the Institute of Mathematical Statistics and of the Statistical Society of Canada; and as Vice-President of the International Statistical Institute.

Dr. Reid is a fellow of the Royal Society of Canada,

the American Statistical Association and the Institute of Mathematical Statistics, a recipient of the Presidents' Award of the Committee of Presidents of Statistical Societies, the first recipient of the Canadian Mathematical Society's Krieger-Nelson Prize Lectureship, and the Institute of Mathematical Statistics' Wald lecturer for 2000. Her research interests include inferential statistics with special emphasis on asymptotic theory for likelihood based inference, design of experiments, and applications of statistics to health and environment.

She has been a member of the PIMS SRP since 2005.



**Bob Russell** received his 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 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).

Dr. Russell's travels include serving 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 (Canadian Applied and Industrial Mathematics Society), 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. He is particularly interested 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.

He has been a member of the PIMS SRP since 2002.



**Donald Saari** is a Distinguished Professor of Mathematics and of Economics as well as the Director of the Institute for Mathematical Behavioral Sciences at the University of California at Irvine.

He received his undergraduate degree from Michigan Technological University and his Ph.D. from Purdue University under advisor Harry Pollard, where his thesis discussed the collision dynamics of the Newtonian N-body problem. After a postdoctoral position in the Yale University Astronomy Department, he joined the Mathematics Department at Northwestern University where he served as chair of the department and was the first Pancoe Professor of Mathematics. After three decades at Northwestern, in July 2000, he moved to California.

Dr. Saari's research interests centre on dynamical systems and their applications to mathematical physics (primarily the Newtonian N-body problem) as well as to mathematical issues from the social sciences coming from economics, voting theory, and evolutionary behaviour. He is the Chief Editor of the "Bulletin of the American Mathematical Society" as well as serving on the editorial boards of several journals on analysis, dynamics, economics, and decision analysis. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, a Guggenheim Fellow, the past chair of the U.S. National Committee of Mathematics, chair of the U.S. delegation to the 2002 general assembly of the International Mathematical Union, and a member of several NRC committees including Math Science Education Board.

He has been a member of the PIMS SRP since 2005.



**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 1974-75 she was a

NATO/SRC postdoctoral fellow in the Department of Genetics, Stanford University. From 1975-81,

she was a Fellow of King's College, Cambridge, and from 1981-85 was Fellow and Director of Studies in Mathematics at Newnham College. From 1976-85, 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. In 1988, Dr. Thompson also became a Professor of Biostatistics at the University of Washington. Since the spring of 2000, she has served as 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 was the 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.

She was a member of the PIMS SRP from 2002 to June, 2005.



**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 Professor in 1992. He is currently a J. Simons Professor at the Massachusetts Institute of Technology. Dr. Tian is a recipient of the Alfred P. Sloan research fellowship (1991-93). 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 Mathematics in Beijing in 2002. In 1994, he received the 19<sup>th</sup> Alan Waterman Award from the National Science Foundation. In 1996, Dr. Tian received the Veblen Prize of the American Mathematical Society.

He has been a member of the PIMS SRP since 2002.

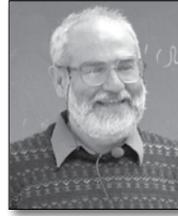


**Tatiana Toro** received her Ph.D. from Stanford University in 1992. Since 1996 she has been at the University of Washington where she became a Professor in 2002. She has held positions at Harvard

University, the University of Chicago, and the University of California-Berkeley. From 1996-2000, she held a Alfred P. Sloan Research Fellowship, and from 1994-98 she held an NSF Mathematical Sciences Postdoctoral Research Fellowship.

Dr. Toro's research areas include geometric measure theory and partial differential equations. She applies techniques from these two fields to study free boundary regularity problems with very rough boundary data. These problems arise naturally in physics and engineering, where the free boundary may appear as the interface between a fluid and the air, or water and ice. She has also worked in the problem of constructing good parameterization for sets satisfying some minimal geometric requirements (for example: snowballs).

She has been a member of the PIMS SRP since 2005.



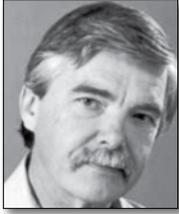
**Gunther Uhlmann** received his Ph.D. in 1976 at MIT under the direction of Victor Guillemin. He held postdoctoral positions at Harvard, Courant Institute and MIT. In 1980 he became Assistant

Professor at MIT and in 1985 he moved to the University of Washington as an Associate Professor. He was promoted to Professor in 1987.

Dr. Uhlmann was awarded the Annual National Prize of Venezuela in Mathematics in 1982. He received an Alfred P. Sloan Research Fellowship in 1984 and a John Simon Guggenheim Fellowship in 2001. He has given numerous lectures throughout the world including 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.

He has been a member of the PIMS SRP since 2002.



**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. 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 1993-94. He has also been a member of the Steacie Awards Selection Committee.

He has been a member of the PIMS SRP since 2002.



**Efim Zelmanov** is the Rita L. Atkinson Chair in Mathematics at the University of California, San Diego. He attended Novosibirsk State University, obtaining his Ph.D. in 1980 having had his

research supervised by Dr. Shirshov and Dr. Bokut. His Ph.D. thesis completely changed the whole of the subject of Jordan algebras by extending results from the classical theory of finite dimensional Jordan algebras to infinite dimensional Jordan algebras. Dr. Zelmanov described this work on Jordan algebras in his invited lecture to the International Congress of Mathematicians at Warsaw in 1983.

In 1980, Dr. Zelmanov was appointed as a Junior Researcher at the Institute of Mathematics of the Academy of Sciences of the USSR at Novosibirsk. By 1986 he had been promoted to Leading Researcher. In 1987 Zelmanov solved one of the big open questions in the theory of Lie algebras. He proved that the Engel identity  $\text{ad } y(n) = 0$  implies that the algebra is necessarily nilpotent. This was a classical result for finite dimensional Lie algebras but Dr. Zelmanov proved that the result also held also for infinite dimensional Lie algebras. In 1990, Dr. Zelmanov was appointed a Professor at the University of Wisconsin-Madison. He held this appointment until 1994 when he was appointed to the University of Chicago. In 1995, he spent the year at Yale University.

In 1991, Dr. Zelmanov went on to settle one of the most fundamental results in the theory of groups: the restricted Burnside problem, which had occupied group theorists throughout the 20<sup>th</sup> century. In 1994, Dr. Zelmanov was awarded a Fields Medal for this work at the International Congress of Mathematicians in Zurich in 1994. He is also a recipient of an André Aisenstadt Prize and a Collège de France Medal. He is a Fellow of the American Academy of Arts and Sciences and a Member of the National Academy of Sciences.

He has been a member of the PIMS SRP since 2005.

## PIMS Site Directors

### SIMON FRASER UNIVERSITY

Dr. Manfred Trummer (*to September, 2005*)

Dr. Rustum Choksi (*from September, 2005*)

### UNIVERSITY OF ALBERTA

Dr. Gerald Cliff

### UNIVERSITY OF BRITISH COLUMBIA

Dr. Alejandro Adem (PIMS Deputy Director)

### UNIVERSITY OF CALGARY

Dr. Gemai Chen

### UNIVERSITY OF VICTORIA

Dr. Chris Bose

### UNIVERSITY OF WASHINGTON

Dr. Gunther Uhlmann

## PIMS Postdoctoral Fellows for 2005 – 06

PIMS has created a large number of postdoctoral opportunities for young researchers in the mathematical sciences. The regular PIMS PDF competition takes place each January. PDFs associated with the Collaborative Research Group periods of concentration go through the same rigorous review process. Candidates must be nominated by a scientist or group of scientists affiliated with PIMS. Fellowships are tenable at any of the Canadian member or affiliated universities.

### SIMON FRASER UNIVERSITY

Boaz Ben-Moshe: *Computational Geometry*  
Supervised by Binay Bhattacharya

Joshua Buresh-Oppenheim: *Computational Complexity*  
Supervised by David Mitchell

Jian-Jun Xu: *Scientific Computing*  
Supervised by: Manfred Trummer

Antonia Kolokolva: *Computational Logic*  
Supervised by Eugenia Temovska

Youngsuk Lee: *Atmospheric Modelling*  
Supervised by Mary Catherine Kropinski and David Muraki

Yongmei Liu: *Artificial Intelligence*  
Supervised by Eugenia Ternovska

Wilson Lu: *Statistics*  
Supervised by Derek Bingham

Robert Samal: *Graph Theory*  
Supervised by Bojan Mohar and Pavol Hell

Rahul Santhanam: *Computational Complexity*  
Supervised by Valentine Kabanets

Christopher Sinclair: *Number Theory*  
Supervised by Peter Borwin and Stephen Choi

Germain Tanoh: *Medical Imaging*  
Supervised by Manfred Trummer

Ronald van Luijk: *Number Theory*  
Supervised by Nils Bruin

### UNIVERSITY OF ALBERTA

Hosne Ara Jasmine: *Mechanics*  
Supervised by Bruce R. Sutherland

Mohammad Akbar: *General Relativity*  
Supervised by Eric Woolgar

Shuang Cai: *Algebraic Geometry*  
Supervised by Vladimir Chernousov

Dana Cobzas: *Algebraic Geometry*  
Supervised by Martin Jagersand  
and John Bowman

Ying-Fen Li: *Analysis*  
Supervised Anthony To-Ming Lau

Holly Freedman: *Biophysics*  
Supervised by Jack Tuszynski  
Hung Le Pham: *Harmonic and Geometric Analysis*  
Supervised by Tony Lau

Iulia Pop: *Algebraic Geometry*  
Supervised by Arutro Piazola

Andriy Prymak: *Approximation Theory*  
Supervised by Zeev Ditzian

## UNIVERSITY OF BRITISH COLUMBIA

Nathaneal Berestycki: *Probability*  
Supervised by Alexander Holroyd

Alexi Cheviakov: *Partial Differential Equations*  
Supervised by George Bluman

Ben Green: *Number Theory*  
Supervised by David Boyd

Jae-Hun Jung: *Theoretical Chemistry*  
Supervised by Bernie Shizgal

Kyungkeun Kang: *Nonlinear PDE*  
Supervised by Stephen Gustafson  
and Tai-Peng Tsai

Friedrich Littman: *Number Theory*  
Supervised by David Boyd

Chris Rowe: *Number Theory*  
Supervised by David Boyd

Jacob Shapiro: *Algebraic Geometry,  
Group Cohomology, Representation Theory*  
Supervised by Kai Behrend and Jim Bryan

Jiaying Zhang: *Scientific Computing*  
Supervised by: Manfred Trummer

Omer Angel: *Probability*  
Supervised by Gorden Slade

Shlomo Hoory: *Expander Graphs*  
Supervised by Joel Friedman

Mario Pineda-Krch: *Mathematical Ecology*  
Supervised by Michael Doebeli

Jens Rademacher: *Dynamics/Scientific Computing*  
Supervised by Michael War and Ralf Wittenberg

Pierpaolo Esposito: *Non-linear PDE*  
Supervised by Nassif Ghoussoub

Guangyue Han: *Coding Theory*  
Supervised by Brian Marcus  
Jochen Kuttler: *Algebraic Geometry*  
Supervised by Jim Carrell

Matilde Lalín: *Number Theory*  
Supervised by David Boyd

Antonio Ramirez: *Topology*  
Supervised by Alejandro Adem

Hsian-Hua Tseng: *Algebraic Geometry*  
Supervised by Jim Bryan and Kai Behrend

Gert Williams: *Robust Statistics*  
Supervised by Ruben Zamar and  
Matias Salibian-Barrera

## UNIVERSITY OF CALGARY

Lassina Dembele: *Number Theory*  
Supervised by Clifton Cunningham

Mark Hamilton: *Symplectic Geometry*  
Supervised by Jędrzej Sniatycki

Ali Reza Khani: *Quantum Information Science*  
Supervised by Barry Sanders

Niu Zhuang: *Algebra*  
Supervised by Berndt Brenken

## UNIVERSITY OF VICTORIA

Lin Wang: *Mathematical Biology*  
Supervised by Pauline van den Driessche  
and Fred Brauer

Xiaoming Yuan: *Statistics*  
Supervised by Jane Yu

## UNIVERSITY OF WASHINGTON

Aravind Asok: *Algebraic Geometry*  
Supervised by Charles Doran

Xiaosheng Li: *Inverse Problems*  
Supervised by Gunther Uhlmann

Vitaliy Vologodskiy: *Algebraic Geometry*  
Supervised by Sandor Kovacs

## UNIVERSITY OF REGINA

Pedro Massey: *Operator Algebras and Operator*  
Supervised by Martin Argermai

# PIMS Distinguished Chairs 2005 – 06

**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 2005-06

William Symes (Rice University)  
Site: Inverse Problems CRG at University of British Columbia  
July 2005

Fred Cohen (University of Rochester)  
Site: Topology CRG at University of British Columbia  
August 2005

Richard Bass (University of Connecticut)  
Site: Probability CRG at University of British Columbia  
September 2004-August 2005

Yaozhong Hu (University of Kansas)  
Site: Probability CRG at University of Alberta  
September 2004-August 2005

Lou Fishman (MDF International)  
Site: Inverse Problems CRG at University of Calgary  
September 2005

Frank Den Hollander (Lieden University and EURANDOM, the Netherlands)  
Site: Probability and Statistical Mechanics CRG at University of British Columbia  
January-August 2006

## PIMS DISTINGUISHED CHAIR LECTURES

Williams Symes (Rice University): Mathematics of Seismic Imaging, July 19, 2005 (Part one), July 20, 2005 (Part two), and July 21, 2005 (Part three).

Fredrick Cohen (University of Rochester): Braid Groups and the Applications, August 2, 2005 (Part one) and August 4, 2005 (Part two)

Lou Fishman (University of Calgary/MDF International): Seismic Imaging-the Seismic Way, September 13, 2005

Lou Fishman (University of Calgary/MDF International): Phase Space and Path Integral Methods, September 15, 2005 (Part One) and September 20, 2005 (Part two)

Lou Fishman (University of Calgary/MDF International): Application to Seismic Imaging, September 20, 2005

Frank den Hollander (University of Leiden and EURANDOM): Phase Transition for Interacting Diffusions, January 18, 2006

Frank den Hollander (University of Leiden and EURANDOM): Random Walk in Random Scenery, February 3, 2006

Panagiotis Souganidis (University of Texas, Austin): Recent Advances to the Theory of Homogenization in Random Environments, March 7, 2006

Weiyue Ding (Peking University): Recent Progress in Schroedinger Flows, March 21, 2006

Weiyue Ding (Peking University): Evolution of Minimal Tori in Riemannian Manifolds, March 28, 2006

## PIMS Personnel



*Top Row (left to right): Fanny Lui, Danny Fan, Melania Alvarez-Adem, Ken Leung, Chee Chow, Clarina Chan, Kelly Choo, Kathryn Wood, Brenda Shakotko, Brent Kearney*

*Front Row (left to right): Shervin Teymouri, Margaret Gardiner, Dil Baines, Andrea Lunquist, Dana McCallum, Marian Miles, Heather Jenkins, Shelley Alvarado, Ivar Ekeland*

# PIMS Personnel

## PIMS CENTRAL OFFICE AT THE UNIVERSITY OF BRITISH COLUMBIA

Dr. Ivar Ekeland, PIMS Director

Shelley Alvarado, Chief Operations Officer

Melania Alvarez-Adem, BC Education  
Coordinator

Clarina Chan, MITACS Administrator for  
PIMS-UBC

Kelly Choo, Website Manager

Chee Chow, Financial Officer

Dr. Alejandro Adem, PIMS Deputy Director

Danny Fan, Assistant to the PIMS Director

Dr. Klaus Hoechsmann, Education Facilitator

Heather Jenkins, Communications and Publications  
Manager

Ken Leung, Programme Coordinator

Fanny Lui, PIMS Administrator

Shervin Teymouri, Computer Systems Administrator

## PIMS AT SIMON FRASER UNIVERSITY

Dr. Manfred Trummer, SFU Site Director  
(to September 2005)

Dr. Malgorzata Dubiel, Education Coordinator

Margaret Gardiner, Administrative Assistant

Shahin Teymouri, PIMS/MITACS Computer  
Systems Administrator

Dr. Antonia Kolokolova, PIMS PDF

Dr. Wilson Lu, PIMS PDF

Dr. Rustum Choksi, SFU Site Director  
(from September 2005)

Dr. Germain Tanoh, PIMS PDF

Dr. Christopher Sinclair, PIMS PDF

Dr. Joshua Buresh-Oppenheim, PIMS PDF

Dr. Rahul Santhanam, PIMS PDF

Dr. Ronald Van Luijk, PIMS PDF

Dr. Robert Samal, PIMS PDF

## PIMS AT THE UNIVERSITY OF VICTORIA

Dr. Chris Bose, UVic Site Director

Dil Bains, Administrative Assistant

Kelly Choo, Web Manager

Dr. David Leeming, Education Coordinator

Dr. Wael Bahsoun, PIMS PDF

## PIMS AT UNIVERSITY OF ALBERTA

Dr. Gerald Cliff, UA Site Director

Dana McCallum, Administrative Assistant

Dr. Jack Macki, Education Coordinator

Dr. Mohammad Akbar, PIMS PDF

Dr. Ying-Fen Lin, PIMS PDF

Dr. Shuang Cai, PIMS PDF

Dr. Holly Freedman, PIMS PDF

Dr. Hung Le Pham, PIMS PDF

Dr. Adriy Prymak, PIMS PDF

## PIMS AT THE UNIVERSITY OF CALGARY

Dr. Gemai Chen, UC Site Director

Dr. Indy Lagu, Education Coordinator

Dr. Gary Margrave, PIMS Industrial Facilitator

Marian Miles, Administrative Assistant

Dr. Lassina Dembele, PIMS PDF

Dr. Mark Hamilton, PIMS PDF

Dr. Wentao Sun, PIMS Research Fellow

Dr. Elena Kudryavtseva, PIMS Visiting Research  
Fellow

## PIMS UNIVERSITY OF WASHINGTON

Dr. Gunther Uhlmann, UW Site Director

Mary Sheetz, Administrative Assistant

Dr. Roger Thelwell, PIMS PDF

Dr. Vitaliy Vologodskiy, PIMS PDF

## BANFF INTERNATIONAL RESEARCH STATION

Dr. Nassif Ghoussoub, BIRS Scientific Director

Danny Fan, Assistant to the BIRS Director

Brent Kearney, BIRS Systems Administrator

Shelley Alvarado, BIRS Managing Director

Brenda Shakotko, BIRS Station Manager

Kathryn Wood, BIRS Programme Coordinator





# Scientific Activities

## Collaborative Research Groups

The PIMS Collaborative Research Groups (CRG) consist of researchers with a common research interest, and with a common desire to collaborate and develop some aspects of their research programmes. Groups may 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 CRGs, they can 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 build on already existing joint efforts and links between the researchers of Western Canada and the Pacific Northwest, opening up a new era of scientific collaborations between the two countries.

The CRGs create critical mass that substantially enhances training programmes at all levels. The pooling of PIMS support with other sources and the joint

planning of resource allocation allows the CRGs to support a large number of PDFs and graduate students, and creates 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 enter 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 usually consists of 10–15 researchers, are to be jointly coordinated by at least three senior researchers representing various PIMS sites.

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### PERIODS OF CONCENTRATED ACTIVITIES FOR THE CRGs

The Periods of Concentration (POC) 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 selects, on a competitive basis, proposed POCs. The selected areas will be the focus of much of the institute's programme over a one- to two-year period of concentrated activities that will be delivered through the selected CRGs. At any given time, it is expected that between five and eight CRGs will lead 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:

- PIMS postdoctoral fellowships
- Pacific Northwest seminar series

- Workshops and conferences at PIMS sites
- Intensive graduate courses
- Distinguished chairs and long-term visitors
- Graduate students exchanges
- Graduate and senior undergraduate schools
- Industrial training camps
- International collaborations

With this support, a CRG can gather a significant portion of the world's experts in its scientific area of research 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.

Each CRG must have significant participation and leadership from at least two Canadian PIMS universities. Each CRG will designate a coordinator for its period of concentration. This coordinator must be based at a Canadian PIMS university; she/he will co-ordinate the various CRG activities, approve all CRG events, and will be the CRG's

liaison with the PIMS scientific and administrative personnel.

Each CRG designs its activities according to its specific needs within the guidelines provided by PIMS. Facilitating the training of highly qualified personnel has been identified as a priority for PIMS. CRGs are encouraged to take full advantage of the opportunities provided through the PIMS Postdoctoral Fellowship programme, and to take a leadership role in the training of graduate and senior undergraduate students. PIMS encourages CRGs to develop innovative programmes in consultation with the Deputy Director.

CRGs have priority access to the PIMS PDF programme. Individual PDF applications have to be submitted to the local PIMS site as part of the regular PIMS PDF competition.

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:

- **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 the PIMS network.
- **Create new research opportunities and enhance training:** The periods of concentration 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 is new opportunities for PIMS graduate students and a larger audience for PIMS and visiting scientists. This leads directly to a vigorous graduate student exchange programme.
- **Support existing collaborative research groups and foster new groups:** The periods of concentration help to strengthen groups and give them a vehicle for long-range planning of research and advanced education activities. As well, the CRGs will encourage and empower isolated groups or smaller ones at one university by bringing them into larger collaborative teams.
- **Effectively facilitate Canada-U.S. collaborations:** The programme effectively integrates the mathematical sciences community at the University of Washington into the operations of the institute. It allows groups of Canadian and U.S. researchers develop their collaborative activities, and allow other groups to launch new 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 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.
- **Provide new ways of having its scientific programmes driven by its member scientists:** The programme will help elicit proposals for thematic summers, mini-programmes, 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 long-term planning of activities with a much more inclusive and flexible format than standard thematic programmes.

# Report on Period of Concentration 2003–05 of the Collaborative Research Group in Dynamics

The University of Washington has long been a leading centre for ergodic theory and dynamical systems. Within the CRG in Dynamics, it assumed a natural leadership role. However, the growth of dynamics in the PIMS sites in Canada has been truly remarkable over the last five years. It includes the appointments of Brian Marcus and Rick Kenyon (Canada Research Chair) at UBC and Anthony Quas (Canada Research Chair) at U.Vic. Through these appointments and the Period of Concentration, the region now has a large presence on the dynamics scene. This has also seen a growth in the number of graduate students and post-doctoral fellows. One, Wael Bahsoun, who was a PIMS PDF through the CRG at Victoria, now has a position at the University of Manchester. Two other former Ph.D. students of Robert Moody at Alberta have held or now hold NSERC PDFs in the CRG. Jeongyup Lee spent one year at the University of Washington and the second at the University of Victoria. Nicolae Strungaru is now at Victoria. Another development is the move of Yuval Peres to Microsoft Research in Seattle. Already, he is involved in a collaboration with Doug Lind and Boris Solomyak at UW.

The CRG has been very effective in establishing links between the sites. There has been some sharing of visitors. In the area of aperiodic order, it has been critical in making connections between Moody's group at Alberta and those at Washington, most notably Boris Solomyak. Solomyak and Lee now have a strong collaboration which has made significant advances over the past two years. In the area of algebraic dynamics, one of the main outstanding problems is the so-called Furstenberg conjecture. Although it remains open, significant progress was made in collaborations between Manfred Einsiedler, Klaus Schmidt and Elon Lindenstrauss. These were largely made possible because of events in the Period of Concentration.

## CRG FACULTY

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- University of Victoria: Chris Bose, Anthony Quas, Ian Putnam
- University of Washington: Doug Lind, Selim Tuncel, Boris Solomyak
- University of British Columbia: Brian Marcus, Richard Kenyon
- University of Alberta: Robert Moody (now at Victoria)

## SCIENTIFIC EVENTS

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- **Distinguished Chair, Klaus Schmidt (University of Vienna), November 2002.** Klaus Schmidt is one of the world leaders in ergodic theory and especially algebraic dynamics, a subject in which he literally wrote the book, an award winning research monograph laying the foundations of the subject. Dr. Schmidt gave series of lectures on the basics and most recent developments in both Victoria and Seattle, as well as a colloquium talk at UBC
- **Banff International Research Station 5-Day Workshop on Joint Dynamics, June 28-July 3, 2003.** In classical dynamical systems, the evolution of a physical system is one dimensional, modelled on temporal evolution. The relatively recent development of dynamics in higher dimensions has revealed a number of striking and unexpected results. The dynamics group within PIMS has been one of the world centres for this development. The workshop brought together most of the leaders of this field.
- **Banff International Research Station 5-Day Workshop on The Many Aspects of Mahler's Measure, April 26-30, 2003.** One area where higher dimensional dynamics has been particularly effective and important has been in algebraic dynamics. This field has seen a beautiful development which includes interactions between dynamics, algebra and number theory. The University of Washington

has been a world leader in this program. This workshop concentrated on aspects in this area, especially those related to number theory. It involved a unique mix of people from these different areas.

- Banff International Research Station Research in Teams on **Topological Orbit Equivalence, April 26-May 10, 2003**. The participants, Giordano (Ottawa), Putnam (Victoria) and Skau (Trondheim) have developed a programme extending the notion of orbit equivalence to the topological setting. This is an appealing mix of ideas from dynamics and operator algebras. This particular project involved extending dynamical ideas from one dimension to higher ones. The result gave conclusive results for certain special cases and has led to a recent solution to the problem in dimension two.
- Banff International Research Station 5-Day Workshop on **Aperiodic Order: Dynamical Systems, Combinatorics and Operators, May 29-June 3, 2004**. Aperiodic order is the phenomenon of physical and mathematical geometric structures which display a high degree of regularity but are not periodic. It has been an extremely lively area since the discovery of such mathematical objects in the 1960s and quasicrystals (analogous physical materials) in the 1980s. It is also notable for the diversity of mathematics that it draws upon to quantify and explain the nature of the order. It may be viewed as dynamics as a ‘spatial’ evolution. The Universities of Washington, Alberta and Victoria are all well-represented in various aspects of this field making PIMS a unique world centre on the area. This workshop was another in a series usually held at research institutes in Europe bringing together experts on a wide variety of areas.
- **Distinguished Chair, Dan Rudolph (University of Maryland and Colorado State University), October 2004**. Dan Rudolph is another world leader in ergodic theory, known especially for his work on restricted orbit equivalence. His lectures in Victoria on the subject were an excellent introduction to the subject, leading to the most significant results. The visit was especially fruitful since Dr. Rudolph is beginning to extend these techniques to the topological setting where Putnam and his collaborators have already obtained interesting results. This stimulated some very interesting interactions which will likely be pursued over the next few years between Colorado State and Victoria. The visit was extremely useful for graduate students because of Dr. Rudolph’s stimulating style of presentations, the interest in the research programme and a special informal session in which he participated on ‘how to be a graduate student’.
- Banff International Research Station Focused Research Group on **Topological Aspects of Aperiodic Order, July 16-30, 2005**. As noted above, the area of Aperiodic Order has drawn on a wide variety of mathematics. Two of these are the areas of topology and operator algebras. Here, classical invariants from topology and others from non-commutative geometry are used to describe and quantify aperiodic order. This particular activity had a unique mix of people with backgrounds in topology, operator algebras and physics. Several open problems were solved during the course of the two weeks. In addition, a volume, to be written by the participants and published by the American Mathematical Society, is planned as a kind of handbook for the subject.
- **Summer School in Aperiodic Order, August 2005**, University of Victoria. The summer school was a highly successful event, intended mainly for graduate students and post-doctoral fellows. There were four lecture series covering the very broad range of the basics of the subject: harmonic analysis for discrete point patterns, ergodic theory, physics and topological aspects. There was also the opportunity for short presentations by participants on their own work.
- **Second Northwest Dynamical Systems Symposium, August 2005**, University of Victoria. This was a follow-up to a similar meeting held five years earlier. Held the week after the Summer School, there was a large overlap among the participants. But this meeting also attracted ergodic theory experts from across North America and Europe. These meetings have helped establish Victoria as a centre for dynamics.

## Report on Period of Concentration 2003–06 of the Collaborative Research Group in 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 that depend upon a myriad of inputs, but often with incomplete details regarding the inputs. Such systems range from spatial disease dynamics (e.g., influenza, tuberculosis, West Nile Virus) to the responses of biota to global environmental change (e.g., vegetation shifts, invaders into lake ecosystems, stream ecosystems), to the impacts of habitat fragmentation on species survival (biodiversity). Mathematical tools for addressing such biological problems include stochastic processes, nonlinear dynamical systems, adaptive dynamics, scaling methods from individuals to populations, statistical inference, and computational methods.

Research in any interdisciplinary field brings its own particular set of challenges: (i) The rigorous and unambiguous aspects of mathematics versus the overwhelming complexity of the biological world. (ii) The different languages of mathematics and biology that can provide a major barrier to interdisciplinary research. With this in mind, an interdisciplinary research programme that significantly impacts both mathematics and biology has some basic requirements: (i) the opportunity for training outside the core discipline of mathematics or biology, and (ii) a mechanism for effective collaborations and cross-communication between empiricists and theoreticians.

The collaboration between mathematicians and ecologists were central to the training of personnel in this research plan. This is expressed through the summer workshops at the University of Alberta for undergraduate students, a BIRS retreat for graduate students, a workshop and summer school for graduate students, a regular seminar series in mathematical biology, the hiring of three

postdoctoral fellows (PDFs) in interdisciplinary research projects and the manifold involvement of students in research activities.

Our primary goal was to develop and strengthen the synergistic interactions between mathematics and ecology within and between PIMS Universities. Considerable collaborations have been fostered between Universities of Victoria, Calgary, Alberta and British Columbia as a result of the PIMS-sponsored CRG. Through the various CRG related activities a very strong collaboration between the groups of Ed McCauley (U. Calgary) and Mark Lewis (U. Alberta) has developed. Regular visits from McCauley in Edmonton and Lewis in Calgary initiated a collaboration, which was further strengthened by a shared PDF, Frithjof Lutscher. F. Lutscher has been instrumental in the continued exchange between these groups and the 2-Day BIRS retreat provided a great opportunity for students from both groups to meet. Recently, Ed McCauley has become co-leader of a new Water Ingenuity Center supported from the Alberta Ingenuity Fund. This research center has a yearly budget of about \$1.5 million. The involvement of PIMS through the CRG and McCauley's close collaboration with mathematicians at PIMS cites has been an important driving force for the establishment of the water center. Within this center mathematical modeling will be used to investigate and understand the overwhelming complexity of river ecosystems. The corresponding projects, which were supported by the CRG, will be continued within this water center.

Collaboration on a smaller scale developed between Michael Doebeli (UBC), Frithjof Lutscher (U. Calgary and U. Alberta) and Thomas Hillen (U. Alberta) on phenotype splitting, which is a keystone to explain the development of biodiversity. It turns out that the integro-differential equation models are mathematically very similar to other models that Lutscher and Hillen have studied previously. A productive collaboration has developed since.

The high involvement of Dr. Lutscher in the CRG activities gave him the necessary scientific maturity to obtain an assistant professor tenure track position at Ottawa University in 2005. The CRG Mathematical Ecology and Evolution supported Mario Pineda-Krch during his PDF at UBC. Dr Pineda-Krch worked on developing a modeling framework for studying ecological and evolutionary dynamics of spatially structured communities. One particular goal of his work is to study dynamics in finite predator-prey populations, and in particular the phenomenon of evolutionary branching, i.e., the adaptive mechanisms generating evolutionary diversification using numerical simulations that were run on the computer clusters provided by WestGrid. He studied two main phenomena: The occurrence of predator-prey cycles due to demographic stochasticity, and evolutionary branching and phenotypic plasticity as alternative responses to disruptive selection.

The PDF Joanna Renclawowicz (U. Alberta) worked with Pauline van den Driessche (U. Victoria) and Mark Lewis (U. Alberta) on the spread of West Nile Virus. This very successful project led to new insight into the mechanism of the spread of this disease (see list of publications). They derived and analyzed the first spatially explicit model for West-Nile Virus spread. In collaboration with Thomas Hillen (U. Alberta) we obtained some specific important results on existence and boundedness of solutions to a chemotaxis model that includes attractive and repulsive signals. This forms a valuable contribution to the mathematical theory of chemotaxis equations.

The CRG hosted two international meetings at BIRS (Banff, Alberta) and supported an international conferences on differential equations in mathematical biology in Nanaimo, BC.

The BIRS-meeting “Mathematical Biology: From Molecules to Ecosystems: The Legacy of Lee Segel” was organized by L. Keshet (UBC), S. Levin (Princeton), and M.A. Lewis (Alberta). In this workshop we explored a unifying common link that highlights how seemingly diverse areas of biological application are interwoven in the discipline, a theme that centers on the work and contributions of Lee Segel. Represented at this workshop were

scientists across all ages (from graduate student to emeritus professors), with significant representation from both genders, and with a mixture of talks from novice and experts alike.

