Pacific Institute for the Mathematical Sciences

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Institute Report

1999/2000

The Pacific Institute for the Mathematical Sciences

Our Mission

The Pacific Institute for the Mathematical Sciences (PIMS) was created in 1996 by the community of mathematical scientists in Alberta and British Columbia. The Institute is dedicated to:

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

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

- The communication and Dissemination of mathematical ideas; Public Outreach, Mathematical Education and Training at all school levels;
- The creation of strong mathematical partnerships and links within Canada and organizations in other countries, with a focus on the nations of the Pacific Rim.

Our Community

PIMS is a partnership between the following organizations and people:

- The five founding universities (Simon Fraser U., U. of Alberta, U. of British Columbia, U. of Calgary, U. of Victoria) and affiliated Institutions (U. of Lethbridge and U. of Northern British Columbia).
- The Government of British Columbia through the Science and Information Technology Agency, The Government of Alberta through the Alberta Ministry of Innovation and Science, and The Government of Canada through the Natural Sciences and Engineering Research Council of Canada.
- Over 300 scientists in its member universities who are actively working towards the Institute's mandate. Their disciplines include pure and applied mathematics, statistics, computer science, physical, chemical and life sciences, medical science, finance, management, and several engineering fields.
- Scientists and practitioners using mathematical ideas in dozens of companies across Canada as well as government researchers in Alberta and British Columbia.
- A large and rapidly growing group of high school and elementary school teachers and educators in Alberta and British Columbia.

From the Chair of the Board

Hugh Morris, FRSC

I am often asked what led to my decision when I was approached in 1998 to chair the board of the Pacific Institute for the Mathematical Sciences (PIMS). The truth is that it was the infectious enthusiasm of the mathematical scientists who invited me, coupled with my curiosity about this fascinating and mysterious subject that permeates essentially every aspect of human endeavour. There was also a conviction that the mathematical sciences should play a key role in supporting the Canadian industrial sector in this new era of knowledge-based economy.

Now, after two years of interaction with a dynamic mathematical science community in Western Canada, I can state simply that my association with the PIMS organization (and subsequently with the MITACS Network of Centers of Excellence) has been exhilarating. It is fascinating to see the energy, the vitality and the pace that the Canadian mathematical scientists are putting into their task.

This annual report represents a compendium of the various activities and programmes organized and supported by PIMS during its first year of fully-funded operations. PIMS not only strives to be a world-class research institute in the mathematical sciences, but also to be leader in the application of mathematics to industry and in mathematics education.

The mathematical sciences play an ever increasing role in the modern information-based economy. The gap between the development of new ideas in mathematical research and their application in Canadian industry must be closed if our industry is to realize the full benefit of the Canadian research community. Through its Industrial Problem Solving Programme and its Industrial Math Training Programme, PIMS has played a leadership role in bringing mathematical scientists in academia together with their counterparts in the private sector.

Hugh Morris speaking with PIMS Scientific Executive Officer, Sandy Rutherford.

This year has also seen a large growth in PIMS involvement in mathematics education. Through such initiatives as the *Mathematics is Everywhere* poster campaign and the *Pi in the Sky* magazine, PIMS is helping educate the youth of British Columbia and Alberta on the importance of mathematics in the future of their society.

My warmest congratulations to all mathematical scientists of BC and Alberta for their wonderful accomplishments.

Director's Notes

Nassif Ghoussoub, FRSC

It was hard to believe, as we were preparing this document, that we were merely reporting on the first year of full operations of the Pacific Institute for the mathematical sciences, after just a two-years interim period. The institute's first and most visible successes —the new cohesion among the mathematical scientists at the five founding universities and the dramatic increase in organized activities in western Canada in the last two years—are simply remarkable.

Through the dedication of the mathematical scientists in Alberta and BC, PIMS has managed an extraordinary level of activity and innovation and has captured the attention of the scientific world with its leadership positions within Canada and abroad. Through the excellence and the innovativeness of its programmes, PIMS has attracted the best scientific minds (3 Nobel laureates to date and many Fields medalists) to our universities. Through the accessability of its programmes and its opportunities, PIMS has sharply increased its user community and greatly solidified its base support. Through its leadership role in the MITACS network, the National Program Committee, the Canada-China cooperative effort, the future of scientific communication and other initiatives, PIMS has rapidly gained in national and international stature.

Here are some of the highlights of a very busy "first" year:

Director at PIMS Elementary School Math Contest

The inauguration of two Research Facilities: These include computer labs, office space for PIMS' postdoctoral fellows, visitors and participants in the thematic programmes as well as interdisciplinary space where industrial partners, math educators get together with PIMS' mathematical scientists to discuss, initiate and develop whatever it takes to achieve their common goals. For now, PIMS can count on UBC's PIMS facility which was inaugurated on June 15th, 1999 while the SFU facility has been ready just on time to host the 3rd Graduate modeling Camp in May, 2000.

The leadership of PIMS in the development of scientific links with Pacific rim countries. The main international initiative of this year was the *First Canada-China Congress* which was an unqualified success as it was the starting point for

the establishment of scientific collaboration and which provided clear directions for specific future collaborative projects. The Canadian delegation consisted of sixty of the best mathematical scientists in Canada and was led by NSERC's President Tom Brzustowski.

The PIMS Distinguished Chair Programme which supports one visiting distinguished mathematical scientist at each one of PIMS' sites. The inaugural chair was held by Prof. Yuri Matiyasevich (Steklov Institute) during a six week visit to the University of Calgary. **Prof. Matiyasevich** is a distinguished mathematician who is known for his outstanding research in logic, number theory and the theory of computer algorithms. One of his most famous results is the definitive solution to the tenth problem posed by David Hilbert at the 1900 International Congress of Mathematics, concerning the solution of certain polynomial equations.

The PIMS Collaborative Industrial Programme which supports academic/industrial collaborative activities in the Mathematical Sciences. The PIMS contribution is directed towards the support of highly qualified personnel (Graduate students, pdfs, research assistants) in the mathematical sciences working directly on the activity. This programme is particularly useful for research groups who are currently initiating industrial contacts and have future plans for a larger collaborative effort such as those within the MITACS Network of Centers of Excellence.

A poster campaign under the theme *Mathematics is everywhere* features the ever growing importance of Mathematics in modern society: From the art of Tying Knots and Risk Management to Genome Sequencing and Quantum Computing! These posters are appearing in public transport systems and schools (initially in Vancouver, Victoria and Calgary). They will also soon appear on calendars and in selected science exhibitions. This campaign joined the mathematics posters campaign in the Montréal Metro from January 4 to January 31, 2000 which was sponsored by the Centre de Recherches Mathématiques.

A semi-annual magazine entitled *Pi in the Sky* designed to be a forum for dialogue between academic mathematical scientists, educators, students and the public at large. PIMS will be distributing this magazine across Canadian high schools.

Both of these initiatives are part of PIMS' contribution to the World Mathematical Year 2000 sponsored by UNESCO and the IMU and are two of the many activities in PIMS' continuing Mathematics Awareness Campaign.

Two new MITACS projects —in addition to the current nine— led by PIMS mathematical scientists in Edmonton and Calgary and involving more than twenty of our colleagues. One project uses mathematical methods for drug delivery problems in pharmacology while the other develops mathematical models relevant to oil exploration.

The PIMS prizes for mathematical research, education and industrial outreach. Until suitable names are be found, the names of the prizes will be: the PIMS Education Prize, The PIMS Research Prize, and the PIMS Industrial Outreach Prize.

To make the institute's opportunities known and available to its evergrowing community, *A General Guide for PIMS Programs* has been prepared and distributed. This comprehensive guide describes in details all of our programs, their objectives, their guidelines and also the decision-making process for each one of them.

Finally, my warmest congratulations and gratitude go to all PIMS mathematical scientists, partners and supporters who made all this possible. Many thanks to Michael Lamoureux and Sandy Rutherford for their tremendous help in making this report comprehensive, useful and pleasant to contemplate.

Contents

I. THEMATIC PROGRAMMES:

1999–2001

Nobel Laureate, Sir Andrew Huxley with M. Barlow and some of the organizers of the **PIMS Thematic Programme in Math. Biology**: L. Keshet, D. Ludwig and R. Miura.

Theme 1999:
Mathematical Biology

Mathematics has been used in many branches of biology for centuries. However, as a separate discipline, mathematical biology has been recognized only over the past few decades. Mathematical biology is as diverse as are the areas making up biological and medical sciences. These areas encompass all aspects of life including populations at all levels from animal to microbial, epidemics, ecology, physiology including neurobiology, cardiology, endocrinology, renal physiology, muscle physiology, and biofluiddynamics such as blood flow and air movements in the lungs, cell biology, biochemistry, molecular biology, morphogenesis, diseases including cancer, HIV/AIDS, Parkinson's, and Alzheimer's, and genomics.

The models and the mathematical techniques used to solve and study the models have been diverse, from simple discrete models using simple automata algorithms and to highly complex models consisting of coupled systems of nonlinear partial differential equations for which no mathematical theories exist. As a consequence of the latter, numerical computations have been an important tool and will continue to become increasingly important as the complexity of the models increases to account for more and more details.

Programme Organisers:

Fred Brauer (U. Wisconsin and UBC)

Leah Keshet (UBC)

Yue-Xian Li (UBC)

Robert M. Miura (UBC)

Pauline van den Driessche (U. Victoria)

Marc Mangel (UC, Santa Cruz)

David Sankoff (U. Montréal)

Gerda de Vries (U. Alberta)

Michael Waterman (U. Southern California)

Workshops:

Mathematical Genomics,
PIMS-UBC, May 31–June 11, 1999

Mathematical Physiology,
PIMS-UBC, June 14–25, 1999

Mathematical Epidemiology,
PIMS-UBC, July 19–30, 1999

Mathematical Ecology,
PIMS-UBC, August 2–13, 1999

Mathematical Cellular Biology,
PIMS-UBC, August 16–27, 1999

Each of the five workshops in this Special Summer programme ran for approximately two weeks. At the beginning of each two week period, there were tutorials of one to two days which were designed to help the participants learn more about the topics presented in the remainder of the workshop.

Formal talks by invited speakers were interspersed with informal seminars and discussions among the participants. Spreading the formal talks over a two week period permitted participants to more fully absorb the material being presented and to have ample time to clarify this information.

Workshop on Genomics, May 31 – June 11, 1999

Organisers: David Sankoff (Centre de Recherches Mathématiques), Michael Waterman (University of Southern California)

Genomics is concerned with the characterization and analysis of genetic material from a wide range of organisms, including man. Within the next ten years, the complete genome sequences of human and many other organisms will be determined.

One of the most interesting areas in mathematical biology is modeling evolutionary processes. Bringing theory into the mass of sequence data is one of the most challenging problems we have. The details of modeling triplet repeats (that cause many human diseases) are not yet entirely worked out. Using homologous sequences to infer evolutionary relationships continues to be of great interest, and new simulation techniques are being employed in this area. Sankoff and others have brought into prominence the distance between genomes problems. The most elegant of these is to compute the reversal distance between two gene orders.

Finding patterns in sequences is a major activity. The database search methods in BLAST and its variants use sophisticated computer science and statistics. Estimating the statistical significance of matches between words (molecular sequences) requires some sophisticated tools. Hidden Markov Models (HMMs) are used to estimate more sophisticated statistical patterns. The area of determining DNA coding for proteins is called "gene finding" and has become very active. The importance in the era of genome sequencing cannot be overestimated.