The BIRS focused research group on “Mathematical Models for Plant Dispersal” was organized by M. A. Lewis (Alberta), and J. Bullock (NERC Centre for Ecology and Hydrology, UK). The ability of plants to move into new environments and adapt to global change depends crucially upon the dispersal of the plant seeds. The importance of dispersal applies equally to invasive pest plants (many of which are extremely costly to agriculture), to persistence of threatened plants and species, and to the movement of indigenous plants, such as hemlock and spruce, in response to climate change. The meeting brought together mathematicians and quantitative biologists. This cross-disciplinary research environment led to specific advances in the modeling of plant dispersal. The focused research group comprised of J. Bullock (NERC, Dorset), D. Greene (Concordia), S. Higgins (UFZ, Leipzig), M. Lewis (Alberta), A. Pielaat (Alberta), T. Robbins (Utah), M. Soons (Utrecht), and O. Tackenberg (Regensburg).

The international conference on “Differential Equations and Applications in Mathematical Biology” at Malaspina University of Nanaimo, BC, was partially supported by the CRG. It was organized by E. Braverman (Calgary), M. Li (Alberta), L. Idels (Nanaimo), L. Berezansky (Israel), A. Ponosov (Norway), and E. Litsyn (Israel). Represented at this conference were about 60 scientists from all over the world, including young and experienced researchers. Focus areas included applications of delay equations, modeling of aquatic ecosystems and modeling of epidemics.

Finally, our educational efforts (summer workshops in 2003, 2004, 2005, 2-Day retreat in 2005, the seminar in mathematical biology 2003-06, and the visitor program) have been well-received and garnered excellent feedback. The summer workshops were held at University of Alberta and the course notes from these workshops have been published as a textbook with SIAM publishing (see references). Moreover, the PDFs and graduate students from U. Alberta were involved in the instruction process and they gained important

experience in the teaching of mathematical biology. From about 60 students of our summer workshops we know that at least 15 have chosen mathematical biology as their area of graduate studies, most of them at PIMS Universities. As an example we cite two replies of undergraduate students of our summer workshops:

- *There were two main benefits of the Workshop to me. First, it gave me some experience in modeling, which I had never done before. As well, it was a wonderful opportunity to meet students from across the country and gave me a broader perspective on my own education. L.F.*
- *I think the biggest thing I got out of the workshop was an appreciation of the wide variety of modeling applications (especially through the*

*projects) - and also the immense power of a relatively limited set of techniques. M.S.*

The PIMS Distinguished Visitors Bryan Grenfell and Roger Nisbet, and the Endowment Fund for the Future Distinguished Visitor Brian Sleeman all spent considerable time with students from the various PIMS Universities. In particular Brian Sleeman and a PhD student, Zhian Wang, worked on a problem related to hyperbolic partial differential equations and a paper has been submitted (see references). The PIMS travel fund was used to send graduate students to BIRS meetings which were held within the CRG. This presented a great opportunity for the students to learn about new methods and to meet scientists from all over the world.

### **CRG FACULTY**

- Michael Doebeli (UBC)
- Eirikur Palsson (SFU)
- Bernard Roitberg (SFU)
- Mark Boyce (U. Alberta)
- Herb Freedman (U. Alberta)
- Thomas Hillen (U. Alberta)
- Subhash Lele (U. Alberta)
- Mark Lewis (U. Alberta)
- Michael Li (U. Alberta)
- Jens Roland (U. Alberta)
- Joseph So (U. Alberta)
- Edward McCauley (U. Calgary)
- James Anderson (U. Washington)
- Carl Bergstrom (U. Washington)
- Daniel Grunbaum (U. Washington)
- Ray Hilborne (U. Washington)
- Mark Kot (U. Washington)
- Pauline van den Driessche (U. Victoria)

### **CRG POSTDOCTORAL FELLOWS**

- Frithjof Lutscher (U. Alberta and U. Calgary), collaboration with E. McCauley (U. Calgary), M. Doebeli (UBC), M. Lewis (U. Alberta) and T. Hillen (U. Alberta). Since 2005 Assistant Professor at U. Ottawa.
- Joanna Renclawowicz (U. Alberta and U. Victoria), collaboration with P. van den Driessche (U. Victoria), M. Lewis (U. Alberta), and T. Hillen (U. Alberta). Since 2004 Polish Academy of Sciences, Warsaw, Poland.
- Mario Pineda-Krch (UBC), collaboration with M. Doebeli (UBC). Now at the Center for Animal Disease Modeling and Surveillance, University Of California, Davis.

### **STUDENTS AND POSTDOCS INVOLVED WITH THE CRG**

#### **GRADUATE STUDENTS:**

- U. Alberta: Tomas de Camino-Beck, Andria Dawson, Raluca Eftimie, Amy Hurford, Chris Jerde, Martin Krkosek, Hannah McKenzie, Jung Min Lee, Peter Molnar, Tom Robbins.
- U. British Columbia: Alistair Blachford, Priscilla Crumrine, Brad Davis, Sandra Merchant, Jabus Tyerman. U. Calgary: Susan Bailey, Priscilla Crumrine, Kyla Flanagan, Bill Nelson, Karilynn Sweet. U. Washington: Rebecca Dore, Jan Medlock, Tim Reluga, Damon Toth. Undergraduates: Andrew Beltaos (U. Alberta)
- Postdocs: (not CRG Postdocs)
- Erik Noonburg (U. Alberta), Alex Potapov (Research Associate, U. Alberta), Shane Richards (U. Calgary), David Brian Walton (U. Wash.), Marjorie Wonham (U. Alberta).

**SCIENTIFIC EVENTS**

The benefits of the PIMS-sponsored CRG have exceeded our expectations. From the very beginning of this CRG we have involved as many PIMS-University research groups as possible. For example, the workshops, the BIRS meetings and an international conference in Nanaimo always included organizers and participants from other PIMS Universities. Through our association with PIMS and the CRG we were able to attract internationally recognized experts in Mathematical Biology to give talks at PIMS institutions, attend BIRS meetings, and collaborate with CRG researchers. Distinguished visitors, such as Roger Nisbet (Santa Barbara), Bryan Sleeman (Leeds) and Brian Grenfell (Cambridge/Pennsylvania State) gave a series of lectures at U. Alberta, UBC and U. Calgary.

Interaction between PIMS sites was particularly demonstrated through three shared PDF positions. Frithjof Lutscher worked with Ed McCauley (U. Calgary) and with Mark Lewis (U. Alberta) on a topic related to the modeling of river-ecosystems. Joanna Renclawowicz worked with Pauline van den Driessche (U. Victoria) and with Mark Lewis (U. Alberta) on the modeling of West Nile Virus; and she worked with Thomas Hillen (U. Alberta) on problems related to chemotaxis modeling. Mario Pineda-Krch worked with Michael Doebeli on modeling of evolution and selection.

The support of the CRG enabled us to increase our educational efforts as well. We gave three summer workshops in mathematical biology for undergraduate students and a 2-Day retreat for graduate students in Banff. The BIRS-retreat involved groups from Calgary, Seattle, Vancouver and Edmonton. None of these research collaborations, workshops, retreats, or talks could have been done without PIMS support. And by hosting such successful events we believe the CRG has augmented PIMS' international reputation.

- April 30-May 9, 2003: 2nd annual PIMS Mathematical Biology Summer Workshop for Undergraduates, U Alberta.
- July 5-10, 2003: BIRS meeting: Mathematical Biology: From Molecules to Ecosystems; The legacy of Lee Segel.
- Aug. 2003 - July 2005: PIMS Postdoc, Dr. Frithjof Lutscher, 50% with McCauley U. Calgary and 50% with Lewis (U Alberta).
- Sept. 2003-March 2006: PIMS/MITACS Seminar in Mathematical Biology, U Alberta. PIMS supported speakers: Christina Cobbold (U. Glasgow), Dan Coombs (UBC), Bo Deng (U. Nebraska-Lincoln), Michael Doebeli (UBC), Bryan Grenfell (Cambridge U.), Michael Mackey (McGill U.), Bernard Roitberg (Simon Fraser U.), Birgitt Schönfisch (U. Tuebingen), Pauline van den Driessche (U. Victoria), James Watmough (U. New Brunswick), Abba Gumel (U. Manitoba), K.P. Hadeler (U. Tuebingen), Eric Cyrtyntbaum (UBC), Roger Nisbet (UC Santa Barbara), Steve Cantrell (U. Miami), Hermann Eberl (U. Guelph), Chris Cosner (U. Miami), Lou Gross (U. Tennessee).
- Sept. 11-25, 2003: PIMS Distinguished Chair: Dr. Bryan Grenfell, (Cambridge and Penn State), five lectures at U. Alberta, U. Calgary and UBC.
- Sept. 20-Oct. 2, 2003: BIRS meeting: Mathematical Models for Plant Dispersal, Focused Research Group.
- Nov. 2003 – Oct. 2004: PIMS Postdoc, Dr. Joanna Renclawowicz, 33% with T. Hillen, 33% with M. Lewis, (both U. Alberta) and 33% with P. van den Driessche (U. Victoria).
- Nov. 1-30, 2003: Long-term visitor: Dr. Pauline van den Driessche, (U. Victoria), one lecture.
- Nov. 21-Dec. 12, 2003: EFF Distinguished Visitor Dr. Brian Sleeman (Leeds), six lectures at U. Alberta.
- March 18-20, 2004: BIRS meeting: 2-Day Retreat on Mathematical Ecology and Evolution.
- April 2004 – March 2005: PIMS Postdoc: Dr. Mario Pineda-Krch, with Michael Doebeli, UBC.
- May 4-14, 2004: 3rd annual PIMS Mathematical Biology Summer Workshop for Undergraduates, U Alberta.
- July 18-23, 2004: International Conference on “Differential Equations and Applications in Mathematical Biology” in Nanaimo (Vancouver Island, Canada).
- Sept. 25–Oct. 16, 2004: PIMS Distinguished Chair Dr. Roger Nisbet (UC Santa Barbara), five lectures at UBC, U Calgary, U Alberta.
- Nov. 27–Dec. 2, 2004: BIRS meeting: Biological Invasions.
- May 2-12, 2005: 4<sup>th</sup> annual PIMS Mathematical Biology Summer Workshop for Undergraduates, U Alberta.
- Oct. 1-7, 2006: Graduate Short Course: Analysis of ecological systems under uncertainty, change and adaptation: Confronting Models with Data. Kananaskis Field Station, Alberta.

For a list of CRG publications, please see the PIMS website [www.pims.math.ca/Collaborative\\_Research\\_Groups/](http://www.pims.math.ca/Collaborative_Research_Groups/)

## Report on Period of Concentration 2003–05 of the Collaborative Research Group in Number Theory

Number theory is one of the oldest and deepest branches of modern mathematics. Its development has led to some of the most sophisticated and profound of mathematical ideas (e.g. Wiles proof of Fermat's Last Theorem). And yet it 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. Notable recent examples are the fields of cryptography and internet security whose protocols are based on computationally intractable number theoretic problems. Number theory is particularly strong in Canada with the PIMS Number Theory Group featuring prominently. This group is large and well distributed across the PIMS Universities. It has a number of prominent senior world-class researchers leading a group of richly talented young mathematicians.

PIMS support of the Number Theory group, especially the core group in Vancouver, has been a major factor in the expansion and strengthening of that group. The core group in Vancouver consists of four number theorists at SFU (P. Borwein, I. Chen, S. Choi and N. Bruin) and four number theorists at UBC (D. Boyd, M. Bennett, V. Vatsal and G. Martin). Prior to the formation of the CRG, S. Choi and N. Bruin had been joint SFU/UBC PIMS postdoctoral fellows and were subsequently hired into tenure-track positions at SFU.

The guaranteed funding of two PIMS postdoctoral positions during the CRG period allowed the group to attract Ben Green to Vancouver for a year of postdoctoral work as a PIMS postdoctoral fellow. His success during that year and his subsequent appointments as chair at Bristol and now as Hershel Smith Professor at Cambridge indicate the wisdom of that decision. One of our other PIMS postdoctoral fellows during that period, Friederich Littmann, found an academic position while another, Christopher Rowe, decided to change direction into financial mathematics. Even after the guaranteed funding for two fellows ended in April

2005, the critical mass of the group built up during the two years of extra funding was certainly a significant factor in being able to attract our current very strong group of PIMS PDFs, Chris Sinclair, Matilde Lalín and Ronald van Luijk, who were awarded PIMS PDFs in competition with a very strong field of applicants.

Regular activities of our group that were in existence prior to the CRG and still continue are the joint PIMS sponsored SFU/UBC number theory seminar (held biweekly alternating between SFU and UBC) and the PIMS sponsored Pacific Northwest Number Theory seminar, which meets once each year at various locations in BC, Washington and Oregon. During the CRG, we were able to plan more ambitious events including a summer period of concentration on Mahler's measure held at SFU in the summer of 2003. One very successful event which certainly would not have taken place without the stimulus of the CRG funding was the one day conference for postdoctoral fellows in Number Theory held in Vancouver prior to the winter CMS meeting in 2003. This broadened the network of many young number theorists and has been repeatedly cited by many of them as a significant event in their careers.

The SFU/UBC Number Theory group organized the PIMS sponsored international conference of the Canadian Number Theory Association in 2006. Again, this event did not occur during the CRG period but the network established during the period of the CRG was certainly a significant factor in its success. Other indications of the continuing influence of the two years of CRG funding are the number of successful BIRS proposals put forward by subsets of the group each year, for example the BIRS workshop Number Theory Inspired by Cryptography, Nov. 5-10, 2005, which was conceived during the period of the CRG funding and the BIRS workshop Analytic Methods for Diophantine Equations, May 13–18, 2006, which built on the success of the two BIRS workshops in November, 2004 organized by the CRG during its period of funding.

No doubt the strength and cohesiveness of the core group of the CRG was a factor in its success in obtaining an NSERC Leadership grant of \$40,000 per year for 2003–2007 which was used entirely for the support graduate students at SFU and UBC. This led to a considerable strengthening of the graduate programme in Number Theory at SFU and UBC.

The PIMS PDF Ben Green (2003-04) was a spectacular success. During his time in Vancouver, he and Terry Tao resolved an important old problem that shows that the sequence of primes contains arbitrarily long arithmetic progressions. This work won him a Clay Research Prize for in 2004, led to his appointment to a chair at Bristol University and then his appointment as Hershel Smith Professor of Pure Mathematics and Fellow of Trinity College, Cambridge. This work also led to his invitation to speak at the International Congress of Mathematicians in Madrid in August 2006. (This work was also cited in the Fields Medal awarded to Terry Tao at that same congress).

CRG member Nike Vatsal was awarded the André Aisenstadt prize of the CRM in 2004, the Ribenboim prize of the CNTA in 2006 and was given an invitation to speak at the ICM in 2006 as the result of his ground-breaking work on the distribution of Heegner points.

The BIRS workshop in Mahler measure and the

subsequent summer programme at SFU in 2003 were influential in attracting two of our current postdoctoral fellows, Chris Sinclair and Matilde Lalín. European participants in these events, Vincent Maillot and Marie-José Bertin were inspired to organize a workshop at CIRM in June, 2005, on Mahler measure and then Dan Silver and Susan Williams organized a conference on Mahler measure and Knot Theory at the University of South Alabama in January, 2006. A number of successful collaborations were begun during the events of 2003, e.g. the work of P. Borwein, E. Dobrowolski and M. Mossinghoff on Lehmer’s problem for polynomials with odd coefficients.

The BIRS workshop on Explicit Methods in Number Theory in November 2004 was the scene of the solution of a long-standing problem in the theory of diophantine equations, namely the complete solution of the equation  $x^2 + y^3 = z^7$  in relatively prime integers, due to B. Poonen, M. Stoll and E. Schaefer. Some of the organizers of that event have been successful in another bid for a BIRS workshop on Explicit methods for rational points on curves, Feb. 4-9, 2007, aimed at a deeper understanding of Kim’s new non-abelian Chabauty method. The workshop and the subsequent activity in the field also played a role in attracting one of our current PIMS PDFs in Number Theory, Ronald van Luijk, who will join us in January 2007.

## CRG FACULTY

- CRG Leaders: Peter Borwein (SFU), David Boyd (UBC)
- UBC: Michael Bennett, David Boyd, Bill Casselman, Rajiv Gupta, Izabella Laba, Greg Martin, Nike Vatsal
- SFU: Peter Borwein, Imin Chen, Stephen Choi, Petr Lisonek
- U. Alberta: James Lewis
- U. Calgary: Richard Guy, James Jones,
- Renate Scheidler, Hugh Williams
- U. Washington: Ralph Greenberg, Adrivan Iovita, Neal Koblitz, Boris Solomyak
- Other Institutions: Amir Akbary (U. Lethbridge), Edward Dobrowolski (College of New Caledonia), Matt Klassen (DigiPen Inst. of Tech.), Kristin Lauter (Microsoft)

## PIMS POSTDOCTORAL FELLOWS

- Ben Green, September, 2003, to August, 2004, now Professor, Trinity College, Cambridge
- Friederich Littmann, September, 2003, to August, 2005, now Assistant Professor, U. North Dakota
- Christopher Rowe, September, 2003, to August, 2005, now in financial mathematics, Boulder, Colorado

**SCIENTIFIC EVENTS**

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- PIMS PNWNT conference, Seattle, April 5-6, 2003
- PIMS sponsored BIRS workshop, The Many Aspects of Mahler's Measure, April 26–May 1, 2003.
- PIMS Number Theory Group Thematic Summer Program, Mahler Measure, June 6-29, 2003.
- PIMS Distinguished Visitor, Jeff Vaaler, June 6-29, 2003.
- PIMS sponsored BIRS workshop, Current trends in arithmetic geometry and number theory, Aug. 23–28, 2003.
- PIMS CRG in Number Theory, postdoctoral conference, Vancouver, Dec. 5, 2003.
- PIMS PNWNT conference in Corvallis, Oregon – April 17, 2004
- PIMS Distinguished Visitor, Sergei Konyagin, March 1–May 1, 2004.
- PIMS sponsored BIRS workshop, Explicit Methods in Number Theory, Nov. 13–18, 2004.
- PIMS sponsored BIRS workshop, Number Theorists weekend, Nov. 18–20, 2004.
- PIMS sponsored BIRS workshop, Diophantine approximation and analytic number theory, Nov. 20–25, 2004.

## Report on Period of Concentration 2003–05 of the Collaborative Research Group in Scientific Computing

The major goal of the period of concentration was to develop the group's common research programmes, and to promote research in scientific computing and increase related interdisciplinary collaboration within the region and on an international level. In addition, this period of increased activity in scientific computing provided a focus to solidly establish SFU's Centre for Scientific Computing (CSC). The majority of the activity of this concentration period took place at the PIMS sites at SFU, UW and UBC and at BIRS.

A large number of graduate students (over 50) and postdoctoral fellows (at least 10) directly benefited from the concentration period in scientific computing.

Scientific computing plays a critical role in applied and industrial mathematics at the PIMS universities and across North America. Within PIMS universities, the scientific computing community has been a very active collaborative group with a tradition of multi-university activities particularly among researchers at U. of Washington, SFU, and UBC. Recently new activities have emerged, due in large part to the leading role played by PIMS. A special feature of this period of concentration was the promotion of a multidisciplinary approach to the subject and the inclusion of important research topics such as fuel cells and medical imaging. The base of support for the group includes researchers from Mathematics, Applied Mathematics, and Computer Science.

### IMPACT OF THE PERIOD OF CONCENTRATION

The period of concentration established new collaborations and strengthened existing ones. Its strongest impact was probably felt at UBC and SFU, but there is also a much increased awareness of activities and expertise at all PIMS Universities. The groups at SFU and UBC worked together in organizing and coordinating the events, establishing a tradition of sharing opportunities. The spirit of this cooperation continues, and researchers regularly attend seminars and talks at the other site.

**Seminars and Talks.** Throughout the period there were regular weekly seminars co-hosted by the Centre for Scientific Computing at SFU, largely by visiting researchers. These weekly seminars provided a focal point for) and students. At UBC, the PIMS-IAM Distinguished seminar series attracted excellent speakers and large audiences. We consider these seminar series (in addition to on-going informal seminars) an important anchor for the activities of the Collaborative Research Group. Indeed, these series of talks continued both at SFU and UBC with Distinguished Lecture Series beyond the period of concentration.

**Workshops and Conferences.** The period of concentration allowed the group to organize a number of scientific meetings. In addition to our annual Pacific Northwest Numerical Seminar (in 2004 we organized a two-day meeting at Banff instead of the customary one-day format) we had an excellent international workshop on numerical linear algebra as well as a 2-Day BIRS workshop on wavelets. In 2005 we organized an international conference on adaptive methods for solving differential equations. All these events attracted world leaders in the field, and provided an invaluable experience for the many postdocs and graduate students in our programmes. Without PIMS support (both financial and administrative) these meetings simply would not have happened.

**Recruitment.** Over the last three to four years many new) members in the field of Scientific Computing joined various departments at PIMS universities. Clearly, the decision whether to accept or reject a job offer is a complex one, and cannot be easily attributed to just one single factor. Yet, the increased scientific activity in the region, the strong collaborative spirit and clear evidence of funding opportunities for scientific initiatives appear to be very attractive to bright young researchers. Recent hires come from the top institutions, and many chose a PIMS university offer over offers from other prestigious universities.

**Student Recruitment.** With the strong emphasis of PIMS programmes on supporting training of highly qualified personnel it is no surprise to find a strong impact of the period of concentration on PIMS researchers' ability to attract excellent graduate students and postdoctoral fellows. As an example, the community spirit in our CRG proved to be contagious to graduate students, who have now organized two regional one-day meetings of students related to the CRG in Scientific Computing, in particular, inviting also colleagues from other areas of applied mathematics.

**Interdisciplinary Collaboration.** The special period gave rise to a close interdisciplinary collaboration in medical imaging, involving the medical imaging group at VGH/Radiology (UBC), and researchers from Computer Science and Mathematics. The period was also a boost to the interdisciplinary fuel cells project with Ballard Power Systems and researchers from UBC and SFU.

**International Collaboration.** PIMS activities during our period of concentration provided many opportunities for international collaboration. All our conferences and workshops attracted a strong

international audience; most speakers in our various Lecture Series were international experts, and many of them spent bigger chunks of time with their hosts and graduate students. The PIMS Distinguished Chairs spent a month or more at the host institutions. They gave a series of lectures, and were engaged in many informal discussions as well as concrete collaborations. These ties have continued beyond the concentration period. For example, this summer two students of PIMS Distinguished Chair Otmar Scherzer participated in the PIMS Graduate Modeling workshop and Industrial Problem Solving Workshop, and one student worked for a month with the PIMS Medical Imaging Group.

Scientific Computing continues to be a very active PIMS Collaborative Research Group, and owes much of its strength to the support provided by PIMS.

Two postdoctoral fellows were funded as part of this period of concentration: Jianying Zhang (at UBC), who is now a member at Western Washington University, and Jianjun Xu (SFU), who currently holds a position at the University of California at Irvine.

## CRG FACULTY

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- R. Choksi (SFU)
- M.C. Kropinski (SFU)
- T. Möller (SFU)
- D. Muraki (SFU)
- K. Promislow (SFU)
- B. Russell (SFU)
- S. Ruuth (SFU)
- L. Trajkovic (SFU)
- M. Trummer (SFU)
- J. Verner (SFU)
- R. Zahar (SFU)
- U. Ascher (UBC)
- O. Dorn (UBC)
- S. Dunbar (UBC)
- I. Frigaard (UBC)
- A. Peirce (UBC)
- B. Seymour (UBC)
- B. Shizgal (UBC)
- J. Varah (UBC)
- M. Ward (UBC)
- B. Wetton (UBC)
- M. Yedlin (UBC)
- Y. Lin (U. Alberta)
- J. Macki, (U. Alberta)
- P. Minev (U. Alberta)
- Y.S. Wong (U. Alberta)
- T. Ware (U. Calgary)
- R. Westbrook (U. Calgary)
- P. van den Driessche (U. Victoria)
- D. Olesky (U. Victoria)
- L. Adams (U. Washington)
- C. Bretherton (U. Washington)
- J. Burke (U. Washington)
- D. Durran (U. Washington)
- A. Greenbaum (U. Washington)
- G. Hakim (U. Washington)
- N. Kutz (U. Washington)
- R. LeVeque (U. Washington)
- R. O'Malley (U. Washington)
- P. Schmid (U. Washington)
- R. Bradean (Ballard Corp.)
- J. Kenna (Ballard Corp.)
- M. Epton (Boeing Corp.)
- S. Filipowski (Boeing Corp.)
- J. Lewis (Boeing Corp.)
- S. Reddy (Quadrus Financial Technologies)
- Jian-Jun Xu PIMS SFU Postdoc
- Jian Ying Zhang, PIMS/MITACS UBC Postdoc

## SCIENTIFIC EVENTS

- PIMS-IAM-CSC Senior Undergraduate Modeling Workshop, SFU & UBC, Feb. 2003
- BIRS Workshop on Computational Fuel Cell Dynamics, BIRS, April 2003
- Workshop on Numerical Linear Algebra and Applications, UBC, Aug. 2003
- Five-Day BIRS Workshop on Computational Techniques for Moving Interfaces, BIRS, Aug. 2003
- Pacific Northwest Numerical Analysis Seminar, UW, Oct. 2003
- Biological Molecular Algorithms - A Mathematician's Perspective on Molecular Biology (Barry Merriman), SFU & UBC, March 2004
- Five-Day BIRS Workshop on Mathematical Foundations of Scientific Visualization, Computer Graphics and Massive Data Exploration, BIRS, May 2004
- Adaptive wavelet and multiscale methods for partial differential equations – 2-Day BIRS workshop, BIRS, June 2004
- PIMS Distinguished Chair - Chris Budd - Analytical and numerical aspects of multi-scale problems SFU, July to August, 2004
- PIMS Distinguished Chair - Otmar Scherzer - Scale Space Methods and Regularization for Denoising and Inverse Problems, UBC, Aug. 2004
- Pacific Northwest Numerical Analysis Seminar – 2-Day BIRS workshop, BIRS, Oct. 2004
- Multiscale Modeling and Computation of Flow in Heterogeneous Media (Tom Hou), UBC-SFU, Oct. 2004
- Joint SFU CSC and UBC IAM Seminar Data Assimilation in Nonlinear Dynamics Models (Juan Restrepo), Simple and complex impact oscillators and their bifurcations (Chris Budd), SFU-UBC, Nov. 2004
- PIMS Distinguished Chair – Juan Restrepo, SFU, Fall 2004
- Computational Fuel Cell Dynamics, BIRS, March 2005
- Intl. Conference: Adaptivity and Beyond, SFU, Aug. 2005
- PIMS-IAM Distinguished Speaker Series, UBC, 2003-2005
- PIMS-MITACS-CSC Seminar Series, SFU, 2003-2005
- University of Alberta Distinguished Lectures Series in Scientific Computing and Information Technology, UA, 2004-2006

## Report on Period of Concentration 2003–05 of the Collaborative Research Group in String Theory

The goal of the Collaborative Research Group on String Theory is to incubate significant new research on string theory.

Elementary particle physics seeks to discover the most fundamental constituents of nature and the laws which govern their behaviour. Current understanding of fundamental physics is in terms of the standard model. This is a beautiful, enormously successful model which describes all known particles and gives a partially unified picture of their interactions. The dynamical framework of the standard model is quantum field theory.

One of the problems of current interest in fundamental physics is to explain the origin of the standard model, particularly the patterns of particles and interactions seen there and to resolve a subtle mathematical inconsistency, the hierarchy problem.

One approach to this is to search for a theory which lies beyond the standard model and encompasses it. It is hoped that such a theory would have a more unified picture of the origin of elementary particles and their interactions. The standard model itself could be regarded as the first successful step in finding such a theory in that it describes the current non-gravitational interactions as gauge field theories and contains a true unification of the electromagnetic interactions and the weak nuclear force. The hope is that identification of the correct unified theory would resolve some of the remaining puzzles of the standard model.

Another long-standing problem is to understand gravitational interactions in regimes where quantum mechanical effects would be important. The present model of gravity is Einstein's general theory of relativity which is a classical field theory. The problem of quantum gravity which asks how to reconcile general relativity with quantum theory has vexed theorists for over half of a century. String theory is dynamical framework which could simultaneously address both of these problems. It is apparently a consistent theory of quantum gravity. It also has solutions with structures tantalizingly

close to the standard model of elementary particle physics. Its promise and excitement have captured the attention of a large fraction of the world's community of theoretical particle physicists for the past 20 years.

Theoretical particle physics is well represented in Canada with many institutions having a long tradition for research in the subject. On the other hand, although it has been a major research area in the international arena for some time, string theory is a relatively new subject for Canada. Following recent faculty hiring initiatives, there are now groups of string theorists at the University of British Columbia, the University of Toronto and the Perimeter Institute, as well as a number of people with interests close to the subject in other institutions nationwide.

Part of the mandate of the Collaborative Research Group on String Theory is to nurture this nascent group of string theorists. It has the aim of seeding collaborative research both at a national and international level and in helping Canadian string theorists to exposit the results of their research to the international community. The Schools, Workshops and Conferences in particular serve these goals while raising the profile of Canadian groups in the international community.

Another essential goal of the programme is to expose synergy between string and particle theory and other fields of physics, most notably cosmology and condensed matter physics. String theory, being a theory of quantum gravity has obvious applications to cosmology where it makes predictions about the initial state of the universe. In fact, understanding how string theory dynamics of the initial state might be printed on the present cosmos is now one of the best suggestions for detecting observable manifestations of strings. Theoretical condensed matter physics and string theory have a large number of common mathematical techniques, particularly in conformal field theory and the study of dissipative systems.

This overlap has not been exploited to any great extent so far and it is a direction in where the programme can make an important contribution.

The benefits of this programme are many. As an attractive asset of the local environment, the infrastructure assembled by the Collaborative Research Group has been instrumental in recruiting and the excellent appointments of junior faculty made at the University of British Columbia over the past five years. In string theory, these are assistant professors Moshe Rozali and Joanna Karzmarek and CRC chair Mark van Raamsdonk (who is also a Sloan Fellow). These researchers form the core of

the UBC node of this group. The existence of the CRG also played a role in attracting Andreas Karch to the University of Washington. Andreas continues to be an enthusiastic participant in the programs.

The second great benefit of the Collaborative Research Group infrastructure has been the enhanced educational environment for graduate students and postdoctoral fellows that the activity generates. Both the UBC and University of Alberta group have produced outstanding Ph.D. graduates during the last few years. Also, the success rate of postdoctoral fellows who have been involved in the programme in finding faculty jobs is high.

## CRG FACULTY

- **University of British Columbia:** Moshe Rozali, Gordon Semenoff, Mark van Raamsdonk, Joanna Karzmarek, Don Witt, Kristen Schleich, Jim Bryan
- **University of Alberta:** Eric Woolgar, Don Page, Valeri Frolov, Bruce Campbell (Now at Carleton), Terry Gannon
- **University of Lethbridge:** Mark Walton
- **University of Washington:** Andreas Karch, Matt Strassler, Charles Doran

## PIMS CRG POSTDOCTORAL FELLOWS:

- Konstantin Zarembo (UBC) (Professor at Uppsala University)
- Sumati Surya (Alberta) (faculty, Raman Research Inst., Bangalore)
- Kazuyuki Furuuchi (UBC) (now at Taiwan National University)
- Udi Schreiber (UBC) (financial industry)
- Dominic Brecher (UBC) (financial industry)

- J. Rasmussen (Lethbridge) (now at Melbourne University)
- Vardarajan Suneeta (Alberta) (now at New Brunswick U.)

The activities of this collaborative research group have been greatly enhanced by the presence of a number of PIMS Postdoctoral Fellows.

## NON-CRG POSTDOCTORAL FELLOWS:

- Domingo Luis-Martinez (UBC) (now faculty at UBC Science 1)
- Andre Dubin (UBC) (senior scientific staff, ITEP, Moscow)
- Roberto Scipioni (UBC) (material science at Oxford University)
- Emil Akhmedov (UBC) (senior scientific staff, ITEP, Moscow)
- Paul Koerber (UBC) (research position at Max Planck Institute, Munich)
- Kazumi Okuyama (UBC) (permanent faculty position in Japan)
- Todd Oliynyk (Alberta) (now at Max Planck Institute, Potsdam)
- Mohammad Akbar (Alberta)

## GRADUATE STUDENTS

### UBC:

- Philip de Boer (M.Sc. 2002, Ph.D. 2005. Financial industry)
- Henry Ling (M.Sc. 2003. Ph.D. student at UBC)
- Mark Laidlaw (Ph.D. 2004. Lecturer at University of Victoria)
- Donovan Young (M.Sc. 2003, Ph.D. student at UBC)
- Bojan Ramadanovic (M.Sc. 2003, Ph.D. student at UBC)
- Shirin Hadizedeh (M.Sc. 2005, Ph.D. student at UBC)
- Jaffer Gardezi (M.Sc. 2003, Ph.D. student at McMaster University)
- Matheson Longton (M.Sc. 2006)
- Matthew Hasselfield (M.Sc. 2006)
- Simon Yewchuk (M.Sc. 2006)
- Brian Shieh (M.Sc. 2004, Ph.D. student at UBC)
- **University of Alberta:**
- Murarri Vasevudean (Ph.D. 2006, Postdoc at Stanford)

**SCIENTIFIC EVENTS**

The Collaborative Research Group on String Theory has organized a significant number of workshops, conferences and schools. The main aim of these events is the efficient dissemination of novel research results and the encouragement of collaborative research. A secondary purpose is to bring together the string theorists in the Canadian community, to encourage synergy between their research programmes and to enhance their profile in the international community by sponsoring world class events.