Finally, DNA structure, particularly that of closed circular duplex DNA, is central to understanding the general chemistry and biology of DNA. Of relevance are topological, geometric and elastic properties. Twist, writhe, and linking numbers have been studied. X-ray crystallography and NMR are powerful methods that have given important information about protein structure, but are not well suited to studying the dynamic processes of the cell. Applications of non-obvious topological and geometrical methods have already yielded some valuable insights.

Principal Speakers:

David Baillie (Department of Biochemistry and Biosciences, SFU): *Some Surprises from Genome Sequencing*

Nadia El-Mabrouk (Departement d'Informatique, U. Montréal): *Genome Reconstruction*

Joseph Felsenstein (Department of Genetics, U. Washington): *Phylogenies and Likelihoods* and *Coalescents and Likelihoods*

Terry Gaasterland (Laboratory of Computational Genomics, Rockefeller U.): *Biological Databases* and *Comparative Genomics*

Philip Green (Department of Molecular Biotechnology, U. Washington): *Sequence Assembly* and *Sequence Searches*

Thomas Hagedorn (Department of Mathematics & Statistics, College of New Jersey): *An Introduction to Phylogenetic Invariants*

Steven Henikoff (Fred Hutchinson Cancer Research Center, U. Washington): *Protein Family Databases*

Philip Hieter (Department of Molecular Medicine & Therapeutics, UBC): *Genome Analysis and Human Biology*

Susan Holmes (Department of Statistics, Stanford U.): *Introduction to the Bootstrap* and *Bootstrap and Evolutionary Trees*

Lee Hood (Department of Molecular Biotechnology, U. Washington): *Biology and Computation*

Richard Karp (Department of Computer Science & Engineering, U. Washington): *Physical Mapping* and *Expression Arrays*

John Kececioglu (Department of Computer Science, U. Georgia): *Physical Mapping* and *Multiple Alignment*

Gene Myers (Algorithm Development, Celara Genomics Corporation): *Assembling Sequences* and *Advanced Search Techniques*

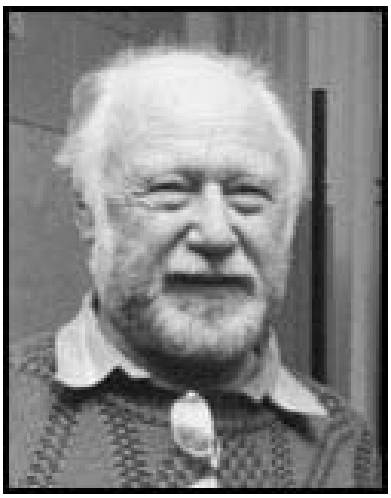
Kermit Ritland (Department of Forest Sciences, UBC): *Plant Breeding and Evolution*

David Sankoff (Centre de Recherches Mathématiques, U. Montréal): *Comparative Mapping*

Gary Stormo (Department of Molecular and Cellular Biology, U. Colorado, Boulder): *Gene Regulation I & II*

Elisabeth Tillier (Department of Molecular & Medical Genetics, U. Toronto): *RNA Structure and Evolution*

Michael Waterman (Department of Biological Sciences, U. Southern California): *Introduction to the Programme*



Prof. Michael Smith, winner of the 1993 Nobel Prize in Chemistry, was a participant in the Workshop on Mathematical Genomics.

Workshop on Mathematical Physiology, June 14–25, 1999

Organisers: Robert Miura (UBC), Yue-Xian Li (UBC), Gerda de Vries (U. Alberta)
This session was divided into three main topics, neurophysiology, cardiology, and endocrinology.

Neurophysiology is the physiology of the nervous system and is the most quantified branch of the biological and medical sciences. It involves some of the most accurate experimental techniques, such as the patch clamp. Neurons and glial cells, including their processes, make up the central and peripheral nervous systems. Neurons are known for their highly complex electrical properties that give rise to a rich variety of dynamical phenomena that have challenged mathematicians for decades. It is also the area where collaborative efforts between experimentalists, mathematicians, and other theorists have had the greatest impact, as evidenced by the pioneering works of Hodgkin and Huxley on the mathematical description of the electrical excitation of the squid giant nerve and of Wilfrid Rall on the electrical properties of dendrites. This session will gather some of the outstanding leaders in this extremely dynamic research field and present a picture of the past, the present, and future of this research field and, most importantly, lay out some of the challenging problems facing us now and in the near future.

Cardiology is the study of the heart and its functions and has become a very active area of research in the medical sciences. A great deal of the electrophysiology and muscle mechanics of the heart is known, and a variety of models have been proposed to increase our understanding of cardiac dynamics. Mathematical modeling, mathematical analysis, and computational methods have helped to reveal the inner workings of the heart, both electrically and mechanically. In this session, we bring together some of the leaders in modeling these phenomena from different points of view.

Endocrinology is the study of gland cells, the secretion of hormones by these cells, and the physiological action of hormones. It is a rapidly expanding field with changing concepts and relatively new to mathematical modellers. Therefore, there is a real need for more collaborative research between experimentalists, modellers, and mathematicians. Hormones are highly potent chemicals that act at low doses and control almost all aspects of our lives including growth, development, metabolism, reproduction, stress response, etc. This session brought some of the leading researchers in this area together to

give an overview of some of their recent research activities.