This activity has been made possible through the generous funding of PIMS, which supported the CRG as a “Period of Concentration in String Theory” between the years 2003-2005. Since then, PIMS has continued to support this group through their contribution to the funding for the series of Summer Schools.

- **Pacific Northwest String Seminar**

- March 2001
- March 2002, Vancouver
- November 2003, Vancouver
- December 2003, Seattle, Washington
- January 2005, Vancouver

The Pacific Northwest String Seminar is a small meeting which has been held on either the campus of the University of British Columbia or the University of Washington. It is usually over a weekend during the academic year. It consists of between five and 10 one-hour seminars, mostly by invited speakers, about recent developments in string theory. The prime purpose of these meetings is to update and inform the string theory researchers in the collaborative research group, particularly graduate students and postdoctoral Fellows working in the Vancouver and Seattle areas, about the latest results in the field. These events typically cost \$5,000 and have been supported by PIMS with some help from other sources, such as the PITP.

- **APCTP Winter School**

- Pohang, Korea, December, 2001.
- Peongchang, Korea, February, 2002
- Seoul, Korea, February, 2005

The APCTP Winter Schools have occurred during the past several years, typically for a week in mid-Winter in Korea. They are aimed at educating young researchers, graduate students and postdoctoral fellows and they draw students from Asia, mainly Korea, China, Taiwan and Japan. With the help of PIMS, we have managed to have a strong presence there a number of times. G. Semenoff, G. Grignani, R. Myers, M. van Raamsdonk and M. Rozali as well as other senior members of the collaborative research group have been speakers at the school on at least one occasion. A number of graduate students and postdoctoral fellows from Canada have been able to attend this school. Financial support from this programme comes almost entirely from the Asia Pacific Center for Theoretical Physics and the Korean Institute for Advanced Study, both based in Korea. Members of the collaborative research group, G. Semenoff, Taejin Lee and S. Nam are also organizers of the string programme at the APCTP. Travel expenses of some students from Canada to attend the school were paid by PIMS.

- **Summer Schools on “Strings, Gravity, Cosmology”**

- July 2003, Vancouver
- August 2004, Vancouver
- June 2005, Perimeter Institute, Waterloo, Ontario
- August 2006, Vancouver
- Planned for Summer 2007, Perimeter Institute, Waterloo

These summer schools are our major event. They are a two-week-long training programme consisting of approximately sixty hours of lectures by prominent experts on the latest developments in string theory and are intended for young researchers. They have drawn students from the U.S. as well as Europe, Asia and Canada. The attendance is limited to 80 students and in the past two years they have been heavily oversubscribed. Financial support totalling about \$50,000 came from PIMS (\$10,000), APCTP (\$15,000), Perimeter Institute (\$10,000), PITP (\$10,000), Institute for Particle Physics (IPP) (\$2,500) the Department of Physics and Astronomy and the Faculty of Science of UBC (\$5,000) and some other sources. These events have been enormously successful. As a

pedagogical venue in an advanced field like String Theory, they have no real competitors in North America. They have therefore been able to draw the very best speakers and students from major institutions worldwide. They are now established as a series of events that students look forward to each year.

- **Frontiers of Mathematical Physics Summer Workshops**

*“Particles, Fields and Strings”, Simon Fraser University, Burnaby, BC, August, 2001 and “Braneworlds and Supersymmetry”, July, 2002, Vancouver*

Before we had Summer Schools, our major Summer event were research workshops. They occurred each year between 1994 and 2002 and involved top physicists from the string theory and theoretical particle physicists from the international community speaking about and collaborating on their ongoing research. Financial support came from PIMS (\$15,000), the Perimeter Institute (\$15,000) and the APCTP (\$15,000).

- **Five-day workshops at the Banff International Research Station (BIRS)**

*“Recent Developments in String Theory”, March, 2003*

*“New Horizons in String Cosmology”, June, 2004*

*“Developments in String Theory”, February, 2006*

These are high profile events located at the Banff International Research Station. Our “Recent Developments in String Theory” workshop was the first ever 5-Day meeting at that institution. All of our workshops there have been extremely successful. They attract the elite of the world’s string theorists and cosmologists as participants. They had an intense programme of seminars and sessions meant to encourage discussion and collaborative work. These workshops have become well-known in the worldwide community as one of the best places for the dissemination of new results and a unique atmosphere which encourages informal discussions. Financial support for local

expenses were borne by BIRS. Some support for travel was obtained from the Canadian Institute for Advanced Research (CIAR), the Institute for Particle Physics (IPP) and the National Science Foundation (NSF).

*“String Field Camp”, Focused Research Group at the Banff International Research Station, July, 2004*

This was a small gathering of 10 people who spent two weeks in Banff collaborating on research in string theory. It brought together researchers from Eastern and Western Canada, Japan, Korea and the United States. It was intended to encourage research contacts between scientists in Canada and the Pacific Rim region and it was quite successful in doing so. A number of research papers have resulted, including some good collaborative work. Financial support for local expenses was supplied by BIRS. Encouraged by our success this time, Amanda Peet (U. of Toronto) and Gordon Semenoff have proposed to hold another focused research group next Summer.

Participants in the 2004 event were:

- Yoshi Kitazawa, KEK Lab, Japan
- Yutaka Matsuo, University of Tokyo, Japan
- Taejin Lee, APCTP, Seoul, Korea
- David Berenstein, University of California Santa Barbara
- Anastasia Volovich, KITP, Santa Barbara
- Marcus Spradlin, KITP, Santa Barbara
- Gordon Semenoff, UBC
- Mark van Raamsdonk, UBC
- Andre Mikhailov, Caltech
- Amanda Peet, University of Toronto
- Washington Taylor, MIT
- Shiraz Minwalla, Harvard University/Tata Institute

**PIMS DISTINGUISHED CHAIRS**

- **2003:** Ashoke Sen, Harish Chandra Research Institute, India: Professor Sen gave a series of lectures on unstable D-branes in July and August of 2003. All lectures were on the UBC Campus. He also participated as a lecturer in the Frontiers of Mathematical Physics Summer School in 2004.
- **2004:** Washington Taylor, Massachusetts Institute of Technology, USA: Professor Taylor gave a series of lectures on his work on matrix model formulations of M-theory and on Open String Field Theory. These lectures took place on the UBC Campus during July and August of 2005. He was also a lecture at the Frontiers of Mathematical Physics Summer School and he participated in the Focused Research Group at BIRS in July, 2004.

**OTHER DISTINGUISHED VISITORS**

- David Gross (2003) KITP, Santa Barbara
- Lisa Randall (2004,2005), Harvard University
- Hirosi Ooguri (on three occasions 2004, 2005, 2006), Caltech
- Nathan Seiberg, (2002) IAS Princeton
- Michael Duff (2004) Imperial College, London
- John Schwarz (two occasions 2004, 2005) Caltech
- Igor Klebanov (2002), Princeton University
- Hermann Verlinde (2005), Princeton University
- Tohru Eguchi (2005), University of Tokyo
- Leonard Susskind (2002, 2003, 2004, 2005), Stanford University
- Steven Shenker (2005), Stanford University
- Alexandre Polyakov (2001), Princeton University International Collaborations

**PARTIAL LIST OF SEMINARS**

- Oct. 30, 2006: Jaume Gomis (Perimeter Institute), “Holographic Wilson Loops”
- Oct. 26, 2006: Matt Strassler (University of Washington), “Mysterious Metamorphoses: Duality in Quantum Theory”
- Sept. 10, 2006: Gordon Semenoff (UBC),

“Fermion droplets, giant gravitons and giant Wilson loops”

- March 28, 2006: Vardarajan Suneeta (University of New Brunswick), “Geometric Flows and String Theory” (at University of Alberta)
- March 30, 2006: Lee Smolin (Perimeter Institute), “Emergence of the standard model from quantum gravity”
- March 9, 2006: Joe Polchinski (KITP and University of California at Santa Barbara), “Cosmic Strings and Superstrings”
- Dec. 9, 2005: Todd A. Oliynyk (Albert Einstein Institute, Potsdam), “Newtonian Limit for Perfect Fluids” (at University of Alberta)
- Dec. 5, 2005: Nadav Drukker (Niels Bohr Institute Copenhagen), “Circular loop operators in conformal field theories”
- Dec. 1, 2005: Paul J. Steinhardt (Princeton University), “Einstein, Time and the Future of the Universe”
- Nov. 14, 2005: Hermann Verlinde (Princeton University), “A Bottom-Up Approach to String Phenomenology”
- Oct. 17, 2005: Mark Trodden (Syracuse University), “Connecting Cosmology and Fundamental Physics”
- Oct. 10, 2005: Hitoshi Murayama (University of California at Berkeley), “The next twenty years in particle physics”
- Oct. 3, 2005: A. Barvinsky (Lebedev Physics Institute, Moscow), “Cosmological branes and macroscopic extra dimensions”
- April 11, 2005: Rafael Bousso (University of California at Berkeley), “From Quantum Gravity to the Physics of Flat Space”
- March 21, 2005: Sergei Gukov (Caltech), “The geography of extra dimensions”
- March 7, 2005: Mark van Raamsdonk (UBC), “An analytic study of confinement/deconfinement in four dimensional gauge theory”
- Jan. 31, 2005: Petr Horava (University of California, Berkeley), “From Godel Universes to Astrophysics of Compact Objects in String Theory”

- Jan. 24, 2005: S. Mathur (Ohio State University), “The quantum structure of black holes”
- Jan. 17, 2005: David Kutasov (University of Chicago), “Fun With Tachyons”
- Jan. 26, 2004: M. Strassler (University of Washington), “An Example of Surprising Nonsuper-symmetric Physics in Field Theory and String Theory”
- Jan. 5, 2004: Y. Frishman (Weizmann Institute, Israel), “QCD2 as a Model for Quantum Chromodynamics”
- Nov. 17, 2003: Steven Shenker (Stanford University), “Exploring the Black Hole Singularity in String Theory”
- Oct. 6, 2003: Steven Giddings (University of California at Santa Barbara), “Moduli, branes, fluxes, and the fate of four dimensions”
- Sept. 22, 2003: Michael Peskin (Stanford Linear Accelerator Center), “Laboratory Astrophysics” of Supersymmetry and Dark Matter”
- Sept. 8, 2003: Sean Carroll (University of Chicago), “Dark Energy and the Preposterous Universe”

The greatest success of the Collaborative Research Group is in spawning productive collaborative research. The following are some examples of research collaborations which resulted from activities supported by the CRG:

M. van Raamsdonk (UBC), O. Aharony (Weizmann Institute, Israel), S. Minwalla (Harvard University): This collaboration has generated one substantial high-impact work on phase transition in high temperature gauge theory and its mirror in string theory duals of gauge theory, that is collapse to black holes. This collaboration was greatly aided by participation of some of the collaborators in Banff events as well as a visit of both Shiraz Minwalla and Ofer Aharony to UBC. The latter visits were supported by the Period of Concentration which PIMS awarded the CRG in the period 2003-2005.

M. Rozali (UBC), K. Okuyama (University of Chicago), R. Lee (University of Illinois, Urbana): This collaboration began when Okuyama visited UBC to participate in a Pacific Northwest String Seminar. This visit was supported by the Period of Concentration. It generated a high impact publication. Since then, Okuyama has joined UBC as a postdoctoral Fellow.

M. Rozali (UBC), B. Pioline (University of Paris), M. Berkhoos (Weizmann Institute, Israel): This collaboration grew out of the participation of Micha Berkhoos of the Weizmann Institute in Israel as a speaker in the Frontiers of Mathematical Physics Summer School in 2003. It generated a very good publication exploring the nature of some exotic cosmologies which are solutions of string theory. As testament to its importance, it was presented by

Berkhoos in a plenary lecture at the Strings 2004 conference in Paris in 2004.

M. van Raamsdonk (UBC), A. Volovich, M. Spradlin (KITP, Santa Barbara): This collaboration resulted from interactions at the BIRS Focused Research Group which occurred in July, 2004. It has generated a research paper which is considered an important input to its subject.

G.W.Semenoff (UBC), Ch. Kristjansen (Niels Bohr Institute, Copenhagen), J. Plefka, N. Beisert, M. Staudacher (Albert Einstein Institute, Potsdam): This collaboration began with Period of Concentration sponsored one-month visits by J. Plefka and M. Staudacher of the Albert Einstein Institute in Potsdam to PIMS in the Spring of 2002 and continued with a subsequent visit of G. Semenoff to the Albert Einstein Institute for one month. It produced a new approach to computing string interactions in string theory on a certain background. As a measure of its importance, it produced two 100+ citation papers. In fact, the first one achieved 100 citations within a year of its first appearance on the hep-th archive, and was among only six papers in the entire field of elementary particle physics to have done so at the time.

G. W. Semenoff (UBC), Yu. M. Makeenko, A. Morozov, A. Marshakov, A. Mironov (ITEP, Moscow), J. Ambjorn, (Niels Bohr Institute, Copenhagen): This is a long-time collaboration which has existed for 15 years. It has examined various aspects of random matrix theories and their applications to gauge field theories and string theory. It has been supported by visitor fellowships at the Niels Bohr Institute and a NATO Collaborative

Research Grant. The collaboration occurred in the Summer of 2003 during a visit by Y. Makeenko to UBC as a speaker in the Summer School.

G. W. Semenoff (UBC), G. Grignani, V. Forini, M. Orselli, G. de Risi (University of Perugia, Italy): This has been an ongoing collaboration for the past 10 years. It focuses on issues in quantum field theory and string theory and has generated a number of published works. It is presently working on a project in string theory. Financial support from the Italian INFN and a crucial element of the collaboration has been a number of visits to PIMS by G. Grignani and M. Orselli.

G. W. Semenoff (UBC), K. Zarembo (Uppsala, Sweden): This collaboration has been ongoing for almost 10 years. It began in 1995 with a visit by G. Semenoff to Moscow where K. Zarembo and continued when Zarembo joined UBC as a NATO Postdoctoral Fellow and then a PIMS Postdoctoral Fellow. It produced a number of results in string theory. The collaboration has continued at a slower pace since Zarembo moved to Uppsala University in Sweden in 2002. It presently has some results which will eventually be published.

G. W. Semenoff, Philip Stamp (UBC), Taejin Lee (APCTP and Kangwon University, Korea): Fermionization of the rolling Tachyon boundary conformal field theory. We found exact boundary states for a decaying unstable D-brane and used them to confirm a number of speculations about the behaviour of the system. The work was supported by a year-long visit of Taejin Lee to PIMS in 2004. With the participation of Philip Stamp, it was then extended to cover some condensed matter systems where the exact solution of the boundary conformal field theory that we found has interesting applications to the motion of particles in a dissipative environment.

For a list of CRG publications, please see the PIMS website:

[www.pims.math.ca/Collaborative\\_Research\\_Groups/](http://www.pims.math.ca/Collaborative_Research_Groups/)

## Ongoing Periods of Concentration

### Topology 2004–06

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.

#### CRG LEADERS:

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

#### CRG FACULTY

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- |   |   |   |
|---|---|---|
| • James Timourian (University of Alberta) | • Kalathoor Varadarajan (University of Calgary) | • Michael Freedman (University of Washington) |
| • Jim Bryan (UBC)                         | • Peter Zvengrowski (University of Calgary)     | • Steve Mitchell (University of Washington)   |
| • Kee Lam (UBC)                           | • Eric Babson (University of Washington)        | • John Palmieri (University of Washington)    |
| • Dale Rolfsen (UBC)                      | • Ethan Devinatz (University of Washington)     | • Jack Segal (University of Washington)       |
| • Laura Scull (UBC)                       |   |   |
| • Denis Sjerve (UBC)                      |   |   |

#### CRG DISTINGUISHED CHAIRS

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- Fred Cohen (University of Rochester, New York) at UBC in 2005

#### SCIENTIFIC ACTIVITIES

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##### WORKSHOP ON HOMOTOPICAL LOCALIZATION AND THE CALCULUS OF FUNCTORS

Banff International Research Centre  
April 2-7, 2005

**Organizers:** Kristine Bauer (University of Calgary), Ralph Cohen (Stanford University), George Peschke (University of Alberta), Hal Sadofsky (University of Oregon).

For more information please see  
[http://www.pims.math.ca/birs/birspages.php?task=displayevent&event\\_id=05w5078](http://www.pims.math.ca/birs/birspages.php?task=displayevent&event_id=05w5078)

##### CASCADE TOPOLOGY SEMINAR

Banff International Research Centre  
July 14-16, 2005

**Organizers:** George Peschke (University of Alberta), Laura Scull (University of British Columbia).

For more information please see  
<http://www.pims.math.ca/birs/workshops/2005/05w2612/Schedule05w2612.pdf>

**WORKSHOP ON HYPERPLANE ARRANGEMENTS**

University of British Columbia

August 21-24, 2005

**Organizers:** Graham Denham (U. Western Ontario),  
Sergey Yuzvinsky (University of Oregon)**Plenary speakers included:**

- Alex Suciu (Northeastern): Algebraic invariants for Bestvina-Brady groups
- Laurentiu Maxim (Pennsylvania): Multivariable Alexander invariants of hypersurface complements
- Nicole Lemire (Western Ontario): Galois Module Structure of Galois Cohomology
- Dan Cohen (Louisiana State): Pure braid monomorphisms
- Daniel Matei (Romanian Academy of Sciences): Local system homology of pure braid groups
- Hal Schenck (Texas A&M): Projective dimension of  $D(A)$
- Richard Randell (Iowa): Some representations of arrangement groups
- Franco Saliola (Cornell): The Face Semigroup Algebra of a Hyperplane Arrangement
- Misha Shapiro (Michigan State): Cluster algebras of finite mutation type

For more information please see

<http://www.pims.math.ca/science/2005/05hyper/>**TOPICS IN HOMOTOPY THEORY****GRADUATE SUMMER SCHOOL**

University of Calgary

August 22-26, 2005

**Organizers:** Kristine Bauer (University of Calgary),  
Laura Scull (University of British Columbia)**Plenary speakers included:**

- Alejandro Adem, University of British Columbia, Orbifolds and group cohomology.
- John Baez, University of California Riverside, Gauge fields and homotopy theory .
- Dan Dugger, University of Oregon, Motivic homotopy theory.
- Dev Sinha, University of Oregon, Operads and the interplay between algebraic and geometric topology.

For more information please see <http://www.pims.math.ca/science/2005/05homotopy/>**TOPOLOGY SYMPOSIUM AT THE WINTER CMS**

University of Victoria

December 10-12, 2005

**Organizer:** Dale Rolfsen (UBC)**Speakers included:**

- Alejandro Adem (UBC)
- Kristine Bauer (Calgary)
- Steven Boyer (UQAM)
- Ian Hambleton (McMaster)
- Gabriel Indurskis (UQAM)
- Rick Jardine (UWO)
- Richard Kane (UWO)
- Robion Kirby (California - Berkeley, USA)
- Elena Kudryavtseva (Calgary)
- Victor Nuñez (CIMAT, Guanajuato, Mexico)
- Dorette Pronk (Dalhousie)
- Antonio Ramirez (UBC)
- Dale Rolfsen (UBC)
- Laura Scull (UBC)
- Donald Stanley (Regina)
- Jens von Bergmann (Calgary)
- Genevieve Walsh (Texas, USA)
- Liam Watson (UQAM)
- Peter Zvengrowski (Calgary)

For a complete list of speakers and title of their presentations please see

<http://www.cms.math.ca/Events/winter05/abs/speakers.html>

# Probability and Statistical Mechanics

## 2004–06

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. The list of such results obtained in recent years is remarkable and includes Fisher-Wright and Fleming-Viot Models in population genetics (Dawson Donnelly, Etheridge, Kurtz, March and Perkins), interacting particle systems including contact process and voter models (Bramson, Cox, Durrett, Le Gall, Perkins, and Sakai), lattice trees and animals above the critical dimension of 8 (Derbez and Slade), and percolation and oriented percolation at criticality above the critical dimensions of 6 and 4, respectively (Hara, van der Hofstad and Slade).

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 these processes and study their properties.
- II. The use of such models in mathematical ecology and evolution.

The rescaling results of Slade and his co-authors have created some strong common interests between the statistical physics and spatial stochastic process communities. The scaling limits of low dimensional statistical physics, however, are not super-Brownian motion. It is a defining goal of statistical mechanics to identify them and to calculate their properties. At present there is excellent progress in two dimensions where the stochastic Loewner processes provide natural candidates for scaling limits (ongoing work of Lawler, Schramm and Werner). Another promising programme is based on the renormalization group. The self-avoiding walk in 4 (and  $4 - \epsilon$ ) dimensions can in principle be analyzed by these methods (on going work of Brydges, Imbrie and others).

### CRG LEADERS:

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|---|--|---|
| • David Brydges (UBC),<br>Chris Burdzy (U.<br>Washington),<br>Ed Perkins (UBC),<br>Byron Schmuland (U. Alberta)   | • Chris Burdzy (University of<br>Washington)<br>Zhen-Qing Chen (University<br>of Washington)   | • Research)   |
| • CRG Faculty<br>Joel Feldman (UBC)<br>Alexander Holroyd (UBC)<br>Vlada Limic (UBC)<br>Gordon Slade (UBC)<br>Martin Barlow (UBC)<br>John Walsh (UBC)<br>Byron Schmuland (University<br>of Alberta)<br>Mike Kouritzin (University of<br>Alberta) | • Bruce Erickson (University of<br>Washington)<br>• Chris Hoffman (University of<br>Washington)<br>Lisa Korf (University of<br>Washington)<br>Steffen Rohde (University of<br>Washington)<br>• Jennifer Chayes (Microsoft<br>Research)<br>• Christian Borgs (Microsoft | • Oded Schramm (Microsoft<br>Research)<br>• David Wilson (Microsoft<br>Research)<br>• Michael Kozdron (University<br>of Regina)<br>Chris Soteros (University of<br>Saskatchewan)<br>Raj Srinivasan (University of<br>Saskatchewan)<br>Remco van der Hofstad<br>(Eindhoven)<br>Don Dawson (McGill<br>University) |

**CRG DISTINGUISHED CHAIR**

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- Frank Den Hollander (Leiden University and EURANDOM, The Netherlands) will be visiting UBC Jan. 1-Aug. 15, 2006.

**CRG VISITORS**

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- June 3-July 9, 2005 Lorenzo Zambotti (Pisa) at UBC
- June and July, 2005 Dan Romik (Weizmann Institute) at UBC
- June 6-July 1, 2005 Yuval Peres (University of California, Berkeley) at UBC
- Summer 2005 Takashi Kumagai (Kyoto University) at UBC
- Summer 2005 Leonid Mytnik (Technion) at UBC
- Summer 2005 Carl Mueller (University of Rochester) at UBC
- Summer 2005 Steve Evans (University of California, Berkeley) at UBC
- Jan. 2-8, 2006 Ted Cox (Syracuse University) at UBC
- Jan. 1 to Aug. 18, 2006 Frank den Hollander (Leiden University and EURANDOM) at UBC
- Feb. 28 to March 9, 2005 Jean-Dominique Deuschel (Technische Universität Berlin) at UBC
- May 21 to June 18, 2006 Akira Sakai (EURANDOM) at UBC
- June 26 to Sept. 9, 2006 Malek Abdeslam (Universite Paris 13) at UBC

**SCIENTIFIC ACTIVITIES**

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**CRITICAL SCALING FOR POLYMERS AND PERCOLATION**

Banff International Research Station  
May 28 to June 2, 2005

**Organizers:** David Brydges (University of British Columbia), Jennifer Chayes (Microsoft Research), Gordon Slade (University of British Columbia).

For more information please see [http://www.pims.math.ca/birs/birspages.php?task=displayevent&event\\_id=05w5025](http://www.pims.math.ca/birs/birspages.php?task=displayevent&event_id=05w5025)

**SUMMER SCHOOL IN PROBABILITY**

University of British Columbia  
June 6 - July 1, 2005

**Organizers:** David Brydges (UBC) and Ed Perkins (UBC)

**Course included:**

- Gordon Slade (University of British Columbia): The lace expansion and its applications
- Yuval Peres (University of California, Berkeley): Mixing for Markov Chains and Spin Systems

For more information please see <http://www.pims.math.ca/science/2005/ssprob/>

**WORKSHOP ON UNIQUENESS QUESTIONS FOR INFINITE DIMENSIONAL DIFFUSIONS**

University of British Columbia  
July 4 - 8, 2005

**Plenary speakers included:**

Steven N. Evans (University of California, Berkeley): Modelling segregation of cellular damage in E. coli with super-processes and stochastic partial differential equations

- Donald A. Dawson (University of Carleton): Uniqueness problems for catalytic branching networks
- Yaozhong Hu (University of Kansas): Detecting moving objects under the ocean
- Jean-Francois Le Gall (Ecole Normale Supérieure): Conditioned Brownian trees
- Leonid Mytnik (Technion): On uniqueness for stochastic heat equations with non-Lipschitz coefficients

- John Walsh (UBC): A stochastic two-point boundary-value problem.
- Yongjin Wang (Nankai): From discrete Markov jump systems to two species competitive stochastic Lotka-Volterra Equations
- Lorenzo Zambotti (Milan): On reversible solutions of SPDEs.

For more information please see

<http://www.pims.math.ca/science/2005/05uidd/>

#### SESSION OF PROBABILITY, CMS WINTER MEETING

Victoria, B.C.

Dec. 10-12, 2005

**Organizing Committee:** Ed Perkins (UBC) and Martin Barlow (UBC)

#### **Speakers included:**

- Oded Schramm (Microsoft Research):
- Juan Alvarez (Saskatchewan): Morita approximations to random copolymer localization
- Omer Angel (UBC): 1 Dimensional DLA
- Virag Balint (Toronto): Noise limits for complex eigenvalues
- David Brydges (UBC): Joint density for the local times of continuous-time random walks
- Jean-Francois Delmas (Ecole Nationale des Ponts et Chaussées, France): Fragmentation associated to continuous random trees
- Antal Jaraí (Carleton): A self-organized critical forest fire model
- Richard Kenyon (UBC): Groves, Pfaffians, and crossing probabilities
- Mike Kozdron (Regina): Loop-erased random walk and Fomin's identity
- Vlada Limic (UBC): Recent progress on the attracting edge problem
- Jeremy Quastel (Toronto): Travelling fronts in the stochastically perturbed KPP equation
- Bruce Reed (McGill): On the diameter of a random Minimum Weight Spanning Tree
- Tom Salisbury (York): Singular stochastic integral equations
- Chris Soteros (Saskatchewan): Self-avoiding walk models of random copolymers

For more information please see

<http://www.pims.math.ca/science/2005/05cmsprob/>

#### STOCHASTIC ANALYSIS CONFERENCE

University of Washington

August 7-11, 2006

**Organizing Committee:** Krzysztof Burdzy and Zhen-Qing Chen

#### **Plenary speakers included:**

- Krzysztof Bogdan (Wroclaw University of Technology, Poland)
- Erhan Cinlar (Princeton University)
- Tzuu-Shuh Chiang (Academia Sinica, Taipei)
- Mike Cranston (University of Californian at Irvine)
- Steven N. Evans (University of Californian at Berkeley)
- Patrick J. Fitzsimmons (University of Californian at San Diego)
- Masatoshi Fukushima (Osaka University, Japan)
- Ronald Gettoor (University of Californian at San Diego)
- Masanori Hino (Kyoto University, Japan)
- Elton P. Hsu (Northwestern University)
- Davar Khoshnevisan (University of Utah)
- Panki Kim (University of Illinois at Urbana-Champaign)
- Kazuhiro Kuwae (Kumamoto University, Japan)
- Edwin Perkins (University of British Columbia)
- Jay Rosen (City University of New York)
- Michael Röckner (Purdue University)
- Rene Schilling (Universität Marburg, Germany)
- Byron Schmuland (University of Alberta)
- Oded Schramm (Microsoft Research)
- Renming Song (University of Illinois at Urbana-Champaign)
- Karl-Theodor Sturm (Universität Bonn, Germany)
- Wei Sun (Concordia University, Canada)
- Jason Swanson (University of Wisconsin at Madison)
- Masayoshi Takeda (Tohoku University, Japan)
- Pierre Vallois (Université Henri Poincaré)
- Zoran Vondracek (University of Zagreb, Croatia)
- Hao Wang (University of Oregon)

For more information please see

<http://www.math.washington.edu/~zchen/Conference/>

# Algebraic Geometry, Cohomology, and Representation Theory

## 2005–07

**A**lgebraic geometry is a mathematical discipline which uses the techniques and tools of algebra (e.g. rings, ideals and fields) to attack geometric problems. The fundamental objects which algebraic geometers study are algebraic varieties, the common zeros of a collection of polynomials. In the last four decades, beginning with the ground breaking work of Alexandre Grothendieck, the discipline has undergone phenomenal growth and has had a profound influence on the development of modern mathematics.

Many of the discipline's celebrated works have led to Fields Medals: the proofs of the Weil Conjectures by Deligne, Mumford's work on geometric invariant theory, Hironaka's work on the resolution of singularities, Mori's work on the classification of algebraic varieties in dimension three and Wiles' proof of Fermat's Last Theorem which used arithmetic algebraic geometry. Furthermore, the work of Kazhdan, Lusztig, Kashiwara and others has made algebraic geometry an indispensable tool for representation theory.

In the last 15 years, exciting new connections between algebraic geometry and physics emerged, which led to unexpected new mathematical theories such as mirror symmetry and quantum cohomology and to many important developments in the field of mathematical string theory.

For the most part, these advances have been brought

about by the fact that algebraic geometry poses intrinsically interesting and relevant problems, and has the property of developing the mathematical tools to solve them. It has therefore attracted many talented mathematicians, many of whom are not formally trained in the area, but have realized its value. This has further stimulated new connections between algebraic geometry and other disciplines: e.g. combinatorics, cryptography, statistics, and quantum computing.

Algebraic geometry has also given us new insight into the nature of algebraic groups and Galois cohomology. During the last two decades many exciting fundamental theorems have been established due to the introduction of new powerful techniques from algebraic topology and algebraic geometry. For instance, Voevodsky's use of homotopy and cobordism theory have resulted first in the solution of Milnor conjecture and, more recently, the Bloch-Kato conjecture. Further development of these ideas is crucial.

The PIMS CRG has many people working in the cutting edge in several of the above areas. Among the specialties represented by our varied group are algebraic stacks, geometric invariant theory, algebraic group actions, toric varieties and torus actions, algebraic cycles, Gromov-Witten theory, arithmetic algebraic geometry, classification theory, algebraic representation theory, Lie theory and Schubert varieties, group cohomology.

### CRG LEADERS:

- |   |   |  |
|---|---|--|
| • Arturo Pianzola (Alberta)                   | Terry Gannon (University of Alberta)      | • Jim Carrell (UBC)                          |
| • Jim Bryan (UBC)                             |   | • Bill Casselman (UBC)                       |
| • Nils Bruin (SFU)                            | • Jim Lewis (University of Alberta)       | • Kalle Karu (UBC)                           |
| • Imin Chen (SFU)                             | • Arturo Pianzola (University of Alberta) | • Dale Peterson (UBC)                        |
| • Xi Chen (University of Alberta)             | • Alejandro Adem (UBC)                    | • Zinovy Reichstein (UBC)                    |
| • Gerald Cliff (University of Alberta)        | • Kai Behrend (UBC)                       | • Clifton Cunningham (University of Calgary) |
| • Vladimir Chernousov (University of Alberta) | • Jim Bryan (UBC)                         | • Eric Babson (University of Washington)     |

- Sara Billey (University of Washington)
- Chuck Doran (University of Washington)
- Arner Iqbal (University of Washington)
- Washington)
- Sandor Kovacs (University of Washington)
- Paul Smith (University of Washington)
- Rekha Thomas (University of Washington)
- James Zhang (University of Washington)

### **CRG DISTINGUISHED CHAIR**

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- Michael Thaddeus (Columbia University):  
September 2005-August 2006

### **CRG VISITORS**

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- P. Gille (CNRS, Universite Paris-Sud)
- D. Harari (ENS Paris)
- Canon Leung (University of Science and Technology, Hong Kong)
- D. Maulik (Princeton)
- Jan Minac (U. Western Ontario)
- M. Roth (Queens)
- S. Smith (U. Illinois at Chicago)
- G. Soifer (Bar - Ilan University, Ramat Gan, Israel)
- O. Mathieu (University of Lyon I, France)
- M. S. Raghunathan (Tata Institute of Fundamental Research, Mumbai, India)
- I. Panin (Steklov Institute, S. Petersburg, Russia)
- Yongbin Ruan (Wisconsin-Madison), August 2-5 2005, UBC
- Steven Mitchell, Feb 22, 2006
- Ching-Li Chai, March 7-10, 2006
- K. Zainoulline (Bielefeld University, Germany), March 2006

### **SCIENTIFIC ACTIVITIES**

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**WESTERN ALGEBRAIC GEOMETRY SEMINAR**  
University of Washington,  
April 9-10, 2005

**Organizing Committee:** Chuck Doran, Sándor Kovács and Vitaly Vologodsky.

**Plenary speakers included:**

- Gavril Farkas (UT Austin): Syzygies and the effective cone of the moduli space of curves
- Mark Gross (UC San Diego): Moduli of log Calabi-Yau spaces
- Christopher Hacon (University of Utah): Shokurov's rational connectedness conjecture
- Joel Kamnitzer (UC Berkeley): Geometry and combinatorics of the Mirkovic-Vilonen cycles
- Ravi Vakil (Stanford University): Murphy's Law in algebraic geometry: Badly-behaved deformation spaces
- Aleksey Zinger (Stanford University): Reduced Genus-One Gromov-Witten Invariants and Applications

For more information please see <http://www.math.washington.edu/~kovacs/wags/>

**GRADUATE STUDENT WARM-UP WORKSHOP FOR AMS SUMMER INSTITUTE IN ALGEBRAIC GEOMETRY**

Seattle, July 18-22, 2005

**Organizing Committee:** Sándor Kovács (UW), Tony Pantev (UPenn), and Ravi Vakil (Stanford), David Ellwood (Clay Math Inst, ex-officio), Doug Lind (UW, ex-officio), Hugo Rossi (MSRI, ex-officio)

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• **AMS SUMMER INSTITUTE IN ALGEBRAIC GEOMETRY**  
**Seattle, July 25-Aug. 12, 2005**

**Organizing committee:** D. Abramovich, A. Bertram L. Katzarkov, R. Pandharipande, M. Thaddeus

**Plenary speakers included:**

- K. Hori (Toronto):
- R. Pandharipande (Princeton):
- P. Seidel (Univ. of Chicago):
- M. Haiman (Berkeley):
- J. Harris (Harvard):

- C. Voisin (Jussieu):
- D. Gaitsgory (Univ. of Chicago):
- P. Griffiths (IAS, Princeton):
- F. Loeser (ENS, Paris):

**BAGS: BELLINGHAM ALGEBRAIC GEOMETRY SEMINAR**

Bellingham, Washington  
Nov. 19, 2005

**WAGS: WESTERN ALGEBRAIC GEOMETRY SEMINAR**

Salt Lake City  
Dec. 3-4, 2005

**BAGS: BELLINGHAM ALGEBRAIC GEOMETRY SEMINAR**

Bellingham, Washington  
Feb. 25, 2006

**Organizing Committee:** Jim Bryan, James Carrell  
Sándor Kovács

**Plenary speakers included:**

- Aravind Asok (Washington): Cohomology of Quotients Revisited
- Andreas Rosenschon (Alberta): Algebraic cycles on products of elliptic curves over  $p$ -adic fields
- Sam Payne (Clay Mathematics Institute and Stanford): Toric vector bundles and the resolution property

**ALBERTA-BRITISH-COLUMBIA ALGEBRA WORKSHOP**

UBC  
April 8-9, 2006

**Organizing committee:** Arturo Pianzola (U. Alberta), Zinovy Reichstein (UBC)

**Plenary speakers included:**

- S. Garibaldi (Emory University): Cohomological invariants
- V. Chernousov (University of Alberta): Connectedness of classes of fields and zero cycles on projective homogeneous varieties.
- P. Brosnan (University of British Columbia): Connectedness of classes of fields and zero cycles on projective homogeneous varieties.
- A. Weiss (University of Alberta): Connectedness

of classes of fields and zero cycles on projective homogeneous varieties.

- J. Minac (University of Western Ontario): Connectedness of classes of fields and zero cycles on projective homogeneous varieties.
- A. Adem (University of British Columbia): Commuting Elements and Spaces of Homomorphisms

**MOTIVE AND PERIOD**

UBC  
June 5-12, 2006

**Organizing Committee:** Jim Carrell (UBC), James D. Lewis (University of Alberta), Stefan Müller-Stach (Universität Mainz), Andreas Rosenschon, (University at Buffalo), Pramath Sastry (University of Toronto)

**APPLICATIONS OF TORSORS TO GALOIS COHOMOLOGY AND LIE THEORY**

Banff, AB  
April 23-28, 2005,

**Organizers:** Vladimir Chernousov (University of Alberta), David Harari (Ecole Normale Supérieure), Shrawan Kumar (UNC-Chapel Hill), Arturo Pianzola (University of Alberta)

**INTERACTIONS BETWEEN NONCOMMUTATIVE ALGEBRA AND ALGEBRAIC GEOMETRY**

Banff, AB  
Sept. 10-15, 2005

**Organizers:** Michael Artin (Massachusetts Institute of Technology), Colin Ingalls (University of New Brunswick), Zinovy Reichstein (University of British Columbia), Lance Small (University of California, San Diego), James Zhang (University of Washington)

**PROGRESS IN ALGEBRAIC GEOMETRY INSPIRED BY PHYSICS**

Banff, AB  
Oct. 8-13, 2005

**Organizers:** Jim Bryan (University of British Columbia), Michael Thaddeus (Columbia University), Ravi Vakil (Stanford University)

**HOMOTOPY THEORY AND GROUP ACTIONS**

Banff, AB  
Nov. 12-17, 2005

Organizers: Alejandro Adem (University of British Columbia), William Dwyer (Notre Dame University), Richard Kane (University of Western Ontario), Clarence Wilkerson (Purdue University)



**REGULATORS II**

Banff, AB  
Dec. 10-15, 2005

Organizers: James Lewis (University of Alberta), Victor Snaith (University of Sheffield)

**PIMS/UNAM SUMMER SCHOOL**

Banff, AB  
July 1-6, 2006

Organizers: Alejandro Adem (University of British Columbia), James Carrell (University of British Columbia), José Antonio de la Peña (Universidad Nacional Autónoma de México)



**MODULI SPACES AND COMBINATORICS**

Banff, AB  
July 22-27, 2006

Organizers: Jim Bryan (University of British Columbia), Richard Kenyon (University of British Columbia), Andrei Okounkov (Princeton University), Rahul Pandharipande (Princeton University)



**ALGEBRAIC GROUPS, QUADRATIC FORMS AND RELATED TOPICS**

Banff, AB  
Sept. 2-7, 2006

Organizers: Vladimir Chernousov (University of Alberta), Richard Elman (University of California, Los Angeles), Alexander Merkurjev (University of California, Los Angeles), Jan Minac (University of Western Ontario), Zinovy Reichstein (University of British Columbia)

## Inverse Problems 2005–07

**I**nverse Problems (IP) are problems where causes for a desired or observed effect are to be determined. An important example is to determine the density distribution inside a body from measuring the attenuation of X-rays sent through this body, the problem of “X-ray tomography”. The mathematical problem was studied first by Radon in 1917. Much later, pioneering work by Hounsfield and Cormack led to the first working X-ray tomography machines and later to CAT scans and was honored with the Nobel Prize for Medicine in 1979. This development revolutionized the practice of medicine.

Other more recent medical imaging techniques are MRI where the effect of a strong magnetic field on the body is measured, ultrasound where sound waves are sent through the body their reflections measures and Electrical Impedance Tomography where electrical measurements are made on the boundary of the body to name just a few. Earth sciences continue to be a generator of many compelling inverse problems. All of our knowledge of the Earth’s interior is indirectly derived from surface measurements, as is a great deal of what we know about the surface and the atmosphere.

Reflection seismology in oil exploration is a well-known and economically important inverse problem. Here sound waves are generated at the surface of the Earth. By looking at the reflection of these waves one would like to determine the location and character of oil deposits. From an economic perspective, seismic imaging is by far the dominant geophysical inversion technique. Seismic imaging creates images of the Earth’s upper crust using seismic waves generated by

artificial sources and recorded into extensive arrays of sensors (geophones or hydrophones). The technology is based on a complex, and rapidly evolving, mathematical theory that employs advanced solutions to a wave equation as tools to solve approximately the general seismic inverse problem. In the year 2000, nearly \$4 billion was spent worldwide on seismic imaging.

The heterogeneity and anisotropy of the Earth’s upper crust require advanced mathematics to generate wave-equation solutions suitable for seismic imaging. Other inverse problems arise in nondestructive evaluation of materials. The structural changes due to cracks or flaws are used to identify the locations of those defects. Radar and sonar are based on inverse scattering methods. Mathematics plays a crucial role in the understanding and modeling of the inverse problem as well as in finding reconstruction algorithms.

Bring 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. Physical situations indicated above are modeled by partial differential equations. The inverse problem is to determine the coefficients of the partial differential equation inside the medium from some knowledge of the solutions, usually on the boundary. Already the interaction between experts in partial differential equations and on inverse problems has produced significant advances.

### **CRG LEADERS :**

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- Gary Margrave (U. Calgary), Gunther Uhlmann (U. Washington)

### **CRG FACULTY**

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|--------------------------|--|---|
| • Joel Feldman (UBC)     | • Paul Binding (University of Calgary) | • Michael Lamoureux (University of Calgary) |
| • Richard Froese (UBC)   | • Peter Gibson (University of Calgary) | • Peter Lancaster (University of Calgary)   |
| • Nassif Ghoussoub (UBC) |  |   |

- Larry Lines (University of Calgary)
- Jedrzej Sniatycki (University of Calgary)
- Tony Ware (University of Calgary)
- Ken Bube (University of Washington)
- Edward Curtis (University of Washington)
- James Morrow (University of Washington)
- John Sylvester (University of Washington)

## SCIENTIFIC ACTIVITIES

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**Lecture Series on Mathematics of Seismic Imaging**, William Symes, Rice University, July 19-20, 2005, at the University of British Columbia

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**PIMS-MITACS-VIGRE Summer Graduate School on Inverse Problems**, August 1-5, 2005, at the University of Washington

### Plenary speakers included:

- Guillaume Bal (Columbia) Some Inverse Transport Problems and Their Applications
  - Joyce McLaughlin (RPI) Interior Elastodynamics inverse problems: Finding shearwave speed from interior displacements
  - Gary Margrave (U. Calgary) Seismic Imaging: Theory and Promise
  - Plamen Stefanov (Purdue University) Tensor Tomography and Boundary Rigidity
  - William Symes (Rice University) Mathematics of Seismic Imaging
  - Gunther Uhlmann (University of Washington) Electrical Impedance Tomography
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**Seismic Imaging Summer School**, August 7-11, 2006, at the University of Calgary

**Organizing Committee:** Gary Margrave (U Calgary), Gunther Uhlmann (U Washington), Mauricio Sacchi (U Alberta), Peter Cary (CSEG), Robert Stewart (CREWES)

### Instructors included:

- David Colton (U of Delaware)
- Robert Ferguson (U Texas, Austin)
- Michael Lamoureux (U of Calgary)
- Gary Margrave (U of Calgary)
- Mauricio Sacchi (U of Alberta)
- Charles Ursenbach (CREWES)

**Geophysical Inversion Workshop**, August 14-18, 2006, at the University of Calgary

**Organizing Committee:** Gary Margrave (U Calgary), Gunther Uhlmann (U Washington), Mauricio Sacchi (U Alberta), Peter Cary (CSEG), Robert Stewart (CREWES)

### Plenary speakers included:

- Norm Bleistein (Mines)
  - Chris Chapman (Schlumberger)
  - David Colton (Delaware)
  - Maarten de Hoop (Purdue)
  - John Etgen (BP)
  - Lou Fishman (Slidell)
  - Sam Gray (Veritas)
  - Dmitri Lokshtanov (Norsk Hydro)
  - Wim Mulder (Shell)
  - Frank Natterer (Muenster)
  - Victor Palamodov (Tel Aviv)
  - George Papanicolaou (Stanford)
  - Gerhard Pratt (Queens)
  - Robert Stolt (ConocoPhilips)
  - Bill Symes (Rice)
  - John Washbourne (ChevronTexaco)
  - Art Weglein (Houston)
  - Ru-shan Wu (University of California, Santa Cruz)
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## BIRS Workshop on Time Frequency Analysis and Nonstationary Filtering, September 24-29, 2005

**Organizers:** Hans Feichtinger (University of Vienna), Karlheinz Groechenig (Institute of Biomathematics and Biometry), Michael Lamoureux (University of Calgary), Gary Margrave (University of Calgary).

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## BIRS Workshop on Inverse Problems and Applications, August 19-24, 2006

**Organizers:** Gary Margrave (University of Calgary), Gunther Uhlmann (University of Washington).

# Quantum Topology

## 2005–07

The problems of interest in this CRG are (i) the so-called “many-body problem” in non-relativistic physics, particularly on lattices in low spatial dimension; and (ii) the problem of finding a universal quantum computer which evades decoherence. Phrased this way, these problems seem almost parochial. However we now know that they are in many ways equivalent, and that moreover they are closely related to important problems in theoretical computation, graph theory, in topology, in black hole physics and string theory, and in non-commutative geometry. There is also a strong relation to problems in number theory. The main purpose of this CRG is to bring together

a group of mathematicians and physicists whose interests are united by the 2 problems stated above. Our aim is to resolve some critical issues, which are issues in both mathematics and physics. The work we plan will focus around the following projects:

1. 1-dimensional Problems
2. Renormalisation Group
3. Topological Methods
4. Numerical Methods
5. New Field Theories
6. Quantum Environments and Decoherence
7. Spin Nets of Qubits

### CRG LEADERS:

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Philip Stamp (UBC), Boris L. Spivak (U. Washington), and Joel Feldman (UBC)

### CRG FACULTY

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- UBC: Ian K. Affleck, Mona Berciu, Joel Feldman, George A. Sawatzky, Philip Stamp
- U. Alberta: Frank Marsiglio
- U. Calgary: Richard E. Cleve, John Watrous
- SFU: Igor Herbut
- U. Washington: Boris L. Spivak

### Others:

- M. Freedman (Microsoft Research), A. Kitaev (Caltech), C. Bourbonnais (Sherbrooke), D. Senechal (Sherbrooke), A. M.
- Tremblay (Sherbrooke), R. Gill (Utrecht), R.B. Laughlin (Stanford), A.J. Leggett (Urbana), S. Popescu (Bristol, UC)
- Berkeley), P.B. Wiegmann (U Chicago), S.C. Zhang (Stanford), C. Nayak (UCLA)



# Core Scientific Activities

## Conferences

### PACIFIC NORTHWEST STATISTICS MEETING

University of Victoria

April 22, 2005

The Pacific Northwest Statistics Meeting was held at the University of Victoria. There were two invited speakers: Brian Leroux (University of Washington) and Steven K. Thompson (Pennsylvania State University).

### THE PACIFIC NORTHWEST NUMBER THEORY CONFERENCE 9

Simon Fraser University

April 23, 2005

**Organizers:** Stephen Choi (SFU), and Peter Borwein (SFU)

[oldweb.cecm.sfu.ca/MRG/NTG/pnwnt9.html](http://oldweb.cecm.sfu.ca/MRG/NTG/pnwnt9.html)

### SECOND ANNUAL PACIFIC NORTHWEST THEORY DAY

University of British Columbia

April 30, 2005

The Second Annual Pacific Northwest Theory Day was held at UBC on April 30. Invited speakers included Joel Friedman (UBC), Frank Ruskey (UVic), Nathan Segerlind (UW), Ryan O'Donnell (MS Research), and Funda Ergun (SFU).

[www.cs.ubc.ca/labs/beta/Div/theoryday/](http://www.cs.ubc.ca/labs/beta/Div/theoryday/)

### CONFERENCE ON BLACK HOLES: THEORIES AND MATHEMATICAL ASPECTS

Banff

May 14-18, 2005

Black Holes V was a scholarly research-related conference focusing on recent advances in the theoretical and mathematical aspects of black holes physics. The conference covered a wide spectrum of topics, such as physical effects near black holes, black holes and quantum gravity, black holes and strings, the statistical mechanics and entropy of black holes, numerical relativity, black holes in astrophysics, relativistic effects and compact objects, gravitational waves production in systems containing black holes, and possible observable consequences of the existence of topologically nontrivial higher-dimensional objects. It also focused on more

mathematically oriented aspects of black hole theory, such as black holes in space times with large extra dimensions, black strings, black rings, and topological black holes.

**Organizers:** Valeri Frolov (University of Alberta), Don Page (University of Alberta)

[fermi.phys.ualberta.ca/Black\\_Holes\\_2005.html](http://fermi.phys.ualberta.ca/Black_Holes_2005.html)

### ISMVL-35<sup>TH</sup> ANNUAL INTERNATIONAL SYMPOSIUM ON MULTIPLE-VALUED LOGIC

University of Calgary

May 19-21, 2005

**Organizers:** Svetlana Yanushkevich, Claudio Moraga, Vlad Shmerko, Jackie Rice, Denis Popel

[www2.enel.ucalgary.ca/ISMVL2005/](http://www2.enel.ucalgary.ca/ISMVL2005/)

### 11<sup>TH</sup> CANADIAN CONFERENCE ON GENERAL RELATIVITY AND RELATIVISTIC ASTROPHYSICS

University of British Columbia

May 19-21, 2005

**Organizers:** Kristin Schleich (UBC), Don Witt (UBC)

[www.pims.math.ca/science/2005/05ccgrra/](http://www.pims.math.ca/science/2005/05ccgrra/)

### FIFTH COMBINATORICS DAY

University of Lethbridge, Alberta

May 20, 2005

The 5th Combinatorics Day attracted about 35 participants, with about half local, with the rest mainly from universities in Western Canada including Calgary, Alberta, Regina, Manitoba, and from Montana, U.S. About half of the participants were graduate and undergraduate students.

The single-day event provided a chance for researchers and others with an interest in combinatorics to meet and exchange ideas, and develop collaborative relationships. The event included the presentation of the 2004 Hall Medal to Masaaki Harada on behalf of the ICA by Professor Ralph Stanton.

The speakers were Masaaki Harada (Yamagata U., Japan), Steve Kirkland (U. Regina), and John W. Moon (U. Alberta).

**Organizers:** Wolf Holzmann (University of Lethbridge) and Hadi Kharaghani (University of Lethbridge)

[www.pims.math.ca/science/2005/05combday/](http://www.pims.math.ca/science/2005/05combday/)

#### FOUNDATIONAL METHODS IN COMPUTER SCIENCE

University of British Columbia  
June 2–5, 2005

The Foundational Methods in Computer Science (FMCS05) workshop was an informal meeting to bring together researchers in mathematics and computer science with a focus on applications of category theory in computer science.

Featured speakers included Vaughan Pratt (Stanford) and Steve Bloom (Stevens Institute of Technology) as well as Ernie Manes (U. Massachusetts) and Phil Mulry (Colgate U.). The meeting began with a reception on the UBC campus on June 2, 2005. This was followed by a day of tutorials aimed at students and newcomers to computer science applications of category theory, followed by a day and a half of research talks. The meeting ended on June 5.

There were a few invited presentations, but the majority of the talks were solicited from the participants. Student participation was particularly encouraged at FMCS with several students making presentations based on their theses.

The next meeting of this workshop will be at the Kananaskis field station of the University of Calgary in June, 2006. It is scheduled to return to the UBC campus in 2009.

**Organizer:** John MacDonald (University of British Columbia)

[www.pims.math.ca/science/2005/05fmcs/](http://www.pims.math.ca/science/2005/05fmcs/)

#### CMS/CSHPM SUMMER 2005 MEETING

University of Waterloo, ON  
June 4-6, 2005

[www.cms.math.ca/Events/summer05/](http://www.cms.math.ca/Events/summer05/)

#### SUMMER SCHOOL ON STRINGS, GRAVITY AND COSMOLOGY

Perimeter Institute, Waterloo  
June 20 - July 8, 2005

The Graduate Summer School on Strings, Gravity and Cosmology was held as part of the thematic programme on the Geometry of String Theory, which was hosted jointly by the Fields Institute and the Perimeter Institute in Waterloo. The school ran for three weeks from June 20 to July 8, 2005, at Perimeter. This was the third in an ongoing series of annual summer schools in theoretical physics held in Canada. The schools are intended to educate graduate students and young researchers on current developments in string theory and also its interface with gravity and cosmology. The first and second editions of the school was held at UBC in 2003 and 2004. As well as being the first time the school was held at Perimeter, this marked the first ever graduate summer school to be organized at the institute.

The school brought together 23 first-class lecturers and approximately 110 students from all of the world (including a dozen students from the local area). The lecture topics ran from introductory material to new (as yet unpublished) research results. The introductory courses included “Supersymmetry Basics” by Erich Poppitz (University of Toronto) and “Perturbative String Theory” by Clifford Johnson (University of Southern California). The advanced topics included lectures by Nathan Seiberg (IAS, Princeton) on “Matrix Models and Noncritical Strings,” by Hiroshi Ooguri (Caltech) on “Topological String Theory” and by Ashoke Sen (Harish Chandra Research Institute) on “Black Holes, Attractors and Elementary Strings.”

**Organizers:** Alex Buchel (Perimeter Institute & University of Western Ontario), Taejin Lee (Kangwon National University & APCTP), Robert Myers (Perimeter Institute and University of Waterloo), Moshe Rozali (University of British Columbia), Gordon Semenoff (University of British Columbia)

[www.pims.math.ca/science/2005/05sssgc/](http://www.pims.math.ca/science/2005/05sssgc/)

#### WORKSHOP ON UNIQUENESS QUESTIONS FOR INFINITE DIMENSIONAL DIFFUSIONS

University of British Columbia  
July 4-8, 2005

The focus of the workshop was on open problems and trying to solve them. As such, the formal part

of the workshop was limited to the mornings, while the afternoons were left open for group discussions and impromptu presentations.

Several participants stayed longer to continue to work on problems discussed at the meeting. These included Steve Evans, Peter March, Leonid Mytnik, Yongjin Wang and Lorenzo Zambotti.

**Organizers:** Ed Perkins (University of British Columbia), Martin Barlow (University of British Columbia)

[www.pims.math.ca/science/2005/05uidd/](http://www.pims.math.ca/science/2005/05uidd/)

### STRINGS 2005 CONFERENCE

University of Toronto  
July 11-16, 2005

Strings is the top international conference series in the field of string theory. Strings 2005 was the first Strings conference held in Canada, bringing over 425 of the world's premiere string theorists to the University of Toronto.

The bulk of the conference was devoted to invited talks highlighting recent progress in the field and charting out new directions.

The public lecture session was presented by Robbert Dijkgraaf (Amsterdam) and Lennie Susskind (Stanford), both international superstars in string theory, will lead us on two engaging introductory tours through mind-bending concepts like warped space-time, black holes, strings, the big bang and the ultimate fate of the universe, in a talk entitled, "If String Theory's the Answer, What's the Question?"

**Organizers:** Alex Buchel (Perimeter/UWO), Jaime Gomis (Perimeter), Kentaro Hori (Toronto), Robert Myers (Perimeter/Waterloo) and Amanda Peet (Toronto)

[www.fields.utoronto.ca/programs/scientific/04-05/string-theory/strings2005/](http://www.fields.utoronto.ca/programs/scientific/04-05/string-theory/strings2005/)

### CONNECTING WOMEN IN MATH ACROSS CANADA II

BIRS  
July 21-23, 2005

The CMS Committee for Women in Mathematics, in cooperation with PIMS and BIRS organized the

2005 Connecting Women in Math Across Canada (CWIMAC) workshop for women graduate students in the mathematical sciences at Canadian universities. It was designed to continue the work started by the very successful CWiMAC which took place June 12–13, 2003, at the University of Alberta. The 30 participants attended two plenary talks in mathematics, given by Barbara Keyfitz (Fields Institute) and Neeza Thandi (actuary), and panel and small group discussions. Each participant gave a 20-minute presentation on their research interests or presented a poster.

The CWiMAC workshops are intended to be an integral part of developing a mentoring network to help young women interested in pursuing research in the mathematical sciences, by giving them opportunity to meet women mathematicians working at Canadian and U.S. universities. They also have the opportunity to present their research to a peer group, as well as learn various career strategies, such as how to present a paper, and how to organize their research goals. They are able to meet other women graduate students from across Canada and from Washington State, and share their experiences.

**Organizers:** Judith McDonald (Washington State University), Malgorzata Dubiel (SFU), Rachel Kuske (UBC) and Gerda de Vries (U. Alberta)

[www.birs.ca/birspages.php?task=displayevent&event\\_id=05w2010](http://www.birs.ca/birspages.php?task=displayevent&event_id=05w2010)

### STOCHASTIC CALCULUS AND ITS APPLICATIONS TO QUANTITATIVE FINANCE AND ELECTRICAL ENGINEERING

University of Calgary  
July 24–27, 2005

The conference, partially funded by PIMS, was exceptionally successful. The scientific organizer was Paul Malcolm (National Information and Communications Technology, Australia).

The conference opened on July 24 with two parallel series of tutorial lectures. One was given by John van der Hoek and Alexei Filinkov (both from U. Adelaide) on fractional Brownian motion and white noise calculus, respectively. The other, on filtering, estimation and control, was given by Paul Malcolm, Lakhdar Aggoun (Sultan Qaboos

U.) and Charalambos Charalambous (U. Cyprus). These tutorials had audiences of over 20 in each parallel session, including graduate students from Calgary, Edmonton, Waterloo and elsewhere.

The conference proper was opened on July 25 by Carol Stewart (Vice-Dean, Haskayne School of Business) and Paul Malcolm. The opening speaker was Dilip Madan (Morgan Stanley and U. Maryland). The other three speakers on the opening morning were Eckhard Platen (U. Technology, Sydney), John van der Hoek and Monique Jeanblanc (Université d'Evry). Monday and Tuesday afternoons were taken up with parallel finance and engineering sessions.

Tuesday morning the opening speaker was Alain Bensoussan (formerly head of the French Space Agency, now at U. Texas, Dallas) followed by Vikram Krishnamurthy (UBC), Charalambos Charalambous and Wolfgang Runggaldier (U. Padova, Italy). The closing speaker on Wednesday was Helyette Geman (ESSEC and Université de Paris IX).

Scientifically and socially the conference was very enjoyable. Many people said it was the best meeting they had attended.

Organizers: Paul Malcolm (Australian National University), Allanus Tsoi (University of Missouri), Gordon Sick (University of Calgary), Vikram Krishnamurthy (University of British Columbia)

[homepages.ucalgary.ca/~rje2005/RJEProgram.html](http://homepages.ucalgary.ca/~rje2005/RJEProgram.html)

### CECM DAY 2005

Simon Fraser University

Aug. 3, 2005

The 2005 CECM one-day summer meeting on computational mathematics was held on Aug. 3 at the IRMACS Centre SFU. The meeting consisted of six invited talks and a poster session. Speakers were Jason Bell (SFU), Marni Mishna (SFU), Kevin Hare (University of Waterloo), Allan Wittkopf (CECM), Walter Gander (ETH Zürich) and Richard Crandall (Apple Computer / Reed College).

**Organizer:** Michael Monagan (Simon Fraser University)

[www.cecm.sfu.ca/events/CECM05/](http://www.cecm.sfu.ca/events/CECM05/)

### ADAPTIVITY AND BEYOND: COMPUTATIONAL METHODS FOR SOLVING DIFFERENTIAL EQUATIONS

CELEBRATING THE 60<sup>TH</sup> BIRTHDAY OF ROBERT D. RUSSELL

Vancouver

Aug. 3–6, 2005

The main theme of this conference was adaptive computational methods for differential equations. Adaptation has now become fundamental to the numerical solution of differential equations: accuracy and efficiency can be gained by adapting the computation to the physical solution or important properties of the equation to be solved. Over the last three decades, adaptive computation has established itself as an area of intensive research activities driven by ever more challenging applications. It is a rapidly changing area and one in need of development of even more robust and reliable strategies and better understanding of the basic principles behind them. Bob Russell has made many ground-breaking contributions to the field, and it was a special privilege to dedicate this conference to Dr. Russell in celebration of his 60<sup>th</sup> birthday.

Ms. Barbara Charlie, an esteemed Elder of the Squamish Nation opened the meeting with a blessing and welcoming ceremony to her traditional lands. A short slide show provided some photographic snapshots of Bob Russell's career. Rolf Jeltsch from the ETH Zurich delivered a special greeting address to Bob from the ICIAM Board of Directors. Chris Budd from the University of Bath gave a humorous yet informative opening talk entitled "Who put the  $r$  into  $r$ -adaptivity?" describing some of Bob Russell's many contributions to scientific computing. In total 32 talks were presented, the majority dealing with current research in "adaptivity", with a few talks in the "beyond" section. Yet even those stirred up a great deal of interest and led to interesting questions and discussions.

**Organizers:** Manfred Trummer (SFU), Steve Ruuth (SFU), John Stockie (SFU), Erik Van Vleck (University of Kansas), Weizhang Huang (University of Kansas), and Luca Dieci (Georgia Tech)

[www.pims.math.ca/science/2005/05adaptive/](http://www.pims.math.ca/science/2005/05adaptive/)

**SUMMER SCHOOL IN APERIODIC ORDER**

University of Victoria

Aug. 8-13, 2005

Mathematically speaking, the term ‘aperiodic order’ is used to describe various geometric objects (such as certain tilings or tessellations of Euclidean space) which are non-periodic and yet display a remarkable degree of regularity. The subject began with the work of Hao Wang, Raphael Robinson, Roger Penrose, and others in the late 1960s and early 1970s.

A dramatic development of the subject was the discovery in the early 1980s of physical materials whose diffraction spectra are discrete, indicating a high degree of regularity in the atomic structure, and yet having symmetry patterns which are impossible in any periodic crystal structure. This engendered a vigorous dialogue and exchange of ideas between the mathematics and physics communities that has provided great insights in both directions and which continues to do so today. The objects of the mathematics of aperiodic order have become the models for these ‘quasi-crystals’ and reciprocally their physics has continued to stimulate directions for research.

Although less than 50 years old, the mathematics of aperiodic order has grown rapidly and is now an area of considerable activity. One of its most remarkable characteristics is the diversity of ideas that are involved: harmonic analysis, dynamical systems, ergodic theory, topology, substitution systems, discrete geometry, and operator algebras have all interacted with the subject and reciprocally examples from aperiodic order have provided unexpected insights in these subjects.

Due to the newness of the subject and the fluidity of the ideas around it, there is no single source that serves as an introduction to the mathematics of aperiodic order and its many facets. As a consequence, students have not found it easy to get a feel for the area, even though some of its more visible aspects, such as the Penrose tilings and spectacular diffraction patterns, may have piqued their interest.

The Summer School in Aperiodic Order was designed to address this deficiency, bringing together four well-known experts in the field: Daniel Lenz

(TU Chemnitz), Franz Gaehler (University of Stuttgart), Lorenzo Sadun (University of Texas at Austin) and Boris Solomyak (University of Washington). They presented a broad introduction to many of the most important and active aspects of the field. The emphasis was on mathematics, but attention was also paid to the physical side of the field.

**Organizers:** Robert Moody (University of Alberta), Ian Putnam (University of Victoria)

[www.pims.math.ca/science/2005/05ssaol](http://www.pims.math.ca/science/2005/05ssaol)

**THE 17<sup>TH</sup> CANADIAN CONFERENCE ON COMPUTATIONAL GEOMETRY**

University of Windsor

Aug. 10-12, 2005

The Canadian Conference on Computational Geometry is an annual international event for the dissemination of new results in the fields of computational and combinatorial geometry. The 17<sup>th</sup> annual conference was held at the University of Windsor on Aug. 10-12.

**Organizers:** Prosenjit Bose (Carleton University), Asish Mukhopadhyay (University of Windsor), Peter Tsing (University of Windsor), Steven Wismath (University of Lethbridge)

[www.cccg.ca/](http://www.cccg.ca/)

**THE NORTHWEST DYNAMICS SYMPOSIUM**

University of Victoria

Aug. 15-19, 2005

The Northwest Dynamics Symposium was held at the University of Victoria on Aug. 15-19, in the week after the Summer School in Aperiodic Order. Speakers included Vitaly Bergelson (Ohio State University), Mike Boyle (University of Maryland), Bob Burton (Oregon State University), Mike Keane (Wesleyan University), Robert Moody (University of

Alberta), Dan Rudolph (Colorado State University), and Klaus Schmidt (University of Vienna).

**Organizers:** Chris Bose (University of Victoria), Chris Hoffman (University of Washington), Doug Lind (University of Washington), Ian Putnam (University of Victoria)

[www.pims.math.ca/science/2005/05nwds/](http://www.pims.math.ca/science/2005/05nwds/)

#### HYPERPLANE ARRANGEMENTS WORKSHOP

University of British Columbia

Aug. 21-24, 2005

The Hyperplane Arrangements Workshop was held at UBC on Aug. 21-24, 2005. Speakers included Alex Suci (Northeastern), Laurentiu Maxim (Pennsylvania), Nicole Lemire (Western Ontario), Dan Cohen (Louisiana State), Daniel Matei (Romanian Academy of Sciences), Hal Schenck (Texas A&M), Richard Randell (Iowa), Franco Saliola (Cornell) and Misha Shapiro (Michigan State).

**Organizers:** Graham Denham (U. Western Ontario), Sergey Yuzvinsky (University of Oregon)

[www.pims.math.ca/science/2005/05hyper/](http://www.pims.math.ca/science/2005/05hyper/)

#### TOPICS IN HOMOTOPY THEORY GRADUATE SUMMER SCHOOL

University of Calgary

Aug. 22-26, 2005

The goal of the Topics in Homotopy Graduate Summer School was to provide an opportunity to graduate students in topology to broaden their experience by gaining exposure to several specialized areas of research in homotopy theory. Lectures were presented by Alejandro Adem (University of British Columbia), John Baez (University of California, Riverside), Dan Dugger (University of Oregon) and Dev Sinha (University of Oregon).