Principal Speakers:

Richard Bertram (Pennsylvania State U.): *Physiology and Methods of Modelling in the Synapse I & II*

Bard Ermentrout (Department of Mathematics, U. Pittsburgh): *From Bower's House to Our House: How to Reduce Complex Neural Models to Simpler Dynamical Systems I & II* and *Synaptic Bistability, Waves, and Bumps in Networks of Excitatory and Inhibitory Cells*

Diane Finegood (School of Kinesiology, SFU): *Investigating Beta-Cell Dynamics with a Mass Balance Equation*

Leon Glass (Department of Physiology, McGill): *Resetting and Entraining Biological Oscillators*, *Dynamics of Cardiac Arrhythmias* and *Controlling Cardiac Arrhythmias*

Jim Keener (Department of Mathematics, U. Utah): *Mathematical Modelling of Cardiac Electrical Activity* and *Mechanisms of Defibrillation*

Yue-Xian Li (Department of Mathematics and Zoology, UBC): *Introduction to Intracellular* Ca^{2+} *Oscillations and Waves*, *Interaction Between Intracellular* Ca^{2+} *Handling and Plasma Membrane Electrical Activity* and *Tango Waves*

John Milton (U. Chicago): *Delay Equations (Delayed Feedback)* and *Multistability in the Nervous System*

Mark Pernarowski (Department of Mathematical Sciences, Montana State U.): *Partial Differential Equation Models of Coupled Bursters* and *Control and Parameter Identification in Excitable Cell Models*

John Rinzel (Courant Institute of Mathematical Sciences, NYU): *Nonlinear Dynamics of Neurons and Networks* and *Rhythms and Waves in the 'Sleeping' Thalamic Slice*

Arthur Sherman (NIDDK/MRB, U. Wisconsin): *Roles of Endoplasmic Reticulum in Excitable Cells* and *The Phantom Model for Beta-Cell Bursting*

Dan Tranchina (Courant Institute of Mathematical Sciences, NYU): *Mathematical Aspects of Vision I & II* and *Population Density Methods for Large-Scale Neural Network Modelling: Applications to Visual Cortex*

Gerda de Vries (Dept. of Mathematical Sciences, U. Alberta): *Introduction to Models of Bursting Electrical Activity in Pancreatic Beta Cells*, *Classification of Bursters* and *Coupling of Beta-Cells: Effects of Noise and Heterogeneity*

Workshop on Mathematical Epidemiology, July 19–30, 1999

Organisers: Pauline van den Driessche (UVic), Fred Brauer (U. Wisconsin and BC)

Mathematical epidemiology is concerned with modeling the spread of infectious disease within a population. The aim is generally to understand the time course of the disease with the goal of controlling its spread. Such models are used, for example, to guide policy in vaccination strategies for childhood diseases. During the last twenty years, models with variable population size have been formulated and analyzed. Such models combine demographic and epidemic effects. Striving for more realism, more complex models have been developed that include such detail as time delays, spatial heterogeneity, age structure, two sexes, multigroups, vectors, and stochastic variation. The dynamical systems that result are highly nonlinear and complex.

This session was designed to bring together established and younger mathematicians and statisticians, biologists, and epidemiologists to take up the current challenges of mathematical epidemiology.

Principal Speakers:

Linda Allen (Department of Mathematics, Texas Technical U.): *Some Stochastic SIS Models*, *Occurence, Duration and Size of an Epidemic in Deterministic and Stochastic SI and SIS Models* and *An Age Structured Model for Canine Rabies*

Frank Ball (Department of Mathematics, Nottingham U.): *Coupling Methods in Epidemic Theory*, *Stochastic and Deterministic Models for SIR and SIS Epidemics Among a Population Partitioned into Households* and *Statistical Inference for SIR Epidemics Among a Population of Households*

Sally Blower (Department of Microbiology & Immunology, UC San Francisco): *Health Policy Modelling: Epidemic Control, HIV Vaccines and Risky Behaviour*, *Antiviral and Antibiotic Resistance: Prediction and Control* and *Tuberculosis: From Historical Epidemiology to the Present Day*

Fred Brauer (Department of Mathematics, BC): *A Quick Overview of the Workshop* and *What is Mathematical Epidemiology All About?*

Carlos Castillo-Chavez (Biometrics Unit, Cornell .): *Cross-immunity and Coevolution in Epidemiology*, *Modeling Contact Structures in Biology and Their Application to the Dynamics of HIV Among Prostitues in Tijuana, Mexico* and *Potential Mechanisms for Disease Evolution: The Case of the Re-emergence of Tuberculosis*

Pauline van den Driessche (Department of Mathematics & Statistics, UVic): *Time Delay in Epidemic Models* and *Epidemic Model with Maturation Delay*

David Greenhalgh (Department of Statistics and Modeling Science, U. Strathclyde): *The Effect of Heterogeneity on the Spread of HIV Amongst Intravenous Drug Injectors* and *The Use of Stochastic Processes in Mathematical Epidemiology*

Karl Hadeler (Biomathematik, U. Tübingen): *The Standard Kermack-McKendrick Model: The Role of R_o and of Maximal Prevalence*, *Competing Virus Strains, Changing Parasites, Superinfection and Applications to Dengue Fever and Trypanosoma*, *Epidemics in Pair Formation Models With Infectivity Depending on Age Since Infection*, *Vaccination and Its Influence on the Basic Reproduction Number* and *Backward Bifurcation in Epidemic Disease Models*

Herbert Hethcote (Department of Mathematics, U. Iowa): *Three Basic Epidemiological Models*, *Age-structured Models for Pertussis (Whooping Cough)*, *Epidemiology Models With Variable Population Size*, *Periodicity in Epidemiology Models I & II*

John Hsieh (U. Toronto): *Stochastic Inference of Vaccine Efficacy and Vaccine Fraction*

Valerie Isham (Department of Statistical Science, University College London): *Overview of Stochastic Epidemic Models I & II*, and *Stochastic Models for Aggregation in Macroparasite Infections*

Christopher Kribs-Zaleta (U. Texas, Arlington): *Two to tango: two-sex models for sexually transmitted diseases* and *Center manifolds and normal forms in epidemic models*

Alan S. Perelson (Theoretical Biology & Biophysics, Los Alamos National Laboratory): *Introduction To the Biology and Modeling of HIV Infection*, *Modeling the Dynamics of HIV Infection In Vivo* and *Modeling the Dynamics Of Hepatitis C Virus (HCV) Infection*

Matt Schuette (U. Iowa): *Modeling the Effects of Varicella Vaccination Programs*

James Watmough (Department of Mathematics, UVic): *Multiple Steady States in an SIS Model with a Nonlinear Contact Rate*

James Watmough, Valerie Isham and Herbert Hethcote at the Workshop on Mathematical Epidemiology.