The talks were aimed to be most beneficial for students who had completed several years of graduate study, or had some exposure to graduate algebra, homotopy theory and algebraic geometry.

**Organizers:** Kristine Bauer (University of Calgary), Laura Scull (University of British Columbia)

[www.pims.math.ca/science/2005/05homotopy/](http://www.pims.math.ca/science/2005/05homotopy/)

#### 5<sup>TH</sup> INTERNATIONAL CONFERENCE ON WORDS

University of Quebec at Montreal

Sept. 13-17, 2005

The 5<sup>th</sup> International Conference on Words was held at the University of Quebec at Montreal on Sept. 13-17. Invited speakers included Arturo Carpi (Italy), Denis Thérien (Montreal), Maxime Crochemore (France), Michel Mendès (France), Antonio Restivo (Italy) and Jeffrey Shallit (Waterloo).

**Organizers:** Srečko Brlek, Cédric Chauve, Annie Lacasse, Geneviève Paquin

[words2005.lacim.uqam.ca](http://words2005.lacim.uqam.ca)

#### PACIFIC NORTHWEST STATISTICS MEETING

UBC Okanagan

Oct. 1, 2005

The Pacific Northwest Statistics Meeting was held at UBC Okanagan on Oct. 1, 2005. A poster session took place, as well as lectures from Keith Worsley (McGill University) and Subhash R. Lele (University of Alberta).

[people.ok.ubc.ca/gillpara/PNWS/](http://people.ok.ubc.ca/gillpara/PNWS/)

#### 26<sup>TH</sup> MIDWEST-PACIFIC DIFFERENTIAL EQUATIONS CONFERENCE

University of Alberta

Oct. 15-17, 2005

The conference was the continuation of the Midwest Differential Equations Conference series. The primary goal was to promote research and education in the field of differential equations, i.e., ordinary and partial differential equations and functional differential equations, measure chains, difference equations, numerical techniques, and their applications to biological, medical, engineering and physical sciences. This conference brought together established and new researchers and advanced graduate students for an exchange of ideas and discussions on the diverse aspects of differential equations, representing a broad participation from across and beyond Midwest and Pacific regions.

The conference was dedicated to Jack W. Macki and James S. Muldowney for the occasion of their retirement from the University of Alberta. It

celebrated their distinguished academic careers and their contributions to research and education in the area of differential equations.

**Organizers:** Michael Li (University of Alberta), Herb Freedman (University of Alberta)

[www.math.ualberta.ca/ami/mwpde.html](http://www.math.ualberta.ca/ami/mwpde.html)

#### **NORTHWEST PROBABILITY SEMINAR**

University of Washington

Oct. 22, 2005

Northwest Probability Seminars are one-day mini-conferences held at the University of Washington and organized in collaboration with the Oregon State University, the University of British Columbia, the University of Oregon, and the Theory Group at the Microsoft Research.

The Birnbaum Lecture in Probability in 2005 was delivered by Charles Newman (Courant Institute, New York University). Invited lectures were presented by Rami Atar (University of Technion and University of Washington), Nathanael Berestycki (UBC), and Yevgeniy Kovchegov (Oregon State University).

**Organizers:** Chris Burdzy (University of Washington), Zhenqing Chen (University of Washington), Ed Perkins (UBC), Qi-Man Shao (University of Oregon), Ed Waymire (Oregon State University)

[www.math.washington.edu/~zchen/nwprob2005.shtml](http://www.math.washington.edu/~zchen/nwprob2005.shtml)

#### **PIMS POSTDOC 2005 DAY**

University of British Columbia

Oct. 29, 2005

PIMS hosted the annual PIMS Postdoc Day, which was jointly organized with the University of Washington VIGRE Program. The event provided much needed information for the professional development of postdocs; topics which were discussed at length included teaching and mentoring, research connections, industrial connections, job applications, and interview skills.

Over 30 postdocs from UBC, U. Washington, UVic and SFU attended this event, which included presentations as well as question-and-answer sessions.

There was also a featured speaker during lunch,

Nigel Boston (University of Wisconsin), who gave advice to students based on his ample experiences in academia and industry. A webpage with resources for postdocs was established, which includes the presentations at this meeting, as well as useful links for job applicants.

**Organizers:** Alejandro Adem (UBC), Loyce Adams (U. Washington), Tom Archibald (SFU), Brian Marcus (UBC) and Brian Wetton (UBC)

[www.pims.math.ca/science/2005/05postdoc/](http://www.pims.math.ca/science/2005/05postdoc/)

#### **COMBINATORIAL POTLATCH 2005**

Seattle University

Nov. 19, 2005

The Combinatorial Potlatch is an irregularly scheduled, floating, one-day conference. It has been held for many years at various locations around Puget Sound and southern British Columbia, and is an opportunity for combinatorialists in the region to gather informally for a day of invited talks and conversation.

Talks were presented by Bojan Mohar (University of Ljubljana (Slovenia) and Simon Fraser University), Jenny Quinn (Occidental College and University of Puget Sound), and John Caughman (Portland State University).

**Organizers:** David Neel (Seattle University), Nancy Ann Neudauer (Pacific University), Rob Beezer (University of Puget Sound)

[buzzard.ups.edu/potlatch/2005/potlatch2005.html](http://buzzard.ups.edu/potlatch/2005/potlatch2005.html)

#### **PACIFIC NORTHWEST PDE MEETING**

University of British Columbia

Dec. 3, 2005

The speakers at this year's Pacific Northwest PDE meeting were Maciej Zworski (University of California, Berkeley), Nassif Ghoussoub (UBC), Yu Yuan (University of Washington), Gustavo Ponce (University of California, Santa Barbara), and Neil Trudinger (Australian National University).

**Organizer:** Richard Froese (UBC)

[www.pims.math.ca/science/2005/05pnwpde/](http://www.pims.math.ca/science/2005/05pnwpde/)

**STRINGY TOPOLOGY CONFERENCE**

Morelia, Mexico

Jan. 9-20, 2006

The Stringy Topology conference was held in Morelia, Mexico, on Jan. 9-20, 2006. This conference featured new ideas in string theory, in particular D-branes and their relevance to open strings, which have in many ways revolutionized modern quantum field theory. The subject is currently highly heuristic: its formalization and mathematical development has barely begun. The geometric naturality and flexibility of these concepts has fostered rapid development, but their codification is completely open. Orbifolds, gerbes, and stacks are all topics with well-established classical literature, but the idea that they should be grouped together, and that the various kinds of twistings they manifest are relevant to physics, is a new idea in mathematics.

The workshop was a Pan-American Advanced Studies Institutes Program. It was part of the one-semester programme, “New Topological Structures in Physics,” which was organized by MSRI. Funding was provided by the Office of International Science and Engineering of the National Science Foundation and the Office of Basic Science of the Department of Energy. PIMS funded the Canadian participants for the conference.

**Organizers:** Ralph Cohen (Stanford), Jack Morava (Johns Hopkins), Alejandro Adem (UBC), Yongbin Ruan (UW-Madison)

[www.msri.org/calendar/workshops/WorkshopInfo/310/show\\_workshop](http://www.msri.org/calendar/workshops/WorkshopInfo/310/show_workshop)

## Seminar and Lecture Series

### PIMS Algebraic Geometry Seminars, UBC

#### The 2005-06 seminars included:

- Alexander Yong (University of California, Berkeley): On Smoothness and Gorensteinness of Schubert Varieties, April 6, 2005
- Behrang Noohi (Max Planck Institute): Uniformization of Deligne-Mumford Curves, April 26, 2005
- Jim Bryan (UBC): Hurwitz-Hodge Integrals and the Crepant Resolution Conjecture, Sept. 12, 2005
- Hsian-Hua Tseng (UBC): Bend and Break: Old and Not-so-Old, Sept. 19, 2005
- Michael Thaddeus (Columbia University): Stable Maps to Loop Groups: Part I, Sept. 26, 2005
- Michael Thaddeus (Columbia University): Stable Maps to Loop Groups: Part II, Oct. 3, 2005
- Julia Gordon (University of Toronto): Are Characters of P-adic Groups Computable? Oct. 4, 2005
- Nai Chung (Conan) Leung (The Chinese University of Hong Kong): Mirror Symmetry and Magic Square, Oct. 17, 2005
- Jochen Kuttler (UBC): Blowing up Certain Singularities of T-Varieties in G/P, Oct. 24, 2005
- Konstanze Rietsch (King's College, University of London): Mirror Families for Flag Varieties G/P and the Peterson Variety, Oct. 31, 2005
- Yinan Song (UBC): Gromov-Witten/Donaldson-Thomas Correspondence, Nov. 7, 2005
- Tonny Springer (Universiteit Utrecht): Some Subvarieties of a Compactification of a Semisimple Group Part I, Nov. 21, 2005
- Kiumars Kaveh (UBC): Canonical Bases and Toric Degeneration of Flag and Spherical Varieties, Nov. 28, 2005

### PIMS Algebraic Topology Seminars, UBC

#### The 2005-06 seminars included:

- Hendryk Pfeiffer (Cambridge): From Hopf Algebras to Trialgebras and Hopf Categories, April 18, 2005
- Claude Viterbo (Ecole Polytechnique Palaiseau): Commuting Continuous Hamiltonians and Symplectic Topology Part I, July 18, 2005
- Claude Viterbo (Ecole Polytechnique Palaiseau): Commuting Continuous Hamiltonians and Symplectic Topology Part II, July 19, 2005
- Sadok Kallel (Universite de Sciences et Technologies de Lille): On Symmetric Products of Two Dimensional Complexes and Applications, July 28, 2005
- Sadok Kallel (Universite de Sciences et Technologies de Lille): On String Topology and Some of its Applications, July 29, 2005
- Yongbin Ruan (University of Wisconsin-Madison): Recent Developments in Orbifold Theory Part I, Aug. 3, 2005
- Yongbin Ruan (University of Wisconsin-Madison): Recent Developments in Orbifold Theory Part II, Aug. 5, 2005
- Antonio Ramirez (UBC): String Topology, Sept. 12, 2005
- Antonio Ramirez (UBC): Open-Closed String Topology, Sept. 21, 2005
- Stephen Smith (University of Illinois at Chicago): Homotopy Decompositions and Classifying Spaces for Sporadic Simple Groups, Oct. 5, 2005
- Marston Conder (University of Auckland): Group actions on hyperbolic 3-manifolds, Oct. 12, 2005
- Denis Sjerve (UBC): Invariant Spin Structures on Hyperelliptic Surfaces Part I, Oct. 26, 2005
- Denis Sjerve (UBC): Invariant Spin Structures on Hyperelliptic Surfaces Part II, Nov. 2, 2005
- Dale Rolfsen (UBC): The Poincaré Conjecture and its Cousins, Nov. 16, 2005
- Tony Springer (Universiteit Utrecht): Some Subvarieties of a Compactification of a

- Semisimple Group, Nov. 23, 2005
- Alejandro Adem (UBC): Products in the Cohomology and K-Theory of Orbifolds, Nov. 30, 2005
- Ian Hambleton (McMaster University): Finite Groups Acting Freely on Products on Spheres, Dec. 7, 2005
- Ian Hambleton (McMaster University): Groups and Geometry, Dec. 9, 2005
- Genevieve Walsh (University of Texas, Austin): Surfaces in Finite Covers and the Group Determinant, Dec. 14, 2005
- Victor Nunez (CIMAT): Universal Montesinos Knots, Dec. 14, 2005
- Rick Jardine (University of Western Ontario): Cocycle Categories and Gerbes, Dec. 16, 2005
- Dale Rolfsen (UBC): Foliations of Orbifolds and Manifolds, Feb. 1, 2006
- Kee Lam (UBC): Truncated Projective Spaces and the Kervaire Invariant Problem, Feb. 8, 2006
- Steve Mitchell (University of Washington):  $K(1)$ -Local Homotopy Theory and the Iwasawa Algebra, Feb. 22, 2006
- Gabriel Indurskis (UBC): On the  $SL(2, \mathbb{C})$  Character varieties of Manifolds Obtained from the Whitehead Link Exterior by Dehn Filling, March 1, 2006
- Behrang Noohi (Max Planck Institute): What is Topological Stack? March 15, 2005

- Alejandro Adem (UBC): A Stringy Product for Twisted Orbifold K-Theory, March 29, 2006

**PIMS Distinguished Lecture Series, PIMS Sites**

**Organizers:** PIMS Site Directors

**The 2005-06 lectures included:**

- Williams Symes (Rice University): Mathematics of Seismic Imaging-Part I, July 19, 2005
- William Symes (Rice University): Mathematics of Seismic Imaging-Part II, July 20, 2005
- Frederick Cohen (University of Rochester): Braid Groups and their Applications-Part I, Aug. 2, 2005
- Frederick Cohen (University of Rochester): Braid Groups and their Applications-Part II, Aug. 4, 2006
- Lou Fishman (University of Calgary/MDF International): Seismic Imaging-the Seismic Way, Sept. 13, 2005
- Lou Fishman (University of Calgary/MDF International): Phase Space and Path Integral Methods Part I, Sept. 15, 2005
- Lou Fishman (University of Calgary/MDF International): Phase Space and Path Integral Methods Part II, Sept. 20, 2005
- Lou Fishman (University of Calgary/MDF International): Applications to Seismic Imaging, Sept. 22, 2005
- Frank den Hollander (University of Leiden and

EURANDOM): Phase Transitions for Interacting Diffusions, Jan. 18, 2006

- Bruno Eckhardt (Phillips-Universität Marburg Germany): Transition to Turbulence in Shear Flows, Jan. 21, 2006
- Frank den Hollander (University of Leiden and EURANDOM): Random Walk in Random Scenery, Feb. 3, 2006
- Panagiotis Souganidis (University of Texas, Austin): Recent Advances to the Theory of Homogenization in Random Environments, March 7, 2006
- Weiyue Ding (Peking University): Recent Progress in Schroedinger Flows, March 21, 2006
- Weiyue Ding (Peking University): Evolution of Minimal Tori in Riemannian Manifolds, March 28, 2006

**PIMS-MITACS Math Biology Seminar, U. Alberta**

**The 2005-06 PIMS funded seminars were:**

- Elaine Beltaos (University of Alberta): DNA Strands and Knots, April 4, 2005
- Javier Gamarra (Cornell): Critical Foraging in Fragmented Fractal Landscapes, April 11, 2004
- Steve Cantrell (University of Miami): Reversals of Competitive Dominance in Ecological Reserves via External Habitat Degradation, April 11, 2005
- Thomas Hillen (University

- of Alberta): Mathematical Models for Mesenchymal Motion, Sept. 26, 2005
  - Hermann Eberl (Guelph University): The Good, The Bad, and the Ugly: On Bacteria and Partial Differential Equations, Oct. 31, 2005
  - Bettina Greese (Alberta): An Integro-Differential Model for Cancer Growth, Nov. 7, 2005
  - Lora Major (University of Alberta): Computational Simulation of Electrodiagnostic Methods, Nov. 21, 2005
  - Jungmin Lee (University of Alberta): TBA, Dec. 5, 2005
  - Francesca O'Rourke (Queen's University of Belfast): Mathematical Modelling of Cancer, Dec. 12, 2005
  - Weide Li (Lanzhou University): Risk as a Tool for Regional Ecosystem Management in Arid Area: A Case Study in Shiyang River Basin, Jan. 16, 2006
  - Kelvin Jones (University of Alberta): Eavesdropping on Biological Sensors to Reveal the Secret Code of Proprioception, Jan. 23, 2006
  - Wenxiang Lu (University of Alberta): A Mathematical Model for Cancer Treatment by Cell Cycle-Specific Chemotherapy, Jan. 30, 2006
  - Claudia Calin (University of Alberta): A Few Theoretical and Numerical Results in the Smoluchowski Coagulation Equation with Unbounded Kernel and Particle Source Terms, Feb. 6, 2006
  - Caroline Bampfylde (University of Alberta): Biological Control Through Intraguild Predation: A Case Study in the Dynamics of Rusty Crayfish and Smallmouth Bass, Feb. 13, 2006
  - Gordon Broderick (University of Alberta): TBA, Feb. 27, 2006
  - Lukasz Kurgan (University of Alberta): What, Why and How of Computational Protein Structure Prediction, March 6, 2006
  - Bill Nelson (University of Alberta): Outbreak Risk in Aggregate Systems: Seeing the Trees Through the Forest in Mountain Pine Beetles, March 13, 2005
  - Alex Potatpov (University of Alberta): TBA, March 20, 2006
  - Matthew Parliament (University of Alberta): Candidate Gene Polymorphisms and Radiation Toxicity, March 27, 2006
  - Michael Bennett (UBC): Integer points on Congruent Number Curves, Sept. 29, 2005
  - Nigel Boston (University of Wisconsin, Madison): Galois Groups of P-Extensions and Applications, Oct. 27, 2005
  - Patrick Ingram (UBC): Primitive Divisors in Elliptic Divisibility Sequences, Oct. 27, 2005
  - Yoonjin Lee (SFU): The Structure of the Class Groups of Global Functions Fields of any Unitrank, Nov. 24, 2005
  - Stephen Choi (SFU): Why Lehmer's Conjecture is so Difficult, Nov. 24, 2005
  - Matilde Lalín (Institute for Advanced Study): Mahler Measures as Values of Regulators, Feb. 9, 2006
  - Vinayak Vatsal (UBC): Special Values of L-Functions Modulo  $p$ , Feb. 9, 2006
  - Kate Petersen (Queen's University): Cusps and Congruence Subgroups of  $PSL(2, \mathbb{O}_K)$ , March 9, 2006
  - Ching-Li Chai (University of Pennsylvania): Canonical Coordinates for Leaves of  $p$ -Divisible Groups, March 9, 2006
  - Renate Scheidler (University of Calgary): The Real Model of a Hyperelliptic Curve, March 23, 2006
  - Peter Borwein (SFU): Littlewood's 22nd Problem, March 23, 2006
- PIMS Number Theory Seminar, UBC and SFU**
- The 2005-06 seminars included:**
- Nathan Ng (University of Ottawa): The Distribution of Zeros of the Riemannzeta Function, June 28, 2005
  - Chris Sinclair (UBC): Counting Reciprocal Polynomials with Integer coefficients, Sept. 29, 2005

**PIMS PDE/Geometry Seminar,  
UBC**

**The 2005-06 seminars  
included:**

- Tai-Peng Tsai (UBC): Stability in  $H^1$  of the Sum of  $K$  Solitary Waves for Some Nonlinear Schrodinger Equations, April 5, 2005
- Tetsu Mizumachi (Kyushu University): Instability of Vortex Solitons for 2D Focusing NLS, Sept. 8, 2005
- Stephen Gustafson (UBC): Scattering for the Gross-Pitaevskii equation, Sept. 20, 2005
- Hadi Jorati (UBC): Singular Kernels Adapted to Curved Flags, Sept. 27, 2005
- Pierpaolo Esposito (UBC): A Singularly Perturbed Neumann/Dirichlet Problem: Pointwise Concentration Towards Spike-Layer Solutions, Oct. 4, 2005
- Zhiqin Lu (University of California, Irvine): Weil-Petersson Geometry on Calabi-Yau Moduli, Oct. 11, 2005
- Massimiliano Berti (SISSA, Italy): Nonlinear Oscillations in Hamiltonian PDEs, Oct. 11, 2005
- Hideo Takaoka (Kobe University): Global Well-Posedness for the Modified Benjamin-Ono Equation in the Energy Space, Oct. 18, 2005
- Yiming Long (Nankai University): Closed Geodesics on 2 Dimensional Spheres, Oct. 18, 2005
- Adam Oberman (SFU): Numerical Approximation of First and Second Order Nonlinear Elliptic PDEs and Stochastic Game Interpretations, Oct. 25, 2005
- Ivar Ekeland (PIMS): A Remarkable PDE Arising from Non-Commitment in Economics, Nov. 1, 2005
- Nassif Ghoussoub (UBC): On the Partial Differential Equations of Electrostatic MEMS Devices, Nov. 8, 2005
- Nataliya Ivanova (UBC): On Symmetry Properties of Non-Linear Schrodinger Equations, Nov. 15, 2005
- Alan Hammond (UBC): Moment Bounds and Gelation in PDE Modelling Coalescence, Nov. 22, 2005
- Claudio Fernandez (Pontificia Universidad Catolica de Chile): Absence of Bound States for Time Dependent Hamiltonians, Nov. 29, 2005
- Andrew Comech (Texas A&M University): Global Attractor for the Klein-Gordon Equation with a Nonlinearity Supported at a Point, Dec. 1, 2005
- Alexei Cheviakov (UBC): Framework for Potential Systems and Nonlocal Symmetries: Algorithmic Approach, Dec. 6, 2005
- Andrej Zlatoš (University of Wisconsin, Madison): Reaction and Diffusion in the Presence of Fluid Flow, Jan. 5, 2006
- Malabika Pramanik (California Institute of Technology): Geometry of Linear and Monomial Polyhedra and the Applications, Jan. 10, 2006
- David Damanik (California Institute of Technology): Geometry of Linear and Monomial Polyhedra and their Applications, Jan. 12, 2006
- Daniele Cassani (UBC): Nonlinear Elliptic Systems with Critical Growth, Jan. 17, 2006
- Zhiwu Lin (New York University): Stability of Collisionless Plasmas, Jan. 19, 2006
- Antoine Mellet (University of Texas): Weak Solutions for Isentropic Compressible Navier-Stokes Equations, Jan. 24, 2006
- Yujin Guo (UBC): On the Partial Differential Equations in Dimensions Four, Feb. 7, 2006
- Frederic Robert (Universite de Nice-Sophia Antipolis): Quantization Issues for Fourth Order Elliptic Equations in Dimension Four, Feb. 21, 2006
- Rustum Choksi (SFU): A Nonlocal Isoperimetric Problem, Feb. 29, 2006
- Valery Serov (University of Washington): Born Approximation in the Multidimensional Inverse Scattering Problem with Singular Potentials, March 23, 2006

**PIMS Probability Seminars,  
UBC****The 2005-06 seminars  
included:**

- Ulrich Horst (UBC): State Dependent Queuing Systems with Semi-Markov Switching and Applications to Finance, April 6, 2005
- Thomas Duquesne (ENS, Paris): Brownian and Levy Continuum Random Trees, June 16, 2005
- Bruce Reed (McGill University): The Mixing Time of the Giant Component of  $G_{(n,p)}$ , June 29, 2005
- Dan Romik (University of California, Berkeley): Young Tableaux, with Young and Old Applications, July 13, 2005
- Anita Winter (Friedrich-Alexander University of Erlangen-Nuremberg): The Tree-Valued Fleming-Viot Dynamics, Aug. 9, 2005
- Nina Gantert (University of Muenster): The Logloglog Story for Recurrent Random Walk in Random Environment, Aug. 24, 2005
- Stanislav Volkov (University of Bristol):  $5x+1$ : How Many Go Down? Aug. 31, 2005
- Gordon Slade (UBC): The Survival Probability for Critical Oriented Percolation Above  $4+1$  Dimensions, Sept. 7, 2005
- Alan Hammond (UBC): Mass-Conservation and Gelation in Reaction-Diffusion PDE, Sept. 14, 2005
- David Wilson (Microsoft Research): Random-Turn Games, Sept. 21, 2005
- Nathanael Berestycki (UBC): Of Mice and Men (and Random Walks), Sept. 28, 2005
- David Brydges (UBC): Joint Density for the Local Times of Continuous-Time Random Walks, Oct. 5, 2005
- Chris Hoffman (University of Washington): Coexistence for Richardson Type Competing Spatial Growth Models, Oct. 12, 2005
- Gabor Pete (University of California, Berkeley): Corner Percolation on  $Z^2$  and the Square Root of 17, Oct. 19, 2005
- Vlada Limic (UBC): The Spatial Lambda-Coalescent, Oct. 26, 2005
- Jean-Francois Delmas (Centre d'Enseignement et de Recherche en Mathematiques): Fragmentation of the Continuous Random Tree, Nov. 2, 2005
- Omer Angel (UBC): One-Dimensional DLA, Nov. 9, 2005
- Richard Durrett (Cornell University): Waiting for ATCAAAG, Nov. 16, 2005
- Codina Cotar (UBC): Edge Reinforced Random Walk as a Random Walk in Random Environment, Nov. 23, 2005
- Burgess Davis (Purdue University): Continuous Time Vertex Reinforced Random Walk, Dec. 5, 2005
- O.J. Boxma (EURANDOM): Phase Transitions for Interacting Diffusions, Jan. 18, 2006
- Michiel van den Berg (University of Bristol): Heat Flow, Brownian Motion and Newtonian Capacity, Jan. 25, 2006
- Anthony Quas (University of Victoria): Non-Monotonicity in (BC) STV, Feb. 1, 2006
- Gregory Maillard (EURANDOM): Parabolic Anderson Model on Interacting Particle Systems, Feb. 8, 2006
- Micheal Kozdron (University of Regina): The Configurational Measure on Mutually Avoiding SLE paths, Feb. 22, 2006
- Reda Messikh (EURANDOM): On the 2d Ising Wulff Crystal Near Criticality, March 1, 2006
- Jean-Dominique Deuschel (Technische Universitat Berlin): Quenched Invariance Principle for Random Walks in Random Environment, March 8, 2006
- Kevin Buhr (UBC): A Simple Construction of Arratia Flow, March 15, 2006
- Nicolas Petrelis (EURANDOM): Polymer Pinning at an Interface, March 22, 2006
- James Martin (University of Oxford): Competition Interfaces and Interacting Particles, March 29, 2006

**PIMS Problems in Discrete and Combinatorial Math Seminar, UBC**

**The 2005-06 seminars included:**

- Gabor Tardos (SFU): Toward an Extremal Theory of Ordered Graphs, Sept. 13, 2005
- Chris Ryan (UBC): Coincidences Amongst Products of Schur Functions, Sept. 20, 2005
- Laura Dunwoody (UBC): Problems of Forbidden Configurations, Oct. 4, 2005
- Kristin Patron (UBC): Bounds on the Achromatic Number of Triple Systems, Oct. 18, 2005
- David Kirkpatrick (UBC): Minimizing Precision/ Input in the Evaluation of Geometric Primitives, Oct. 25, 2005
- Jason Bell (SFU): New Methods in the Theory of Quasi-Invariants, Nov. 1, 2005
- Luis Goddyn (SFU): An Optimization Problem Arising from Video-On-Demand Broadcasting, Nov. 8, 2005
- John Bueti (University of California, Los Angeles): A Combinatorial Result for the  $(N, K, \lambda)$  Problem, Nov. 15, 2005
- Ryan O'Donnell (Microsoft Research): An Invariance Theorem for Functions with Small Influences, Jan. 17, 2006

- Adam Smith (Weizmann Institute of Science): Correcting Errors Without Leaking Partial Information, Feb. 21, 2006
- Shakhar Smorodinsky (Courant Institute of Mathematical Sciences): On  $K$ -Sets in Dimensions 2, 3, and 4, Feb. 28, 2006
- Richard Ehrenborg (University of Kentucky): The Mobius Function of Partitions with Restricted Block Sizes, March 21, 2006
- Kee Lam (UBC): The Combinatorics of Sums of Squares as Studied Via Topology, March 28, 2006

**PIMS/Shell Lunchbox Lecture Series, Shell Centre, Calgary**

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.

**The 2005-06 seminars included:**

- Gemai Chen (University of Calgary): The Past, Present and Future of Prairie Droughts: How Bad is Bad? April 20, 2005
- Mark Bauer (University of Calgary): Elliptic Curve

Cryptography, Oct. 13, 2005

- David Keith (University of Calgary): Fossil Fuels Without Emissions: Managing the Risks of Underground CO<sub>2</sub> Storage, Nov. 10, 2005
- Ian Gates (University of Calgary): On the Operating Strategy in Solvent-Aided Steam-Assisted Gravity Drainage, Dec. 6, 2005
- Larry Bates (University of Calgary): Spinning Tops, Dec. 20, 2005
- Gerald Lachapelle (University of Calgary): GPS-Concepts and Computational Challenges, Jan. 11, 2006
- Richard Guy (University of Calgary): Everyone Does Combinatorics (But Few People Know They Do), Feb. 14, 2006
- Ross Mitchell (University of Calgary): Applications of Time/Frequency Analysis in Medicine and Geophysics, March 28, 2006

**IAM-PIMS-MITACS Joint Distinguished Colloquium Series, UBC**

This series of seminars is co-hosted by the Institute for Applied Mathematics at UBC and PIMS.

**The 2005-06 seminars included:**

- Eli Tziperman (Harvard): Rapid Past Climate Change: It is the Sea Ice, Sept. 26, 2005

- Tadmor Eitan (University of Maryland): Edge Detection, Hierarchical Decompositions and Velocity Averaging, Oct. 17, 2005
- Greg Kriegsmann (New Jersey Institute of Technology): Microwave Heating of Materials: A Mathematical and Physical Overview, Nov. 7, 2005
- Lakshminarayanan Mahadevan (Harvard): Geometry and Elasticity in Physical Packing Problems, Jan. 16, 2006
- Philip Holmes (Princeton University): Optimal Decisions in the Brain: From Neural Oscillators to Stochastic Differential Equations, March 20, 2006
- Robert Elliot (University of Calgary): Indifference Pricing and Real Options, Sept. 29, 2005
- Traian Pirvu (UBC): Satisfying Convex Risk Limits by Trading, Oct. 13, 2005
- Art Shneyerov (UBC): Dynamic Matching, Two-Sided Incomplete Information, and Participation Costs: Existence and Convergence to Perfect Competition, Oct. 20, 2005
- Biao Wu (Carleton University): Interacting Systems in Time-Varying and Random Environments, Nov. 17, 2005
- Tahir Choulli (University of Alberta): Minimal Hellinger Martingale Measures of Order  $Q$ , Nov. 24, 2005
- Traian Pirvu (UBC): Maximizing Portfolio Growth Rate Under Risk Constraints, Jan. 12, 2006
- Traian Pirvu (UBC): Portfolio Optimization Under Value-at-Risk Constraint, Jan. 26, 2006
- Ulrich Haussmann (UBC): Economic Equilibrium with Multivariable Utility, Feb. 9, 2006
- Matthias Mueller (UBC): Robust Utility Maximization and BSDE, Feb. 23, 2006
- David Lando (University of Copenhagen): Decomposing Swap Spreads, March 2, 2006
- Alexey Kuznetsov (McMaster University): Explicit Formulas for Laplace Transforms of Stochastic Integrals, March 9, 2006
- Patrick Cheridito (Princeton University): Time-Consistency of Indifference Prices and Monetary, March 16, 2006
- Ivar Ekeland (PIMS): Rational Behaviour with Non-Exponential Discount, and What Happens to Hamilton-Jacobi Part I, March 23, 2006
- Ivar Ekeland (PIMS): Rational Behaviour with Non-Exponential Discount, and What Happens to Hamilton-Jacobi Part II, March 30, 2006

### **PIMS-MITACS Finance Seminar Series, UBC**

In conjunction with research activities of MITACS, PIMS hosts a series of talk on recent work in financial mathematics.