Workshop on Mathematical Ecology, August 2–13, 1999

Organiser: Marc Mangel (UC Santa Cruz)

Mathematical analysis and methods contribute to the study of ecology at a number of different levels.

Individual behavior: A generation ago, the computational complexity associated with predicting individual behaviour made it an enormous task. The development of computational power has made behavioural prediction using stochastic dynamic programming, genetic algorithms and other optimization methods feasible. Furthermore, this is an area where collaboration between experiment and mathematical theory is particularly fruitful because the time scale of individual behavior is conducive to the rapid collection of data. Even so, many mathematical challenges remain, ranging from problems of numerical analysis of interpolation at boundaries to overcoming the curse of dimensionality in problems with many state variables.

Single population dynamics: The analysis of the population dynamics of single species has contributed to the development of nonlinear differential equations, the theory of chaos through analysis of discrete maps, nonlinear diffusion theory through analysis of equations such as the

Fisher equation, and stochastic population theory. Many interesting problems remain. These include: i) determining the spectra of time series generated by nonlinear maps (a topic that recently received much coverage in high profile journals such as Nature), ii) connecting nonlinear stochastic and deterministic models where closure problems similar to the ones in the theory of turbulence arise, and iii) the origins of diffusion models from discrete movement models, particularly when some fraction of the population may make large movements.

Multi-species population dynamics and community ecology: The interactions of two or more species, as in predatation, competition, mutualism and disease, present new kinds of mathematical challenges. These include the extension of phase plane analysis to more than two dimensions, the estimation of parameters for complicated nonlinear systems, the possibilities of large excursions (as occur in pest or disease outbreaks) and understanding the stability properties of large multidimensional systems of ordinary, partial, and stochastic differential equations.

Principal Speakers:

Fred Adler (Department of Mathematics, U. Utah): *Metapopulations, Coexistence, and the Evolution of Virulence, Part I & II*

Colin Clark (Department of Mathematics, UBC): *Winter Survival Strategies For Small Birds: Managing Energy Supply and Expenditure*

Michael Doebeli (Department of Zoology & Mathematics, University of British Columbia): *Adaptive Dynamics, Evolutionary Branching, and Sympatric Speciation*

Greg Dwyer (Department of Ecology & Evolution, U. Chicago): *Host Heterogeneity in Susceptibility, Disease Dynamics, and Insect Outbreaks* and *Host Heterogeneity in Susceptibility and Host Pathogen Coevolution*

Shea Gardner (NERC Centre for Population Biology, Imperial College at Silwood Park): *Matrix Methods in Ecology* and *Examples of Matrix Methods Applied in Conservation and Management*

Don Ludwig (Department of Zoology & Mathematics, UBC): *Optimal Phosphorus Loading of a Lake that Possibly Has Several Stable Equilibria*

Bernard Luttbeg (School of Forestry & Environmental Studies, Yale U.): *Information as a State Variable* and *The Effects of Flexible Behavior and Imperfect Perception on Predator-prey Dynamics*

Marc Mangel (Department of Environmental Studies, UC Santa Cruz): *Welcome and Introductions* and *On the Need For Dynamic State Variable Models in Conservation Biology* and *Models For the Ecology of Aging and the Evolution of Aging*

Jonathan Newman (Department of Zoology, Southern Illinois U.): *The Use of Large Dynamic Systems Models in Ecology* and *Modeling the Effects of Climate Change on Plant-animal Interactions: A Dynamic Systems Approach*

Bernard D. Roitberg (SFU): *Misinformation As a Second Line of Defense*

Workshop on Mathematical Cellular Biology, August 16–27, 1999

Organiser: Leah Keshet (UBC)

The fields of molecular and cellular biology have undergone explosive growth over the last decade, with a wealth of biological detail emerging from high-tech experimental techniques. The life of the cell, down to its smallest components is now the subject of intense scrutiny. We know more than ever before about the way that the cell is shaped and controlled, how it moves and divides, how it senses and reacts to its environment, and how it influences other cells. The way that cell aggregates work together to produce multicellular structures with their own repertoire of behaviour is also a fascinating and fervent area of research. Many of the speakers in this list have worked productively at the interface of mathematics and biology. Their collective understanding, synergy, and presentation strengths made this an exciting and informative session. The order of the topics proceeded from the subcellular and gradually went up the hierarchical scale, highlighting some of the most exciting and productive areas of cross-fertilization of mathematical, theoretical and experimental work.

This session covered a number of specific topics:

Subcellular molecular dynamics and control of cell behaviour: This topic focuses on the behaviour of molecular systems that lead to periodic behaviour, e.g., in cells and in hormonal systems, bifurcation, or other dynamical results that are closely linked with the function of the cell. Signal transduction and calcium dynamics with their implications for cellular behaviour, as well as cellular and intra- cellular oscillations and feedback will form the main theme.

The cellular cytoskeleton: The role that mathematicians who have studied detailed experimental systems have played in understanding the details of the cell will be highlighted. An example is the detailed demonstration of the involvement of various parts of the structure of the cytoskeleton in key steps of the developmental process of a drosophila embryo.

Molecular motors to muscle motion: The mathematical analysis of molecular motors and the role which such analysis plays in understanding the way that molecular motors work will be described. Experimental biologists have studied muscles for some time, and they now are developing an understanding of how motor aggregates (myosin) arrayed along a one dimensional filament work cooperatively to produce muscle motion.

Biotechnology applications of cell biology: Cellular components can be used in designing artificial skin grafts, and artificial vessels. The understanding of the interactions of cells with their molecular components and extracellular matrix is vital to success in biomedical applications. A particular problem is how the cytoskeleton dynamics affects signal transduction.

Cell-surface receptors, the cytoskeleton, and cell division: Two topics were discussed. One topic was on the way that cells sense their environment and respond to incoming signals. Cell-surface receptors are important and experiments and models for the diffusional and interaction dynamics of such systems have been developed. The second topic was on the problem of cytokinesis or cell-division, and how the cell accomplishes this complex task. Numerical simulations of the dynamics of the cytoskeleton have been carried out.

Cell motion and interaction: models and visualization: The important problem of cell motion from the point of view of many cells, cell aggregates, and interactions of cells with one another and with their environment was discussed. Models have been developed for cell motion, chemotaxis, and interactions, including immunological networks. New computational techniques, e.g., immersed boundary methods, were used to show the motions and and interactions of cells, e.g., in models of biofilms.

Principal Speakers:

Dean Bottino (Department of Mathematics, U. Utah):] *Computational Models For Cell Crawling*

Micah Dembo(Department of Biomedical Engineering, Boston U.): *Investigations of Cytokinesis and Cell Motility*

Evan Evans (Department of Physics, UBC): *Dynamic Strength of Molecular Bonds and Consequences for Cell motility*

Byron Goldstein (Department of Mathematics & Statistics, U. New Mexico): *Cell Signalling through Aggregating Receptor Systems: An Introduction* and *An Introduction to Biosensors*

Peter Lansdorp (Terry Fox Lab., UBC): *Stem Cells*

Joe Mahaffy (Department of Mathematical Sciences, San Diego State U.): *Models of hematopoeisis*

Alex Mogilner (Department of Mathematics, UC Davis): *An introduction to Cell Motility*

Garett Odell (Department of Zoology, U. Washington): *Cytoskeletal interactions between microtubules, F-actin, and myosin II*

George Oster (UC Berkeley): *Recent Advances in Cellular Biology: Models, experiments, and Synthesis*

Jamie Piret (Biotechnology Laboratory and Department of Microbiology & Immunology, UBC): *Hematopoeisis*

Lee Segel (Department of Applied Mathematics, Weizmann Institute): *On the role of feedback in promoting conflicting goals of the adaptive immune system*

Carla Wofsy (Department of Mathematics & Statistics, U. New Mexico): *Modelling Receptor Aggregation* and *Early Events in Cell Signaling through Immunoreceptors: Modeling and Experiments*

Theme 2000 (A): Graph Theory & Combinatorial Optimization

Mathematically, a **graph** consists only of a set of "vertices" and a set of pairs of vertices that are "joined" by "edges". Physical examples abound. For example, the vertices can be communication centres and the edges can represent direct connections between pairs, or the vertices can be the atoms of a molecule, and the edges can be chemical bonds. Although graphs are extremely basic objects, the subject of Graph Theory, which the studies the theoretical structure of graphs and the algorithmic exploitation of such structure, is a deep and active part of mathematics. There are also important applications and strong connections to other parts of mathematics and computer science.

Combinatorial Optimization is the mathematics of finding the best among some collection of discrete structures. An example would be to find the graph with some connectivity property and having the smallest number of edges, or to find the best route through a given graph. Again, this subject is both mathematically interesting and rich with applications.

Organizing Committee:

Brian Alspach (SFU)
Luis Goddyn (SFU)
Arvind Gupta (SFU)
Pavol Hell (SFU)
Valerie King (U. Victoria)
David Kirkpatrick (UBC)
Frank Ruskey (U. Victoria)

Workshops:

Computational Graph Theory and Combinatorics,
University of Victoria, May 6–8, 1999

Algorithms and Data Structures,
SFU Harbour Centre, August 11–14, 1999

11th Canadian Conference on Computational Geometry,
UBC, August 15–18, 1999

Dynamic Graph Problems,
U. Victoria, June 5–9, 2000

Graph Decompositions,
PIMS-SFU, June 19–30, 2000

Flows, Cycles, and Orientations,
PIMS-SFU, July 3–14, 2000

Graph Colourings and Homomorphisms,
PIMS-SFU, July 17–28, 2000

This is a joint programme of the Fields Institute and the Pacific Institute of Mathematical Sciences for a special year on graph theory and combinatorial optimization, taking place over the period June 1999 to August 2000. Lead-off workshops started at PIMS in the summer of 1999. September through May activities shifted to Fields, to eventually return to PIMS for the June through August, 2000 period. The fall term concentrated on combinatorial optimization, and the remaining period would concentrate on graph theory and related topics.

Lead-off Events:

Preceeding the thematic year, PIMS sponsored a pre-thematic workshop on Computational Graph Theory and Combinatorics at the University of Victoria in May, 1999. The lead-off event for the joint thematic year was the Workshop on Algorithms and Data Structures (WADS), held at the SFU harbour Centre in August, 1999. Immediately following WADS was the Canadian Conference on Computational Geometry (CCCG), which took place at UBC in late August. The activities of these three events are expanded below.

Computational Graph Theory and Combinatorics, University of Victoria, May 6–8, 1999

Organizers: Wendy Myrvold and Frank Ruskey (Department of Computer Science, UVic)

The workshop attracted more than 70 attendees and featured invited talks by three distinguished mathematical scientists. Herbert Wilf (U. Pennsylvania) gave a talk entitled "East-West, a Recursive Package for Generating Combinatorial Families". Brendan McKay (Australian National U.) gave a talk entitled "Generating Representatives of Isomorphism Classes". Steven Skiena (SUNY Stonybrook) gave a talk entitled "Who is interested in algorithms and why?: Lessons from the Stony Brook Algorithms Repository". In addition Brendan McKay gave a public lecture "The Bible Code: Fact or Fallacy" (partially sponsored by the UVic Lansdowne Fund). There were 30 contributed talks given by speakers from around the world: the countries represented include France, Belgium, Germany, Poland, Australia, and the U. S. A.