#### **The 2005-06 seminars included:**

- Matthias Mueller (UBC): Pricing and Hedging Market External Risks: Weather and Climate, Sept. 8, 2005
- Matthias Mueller (UBC): Pricing and Hedging Market External Risks: Weather and Climate—Open Problems, Sept. 15, 2005
- Dmitry Kramkov (Carnegie Mellon University): On the Two-Times Differentiability of the Value Functions in the Problem of Optimal Investment in Incomplete

### **PIMS/MITACS Mathematical Biology Seminars, UBC**

#### **The 2005-06 seminars included:**

- Adriana Dawes (UBC): Modelling the Spatial Profile of Barbed Ends and Filament Density Behind the Leading Edge of a Motile Cell, April 6, 2005
- Christopher Kribs Zaleta (University of Texas at Arlington): Vector Consumption and Contact Process Saturation in Sylvatic Transmission of T. Cruzi, April 13, 2005
- Don Ludwig (UBC): Uncertainty in Discount Models and Mitigation of Environmental Change, April 20, 2005
- Amil Shah (Vancouver

- Cancer Centre): In Search of the Achilles Heel of Cancer, April 27, 2005
- Toby Elmhirst (University of Houston): Adaptive Radiation as Pattern Formation in Phenotype Space, June 8, 2006
  - Carol Shaoshan Huang (UBC): Modelling the Effect of Metal Ions in Alzheimer's Disease, Aug. 10, 2005
  - Ying-Hen Hsieh (National Chung Hsing University): Candidate Genes Associated with Susceptibility to SARS-CoV, Aug. 15, 2005
  - Stan Maree (Utrecht University): Modelling Cell Movement Patterns During Chick Gastrulation, Aug. 17, 2005
  - Veronica Albers Grieneisen (Utrecht University): Modelling Tumour Growth Dynamics, Aug. 17, 2005
  - Lindi Wahl (University of Western Ontario): Modelling Experimental Evolution, Sept. 7, 2005
  - Steven Plotkin (UBC): How Does a Protein Fold? The Effects of Structure, and a Segue into Differential Geometry, Sept. 21, 2005
  - Rodrigo A. Restrepo (UBC): A Plausible Ancestry for the tRNAs, Sept. 28, 2005
  - Eric Cytrynbaum (UBC): Finding the Centre-How to Solve Simple Geometry Problems at the Cellular Scale, Oct. 5, 2005
  - Nicola Fameli (UBC): Modelling of Ca<sup>2+</sup> Transport in Smooth Muscle Cells, Oct. 12, 2005
  - Byron Goldstein (Los Alamos National Laboratory): Immunoadhesins and Monoclonal Antibodies in the Treatment of Disease: Modelling How They Couple Target Cells to Natural Killer Cells, Oct. 19, 2005
  - Nima Geffen (Tel Aviv University): A Micro Helical Organism Revisited, Oct. 26, 2005
  - Nicholas Swindale (UBC): Coverage, Polymaps and the Visual Cortex, Nov. 2, 2005
  - Lin Wang (University of Victoria): Competition in the Chemostat, Nov. 9, 2005
  - Neil Balmforth (UBC): Locomotion of Gastropods: Lubrication Theory Plus RoboSnail, Nov. 16, 2005
  - Fred Brauer (UBC): Simple Pandemic Models, Nov. 23, 2005
  - Muhammad Aslam Chaudhry (King Fahd University of Petroleum and Minerals): Influence of Culture pH and Osmolality on the Maintenance of Pluripotentiality of Murine Embryonic Stem Cells, Nov. 30, 2005
  - Anmar Khadra (Institute of Applied Mathematics): Modelling the Pulsatile and Synchronized Behaviour of GnRH Neurons, Dec. 7, 2005
  - Yoichiro Mori (New York University): A Three Dimensional Model of Cellular Electrical Activity, Jan. 4, 2006
  - Sasha Jilkine (UBC): Cytoskeletal Dynamics During Cleavage of the *C. elegans* Embryo, Jan. 11, 2006
  - Dejan Milutinovic (University of Utrecht): Stochastic Model of a Micro-Agent Population, Jan. 18, 2006
  - Joseph Mahaffy (San Diego State University): Modelling Marine Phage Ecology, Jan. 25, 2006
  - Yangjin Kim (University of Minnesota): Mathematical Modelling of Tumor Spheroid Growth, Jan. 27, 2006
  - Eldon Emberly (SFU): Synchronizing Mechanisms in Circadian Oscillators, Feb. 1, 2006
  - Rafael Meza Rodriguez (University of Washington): Gestational Mutations and Carcinogenesis, Feb. 7, 2006
  - Meredith Greer (Bates College): Modelling Protein Population Interactions in Prion Diseases, Feb. 8, 2006
  - Leah Keshet (UBC): Biopolymers: Kinetics and Behaviour, Feb. 22, 2006
  - Jim Faeder (Los Alamos National Lab): Rule-Based Modelling of Biochemical Networks, March 1, 2006
  - Samuel Isaacson (University of Utah): Stochastic Reaction-Diffusion Methods for Modelling Gene

Expression and Regulation in Complex Geometries, March 8, 2006

- Eirikur Palsson (SFU): How do Changes in the Properties of the cAMP Signaling System in Dictyostelium Affect the Patterns Observed? March 15, 2006
- Fiona Brinkman (SFU): Trends in Microbial Protein Networks and their Evolution, March 22, 2006
- Peter Sozou (London School of Economics): Costly but Worthless Gifts as Signals in Courtship, March 23, 2006
- Dmitry Kondrashov (University of Wisconsin-Madison): Coarse-Grained Models of Residue Interactions Within and Between Protein Structures, March 29, 2006

### UBC Mathematics Department Colloquium Hosted by PIMS-UBC

#### The 2005-06 seminars included:

- Benjamin Sudakov (Princeton University): Probabilistic Reasoning and Ramsey Theory, April 29, 2005
- R. Sujatha (Tata Institute): Birational Geometry and Localisation, April 18, 2005
- Boris Kunyavskii (Bar-Ilan University): Characterization of Radicals in Finite Dimensional Lie Algebras and Finite Groups, April 15, 2005

- Andrej Zlatos (University of Wisconsin, Madison): Reaction and Diffusion in the Presence of Fluid Flow, Jan. 5, 2006
- Ching-Li Chai (University of Pennsylvania): Hecke Orbits, March 10, 2006

### PIMS/SFU Computing Science Distinguished Lecture Series at SFU

#### The 2005-06 speakers were:

- Sebastian Thrun (Stanford University): Winning the DARPA Grand Challenge, Dec. 8, 2005
- Pavel Pevzner (University of California, San Diego): Fragile Versus Random Models of Chromosome Evolution, Jan. 12, 2006
- Prabhakar Raghavan (Yahoo! Research): The Changing Face of Web Search, Feb. 16, 2006
- Andries van Dam (Brown University): Immersive Virtual Reality for Scientific Visualization, March 3, 2006

### Centre for Scientific Computing - a PIMS/MITACS Event at SFU

#### The 2005-06 speakers were:

- Robert Beardmore (Imperial College of Mathematics London): Invariant Manifolds in Difference-Algebraic Equations-the Discrete DAEs, April 8, 2005
- Mohamad Sawan (Ecole Polytechnique de Montreal): Advanced Techniques to Build Smart Implantable

Medical Devices, May 4, 2005

- Don Wilson (BC Cancer Agency): Molecular Imaging in Oncology-the Evolving Role of PET, May 6, 2005
- Adam Oberman (SFU): Numerical Approximation of Nonlinear Elliptic PDEs, Oct. 28, 2005
- Youngsuk Lee (SFU): Resonant Instability of Steady Mountain Waves, Nov. 4, 2005
- Korikalapudi Sriram (National Institute of Standards and Technology): Internet Routing Security: BGP Behaviour Under Peering Session Attacks, Nov. 9, 2005
- Richard Tsai (University of Texas at Austin): Visibility Optimization Using Variational Approaches, Nov. 18, 2005
- Faramarz Samavati (University of Calgary): Sketch Based Modelling Using Few Strokes, Nov. 25, 2005
- Ozgur Yilmaz (UBC): The Role of Sparsity in Blind Source Separation, Nov. 25, 2005
- Wayne Hayes (University of California, Irvine): From Butterflies to Galaxies: Reliable Simulation of Chaotic Systems, Dec. 7, 2005
- David L. George (University of Washington): Finite Volume Methods and

- Adaptive Refinement for Tsunami Propagation, Jan. 13, 2006
- Traian Pirvu (UBC): Maximizing Portfolio Growth Rate under Risk Constraints, Jan. 20, 2006
- Michael Ward (UBC): The Stability of Localized Stripes for Some Reaction-Diffusion Systems, Jan. 27, 2006
- Xiao-Wen Chang (McGill University): Solving Integer Least Squares Problems, Feb. 3, 2006
- Robert S. Laramée (VRVis Research Centre GmbH, Austria): Interactive Flow Visualization Based on Textures and Geometric Primitives, Feb. 6, 2006
- Boyce Griffith (Courant Institute of Mathematical Sciences): Adaptive Immersed Boundary Methods for Simulating Cardiac Mechanics and Electrophysiology, Feb. 23, 2006
- Ivar Ekeland (PIMS): Problems with Global Convexity Constraints, Feb. 24, 2006
- Philip Holmes (Princeton University): Piecewise-Holonomic Mechanics, Hybrid Dynamical Systems, and Escaping Cockroaches, March 17, 2006

**UBC/SFU Joint Seminars in Statistics in Vancouver**

**The 2005-06 speakers were:**

- Tim Swartz (SFU): Skew-Normal Importance Samplers,

Oct. 6, 2005

- Paul Gustafson (UBC): The Application of Bayesian Methods to the Problem of Analyzing Data Where the Data Quality or the Assumptions About the Study Design are Questionable, Oct. 6, 2005
- A. John Petkau (UBC): Case Studies in Statistical Science: Neutralizing Antibodies and the Efficacy of Interferon Beta-1b in Multiple Sclerosis Clinical Trials, Jan. 16, 2006
- Carl James Schwarz (SFU): Case Studies in Statistical Science: One fish, two fish, red fish, blue fish: How can we count animals? Jan. 16, 2006

**Syncrude/PIMS/AMI Lecture Series at the University of Alberta**

This lecture series is sponsored by Syncrude, organized by PIMS in consultation with Syncrude, and hosted by the Applied Mathematics Institute (AMI) at the University of Alberta.

**The 2005-06 speakers were:**

- Barbara Lee Keyfitz (Fields Institute and University of Houston): Hyperbolic Conservation Laws: Do We Need Proofs? Sept. 23, 2005
- Bruno Eckhardt (Philipps-Universität Marburg): Transition to Turbulence in Shear Flows, Jan. 21, 2005

**PIMS Distinguished Lecture Series**

- Ingrid Daubechies (Princeton University): Introduction to

Wavelets, July 18, 2006 SFU

- Robert Calderbank (Princeton University): Heisenberg-Weyl Groups and their Applications to Sequence Design, July 18, 2006 SFU

**AMI-PIMS Joint Distinguished Lecture on Scientific Computing 2006 Alberta**

- Jinchao Xu (Pennsylvania State University): An Integrated Study of Discretization, Adaptivity and Iterative Methods for Solving Partial Differential Equations, March 24, 2006

**Representation Theory Seminar**

- Jose Antonio de la Pena (National University of Mexico): Stable Representations of Quivers, Oct. 18, 2005
- Arturo Pianzola: Infinite Dimensional Lie Theory: A Galois Cohomology Perspective, July 22, 2005

**PIMS-MITACS Medical Imaging Seminar**

- Urs Hafeli (UBC): Magnetic Drug Targeting, Nov. 29, 2005
- Don Lyster (Vancouver Hospital and Health Sciences Centre, UBC): Imaging in Nuclear Medicine—Is Chemistry Important? Nov. 15, 2005
- Eduard Groeller (Vienna University of Technology, Institute of Computer Graphics and Algorithms): Smart Visibility in Illustrative Visualization, Oct. 21, 2005

- Chris McIntosh (Simon Fraser University): Artificial-Life Models for Medical Image Analysis, Oct. 18, 2005
- Cara Fisher (UBC): Molecular Imaging with Glucose Derivatives, Oct. 4, 2005
- Steven Bergner (SFU): A Framework for SPECT Image Reconstruction Using Graphics Hardware and Software, Sept. 20, 2005
- Donald Yapp (UBC): Non-invasive Evaluation of Tumour Microenvironment Using PET and MRI in Animal Models of Cancer, March 14, 2006
- Kees van den Doel (UBC): Level Set Regulation for Highly Ill-Posed Distributed Parameter Estimation Problems, Feb. 28, 2006
- Piotr Kozłowski (UBC): Magnetic Resonance Imaging and Spectroscopy in Animal Models of Human, Jan. 17, 2006



# Industrial Activities

## PIMS Industrial Activities

**P**IMS views mathematics as a chain, connecting core mathematics to applied and industrial mathematics. PIMS works to ensure that the chain is strengthened through continued collaboration and research between mathematicians and industry. Since 1997, PIMS has organized annual Graduate Industrial Mathematics Modelling Camps (GIMMC), followed by Industrial Problem Solving Workshops (IPSW). These programmes provides the necessary opportunities and infrastructure for intensive study periods in which graduate students are exposed to challenging industrial problems with mathematical content. Research workers with industrial and commercial concerns are invited to present one of their current technical problems. Students who have gone through the GIMMC study these problems in teams during the IPSW. They are mentored by faculty throughout, and present the results of their study to the industrial participants at the end of the week. Problems come from a wide variety of subject areas related to applied and industrial mathematics, with an emphasis on mathematical modelling and analysis. PIMS industrial activities are by no means limited

to the GIMMC and IPSW. PIMS Collaborative Research Groups also have important industrial components. For example, the CRG on Inverse Problems, led by Gunther Uhlmann (U. Washington) and Gary Margrave (U. Calgary), is organizing a major international summer school on Seismic Imaging and a workshop on Geophysical Inversion in the summer of 2006. Such conferences are fundamentally connected to problems in oil exploration.

Since 2005, PIMS has systematically built contacts with the mining industry in B.C. and the oil industry in Alberta. PIMS has also expanded its scientific activities to include focused research projects in industrial mathematics, which combine cutting-edge mathematics with strategic industrial problems. In particular, PIMS developing an exciting project on the Mathematics of Mining in collaboration with its partners at CMM in Chile. PIMS will be co-organizing an important international meeting on this topic in Santiago in February, 2007. An international project on the mathematics of oil exploration is being developed, connecting scientists in Alberta with PIMS' partners in Mexico.

### INDUSTRIAL PROGRAMME COMPONENTS

**Industrial Problem Solving Workshops** are based on the Oxford Study Group Model, in which problems of relevant and current interest to participating industrial companies are posed to the workshop participants, by experts from those various industrial companies. Participating graduate students and faculty spend five days working on the problems, and the results are published. 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.
- Helping PIMS and mathematics by demonstrating to businesses and governments the tangible benefits of supporting the mathematical sciences.

**PIMS Graduate Industrial Mathematics Modeling Camps** have graduate students from Canadian universities attend to learn various aspects of high-level techniques for solving industrial mathematics problems. The camp prepares them for the PIMS Industrial Problem Solving Workshop (IPSW), which follows the GIMMC.

**Industrial workshops, mini-courses and summer schools** are organized by PIMS researchers, with topics of interest to both industry and academia serve to disseminate newly developed mathematical tools that can be of use in industry.

## Industrial Problem Solving Workshop



### 8<sup>TH</sup> ANNUAL PIMS GRADUATE INDUSTRIAL MATHEMATICS MODELLING CAMP (GIMMC)

University of Lethbridge

May 7-11, 2005

The 8<sup>th</sup> Annual Graduate Industrial Mathematics Modelling Camp presents graduate students in the mathematical sciences an opportunity to learn techniques of mathematical modelling under the supervision and guidance of experts in the field. The GIMMC was the first leg of the PIMS Industrial Mathematics Forum 2005, which also included the PIMS Industrial Problem Solving Workshop (IPSW 9), held at the University of Calgary on May 15-19, 2005.

Students worked together in teams under the supervision of invited mentors. Each mentor posed a problem arising from an industrial or engineering application and guided his or her team of graduate students through a modelling phase to a resolution. At the end of the workshop, reports were presented and a written summary of conclusions was made available for distribution.

The camp was available to outstanding graduate students at both the Masters and Ph.D. levels in the fields of mathematics, applied mathematics, statistics, and computer science, or related disciplines.

**Organizers:** Elena Braverman (University of Calgary), Hadi Kharaghani (University of Lethbridge)

[www.pims.math.ca/industrial/2005/05gimmc/](http://www.pims.math.ca/industrial/2005/05gimmc/)

### 9<sup>TH</sup> PIMS INDUSTRIAL PROBLEM SOLVING WORKSHOP (IPSW)

University of Calgary

May 15-19, 2005

The 9<sup>th</sup> Annual PIMS Industrial Problem Solving Workshop (IPSW) was sponsored by PIMS, Alberta Innovation and Science, iCORE and the University of Calgary. Participants from all across Canada and the United States arrived to take part in the workshop. The event was preceded by the 8<sup>th</sup> PIMS GIMMC, where the graduate student IPSW participants had already mastered some mathematical modelling techniques under the guidance of experts.

Industrial problems were presented on the morning of May 15. During the four subsequent days, 40 students, 12 professional academics, and four industry representatives worked in collaboration to resolve these problems. Final presentations on May 19 outlined the progress achieved in all five problems.

The five problems and presenters were:

**Donald M. Henderson** (Vertebrate Morphology and Palaeontology Research Group, U. Calgary, in collaboration with Royal Tyrrell Museum of Palaeontology, Drumheller): *Models of the mechanics and dynamics of dinosaur tails.*

The group investigated the motion and oscillations of the tails of dinosaurs. Unlike mammals, dinosaurs had tails which represented a substantial fraction of their body lengths and masses. It is expected that the movement of the body led to tail oscillations; tail movements could be also essential for balance purposes. The extreme sizes of some dinosaurs (up to 30 tonnes in some cases) and the great range of body sizes (from a few hundred grams to many tonnes) makes them insightful models for the study of locomotory dynamics in terrestrial animals. The results may also differ between four-legged and two-legged dinosaurs.

The group developed four approaches to the problem: the dimensional analysis of the problem, the discrete approach (representing a dinosaur's

body as a collection of “moving connected cylindrical slices”), considered a tail as an elastic beam and the equal arc-length approach (which, unlike a stiff beam, imposed only the condition that the length of the tail be preserved).

**Gerald K. Cole** (Human Performance Laboratory Faculty of Kinesiology, U. Calgary, in collaboration with Biomechanigg Research Inc. which worked with Adidas): *Designing running shoes.*

A robotic system was developed to replicate the mechanics of the contact between the shoe and the ground during human locomotion. The system has six degrees of freedom; the input to the system is the movement of the platform, the outputs are the force and the momentum acting on the foot over time. The purpose was to develop a method which can identify the 3-D movement path of the platform that is required to produce a specified time profile of force and moment acting on the foot.

Using local linearization and PDE approaches, considering path optimization, the problem solution was advanced. The group also noted that irreversibility and robustness of the system should be analyzed.

**Pierre Lemire and Rob Pinnegar** (Calgary Scientific): *Identification of seismic layers using classification of pixels' local spectra.*

The global objective of the project was to identify layers in seismic pseudo-sections which is crucial in oil field analysis. Under the approach which is currently being developed by Calgary Scientific, pixels are classified based on their local characteristics. The local spectrum of each point of a 2-D image is obtained by S-transform. However the classification technique involved finding a dominant peak in each local spectrum. This method was not satisfactory, because the feature of interest does not necessarily dominate at every pixel. Thus second-largest and third-largest peaks may also be significant. The problem stated for the workshop was to find ways of identifying these secondary peaks.

The development was in three directions: application of slicing methods (which works well when the local spectra is smooth), cluster analysis and a subtraction technique which identified and

subtracted the highest peak, then proceeded to the next one, etc.

**Brad Bondy** (Genus Capital Management, Vancouver): *Adaptive statistical evaluation tools for equity ranking models.*

A major challenge in investment management is to identify stocks that are likely to outperform in the future. To this end, the factors which are associated with future out-performance (like earnings-to-price ratio, dividend yield, etc.) are chosen; the “best” factors are incorporated into a model which we use to rank our universe of stocks. These models need to be adaptive, in order to avoid the risk of delaying introduction of a new factor until the market has already cleaned it out. The problem for IPSW was to recommend adaptive statistical evaluation tools to dynamically update the models. Using the genetic optimization (where the performance of the portfolio is to be optimized), the constrained regression approach and an artificial Neural Network, the group obtained promising results outperforming the benchmark (especially with the first and the second methods).

**Brian Russell** (Hampson-Russell Software, a Veritas Company, Alberta): *Seismic prediction of reservoir parameters.*

Assuming there is a set of multivariate observations (which is a set of seismic attribute values), it is necessary to find an approximating function which is the closest to the data in the sense of the least-squares criterion. The analysis is done for various types of data corresponding to different wells.

Several parametric and non-parametric approaches were suggested, among which the spline method outperformed the others.

**Organizers:** Elena Braverman (University of Calgary), Gary Margrave (University of Calgary)

[www.pims.math.ca/industrial/2005/05ipsw/](http://www.pims.math.ca/industrial/2005/05ipsw/)

**4<sup>TH</sup> ANNUAL PIMS-MITACS MATHEMATICAL BIOLOGY SUMMER WORKSHOP**

University of Alberta

May 2-12, 2005

The workshop was an activity of the PIMS Collaborative Research Group on Mathematical Ecology and Evolution. Through lectures and exercises, students were introduced to various techniques of mathematical modelling of biological systems. Students formed project teams to experience the modelling process. Projects were chosen from a wide variety of topics, including epidemiology, population biology, cell biology and physiology.

**Organizers:** PIMS Collaborative Research Group on Mathematical Ecology and Evolution.

[www.math.ualberta.ca/~mathbio/summerworkshop/2005/](http://www.math.ualberta.ca/~mathbio/summerworkshop/2005/)

**MITACS/PIMS NATURAL RESOURCES WORKSHOP**

University of Calgary

May 11-12, 2005

The MITACS/PIMS Natural Resources Workshop served to network individuals from industry, government and academia who were interested in natural resource research; share experiences from industry and government participants on key issues relating to monitoring heavy oil, bitumen recovery processes and monitoring, measurement and verification in geological storage of CO<sub>2</sub>; establish future natural resources research priorities, and create new opportunities for research collaborations between industry, government and academia.

This workshop allowed industrial, academic and governmental organizations to discuss and identify key research areas in the field of (but not limited to) monitoring heavy oil and bitumen recovery processes, and MMV (monitoring, measurement and verification) in geological storage of CO<sub>2</sub>.

**Organizers:** Gary Margrave (University of Calgary) Steve Larter, (University of Calgary) Phil Murray, (ARC) Ron Sawatzky, (ARC) Brent Lakeman, (ARC) Jim Brookes, (MITACS) Jeff Lucas, (MITACS)

[www.mitacs.ca/main.php?mid=10000162&pid=102&eventid=224](http://www.mitacs.ca/main.php?mid=10000162&pid=102&eventid=224)

**35<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON MULTIPLE-VALUED LOGIC**

University of Calgary

May 19-21, 2005

The 35<sup>th</sup> International Symposium on Multiple-Valued Logic was held at the University of Calgary on May 19-21, 2005. The keynote speakers were Barry Sanders (University of Calgary), “Quantum Fingerprinting”; Michael Frank (FAMU-FSU College of Engineering) “Approaching the Physical Limits of Computing”; and Marek Perkowski (Portland State University) “Hahoe KAIST Robot Theatre: learning rules of interactive robot behaviour as a multiple-valued logic synthesis problem.”

The Symposium was preceded by the 14<sup>th</sup> International Workshop on Post-Binary ULSI Systems.

**Organizers:** Svetlana Yanushkevich (University of Calgary), Claudio Moraga (University of Dortmund), Vlad Shmerko (University of Calgary), Jackie Rice (University of Lethbridge), Denis Popel (Baker University)

[//www.enel.ucalgary.ca/ISMVL2005/](http://www.enel.ucalgary.ca/ISMVL2005/)

**PIMS-MITACS SUMMER SCHOOL IN PROBABILITY**

June 6-30, 2005

University of British Columbia

As part of the PIMS Collaborative Research Group in Probability and Statistical Physics, organizers ran two advanced graduate courses at UBC in the summer of 2005. The lectures were given by Yuval



Peres (University of California, Berkeley), titled “Mixing for Markov Chains and Spin Systems,” and Gordon Slade (UBC), titled “The Lace Expansion and Its Applications.” The courses were official courses at UBC and graduate students at universities in Western Canada received credit through the Western Deans Agreement. There were a total of 30 hours of lectures in each course.

**Organizers:** David Brydges (UBC), Ed Perkins (UBC)

[www.pims.math.ca/science/2005/ssprob/](http://www.pims.math.ca/science/2005/ssprob/)

### CANADIAN APPLIED & INDUSTRIAL MATHEMATICS SOCIETY (CAIMS) MEETING 2005

University of Manitoba

June 16-18, 2005

The 26<sup>th</sup> annual meeting of the Canadian Applied and Industrial Mathematics Society (CAIMS) was held at the Fort Garry campus of the University of Manitoba, Winnipeg, June 16-18, 2005.

The meeting featured six themes: Dynamical Systems and Mathematical Biology, Signal Processing, Bioinformatics, Mathematics in Industry, Computational Mathematics, and Pattern Recognition. These themes were chosen not only to reflect some of the main current research interests of CAIMS•SCMAI members and the wider global applied and industrial mathematics community, but also to reflect and highlight the research expertise and interests of mathematical scientists within the University of Manitoba and the local research community and industry.

There were approximately 60 speakers and 130 participants at CAIMS•SCMAI 2005. Furthermore, 20 graduate students and post-doctoral fellows presented posters during the Poster Session held concurrently with the opening night stand-up reception.

**Organizers:** Abba Gumel (University of Manitoba), Rob McLeod (University of Manitoba), Richard Baumgartner (Institute for Biodiagnostics, National Research Council Canada), Chris Bowman (Institute for Biodiagnostics, National Research Council Canada), John Brewster (University of Manitoba), Virginie Charette (University of Manitoba), Darryl Dormuth (Atomic Energy of

Canada), Witold Kinsner (University of Manitoba), Kirill Kopotun (University of Manitoba), Alex Leblanc (University of Manitoba)

[www.umanitoba.ca/institutes/iims/caims2005.shtml](http://www.umanitoba.ca/institutes/iims/caims2005.shtml)

### MINI-COURSE IN FINANCIAL ECONOMICS: EQUILIBRIUM MODELS WITH BELIEFS HETEROGENEITY

University of British Columbia

July 4-5, 2005

Professor Elyes Jouini (U. Paris Dauphine) has made recent and striking progress on the problem of aggregating individual beliefs into collective expectations. This issue is in general sidestepped by defining a “representative consumer.” Professor Jouini showed that going back to individual beliefs makes many apparent paradoxes, such as the equity premium puzzle, disappear.

There was a regular audience of 15 at the minicourse, five of whom were graduate students from other PIMS sites.

**Organizer:** Ivar Ekeland (UBC)

[www.pims.math.ca/industrial/2005/05ssfin/](http://www.pims.math.ca/industrial/2005/05ssfin/)

### PIMS-MITACS-VIGRE SUMMER GRADUATE SCHOOL ON INVERSE PROBLEMS

University of Washington

Aug. 1-5, 2005

In conjunction with the PIMS Distinguished Lectures by William Symes (Rice University), the PIMS Collaborative Research Group on Inverse Problems organized a graduate summer school on inverse problems. The summer school was targeted to graduate students, postdoctoral fellows and scientists interested in learning the subject. Six distinguished researchers each presented a minicourse consisting of three one-hour lectures. The presenters were Guillaume Bal (Columbia University), Joyce McLaughlin (Rensselaer Polytechnic Institute), Gary Margrave (University of Calgary), Plamen Stefanov (Purdue University), William Symes (Rice University), Gunther Uhlmann (University of Washington).

**Organizer:** Gunther Uhlmann (University of Washington)

[www.pims.math.ca/science/2005/05inverse/](http://www.pims.math.ca/science/2005/05inverse/)

**4<sup>TH</sup> INTERNATIONAL CONFERENCE ON ARTIFICIAL IMMUNE SYSTEMS**

Banff Centre

Aug. 14-17, 2005

The field of Artificial Immune Systems (AIS) is one of the more recent biologically inspired approaches to emerge from computer science. The natural immune system is an adaptive learning system that employs many parallel and complementary mechanisms for defense against foreign pathogens. It is a distributed system, capable of learning to identify previously unseen invaders and remembering what it has learnt. Numerous immune algorithms now exist, based on processes identified within human immune systems. These computational techniques have many potential applications, such as in machine learning, pattern recognition, fault detection, computer security, optimization, and distributed system design.

The aims of the 4th International Conference on Artificial Immune Systems are to strengthen AIS research by exploring different immunological mechanisms, and their relation to information processing and problem solving. The conference provided the leading forum for presenting and disseminating the latest work in the field of AIS, and is the only conference dedicated entirely to the field of AIS.

The main themes of the conference included self-nonsel models, or danger theory; network models (e.g., of B-cells); clonal selection and hypermutation; danger theory models; abstractions of other immunological processes; comparisons between AIS and other naturally-inspired paradigms; applications of AIS; and theory of AIS.

Stephanie Forrest (University of New Mexico), a pioneer in immune system computing, presented the ICARIS 2005 Keynote Lecture.

**Organizers:** Jonathan Timmis (University of Kent), Peter Bentley (University College, London), Christian Jacob (University of Calgary), Marcin Pilat (University of Calgary), Simon Garrett (University of Wales, Aberystwyth), Namrata Khemka (University of Calgary)

[oak.cpsc.ucalgary.ca/ICARIS-2005/](http://oak.cpsc.ucalgary.ca/ICARIS-2005/)

**ALBERTA CONFERENCE ON INDUSTRIAL ORGANIZATION**

University of Calgary

October 7-8, 2005

This two-day conference on industrial organization featured lectures by Asdemir Kursad (University of Alberta), Curtis Eaton (University of Calgary), David Krause (Competition Bureau), John Boyce (University of Calgary) and Lucia Vojtassak (University of Calgary), Pat Coe (Carleton University), and Moin Yahya (University of Alberta).

The keynote lecture was delivered by Ralph Winter (UBC), on “Vertical Control of Inventory and Pricing Decisions.”

**Organizer:** Aidan Hollis (University of Calgary)

[www.pims.math.ca/industrial/2005/05acio/](http://www.pims.math.ca/industrial/2005/05acio/)

**OPERATIONS RESEARCH: REAL WORLD CHALLENGES, FIRST INTERNATIONAL SYMPOSIUM ON ALGORITHMIC OPERATIONS RESEARCH**

Simon Fraser University

Jan. 27, 2006

The Symposium brought together researchers, practitioners, and graduate students interested in operations research and its applications. The day hosted an excellent list of speakers on various applied and theoretical topics in operations research.

The conference was the site of the announcement of the publication of a new scholarly journal “Algorithmic Operations Research”. The inaugural issue of the journal was edited by John Birge and is dedicated to the memory of George B. Dantzig. Professor Birge also presented a public lecture associated with the conference, “Operations Research: The legacy of George B. Dantzig for today and tomorrow”.

Speakers at the symposium included John Birge (University of Chicago), Harvey J. Greenberg (University of Colorado), Santosh Kabadi (University of New Brunswick), Gilbert Laporte (HEC Montreal), Katta G. Murty (University of Michigan), Maurice Queyranne (University of British Columbia)

**Organizers:** Binay Bhattacharya (Simon Fraser University), Lou Hafer (Simon Fraser University), Luis Goddyn (Simon Fraser University), Vadym P Kyrylov (Simon Fraser University), Snezana Mitrovic-Minic (Simon Fraser University), Abraham P. Punnen (Simon Fraser University), Kristina Rothley (Simon Fraser University)

[math-optima1.surrey.sfu.ca/orc/orc.htm](http://math-optima1.surrey.sfu.ca/orc/orc.htm)

**APPLIED MATHEMATICS GRADUATE  
STUDENT CONFERENCE 2006**

Simon Fraser University

January 28, 2006

PIMS and Simon Fraser University jointly hosted the second annual Applied Mathematics Graduate Student Colloquium. The event brought together students in Applied Mathematics from several universities and gave them the opportunity to present their research or a course project. The one-day conference was organized and run entirely by graduate students, and was well-attended by around 30 participants. The attendees were graduate and senior undergraduate students from SFU, UBC and UVic. Throughout the day, 12 interdisciplinary talks were presented by students in a variety of areas.

JF Williams (SFU) presented opportunities for students at the 2006 IPSW and GIMMC, and John Stockie (SFU) discussed MITACS internships for students.

**Organizers:** Enkeleida Lushi (SFU), and Colin Macdonald (SFU)

[www.math.sfu.ca/~amgsc/](http://www.math.sfu.ca/~amgsc/)



# Educational Activities

## Education

**P**IMS sponsors and coordinates a wide assortment of educational activities targeting K-12 students and teachers, as well as undergraduate and graduate students, women, and minorities. Many of PIMS' best research scientists are involved in these activities.

### GOALS OF OUR EDUCATION PROGRAMME:

- Promotion of public awareness of the importance of mathematics in the world around us. PIMS wants young people to see that mathematics is a subject that opens doors

to far more than just careers in science. Many different and exciting fields in industry are eager to recruit people who are well prepared in mathematics.

- Narrowing of the historical gap that exists between men, women and minorities, and their interest in mathematics. We believe that this historic lack of interest is because some of these groups have never had access to mathematics in challenging and appropriate ways most likely make a difference.

## Educational Outreach

**S**ince its inception, PIMS has actively been involved in promoting mathematical outreach in the schools of Alberta and British Columbia. They involve students, teachers and parents, and seek to convey the excitement of discovery learning that underlies mathematics and its applications. The following is a list of some of the major outreach activities that are currently organized by PIMS.

## K-12 Education Activities

### MATH MANIA

**M**ath Mania is a popular alternative math education event that has been presented in elementary schools across British Columbia, with its origins in Victoria in 1997. Three to four Math Mania events are held every year. The event is particularly suited to students in grades 2-5. Math Mania is free and open to the public. All students, parents and teachers in the host school are encouraged to attend. Parents involved in home schooling are also encouraged to come along with their children. Each event usually attracts over 200 participants.

Math Mania presents a variety of interactive demonstrations, puzzles, games and art such as soap bubbles, 'get your goat' (Monty Hall game), the penny game, the Set Game, the 'Game of 24', kaleidoscopes and hexaflexagons, Nim, Tower of Hanoi, the amazing sorting network and a number of other mathematical puzzles and paradoxes. These activities are designed to demonstrate to children



and their parents fun ways of learning both math and computer science concepts.

Math Mania is run by volunteers, ranging from undergraduate and graduate students to faculty and staff. Volunteering in Math Mania is a good exercise in peer instruction and also can serve as a recruiting tool to bring good students into the PIMS Universities, and hopefully, some of them into mathematics.

The Math Mania events in 2005-06 were:

- October 07, 2005 - Sk'elep School of Excellence, Kamloops
- November 03, 2005 - Willows Elementary, Victoria
- January 26, 2006 - Cedar Hill Middle School, Victoria
- March 21, 2006 - Rogers Elementary, Victoria
- March 28, 2006 - Gifted Children Association of BC, Victoria

[www.pims.math.ca/mathmania/](http://www.pims.math.ca/mathmania/)

#### MATH PROBLEM-SOLVING WORKSHOPS

In 2005, PIMS began a collaborative effort with the UBC Mathematics Department and their Math Workshops Course (Math 414), in finding and coordinating volunteers for math problem-solving workshops at schools throughout the Lower Mainland. The workshops aim to excite students about mathematics by exposing them to challenging math problems taught by interesting mathematicians. About 70 workshops are held each year.

#### MATHCLICK WORKSHOPS

August 24, 2005

MathClick workshops are full-day mathematics immersions experiential events for students in grades 5-7. They are not only for mathematically talented children; the main intention is to awaken all children's latent talent and interest by showing them that mathematics can be also playful and intriguing. Students in these workshops become engaged in genuine mathematical inquiry in a very encouraging environment that promotes ample opportunity for success. Klaus Hoehsmann (PIMS Education Facilitator) and one of the workshop instructors coauthored the mathematical content for the workshop programme.

The workshops are taught by Edel Vo and Natasa Sirotic from Collingwood School, and assisted by Wendy Dorn from the Burnable School District. Students received certificates of participation.

#### MATH CIRCLES

The Math Circles Coaching Programme is a follow-up to the MathClick workshops. MathCircles takes

place on Saturdays over 17 weeks, for 90 minutes of instruction. The programme, based on the Singapore Grade 6 mathematics programme with modifications, is intended for all students in grades 5-8. The goal is to ensure that the students develop mathematical competence by learning new math skills and practicing the math skills that the students have learned.

#### CONTEST FOR EPSILONS

University of Victoria

April 29, 2005

The third annual Contest for Epsilons was held on April 29, 2005. The half-day competition, with 200 students in grades 6-8, was organized and run by the UVic Math and Stats Course Union (MASCUCU).

The event consists of written tests and also several mini-lectures given by MASCUCU students and departmental members. PIMS helped coordinate the event by giving logistical support. Prizes were awarded to the top three competitors in each grade.

[www.math.uvic.ca/~mascu/Events/Epsilon/epsilon.html](http://www.math.uvic.ca/~mascu/Events/Epsilon/epsilon.html)

#### BC SCIENCE FAIR

University of British Columbia

April 7-9, 2005

#### CANADA WIDE SCIENCE FAIR

University of British Columbia

May 15-22, 2005.

PIMS held two presentation workshops for grades 7-9 students attending the BC Science Fair and the Canada Wide Science Fair. The workshops took place on April 8 and May 16. Mark Maclean (Science One, UBC) ran *Bubbles* and *Topology* sessions. *Maple: Where Mathematics Meets Technology* sessions were presented by Veselin Jungic and Mohammad Ali Ebrahimi. At the regional science fair, PIMS presented awards in the mathematical sciences division. For the Best Pure Math project, Elizabeth Du (Churchill) received a cash prize of \$100. In the Applied Math section, Jennifer Loong (York House) and Gary Hou (Robert A. McMATH) received prizes of \$200 and \$100, respectively.

**FOREVER ANNUAL MATH EXHIBITION FAME 2005**

Victoria

May 17, 2005

FAME 2005 was held at S.J. Willis Auditorium.

There were 10 senior entries, five middle school entries, and 22 elementary, from a total of 69 students. The six schools involved were: Lambrick Park (10 entries), Arbutus (three entries), Hillcrest (10 entries), Frank Hobbs (12 entries), Campus View (one entry) and Craigflower (one entry). There were 12 distinction awards, given out to projects with a score greater than 90 percent.

- Elementary: Hillcrest (2), Campus View (1), Frank Hobbs (3).
- Middle School: Arbutus (2), Hillcrest (1).
- Senior: Lambrick Park (3).

The winning schools were Frank Hobbs (elementary), Arbutus (middle) and Lambrick Park (senior).

**ELMACON 2005**

University of British Columbia

April 30, 2005

The 7<sup>th</sup> Annual PIMS Elementary Grades Math Contest (ELMACON) was the most successful to date, with a record-breaking 300 students participating.

ELMACON 2005 was combined with a Math Mania event, involving methods of teaching mathematics and computer science concepts to children and their parents through games and hands-on activities. ELMACON is open to Lower Mainland students in grades 5-7, giving them a chance to experience mathematics as an exciting sport.

ELMACON consists of three rounds starting with the written component, the Sprint and Target rounds. The top 10 students in each grade go on to the Countdown round where contestants 'duel' against each other. It starts with the 9<sup>th</sup> and 10<sup>th</sup> ranking contestants, and the winner of that contest goes on to 'duel' the 8<sup>th</sup> place holder. The contestant who is ranked 10<sup>th</sup> after the first two rounds has the potential of winning the contest by beating the

nine contestants ahead of him or her. The dueling consists of answering math questions against the clock and sounding a buzzer.

[www.pims.math.ca/The\\_news/Latest\\_News/ELMACON\\_2005](http://www.pims.math.ca/The_news/Latest_News/ELMACON_2005)

**2005 MATHEMATICAL OLYMPIAD**

Mérida, Mexico

July 8-19, 2005

Canadian high school students won one gold medal, two silver medals, and two bronze medals at the 46<sup>th</sup> International Mathematical Olympiad (IMO), held in Mérida, Mexico. The team attended a special IMO Training Camp at the University of Calgary from June 25–28, 2005, before moving to BIRS to train until July 9, 2005. The six members of the 2005 Canadian IMO team were selected from among more than 200,000 students who participated in local, provincial and national mathematics contests. The gold medal was awarded to Yufei Zhao, silver medals to Yang (Richard) Peng and Peng Shi, and bronze medals to Elyot Grant and Donk Uk (David) Rhee.

The Canadian team placed 19<sup>th</sup> out of 91 competing countries, with a score of 132. Since 1981, Canadian students have received a total of 16 gold, 29 silver, and 57 bronze medals.

[www.cms.math.ca/Olympiads/](http://www.cms.math.ca/Olympiads/)

**2005 ESSO-CMS-PIMS MATH CAMP**

Simon Fraser University

June 27-30, 2005

The ESSO–CMS–PIMS Math Camps are designed to provide high-school students, who have demonstrated a talent for mathematics, with a variety of enrichment activities in a fun and rewarding environment.

In 2005, 35 participants were selected out of a record 90 applications. The students attended exciting talks and problem solving sessions. For the first time, their teachers were also invited to a special talk and an afternoon reception.

**Organizer:** Malgorzata Dubiel (SFU)

[www.cecm.sfu.ca/~lisonek/MathCamp.htm](http://www.cecm.sfu.ca/~lisonek/MathCamp.htm)

## First Nations Outreach

### PIMS COLLABORATIONS WITH FIRST NATIONS COMMUNITIES IN BRITISH COLUMBIA

PIMS has formed a partnership with the First Nations Education Steering Committee (FNESC) in British Columbia. On May 26–27, 2005, FNESC and PIMS held a Vancouver workshop for teachers and principals of First Nations elementary and secondary schools.

### TEACHER-TRAINING SESSIONS

As part of its commitment to improve mathematics education in First Nations communities, PIMS organized teacher-training sessions for teachers at First Nations schools, with the participation of mathematicians and other highly qualified lecturers with an interest in both math content and pedagogy. PIMS plans to open these sessions to teachers from several other elementary schools. As a pilot program, PIMS organized a one-week teacher-training session at the Sk'elep School of Excellence in Kamloops, Aug. 22-26, 2005, to assist in the implementation of the math curriculum. Qualified personnel at PIMS, headed by Melania Alvarez-Adem, PIMS B.C. Education Coordinator, provided support throughout the school year in all matters related to mathematics.

### MENTORSHIP PROGRAMMES

PIMS has developed mentorship programmes, where faculty and students from local universities can be paired with school teachers to assist in the teachers' First Nations Outreach mathematical training and to provide a support network. Richard Brewster at the Thompson Rivers University Department of Mathematics and Statistics developed the initiative in Kamloops with PIMS' support. PIMS feels that these mentorship programmes are an excellent idea, and have great potential to be expanded to other regions.

The pilot teacher training and mentorship programmes are possible due to donations by Haig Farris (Fractal Capital Corp), Andrew and Helen Wright (Willow Grove Foundation), and Ken Spencer (co-founder & ex-CEO, CREO).

### MATHEMATICAL OUTREACH

PIMS has organized several mathematical outreach events at First Nations schools. We have run successful Math Mania events at several schools, and plan to expand and develop these outreach activities, which have the benefit of bringing together students, teachers and parents with mathematical scientists. PIMS has organized meetings of mathematicians and educators from Western Canada with First Nations representatives. The first meeting is planned at BIRS in June, 2006.



## Undergraduate and Graduate Educational Activities

### ALBERTA CONFERENCE FOR YOUNG RESEARCHERS IN MATHEMATICS

University of Calgary

April 9-10, 2005

The annual Alberta Conference for Young Researchers in Mathematics, for graduate students at Albertan universities, promoted academic collaboration among young researchers. By giving graduate students a forum to discuss their work with other researchers, the conference promotes progress through discourse.

Graduate students were given the opportunity to present their own research, learn about the research being conducted by other graduate students and discuss research issues.

Thirty-three talks were presented at the conference.

**Organizer:** Peter David Papez (University of Calgary)

[www.pims.math.ca/science/2005/05gradcon/](http://www.pims.math.ca/science/2005/05gradcon/)

### MATH IN BUDAPEST WITH ART HISTORY: A UNIVERSITY OF CALGARY CREDIT TRAVEL STUDY PROGRAMME

Budapest, Hungary

May 29 - July 1, 2005

A group of students from the University of Calgary, either from the Department of Mathematics and Statistics or from the Engineering Faculty, traveled to Budapest, Hungary as part of a Credit Travel Study Program. The group leader was Marguerite Fenyvesi, and the instructors were Yousry Elsabrouty for AMAT 307/311 – Differential Equations, Karoly Boroczky Jr. from Hungary for MATH 311 – Linear Methods II, and Janos Szirmai with Gabriella Szigethy for ARTH 205 – Art History. Marton Naszodi was the mathematics tutorial instructor. The students all took two of the three courses offered.

**Organizer:** Marguerite Fenyvesi (University of Calgary)

[www.pims.math.ca/education/2005/05budapest/Budapest\\_Report.pdf](http://www.pims.math.ca/education/2005/05budapest/Budapest_Report.pdf)

### CANADIAN UNDERGRADUATE MATHEMATICS CONFERENCE

Queen's University

July 13-17, 2005

The 2005 Canadian Undergraduate Mathematics Conference was the largest event to date. In its 12<sup>th</sup> year, the event was marked by 143 participants and 85 student talks of exceptional quality. Nearly every province was represented, with students coming from as far west as Victoria, B.C., and as far east as St. John's, Newfoundland. Many took advantage of the ample opportunities to explore different areas of mathematics and to network with potential future colleagues from across the nation.

Highlights of the conference included the four keynote speakers (and two special guests) who gave memorable talks on a vast array of subjects. Students, however, were the chief focus of the conference, and rightly so. Over 80 students gave talks ranging greatly in style and content; aside from pure and applied mathematics, there were talks in financial mathematics, physics, philosophy and computer science. Both faculty and students commented that the quality of talks far exceeded that of previous years, a trend that will only continue in future years.

**Organizer:** Erica Blom (Queen's University at Kingston)

[www.pims.math.ca/science/2005/05cumc/](http://www.pims.math.ca/science/2005/05cumc/)



## Mathematics Educator Activities

### CHANGING THE CULTURE 2005: MATHEMATICS FOR ALL?

Simon Fraser University at Harbour Centre  
April 22, 2005

The Eighth Annual Changing the Culture conference, sponsored and supported by PIMS, was held at the SFU Harbour Centre. Over the last eight years, the conference has become a forum gathering schoolteachers from all levels, and faculty and graduate students from colleges and universities. Participants discuss issues relating to education in mathematics, and work together towards improving the teaching and image of mathematics. Over 100 participants took part in talks, workshops and discussions focusing on school mathematics curriculums, and students' preparation for University Initiatives with Mathematics Educators courses, including Calculus and Mathematics for Elementary School Teachers.

The conference featured two plenary talks in the morning. Secondary teachers who conducted their graduate work at SFU, Rina Zazkis, Tanya Berezovski, Calin Lucus and Natasha Sirotych, presented "Understanding Mathematical Concepts," and their recently conducted research on understanding several mathematical concepts by high school students and pre-service teachers. They discussed their insights on students' understanding of composition of functions, logarithms and irrational numbers, and presented pedagogical ideas that may assist in shaping a more profound understanding of these mathematical concepts in students.

The first talk was followed by a short lecture by Philip Loewen (UBC), on "Inspiring Students in the Mathematics Classroom."

Participants then took part in one of two workshops for the duration of the conference. The workshops focused on the preparation of high school students for calculus in university, especially in light of recent changes to the Math 12 and Calculus 12 curriculum; and on new curriculum requirements at SFU and other universities that require students to have more mathematics courses for graduation.

In the afternoon, a panel discussion on "Making the Grade: How Reliable Are Our Assessment Standards" was hosted by Melania Alvarez-Adem (PIMS), Kerry Bidder (North Island Distance Education School) and Jim Gaskill (BC Ministry of Education).

The conference ended with a public lecture by Keith Devlin (Stanford University), "The Math Instinct: The amazing mathematical abilities of animals, birds, insects, and babies, and what we can learn from them." Dr. Devlin discussed how most people mistakenly believe that they do not have much mathematical ability. Numerous studies have shown that practically everyone has considerable facility with basic math, but they do not recognize that ability. If the average person was given a math test, they score poorly. But present them with the very same problems in the form of a real-life activity, which is not viewed as "math," and they will score in the 95-per-cent to 100-per-cent range. Dr. Devlin also spoke about some of the more remarkable examples of natural mathematical ability in animals, and ended by asking what, if anything, our fellow creatures have to offer that we can take into the math classroom.

**Organizer:** Malgorzata Dubiel (SFU)

[www.pims.math.ca/education/2005/05ctc/](http://www.pims.math.ca/education/2005/05ctc/)

### ALBERTA COLLEGES MATHEMATICS CONFERENCE AND THE 5<sup>TH</sup> ANNUAL NORTH/ SOUTH DIALOGUE IN MATHEMATICS

Grant MacEwan College, Edmonton

April 29 – May 1, 2005

The 2005 Alberta College Mathematics Conference took place on April 29 at Grant MacEwan College in downtown Edmonton. It was a very informative conference about the teaching issues specific to the colleges and their math course offerings.

The 5<sup>th</sup> Annual North/South Dialogue was sponsored by PIMS and was held on April 30 and May 1 at Grant MacEwan. The morning sessions included curriculum reports while the afternoon sessions were devoted to research talks. The

keynote address was given by Leo Neufeld (U. Victoria) and was on “BC Common Curriculum Eliminates Transfer Evaluations.”

The joint meetings gave educators a chance to meet with colleagues from Alberta’s post-secondary institutions to discuss research, teaching, funding, technology and other ideas of common interest. The development of the dialogue allowed individuals who may not normally have a chance to meet, to share perspectives on research, curriculum, experiences and common interests of mathematics in Alberta.

**Organizers:** Tiina Hohn (Grant MacEwan College), David McLaughlin (Grant MacEwan College), Thomas Hillen (University of Alberta), Michael Lamoureux (University of Calgary)

[www.artsci.macewan.ca/NorthSouthMath2005/](http://www.artsci.macewan.ca/NorthSouthMath2005/)

## 2005 CANADIAN MATHEMATICS EDUCATION FORUM

University of Toronto

May 6-8, 2005

The 2005 Canadian Mathematics Education Forum (CMEF2005) was organized by the Canadian Mathematics Society (CMS). The purpose of the invitational forum was to develop a ongoing national conversation among educators at all levels of schooling about important issues and concerns in the development and future of mathematics education in Canada. The overall theme of the 2005 Forum is “Why Teach Mathematics?” The Forum was design as a working meeting and included plenary panel sessions and talks, as well as 11 working groups.

The Forum brought together 200 participants from all sectors connected to education in mathematics and from all the provinces and territories of Canada, from such groups as:

- Teachers and instructors of mathematics at all levels;
- Researchers in mathematics and mathematics education;
- Consultants and education advisors;
- Representatives of associations of teaching and teachers of mathematics;

- Representatives of the provincial ministries for education; and
- Representatives of other groups having a particular interest for the teaching of mathematics: industry representatives, parents, administrators, editors, textbook writers, etc.

It was the intent that groups working together in the Forum would develop projects, initiatives, and statements that will outline ways in which Canadians may address these issues and concerns. The projects, initiatives, and statements developed during this forum were shared widely with policy makers, school divisions, universities, colleges, parents, students, and the general public.

The public lecture was given by Stephen Lewis (UN Secretary-General’s Special Envoy for HIV/AIDS in Africa) on May 6, entitled “Deciphering Our World.”

**Organizers:** Florence Glanfield (University of Saskatchewan), Frédéric Gourdeau (Université Laval), Bradd Hart (McMaster University).

[www.math.ca/Events/CMEF2005/](http://www.math.ca/Events/CMEF2005/)

## PIMS EDUCATION DAY 2005

University of Victoria

June 1, 2005



Approximately 40 academics and educators, along with university and government administrators, met at the University of Victoria for the first annual PIMS Education Day on June 1, 2005.

Two keynote speakers addressed the group during the morning session. George Bluman (UBC) is well known throughout North America for his passionate views on mathematics and education. Professor Bluman gave the audience a broad view of BC and Canadian mathematics education, both past and present, as well as numerous reasons to have hope for the future.

The second keynote speaker was Hon. Ida Chong, Minister of Advanced Education for BC. Minister Chong recognized the importance of numeracy and mathematical literacy, and left no doubt about the BC government's commitment to continue improving science and technology training over the next few years.

The event included the presentation of the 2005 PIMS Education Prizes, generously funded in 2005 by Hugh Morris of Padre Resource Management. The awards were presented by Richard Keeler (Associate Vice-President Research, UVic), who also spoke about each of the awardees and their accomplishments. The prize winners were David Leeming (University of Victoria) and Jim Morrow (University of Washington).

Professor Leeming's award recognized his decades of service to university and high school education. Highlights include Math Mania, First Nations



Educational Initiatives and editorship of *Pi in the Sky*, the popular PIMS magazine aimed at high school students.

Professor Morrow's accomplishments have won him numerous accolades from colleagues and in the media. Highlights include MATHDAY at the University of Washington, coaching UW's winning math modelling teams, and the Summer Math Institute for high-school students. Professor Morrow was also a key figure in the highly regarded, NSF-funded Research Experience for Undergraduates initiated at UW.

[www.pims.math.ca/education/2005/05eduprize/](http://www.pims.math.ca/education/2005/05eduprize/)

### RENAISSANCE BANFF: MATHEMATICS, MUSIC, ART, CULTURE

Banff International Research Station

July 31 - Aug. 3, 2005

Renaissance Banff was the first event of this size or scope in Canada devoted to mathematics and the arts. It successfully brought together artists, mathematicians, writers and computer scientists from Canada and internationally in a highly enjoyable, stimulating and encouraging atmosphere of mutual exchange and appreciation. The conference's public component (the art gallery and the public lecture on Coxeter) drew a capacity crowd to the Max Bell auditorium at the Banff Centre. An innovative new play was sponsored that went on successfully to run as an off-Broadway production in January-February of 2006. The conference brought a new appreciation to Canadian mathematicians and artists, as well as ordinary citizens of this country, just how much these disciplines have to offer each other and just how approachable and fascinating mathematical ideas can be when they are put in settings which emphasize visual and auditory appreciation.

The public lecture, titled "The Man Who Saved Geometry," was delivered by Toronto-based journalist and science writer Siobhan Roberts. The lecture was a delightful look at the life and impact of Coxeter. Ms. Roberts spent a lot of time with Coxeter during the last few years of his life and accompanied him to several conferences. The talk draws heavily from her biography *The King of Infinite Space: Donald Coxeter, The Man Who Saved Geometry*. This public lecture was well advertised around Banff and the Banff Centre. Over 250 people were on hand to listen to this engaging

talk and to participate in a reception afterwards. A very important component of the conference was the presentation of a lecture for the general public of Banff and the fellow artists and residents of the Banff Centre. This was an opportunity for a wider audience to come and see mathematics from a cultural perspective and to visit the conference art exhibition.

Another important aspect of the Bridge conference was Bridges for Teachers; Teachers for Bridges: a workshop series for teachers of all levels, from elementary to college. The workshop series provided many opportunities for dramatically illustrating mathematical ideas and bringing their intuitive content to life. The math-education workshop at Renaissance Banff was organized by Mara Alagic (Wichita State University).

The conference was accompanied by a refereed and edited proceedings book that contains all the talks (over 80) that were presented during the conference.

**Organizers:** Ivar Ekeland (UBC), Nassif Ghoussoub (UBC), Robert Moody (University of Alberta), Christiane Rousseau (University of Montreal), Reza Sarhangi (Towson University)

[www.bridgesmathart.org](http://www.bridgesmathart.org)



### **JUMP: SUMMER TRAINING SESSION AT PIMS**

University of British Columbia

Aug. 31, 2005

The JUMP Summer Training Session was led by Laura Miggiani Hannah (National Programme Director, JUMP). Over 50 enthusiastic people attended the session. It was geared towards teachers wanting to use JUMP in their classrooms during the 2005-06 school year. Teachers, administrators and community members who wanted to refresh their skills were also welcome to attend.

Junior Undiscovered Math Prodigies (JUMP) is a volunteer based charitable organization that was founded by John Mighton in 1998. Since its inception, the JUMP programme has expanded nationally.

**Organizer:** Melania Alvarez-Adem (PIMS)

[www.pims.math.ca/education/2005/05jump/](http://www.pims.math.ca/education/2005/05jump/)



# Banff International Research Station (BIRS)

# Banff International Research Station (BIRS)

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 AIS (grant to PIMS), the U.S. 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. Researchers attend five-day workshops, two-day workshops, research in teams, focused research groups and summer schools over 40 weeks of operation in 2005 and 44 weeks of operation in 2006.



*Nassif Ghoussoub, BIRS Scientific Director*

## THE LOCATION OF BIRS

BIRS is located in two adjacent buildings at the Banff Centre: the Max Bell building, which has two lecture rooms and several smaller meeting and discussion rooms, and Corbett Hall, which will be entirely taken over by BIRS, houses 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 morning through to Thursday afternoon. Each workshop is devoted to one specific area of high research interest. Expert participants from around the world are invited to attend, with about 40 invited to every five-day workshop. The objective is to exchange the latest advances in the field and to provide an environment that 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 leaves open two days every week (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 two to four researchers for periods of two to four weeks. This programme will offer collaborating researchers from different institutions 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 has up to eight mathematicians staying in residence at BIRS for two to four weeks. This provides a good venue for collaborative work for teams of mathematical researchers, such as those identified and supported by NSF's Focused Research Groups programme and NSERC's Collaborative Research Opportunities programme.

## SUMMER SCHOOLS

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

## The BIRS Scientific Advisory Board

- Nassif Ghoussoub (Chair) (Banff International Research Station): Non-linear Analysis, Partial Differential Equations.
- Alejandro Adem (University of British Columbia): Algebraic Topology, Group Cohomology
- Raymundo Bautista (Universidad Nacional Autonoma de Mexico): Representation Theory, Lie Theory
- Jean Bellissard (Georgia Institute of Technology): Mathematical Physics
- Karoly Bezdek (University of Calgary): Combinatorial, Convex and Discrete Geometry
- David Brydges (University of British Columbia): Statistical Mechanics
- Vladimir Chernousov (University of Alberta): Algebraic Groups
- Octav Cornea (Universite de Montreal): Algebraic/Symplectic Topology
- Jaksza Cvitanic (California Institute of Technology): Mathematical Finance
- Darrell Duffie (Stanford University): Mathematical Economics
- David Eisenbud (University of California, Berkeley): Commutative Algebra, Algebraic Geometry, Computation
- Ivar Ekeland (University of British Columbia): Mathematical Economics
- Yakov Eliashberg (Stanford University): Symplectic geometry, Topology, Several Complex Variables
- Lawrence C. Evans (University of California, Berkeley): Nonlinear PDE & Calculus of Variations
- Daniel Freed (University of Texas at Austin): Geometry, Math Physics
- John Friedlander (University of Toronto): Number Theory
- Eyal Goren (McGill University): Arithmetic Geometry
- Arvind Gupta (MITACS): Combinatorics, Optimization and Complexity Theory
- Helmut Hofer (New York University): Symplectic Geometry
- Gerhard Huisken (Max-Planck-Institute for Gravitational Physics): Analysis and Differential Geometry, Geometric Evolution Equations
- Lisa Jeffrey (University of Toronto): Symplectic Geometry
- Carlos Kenig (University of Chicago): Analysis
- Leah Keshet (University of British Columbia): Mathematical Biology
- Thomas G. Kurtz (University of Wisconsin, Madison): Statistics
- Rachel Kuske (University of British Columbia): Applied Partial Differential Equations
- Robert Lazarsfeld (University of Michigan): Algebraic Geometry
- Mary Pugh (University of Toronto): Applied Partial Differential Equations
- Alexander Razborov (Institute for Advanced Study): Combinatorics, Theoretical Computer Science
- Gadiel Seroussi (MSRI): Information Theory
- Gordon Slade (University of British Columbia): Probability, Statistical Mechanics
- Karen Smith (University of Michigan): Commutative Algebras
- Panagiotis Souganidis (University of Texas, Austin): Nonlinear Partial Differential Equations
- Douglas Stinson (University of Waterloo): Computer Science, Cryptography
- Elizabeth Thompson (University of Washington): Statistics
- Nicole Tomczak-Jaegermann (University of Alberta): Asymptotic Geometric Analysis
- Michael Waterman (University of Southern California): Mathematical and Computational Biology
- Peter Winkler (Dartmouth College): Discrete Mathematics and the Theory of Computing
- Jianhong Wu (York University): Applied Mathematics, Mathematical Biology
- Efim Zelmanov (University of California, San Diego): Algebra, Group Theory, Non-associative Algebras

# BIRS Calendar for 2005 – 2006

## 2005 PROGRAMME FOR 5-DAY WORKSHOPS

### March 12-17: **Dynamics, Probability, and Conformal Invariance**

Organizers: P. Jones (Yale), M. Yampolsky (Toronto), I. Binder (Toronto), S. Rohde (Washington)

### March 19-24: **Computational Fuel Cell Dynamics-III**

Organizers: B. Wetton (UBC), K. Promislow (Michigan State), J. St. Pierre (Ballard)

### March 26-31: **Representations of Kac-Moody Algebras and Combinatorics**

Organizers: V. Chari (UC Riverside), G. Cliff (Alberta), P. Littelmann (Wuppertal), N. Reshetikhin (UC Berkeley)

### April 2-7: **Workshop in Homotopical Localization and the Calculus of Functors**

Organizers: G. Peschke (Alberta), K. Bauer (Calgary), R. Cohen (Stanford), H. Sadofsky (Oregon)

### April 9-14: **Complex Data Structures**

Organizers: J. Stafford (Toronto), J. Berger (SAMSI), M. Thompson (Waterloo), N. Reid (Toronto)

### April 16-21: **Numerical Relativity**

Organizers: R. LeVeque (Washington), M. Choptuik (UBC), L. Lehner (Louisiana State), D. Arnold (Minnesota), E. Tadmor (Maryland)

### April 23-28: **Applications of Torsors to Galois Cohomology and Lie Theory**

Organizers: A. Pianzola (Alberta), V. Chernousov (Alberta), S. KuMarch (North Carolina), D. Harari (ENS Paris)

### April 30-May 05: **Micro- and Nano-fluidic Systems Descriptions**

Organizers: J. Harrison (Alberta), J. Santiago (Stanford), K. Jensen (MIT)

### May 7-12: **Aggregation and Disaggregation Characterization and Identification of Collective Demand**

Organizers: P.A. Chiappori (Chicago), I. Ekeland (UBC)

### May 14-19: **Densest Packings of Spheres**

Organizers: K. Bezdek (Calgary), H. Cohn (Microsoft Research), C. Radin (Texas, Austin)

### May 21-26: **Moment Maps in Various Geometries**

Organizers: E. Lerman (Illinois UC), L. Jeffrey (Toronto), E. Meinrenken (Toronto), Y. Karshon (Toronto), T. Holm (UC Berkeley)

### May 28-June 2: **Critical Scaling for Polymers and Percolation**

Organizers: D. Brydges (UBC), J. Chayes (Microsoft Research), G. Slade (UBC)

### June 4-9: **Mathematical Issues in Molecular Dynamics**

Organizers: P. Tupper (McGill), R. Skeel (Illinois UC)

### June 11-16: **Geometric and Asymptotic Methods in Group Theory**

Organizers: A. Rhemtulla (Alberta), M. Sapir (Vanderbilt), R. Grigorchuk (Texas A&M), A. Olshanskiy (Vanderbilt), D. Wise (McGill)

### June 18-23: **Combinatorial Game Theory Workshop**

Organizers: R. Nowakowski (Dalhousie), E. Berlekamp (UC Berkeley), M. Muller (Alberta), D. Wolf (Gustavus Adolphus)

### July 2-7: **New Directions in PDE**

Organizer: Stephen Gustafson (UBC)

### July 9-14: **Rigidity, Dynamics, and Group Actions**

Organizers: D. Fisher (Lehman, CUNY), R. Spatzier (Michigan), D. Witte Morris (Lethbridge)

### July 16-21: **Mathematical Biology of the Cell: Cytoskeleton and Motility**

Organizers: L. Keshet (UBC), A. Mogilner (UC Davis), P. Janmey (U Penn), E. Cytrynbaum (UBC)

### July 23-28: **Multimedia and Mathematics**

Organizers: Robert Gray (Stanford), Rabab Ward (UBC)

### July 30-Aug. 4: **Renaissance Banff: Mathematics, Music, Art, Culture**

Organizers: R. Moody (Alberta), N. Ghoussoub (UBC), C. Rousseau (Montreal), R. Sarhangi (Towson), J. Morrow (Banff Centre)

### Aug. 20-25: **Mathematical Epidemiology**

Organizers: P. van den Driessche (Victoria), H. Hethcote (Iowa), S. Levin (Princeton)

### Aug. 27-Sept. 1: **Topology**

Organizers: R. Stern (UC Irvine), I. Hambleton (McMaster), M. Hopkins (MIT), M. Kreck (Heidelberg)

### Sept. 3-8: **Workshop on Analytic and Algebraic Methods in Complex and CR Geometry**

Organizers: J. Bland (Toronto), Y.T. Siu (Harvard), J. Kohn (Princeton), L. Lempert (Purdue), J. D'Angelo (Illinois UC)

Sept. 10-15: **Interactions Between Noncommutative Algebra and Algebraic Geometry**

Organizers: C. Ingalls (New Brunswick), M. Artin (MIT), Z. Reichstein (UBC), L. Small (UC, San Diego), J. Zhang (Washington)

Sept. 17-22: **Order, Disorder, and Transport: Recent Advances in Schrödinger Operator Theory**

Organizers: P. Hislop (Kentucky), R. Froese (UBC), V. Jaksic (McGill), A. Klein (UC, Irvine)

Sept. 24-29: **Time-frequency Analysis and Nonstationary Filtering**

Organizers: G. Margrave (Calgary), H. Feichtinger (Vienna), K. Groechenig (Connecticut), M. Lamoureux (Calgary)

Oct. 1-6: **Challenges in Linear and Polynomial Algebra in Symbolic Computation Software**

Organizers: E. Kaltofen (North Carolina State), W. Decker (Saarlandes), K. Geddes (Waterloo), S. Watt (Western Ontario)

Oct. 8-13: **Progress in Algebraic Geometry Inspired by Physics**

Organizers: M. Thaddeus (Columbia), J. Bryan (UBC), R. Vakil (Stanford)

Oct. 16-19: **Growth and Control of Tumours**

Organizers: Jeff Lucas (MITACS), Michael Mackey (McGill), Chris Sander (Sloan Kettering), Siv Sivaloganathan (Waterloo), Kristin Swanson (Washington), Jack Tuszynski (Alberta)

Oct. 19-22: **Therapeutic Efficacy in Population Veterinary Medicine**

Organizers: Jacques Belair

(Montreal), Renée Bergeron (Laval), Jérôme del Castillo (Montreal), Jun Li (Montreal), Jeff Lucas (MITACS), Fahima Nekka (Montreal), Don Schaffner (Rutgers)

Oct. 22-27: **Visco-plastic Fluids: from Theory to Application**

Organizers: I. Frigaard (UBC), N. Balmforth (UC, Santa Cruz)

Oct. 29-Nov. 3: **Probabilistic Combinatorics: Recent Progress and New Frontiers**

Organizers: B. Sudakov (Princeton), N. Alon (Tel Aviv), B. Redd (McGill), V. Vu (UC, San Diego)

Nov. 5-10: **Number Theory Inspired by Cryptography**

Organizers: D. Boyd (UBC), C. Pomerance (Dartmouth), I. Shparlinski (Macquarie), H. Williams (Calgary)

Nov. 12-17: **Homotopy Theory and Group Actions**

Organizers: Alejandro Adem (UBC), William Dwyer (Notre Dame), Richard Kane (Western Ontario), Clarence Wilkerson (Purdue)