Participants: Timothy Walsh (U. Quebec), Dominique Roelants van Baronaigien (UVic), Joe Sawada (UVic), Veerle Fack (U. Ghent), S. Lievens (U. Ghent), J. Van der Jeugt (U. Ghent), Herb Wilf (U. Pennsylvania), Charles Colbourn (U. Vermont), Joe Peters (SFU), Yontha Ath (Claremont Graduate U.), Milton Sobel (UC Santa Barbara), Stephen Ryan, Lhouari Nourine (U. Montpellier), Oliver Raynaud (U. Montpellier), Julian West (Malaspine Unversity-College, Nanaimo), Brendan McKay (Australian National U.), Thomas Harmuth, Konrad Piwakowski (Technical U. Gdansk, Poland), Stanislaw P. Radziszowski (Rochester Institute of Technology), Brian Blitz, Brendan McKay (Australian National U.), Malcolm Greig (Greig Consulting), David Pike (Memorial U.), Nabil Shalaby (Memorial U.), Frank Ruskey (UVic), Stirling Chow, Pierre Hansen (GERAD and Ecole des Hautes Etudes Commerciales de Montreal), Gilles Caporossi (Ecole Polytechnique de Montreal), Janez Ales, Joshua Madden (UBC), Richard Anstee (UBC), Moshe Rosenfeld (Pacific Lutheran U.), Larry Cummings (U. Waterloo), Jack Snoeyink (UBC), Bettina Speckmann (UBC), Perry Fizzano (U. Puget Sound), Arvind Gupta (SFU), Ramesh Krishnamurti (SFU), Stephane Durocher (UBC), David Kirkpatrick (UBC), Steve Skiena (SUNY Stony Brook), Wendy Myrvold (UVic), Jianping Roth (Seagate Software), Mike Fellows (UVic), Louis Goddyn (SFU), Andrzej Proskurowski (U. Oregon), Jan Arne Telle (U. Bergen, Norway), Prosenjit Bose (Carleton U.), William Evans (U. Arizona), David Kirkpatrick (UBC), Dean Hoffman (U. Auburn)

Workshop on Algorithms and Data Structures, SFU Harbour Centre, August 11–14, 1999

Organizers: Binay Bhattacharya (SFU), Arvind Gupta (SFU), Arthur Liestman (SFU), Thomas Shermer (SFU)

More than 90 scientists from around the world participated in the workshop. Invited talks were given by five distinguished mathematical scientists: Marc Snir (IBM), Charles Leiserson (MIT), Nadia Thalmann (Geneva), Umesh Vazirani (UC Berkeley) and Jeff Vitter (Duke). As well, 34 contributed papers from more than 80 submissions were chosen by the program committee to be presented at the workshop. Additional funding for WADS was provided by the School of Computing Science, Simon Fraser University.

WADS alternates with the Scandinavian Workshop on Algorithm Theory and is a forum for researchers in the area of design and analysis of algorithms and data structures. Contributed papers presented original research results on the theory and application of algorithms and data structures in all areas, including combinatorics, computational geometry, databases, graphics, and parallel and distributed computing.

Programme Committee: A. Gupta (SFU), F. Dehne (Carleton), J.-R. Sack (Carleton), R. Tamassia (Brown), A. Andersson (Uppsala), A. Apostolico (Purdue and Padova), G. Ausiello (Rome), G. Bilardi (Padova), K. Clarkson (Lucent), R. Cleve (Calgary), M. Cosnard (INRIA-LORIA, France), L. Devroye (McGill), P. Dymond (York), M. Farach-Colton (Rutgers), P. Fraigniaud (Paris), M. Goodrich (Johns Hopkins), A. Grama (Purdue), M. Keil (Saskatchewan), D. Kirkpatrick (UBC), R. Krishnamurti (SFU), D. T. Lee (Northwestern), F. Luccio (Pisa), A. Maheshwari (Carleton), G. Plaxton (Univ. of Texas at Austin), A. Rau-Chaplin (Dalhousie), J. Reif (Duke), F. Ruskey (U. Vic), P. G. Spirakis (Patras), L. Stewart (Alberta), H. Sudborough (U. Texas Dallas), P. Vitanyi (CWI), P. Widmayer (ETH), C. K. Wong (Chinese U. Hong Kong).

11th Canadian Conference on Computational Geometry, UBC, August 15–18, 1999

Organizers: Jack Snoeyink (UBC) and David Kirkpatrick (UBC)

Computational geometry started as an independent research discipline about 20 years ago. Research relevant to computational geometry involves the study of the computational complexity of well-defined problems that have geometric constraints as well as the design, analysis and implementation of algorithms and associated data structures for the efficient solution of these problems. Thus, computational geometry concerns the study of familiar problems in combinatorics and discrete mathematics with added geometric constraints, the application of tools from discrete mathematics in the formulation and analysis of geometric algorithms, and the application of these algorithms in the widespread application domains that naturally give rise to problems with geometric attributes or constraints. Fundamental application areas identified in the recent reports setting out strategic directions for the development of the discipline include computer graphics and imaging, shape reconstruction, computer vision, geographic information systems, mesh generations, robotics, robustness, molecular biology, and information visualization, which includes among others graph drawing and algorithm animation.

Computational geometry has established itself both as a discipline and as a community of researchers. It enjoys two unique assets:

(a) its diversity and potential to affect most forms of computing;

(b) its mature algorithmic foundations.

To realize the discipline's full potential for usefulness to others and to maintain its vigor, the community seeks close collaboration with theoreticians in other areas such as graph theory, combinatorics, and discrete optimization, and practitioners in relevant application areas. The computational geometry based activities within this special year touch on both of these forms of outreach.

The Canadian Conference on Computational Geometry (CCCG) focuses on the mathematics of discrete geometry from a computational point of view. Abstracting and studying the geometry problems that underly important applications of computing (such as geographic information systems, computer-aided design, simulation,

robotics, solid modeling, databases, and graphics) leads not only to new mathematical results, but also to improvements in these applications.

Despite its international following, CCCG maintains the informality of a smaller workshop (70–85 attendees) and attracts a large number of students.

Invited Speakers:

Susanne Fortier (Queen's): *Molecular Mining*

Victor Klee (U. Washington): *Shapes of the Future — Some Unsolved Problems in High-Dimensional Intuitive Geometry*

Dinesh Pai (UBC): *Touching Geometry*

Scheduled Speakers:

T. Biedl, A. Lubiw and J. Sun (U Waterloo): *When Can a Net Fold to a Polyhedron*

Roxana Cocan and Joseph O'Rourke (Smith College): *Polygonal Chains Cannot Lock in 4D*

Godfried Toussaint (McGill U): *The Erds-Nagy Theorem and its Ramifications*

Marshall Bern (Xerox PARC), Erik Demaine (U Waterloo), David Eppstein (UC Irvine), Eric Kuo (MIT): *Ununfoldable Polyhedra*

Bette Bultena (U Vic) Branko Grunbaum (U Washington), Frank Ruskey (U Vic): *Convex Drawings of Intersecting Families of Simple Closed Curves*

Vladimir Estivill-Castro (U. Newcastle, Aus.): *Convex Group Clustering of Large Geo-referenced Data Sets*

Ileana Streinu (Smith Coll): *Non-Stretchable Pseudo-Visibility Graphs*

Herman Haverkort, Hans Bodlaender (Utrecht): *Finding a Minimal Tree in a Polygon with its Medial Axis*

H. Balza-Gomez, D. Michelucci and J. M. Moreau (Lisse/ENSM.SE): *The periodicity of integral convex hulls for conics in* $\mathbb{R}^2$

Stefan Funke, Kurt Mehlhorn (MPI Inf), Stefan Näher (U. Halle-Wittenberg): *Structural Filtering: A Paradigm for Efficient and Exact Geometric Programs*

Mike Soss (McGill U): *On the size of the Euclidean Sphere of Influence Graph*

Binhai Zhu (City U. HK & Laurentian): *A simple probablistic algorithm for approximating two and three-dimensional objects*

Matthias Fischer, Tamas Lukovszki, Martin Ziegler (Uni-Paderborn): *Partitioned Neighborhood Spanners of Minimal Outdegree*

Ian Ashdown (UBC): *Comparing Photometric Distributions*

Evangelos Kranakis (Carleton), Harvinder Singh, Jorge Urritia (U. Ottawa): *Compass Routing on Geometric Networks*

Robert Dawson (St Mary's, Halifax) and Wendy Finbow (U. Calgary): *A computational approach to stability problems*

Matthew Katz, Klara Kedem, and Michael Segal (Ben-Gurion Univ): *Improved Algorithms for Placing Undesirable Facilities*

Ian Sanders (U. Witwatersrand): *Non-orthogonal Ray Guarding*

Sergie Bespamyatnikh, David Kirpatrick (UBC): *Rectilinear 2-center problems*

Eduardo Rivera-Campo and Virginia Urrutia-Galicia (UAM-Iztapalapa): *A note on the path graph of a set of points in convex position in the plane*

Michael Hoffman (ETH Zurich): *A Simple Linear Algorithm for Computing Rectangle 3-Centers*

Otfried Cheong and René van Oostrum (HKUST): *The Visibility Region of Points in a Simple Polygon*

Boaz Ben-Moshe, Matthew Katz, and Michael Segal (Ben-Gurion Univ): *Obnoxious Facility Location: Complete Service with Minimal Harm*

Atsushi Kaneko (Kogakuin U), Yoshiaki Oda (Keio U), and Kiyoshi Yoshimoto (Nihon U): *Some results on geometric independency trees*

Richard Hammersley, Karen Lu, Steven Assa (Schlumberger): *Geometric Modeling with a Multiresolution Representation*

Nandy Subhas Chandra (JAIST): *Shattering a set of objects in 2D*

Ernst Huber (TU Wien): *Surface-to-surface intersection based on triangular parameter domain subdivision*

Adrian Dumitrescu (Rutgers): *On two lower bound constructions*

Michael McAllister (UBC): *A Watershed Algorithm for Triangulated Terrains*

Tetsuo Asano, Yasuyuki Kawamura, (JAIST): *Computational Comparison of Voting-based and Arrangement-based Schema for Digital Line Detection*

Christian Icking, Rolf Klein (FU Hagen), Ngoc-Minh L (HKUST), Lihong Ma (FU Hagen), Francisco Santos (U Cantabria): *On Bisectors for Convex Distance Functions in 3-Space*

L. Devroye (McGill U), C. Lemaire (CEA/MLS), and JM Moreau (Lisse/ENSM.SE): *Fast Delaunay point location with search structures*

Michael Spriggs (U Sask), J. Mark Keil (U. Sask): *Minimum Spanning Trees on Polyhedra*

Christian Sohler (U. Paderborn): *Fast Reconstruction of Delaunay Triangulations*

Hee-Kap Ahn, Siu-Wing Cheng, Otfried Cheong (HKUST): *Casting with Skewed Ejection Direction Revisited*

Davis King and Jarek Rossignac (Georgia Tech): *Guaranteed 3.67V bit encoding of planar triangle graphs*

Fumihiko Takeuchi, Takayuki Ishizeki (U. Tokyo): *Geometric Shellings of 3-Polytopes*

Francois Anton (UBC), Darka Mioc (U Laval): *On the conversion of ordinary Voronoi diagrams into Laguerre diagrams*

G. Csizmadia (Hun Acad. Sci & SUNY Brooklyn), J. Czyzowicz (U Quebec Hull), L. Gasieniec (U. Liverpool), E. Kranakis (