Nov. 17-22: **Flavors of Groups**

Organizers: Mladen Bestvina (Utah), Jeffrey Brock (Brown), Jon Carlson (Georgia), Persi Diaconis (Stanford), Hugo Rossi (MSRI)

Nov. 26-Dec. 1: **Canada-Chile Meeting on the Mathematics of Economic Geography and Natural Resource Management**

Organizers: Ivar Ekeland (UBC), Alejandro Jofré (CMM)

Dec. 3-8: **Recent Advances in Symplectic Geometry - Celebrating Dusa McDuff's 60th Birthday**

Organizers: Yakov Eliashberg (Stanford), Helmut Hofer (NYU), John Milnor (SUNY at Stony Brook), Dietmar Salamon (ETH Zurich)

Dec. 10-15: **Regulators II**

Organizers: J. Lewis (Alberta), V. Snaith (Southampton)

**2005 PROGRAMME FOR FOCUSED RESEARCH GROUPS (FRG), RESEARCH IN TEAMS (RIT), SUMMER SCHOOLS (SS) AND 2-DAY WORKSHOPS**

March 12-26: **Analysis, Computations and Experiments on Pinch-Off in Liquid Jets (FRG)**

Organizers: Huaxiong Huang (York), Robert Muir (New Jersey Institute of Technology), Demetrius Papageorgiou (New Jersey Institute of Technology), Michael Siegel (New Jersey Institute of Technology)

March 17-19: **Second Northwest Functional Analysis Symposium (2-Day Workshop)**

Organizers: Doug Farenick (Regina), Marcelo Laca (Victoria), Michael Lamoureux (Calgary), Volker Runde (Alberta)

April 16-30: **The Local Index Theorem in Noncommutative Geometry (FRG)**

Organizers: Nigel Higson (Pennsylvania State), John Phillips (University of Victoria)

April 21-23: **Math Fair Workshops (2-Day Workshop)**

Organizers: Ted Lewis (University of Alberta), Lee Grimard (Alberta)

April 30 - May 14: **Speciality of Malcev Algebras (RIT)**

Organizers: Murray Bremnar (Saskatchewan), Irvin Hentzel (Iowa State)

April 30 - May 14: **Random Matrices, Multi-Orthogonal Polynomials and Riemann-Hilbert Problems (RIT)**

Organizer: John Harnard (Concordia)

May 12-14: **The Dark Side of Extra Dimensions** (2-Day Workshop)

Organizers: Valeri Frolov (Alberta), Lee Grimard (University of Alberta)

May 19-21: **Convex and Abstract Polytopes** (2-Day Workshop)

Organizers: Ted Bisztriczky (Calgary), Egon Schulte (Northeastern University), Asis Weiss (York)

May 21-June 4: **Affinizations of Extended Affine Lie Algebras** (RIT)

Organizers: Bruce Allison (Alberta), Stephan Berman (Saskatchewan), Artus Pianzola (Alberta)

May 28-June 11: **Influenza Dynamics Models and Data** (FRG)

Organizers: Jonathan Dushoff (Princeton), David Eain (McMaster), Joshua Plotkin (Harvard)

June 9-11: **Meeting of Canadian CS Chairs-CACS/AIC** (2-Day Workshop)

Organizers: Ken Barker (Calgary), Gord McCalla (Saskatchewan)

June 11-18: **Hyperplane Arrangements: Cohomology and Rational Homotopy** (FRG)

Organizers: Graham Denham (Western Ontario), Alexandru Suar (Northeastern)

June 25-July 1: **PIMS Summer School: BREAD Summer School in Development Economics** (SS)

Organizers: Siwan Anderson (UBC), Esther Dufes (Massachusetts Institute of Technology), Sendhil Mullainathan (Harvard)

June 28- July 9: **2005 Summer IMO Training Group** (SS)

Organizer: Bill Sands (Calgary)

July 14-16: **Cascade Topology Seminar Melling Spring 2005** (2-Day Workshop)

Organizers: George Peschke (Alberta), Laura Scull (UBC)

July 16-30: **Topological Methods of Aperiodic Tilings** (FRG)

Organizers: Johannes Kellendonk (Universite Claude Bernard Lyon I), Ian Putnam (Victoria), Lorenzo Sadun (Texas)

July 21-23: **Connecting Women in Mathematics Across Canada II** (2-Day Workshop)

Organizers: Gerda de Vries (Alberta), Malgorzata Dubiel (SFU), Rachel Kuske (UBC), Judith McDonald (Washington State)

Aug. 6-13: **Hyperbolic Geometry and Quasiconformal Mappings** (FRG)

Organizers: Petra Bonfert-Taylor (Wesleyan), Martin Bridgeman (Boston College), Richard Canary (Michigan), Garan Martin (University of Auckland), Richard Schwartz (Maryland), Edward Taylor (Wesleyan)

Aug. 6-20: **Computing the Continuous Discretely: Integer Point Enumeration in Polyhedra S2 Convex and Discrete Geometry** (SS)

Organizers: Matthias Beck (San Francisco State University), Sinai Robins (Temple), Hugo Rossi (Mathematical Sciences Research Institute)

Aug. 20-27: **Hamiltonian Systems with Symmetry** (RIT)

Organizer: George Patrick (Saskatchewan)

Aug. 21-Sept. 3: **Cohomogeneity Three Actions on Spheres** (RIT)

Organizers: Jill McGowan (Howard), Catherine Searle (IMATE-UNAM Unidad Cuernavaca)

Aug. 25-Sept. 3: **Symmetries of External Conformal Mappings** (RIT)

Organizers: Oliver Roth (University of Wuerzburg), Eric Schippers (Manitoba)

Sept. 15-17: **West Coast Operator Algebras Seminar 2005** (2-Day Workshop)

Organizers: Anthony To-Ming Lau (Alberta), Volker Runde (Alberta)

Sept. 29-Oct. 1: **Alberta Postsecondary Curriculum Conference II** (2-Day Workshop)

Organizer: Jack Macki (Alberta)

Oct. 1-15: **Arithmetic Applications of Theta Functions** (RIT)

Organizers: Christopher Skinner (Michigan), Vinayak Vatsal (UBC)

Oct. 13-16: **Pacific Rim Mathematical Forum** (2-Day Workshop)

Organizers: Alejandro Adem (UBC), David Eisenbud (UC Berkeley), Ivar Ekeland (UBC)

Nov. 3-5: **The Kneser-Poulsen Conjecture** (2-Day Workshop)

Organizers: Karoly Bezack (Calgary), Robert Connelly (Cornell)

**2006 PROGRAMME FOR 5-DAY WORKSHOPS**

Feb. 11-16: **Frontiers in String Theory**

Organizers: Brian Greene (Columbia), Hiroshi Ooguri (California Institute of Technology), Amanda Peet (Toronto), Gordon Semenoff (UBC)

Feb. 18-23: **Advances in Computational Scattering**

Organizers: David Nicholls (University of Illinois at Chicago), Nilima Nigam (McGill), Fernando Reitich (Minnesota)

**March 4-9: Convex Sets and their Applications**

Organizers: Ted Bioztriczky (Calgary), Paul Goodey (Oklahoma), Peter Gritzmann (Technische Universitat Munchen), Martin Henk (University of Magdeburg), David Laiman (University College London)

**March 11-16: Coarsely Quantized Redundant Representations of Signals**

Organizers: Sinan Gunturk (Courant Institute of Mathematical Sciences), Thao Nguyen (City College, CUNY), Alex Powell (Vanderbilt), Ozgur Yulmaz (UBC)

**March 18-23: Reaction-Diffusion and Free Boundary Problems**

Organizers: Peter Constantin (Chicago), Francois Hamel (Universite Paul Sabatier Toulouse III), Lenya Ryzhik (Chicago),

**March 25-30: Exploring the Frontiers of Dynamic Nuclear Medicine Imaging for Medical and Molecular Applications**

Organizers: Anna Celler (UBC, Vancouver Coastal Health Research Institute), Grant Gullberg (E.O. Lawrence Berkeley National Laboratory), Michael King (University of Massachusetts Medical School), Manfred Trummer (SFU)

**April 1-6: Recent Trends in Higher Dimensional Geometry**

Organizers: Xi Chen (Alberta), Alessio Corti (University of Cambridge), Colin Ingalls (University of New Brunswick), Sandor Kovacs (University of Washington), James McKernan (UC Santa Barbara), Miles Reid (University of Warwick)

**April 8-13: Noncommutative Geometry**

Organizers: Alain Connes (College de France), Joachim Cuntz (University of Muenster),

George Elliot (Toronto), Masoud Khalkhali (University of Western Ontario), Boris Tsygan (Northwestern University)

**April 15-20: Nonlinear Diffusions: Entropies, Asymptotic Behavior and Applications**

Organizers: Eric Carlen (Georgia Institute of Technology), Jose Antonio Carrillo (ICREA), Jean Dolbeault (University of Paris Dauphine), Peter A. Markowich (University of Vienna), Robert J. McCann (University of Toronto)

**April 22-27: Schrodinger Evolution Equations**

Organizers: James Colliander (Toronto), Jared Wunsch (Northwestern University)

**April 29-May 4: Analytic and Geometric Theories of Holomorphic and CR Mappings**

Organizers: Herve Gaussier (University of Provence), Kang-Tae Kim (Pohang Institute of Science and Technology, Korea), Steven G. Krantz (Washington University in St. Louis), Finnur Lauisson (University of Western Ontario), Junjus Noguchi (University of Toyko)

**May 6-11: Forests, Fires and Stochastic Modelling**

Organizers: W. John Braun (University of Western Ontario), Charmaine Dean (SFU), Fangliang He (Alberta), David Martell (Toronto), Haiganous Preisler (USDA Forest Service)

**May 13-18: Analytic Methods for Diophantine Equations**

Organizers: Michael Bennett (UBC), Chantal David (Concordia), William Duke (UC Los Angeles), Andrew Granville (Universite de Montreal), Yuri Tschinkel (Courant Institute NYU and University of Goettingen)

**May 20-25: Optimization Problems in Financial Economics**

Organizers: Jaksa Cvitanic (California Institute of Technology), Ali Laziak (UBC), Nizau Touzi (ENSAE Paris)

**May 27-June 1: Interfacial Dynamics in Complex Fluids**

Organizers: James J. Feng (UBC), Chun Lew (Penn State)

**June 3-8: Modular Forms and String Duality**

Organizers: Charles Doran (Washington), Helena Verrill (Louisiana State), Noriko Yui (Queen's University)

**June 10-15: Evolutionary Game Dynamics**

Organizers: Ross Cressman (Wilfrid Laurier), Karl Sigmund (University of Vienna), Christine Taylor (Harvard)

**June 17-22: First Nations: Mathematics and Science**

Organizers: Melania Alvarez (PIMS), Kelly Kitchen (FNESC)

**June 17-22: Creative Writing in Mathematics and Science Education**

Organizers: Chandler Davis (Toronto), The Writing and Publishing Department (The Banff Centre), Marjorie Senechal (Smith College), Jan Zwicky (Victoria)

**June 24-29: Statistics at the Frontiers of Science**

Organizers: David Brillinger (UC Berkeley), Gemai Chen (Calgary), Jianqung Fan (Princeton University), June Liu (Harvard), Jim Ramsay (McGill), Keith Worsely (McGill)

**July 8-13: Computational and Statistical Geomics**

Organizers: Jennifer Bryan (UBC), Sandrine Dudoit (UC Berkeley), Sunduz Keles (Wisconsin-Madison), Katherine S. Pollard (UC Davis), Mark Van Der Laan (UC Berkeley)

**July 15-20: Statistical Inference Problems in High Energy Physics and Astronomy**

Organizers: James Linnemann (Michigan State), Louis Lyons (Oxford), Nancy Reid (Toronto)

**July 22-27: Moduli Spaces and Combinatorics**

Organizers: Jim Bryan (UBC), Richard Kenyon (UBC), Andrei Okounkov (UC, Berkeley), Rahul Dandharipande (Princeton University)

**July 29-Aug. 3: Spin, Charge, and Topology in Low Dimensions**

Organizers: Valeri Frolov (Alberta), George Sawatzky (UBC), Boris Spivak (Washington), Philip Stamp (UBC), William Unruh (UBC), Shoucheng Zhang (Stanford)

**Aug. 5-10: Measurable Dynamics, Theory and Applications**

Organizers: Chris Bose (Victoria), Parvel Gora (Concordia), Brian Hunt (Maryland), Anthony Quas (Victoria)

**Aug. 12-17: Geometric and Nonlinear Analysis**

Organizers: Matthew Gursky (University of Notre Dame), Emmanuel Debey (Universite de Cergy-Pontoise), Frederic Robert (Universite de Nice-Sophia Antipolis)

**Aug. 19-24: Inverse Problems and Applications**

Organizers: Gary Margrave (Calgary), Gunther Uhlmann (Washington)

**Aug. 26-Aug. 31: Recent Advances in Computational Complexity**

Organizers: Stephen Cook (Toronto), Arvind Gupta (SFU), Russell Impagliazzo (UC San Diego), Valentine Kalanets (SFU), Madhu Sudan (MIT), Avi Wigderson (Princeton)

**Sept. 2-7: Algebraic Groups, Quadratic Forms, and Related Topics**

Organizers: Vladimer Chernousov (Alberta), Richard Elman (UC Los Angeles), Alexander Merkurjev (UC Los Angeles), Jan Minac (Western Ontario), Zinovy Revchstein (UBC)

**Sept. 9-14: Evolution of Microscopic and Macroscopic Fields**

Organizers: Juerg Froehlich (Swiss Institute of Technology Zurich ETH), Israel Michael Signal (Toronto), Avy Soffer (Rutgers), Michael Weinstein (Columbia)

**Sept. 16-21: Topics on von Neumann Algebras**

Organizers: Juliana Erlyiman (Regina), Hans Wenzel (UC San Diego)

**Sept. 23-28: Women in Mathematics**

Organizers: Gerda de Vries (Alberta), Malgorzata Dubiel (SFU), Clara Garza-Hume (UNAM), Barbara Lee Keyfitz (Fields Institute and University of Houston), Rachel Kuske (UBC), Marni Mishna (SFU), Helen Moore (Stanford)

**Sept. 30-Oct. 5: Mathematical Methods in Computer Vision**

Organizers: Dana Cobzas (INRIA Rhone-Alpes), Anders Heyden (Malmo University, Sweden), Martin Jagersand (Alberta), Jim Little (UBC), Peter Strum (INRIA Rhone-Alpes), Bill Triggs (GRAVIR-CNRS-INRIA), Steve Zucker (Yale)

**Oct. 7-12: Positive Polynomials and Optimization**

Organizers: Salma Kuhlmann (Saskatchewan), Sanjay Lure (Stanford), Victoria Powers (Emory), Frank Sottile (Texas A&M)

**Oct. 14-19: Syzygies and Hilbert Functions**

Organizers: Irena Peera (Cornell), Michael Stillman (Cornell)

**Oct. 21-26: Topological Graph Theory and Crossing Numbers**

Organizers: Bojan Mohar (SFU), Janos Pach (Courant Institute and City College), Bruce Richter (Waterloo), Robin Thomas (Georgia Institute of Technology), Carsten Thomassen (Technical University of Denmark)

**Oct. 28-Nov. 2: Hyperbolic Systems of Conservation Laws and Related Problems**

Organizers: Gui-Qiang Chen (Northwestern), Walter Craig (McMaster), Constantine Dafermos (Brown), Konstantina Trivisa (Maryland)

**Nov. 4-9: Random Media**

Organizers: Martin Burlow (UBC), Erivin Bolthausen (Univerisitat Zurich), Alain-Sol Sznitman (ETH-Zurich)

**Nov. 11-16: Optimization and Engineering Applications**

Organizers: Jiming Peng (McMaster), Tamas Terlaky (McMaster), Robert Vanderbei (Princeton), Henry Wolkowioz (Waterloo), Yunyu Ye (Stanford)

**Nov. 18-23: Polynomials over Finite Fields and Applications**

Organizers: Ian Blake (Toronto), Stephen Cohen (Glasgow), Gary Mullen (Pennsylvania State), Daniel Panario (Carleton)

**Nov. 25-29: Modelling and Mining of Networked Information Spaces – MITACS**

Organizers: William Aiello (UBC), Andrei Broder (Yahoo Inc), Jeannette Janssen (Dalhousie), Evangelos Milios (Dalhousie)

**Dec. 2-7: Operator Methods in Fractal Analysis, Wavelets and Dynamical Systems**

Organizers: Ola Bratteli

(University of Oslo), Palle Jorgensen (University of Iowa), David Kribs (University of Guelph), Gestur Olafsson (Louisiana State University), Sergei Silvestrov (Lund University)

Dec. 9-14: **Numerical Methods for Degenerate Elliptic Equations and Applications**  
Organizers: Doron Levy (Stanford University), Ian Mitchell (University of British Columbia), Adam Oberman (Simon Fraser University), Panagiotis Souganidis (University of Texas, Austin)

**2006 PROGRAMME FOR FOCUSED RESEARCH GROUPS (FRG), RESEARCH IN TEAMS (RIT), SUMMER SCHOOLS (SS) AND 2-DAY WORKSHOPS**

Feb. 11-25: **Saari's Conjectures** (RIT)  
Organizers: Florin Diacu (Victoria), Ernesto Perez (UAM-I, Mexico), Manuela Santoprete (UC Irvine)

March 4-18: **Partial Unconditionality in Banach Spaces** (RIT)  
Organizer: Thomas Schlumprecht (Texas A&M)

March 18-25: **Multi-Parameter Nehari Theorems** (RIT)  
Organizers: Michael Lacey (Georgia Institute of Technology), Stefanie Petermiche (University of Texas at Austin), Brett Wick (Vanderbilt)

April 8-22: **Homology Stability of Moduli of Vector Bundles Over a Curve** (RIT)  
Organizers: Donu Avapura (Purdue University), Ajneet Dhillon (Western Ontario), Pramathanath Sasty (Toronto)

April 20-22: **Math Fair Workshop** (2-Day workshop)  
Organizers: Tiina Hohn (Grant MacEwan College), Ted Lewis (Alberta)

April 22-May 6: **Random Sorting Processes** (FRG)  
Organizers: Omer Angel (UBC), Alexander Holroyd (UBC), Dan Romik (UC Berkeley), Balint Virag (Toronto)

May 6-20: **Infinite Dimensional Lie Algebras and Local Von Neumann Algebras in CFT** (FRG)  
Organizers: Victor Kac (MIT), Roberto Longo (University of Rome Tor Veigata)

May 20-27: **Curvature and Instability of Flows of Ideal Incompressible Fluid** (RIT)  
Organizer: Alexander Shnirelman (Concordia)

May 27-June 3: **Mathematical and Computational Approaches to Linguistic Phylogeny** (FRG)  
Organizer: Steve Evans (UC Berkeley)

June 10-17: **Complex Arrangements: Algebra, Geometry, Topology** (FRG)  
Organizers: Hal Schenk (Texas A&M), Sergery Yuzvinsky (Oregon)

June 24-July 1: **A Dynamical Approach to Rigidity of Automorphism** (RIT)  
Organizers: Alex Fruman (University of Illinois, Chicago), Barak Weiss (Ben Gurion University)

July 1-6: **PIMS/UNAM Algebra Summer School** (SS)  
Organizers: Alejandro Adem (UBC), James Carrell (UBC), Jose Antonio de la Pena (UNAM)

July 8-22: **Inflation from String Theory** (RIT)  
Organizer: James Cline (McGill)

July 22-29: **Off-Shell Supersymmetry via Graph Theory and Superspace** (FRG)  
Organizers: Charles Doran (Washington), Gregory Landweber (Oregon)

July 29-Aug. 5: **Threshold Dynamics, with Applications to Image Processing and Computer Vision** (RIT)  
Organizer: Steven Ruuth (SFU)

Aug. 5-12: **The Path Partition Conjecture for Orientated Graphs** (RIT)  
Organizers: Jean Dunbar (Converse College), Marietjie Frick (University of South Africa), Ortrud Oellermann (Winnipeg), Susan van Aardt (University of South Africa)

Aug. 12-19: **Statistical Models for the Study of Science Teacher OTL in Canada** (FRG)  
Organizers: Richard Houang (Michigan State), Hsing Chi A. Wang (Calgary), Richard Wolfe (OISE, Toronto)

Aug. 19-26: **The Topology of Hyperkahler Quotients** (RIT)  
Organizers: Megumi Haiada (Toronto), Greg Landweber (Oregon), Graeme Wilkin (Brown)

Aug. 19-26: **Exact Primal-Dual Regularization of Linear Programs** (RIT)  
Organizers: Michael Friedlander (UBC), Dominique Oilan (Ecole Polytechnique Montreal)

Aug. 26-Sept. 4: **Generalized Harish-Chandra Modules of  $gl(\infty)$**  (RIT)  
Organizers: Ivan Dimitrov (Queen's), Ivan Penkov (UC Riverside), Gregg Zuckerman (Yale)

Sept. 5-9: **Inverse Protein Folding** (FRG)  
Organizers: Ken Dill (UC San Francisco), Arvind Gupta (SFU), Ladislav Stacho (SFU)

Sept. 9-16: **Second Duals of Measure Algebras** (RIT)  
Organizers: Anthony To-Ming Lau (Alberta)

Sept. 14-16: **CanQueue 2006: 8<sup>th</sup> Annual Conference for**

**Canadian Queueing Theorists  
and Practitioners** (2-Day  
workshop)

Organizers: Diane Biochak  
(Calgary), Armann Ingolfsson  
(Alberta), Van Enns (Calgary)

Sept. 16-23: **Quantum  
Algorithms for Algebraic  
Problems** (FRG)

Organizers: Ashwin Nayak  
(Waterloo), Leonard Schulmann  
(Caltech), John Watrous (Calgary)

Oct. 7-21: **Classification of  
Smooth 4-Manifolds** (RIT)

Organizers: Ronald Fintushee  
(Michigan State), Ronald Stein  
(UC Irvine)

Nov. 29-Dec. 2: **Models and  
Algorithms for the Web Graph  
(MITACS)** (FRG)

Organizers: William Aiello  
(UBC), Andrei Broder  
(Yahoo Inc.), Jeanette Janssen  
(Dalhousie), Evangelos Miliotis  
(Dalhousie)



# Publications

# Publications

## PI IN THE SKY

*Pi in the Sky* is primarily aimed at high-school students and teachers, with the main goal of providing a cultural context/landscape for mathematics. It has a natural extension to junior high school students and undergraduates, and articles may also put curriculum topics in a different perspective.

*Pi in the Sky* accepts materials on any subject related to mathematics or its applications. Submissions are subject to editorial review and revision. *Pi in the Sky* is mailed to schools in Alberta, B.C., and Washington State. Individuals may request a copy of *Pi in the Sky* magazine by sending their mailing address to [pi@pims.math.ca](mailto:pi@pims.math.ca).

Significant funding for *Pi in the Sky* is provided by Alberta Innovation and Science.

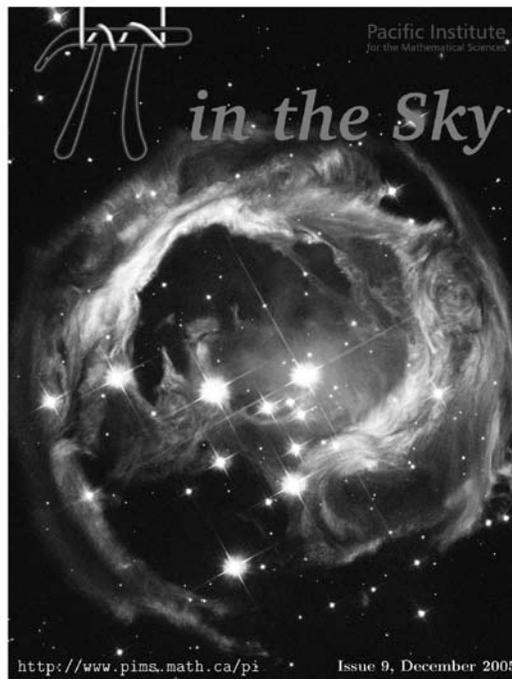


### The editorial board is:

- **Editor in Chief:** Ivar Ekeland (UBC)
- **Managing Editor:** David Leeming (UVic)
- **Editorial Board:** Len Berggren (SFU), John Bowman (UA), John Campbell (Archbishop MacDonald Academic High School, Edmonton), Florin Diacu (UVic), Sharon Friesen (Galileo Educational Network, Calgary), Dragos Hrimiuc (UA), Klaus Hoechsmann (UBC), Wieslaw Krawcewicz (UA), Michael Lamoureux (UC), Mark MacLean (UBC), Alexander Melnikov (UA), Volker Runde (UA), and Wendy Swonnell (Lambrick Park Secondary School, Victoria).
- **Editorial Coordinator:** Heather Jenkins (PIMS).

*Pi in the Sky* can be downloaded for free.

[www.pims.math.ca/pi](http://www.pims.math.ca/pi)



### COVER IMAGE

**The Silent Echo.** One in a series of Hubble images of “light echo” images of the star V838 Monocerotis and its environs. In 2002, the red supergiant star at the middle of the image gave off a flashbulb-like pulse of light. As the halo of light expands, different parts of the surrounding dust are gradually illuminated unveiling never-before-seen patterns. Nature’s own piece of performance art, this structure will continue to change its appearance for many years to come. The image is associated with the article *The Art of Physics: Visualizing the Universe, Seeing the Unseen*, by Anna Czolpinski and Arif Babul. Photo kindly provided by NASA, the Hubble Heritage Team (AURA/STScI) and ESA

## PIMS MAGAZINE 9.1

**Alberta, US, and Mexican Governments to Give Full Funding for the Banff International Research Station**

Three months after a thorough international review of the Banff International Research Station (BIRS), the Alberta government—on the recommendation of the Alberta Science Research Agency (ASRA)—has pledged \$CAD 1,424,000 to support the scientific activities of BIRS for a period of five years starting in 2009 (see page 4 for the official award letter from Minister Victor Doucet). This decision came at the behest of a recommendation by the Division of the Mathematical Sciences (DMS) of the National Science Foundation for the full funding (\$US 2,541,500) of BIRS for the next 7 years, coupled with a pledge of \$CAD 550,000 from Mexico’s CONACYT for this groundbreaking North American collaboration. In addition, the Universidad Nacional Autónoma de México (UNAM) has committed substantial funds to support Mexican participants in BIRS activities.

NSERC’s decision however, has been reportedly delayed until April 2006. In view of the delay, the NSERC’s executive has extended the old BIRS grant by one year. This delay is due to a serious restructuring that is currently under consideration within NSERC’s Research Grant Programme. The current Major Facilities Access (MFA) envelope is in the process of being redesigned to reflect major international collaborative initiatives such as BIRS. As of the day of writing this, we are still awaiting the new criteria/policies affecting such a programme and consequently the funding decisions for BIRS.

**New Chair of the PIMS Board of Directors**

In June 2005, Brian Russell (New Zealand, Victoria, BC, Canada) became the new chair of the PIMS Board of Directors.

To read an interview with Brian see page 10.

**University of Regina, Now a PIMS Affiliate**

We are pleased to announce that the University of Regina is joining PIMS as an affiliated institution. The contact person for PIMS at the University of Regina is Susan Falter. He is an Associate Professor in the Department of Mathematics and Statistics.

**Rustum Chokshi, New SFU Site Director**

Rustum Chokshi became the new PIMS Site Director at Simon Fraser University on September 1, 2005.

Rustum Chokshi is an Associate Professor of Applied and Computational Mathematics in the Department of Mathematics at SFU. Dr. Chokshi received his PhD from Brown University in 1994. He held postdoctoral positions at the Courant Institute, 1995-97, and the Center for Nonlinear Analysis at Carnegie-Mellon University, 1994-95.

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**PIMS Collaborative Research Groups: New and Ongoing**

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Continued on page 7.



# Financial Reports

# Financial Reports

**The information in this appendix outlines the income and expenses of PIMS for the fiscal year April 1, 2005, to March 31, 2006. 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 Regina).
- 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).

## Income for 2005–06

**The total income received by PIMS in the 2005–06 fiscal year is listed in Table 1. Each member university makes an annual cash contribution. 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.**

**Simon Fraser University made a cash contribution of \$75,000 to the PIMS operating budget.**

**The University of Alberta** made a cash contribution of \$70,000 to the PIMS operating budget.

**The University of Washington** made a cash contribution of \$12,150 to the PIMS operating budget.

**The University of British Columbia** made a cash contribution of \$190,915 to the PIMS operating budget.

**The University of Lethbridge**, an affiliated institution of PIMS, made a cash contribution of \$5,000.

**The University of Calgary** made a cash contribution of \$61,000 to the PIMS operating budget.

**The University of Regina**, an affiliated institution of PIMS, made a cash contribution of \$5,625.

**The University of Victoria** made a cash contribution of \$60,000 to the PIMS operating budget.

## PIMS Total Income

### April 1, 2005, to March 31, 2006

<i>Table 1</i>			
<b>Source</b>	<b>Estimated Carryforward</b>	<b>Income 2005-06</b>	<b>Operating Funds 2005-06</b>
NSERC	\$796,013	\$1,023,100	\$1,819,113
BC Government (CSE, formerly ISTA)	\$193,739	\$127,805	\$321,544
Alberta Government (Grant at UA)	\$0	\$100,000	\$100,000
Alberta Government (Grant at UC)	\$118,500	\$100,000	\$218,500
PIMS Partner Universities*	\$266,419	-	\$266,419
Simon Fraser University	-	\$75,000	\$75,000
University of Alberta	-	\$70,000	\$70,000
University of British Columbia	-	\$190,915	\$190,915
University of Calgary	-	\$61,000	\$61,000
University of Victoria	-	\$60,000	\$60,000
University of Washington	-	\$12,150	\$12,150
University of Lethbridge	-	\$5,000	\$5,000
University of Regina	-	\$5,625	\$5,625
MITACS NCE	\$34,051	\$82,500	\$116,551
BC-NCE Infrastructure	\$89,951	\$51,934	\$141,885
Other Funding**	\$83,241	\$34,692	\$117,933
<b>TOTAL</b>	<b>\$1,581,914</b>	<b>\$1,999,721</b>	<b>\$3,581,635</b>

\* Income for 2005-06 for PIMS Partner Universities is broken down between universities, while the Estimated Carryforward is the total amount from all PIMS Partner Universities.

\*\* Includes donations.

## Other Contributions

### April 1, 2005, to March 31, 2006

Tables 2.1 and 2.2 outline 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.

**BC-NCE Infrastructure Support:** Only the BC-NCE infrastructure award held at the PIMS central office at UBC is listed in Tables 1 and 2.2. These funds are made available through the UBC Vice-President Research Office to support federal NCE activities.

**Additional Support for Scientific Postdoctoral Fellows:** The PIMS contributions to scientific postdoctoral fellowships (\$20,000 each) have been at least matched (minimum \$20,000 contribution) by individual research grants and by teaching stipends from the postdoctoral fellow's department. These funds are usually paid as salary directly to the postdoctoral fellow and are not reported here.

**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 co-sponsorship with other organizations.

**Corporate Support:** Industrial partners or corporations may contribute to scientific, industrial and educational activities.

**Industrial Support:** Many industrial outreach events, in particular, the Graduate Industrial Math Modelling Camp and Industrial Problem Solving Workshop (among others) are partially supported by direct and indirect contributions from the industrial participants.

**Education Support:** Most education activities of PIMS are co-sponsored by schools, university departments, provincial ministries of education, professional societies and private donations.

## PIMS Summary of Expenditures

### April 1, 2005, to March 31, 2006

<i>Table 2.1</i>			
<b>Expense Category</b>	<b>Budgeted</b>	<b>Actual</b>	<b>Variance</b>
Site Offices	\$191,500	\$226,607	(\$35,107)
Scientific Personnel	\$100,000	\$61,785	\$38,215
Central Office	\$411,500	\$422,000	(\$10,500)
Special Events	\$51,000	\$9,896	\$41,104
Industrial Outreach*	\$154,000	\$177,517	(\$23,517)
Education Programmes	\$116,635	\$70,508	\$46,127
Scientific Activities	\$821,260	\$649,641	\$171,619
PIMS Postdoctoral Fellows**	\$380,000	\$393,152	(\$13,152)
<b>TOTAL Expenses</b>	<b>\$2,225,895</b>	<b>\$2,011,106</b>	<b>\$214,789</b>

\* Figures include neither industrial funds nor MITACS projects

\*\* Figures do not include matching funds

<i>Table 2.2</i>			
<b>Expense by Funding Source</b>			
<b>Source</b>	<b>Budgeted</b>	<b>Actual</b>	<b>Variance</b>
NSERC	\$1,149,550	\$948,486	\$201,064
BC Government (CSE, formerly ISTA)	\$85,500	\$73,739	\$11,761
Alberta Government (ASRA)	\$193,333	\$96,246	\$97,087
PIMS Partner Universities	\$626,667	\$683,861	(\$57,194)
MITACS NCE	\$82,500	\$97,742	(\$15,242)
BC-NCE Infrastructure	\$12,000	\$68,576	(\$56,576)
Other Funding	\$76,345	\$42,456	\$33,889
<b>TOTAL Expenses</b>	<b>\$2,225,895</b>	<b>\$2,011,106</b>	<b>\$214,789</b>





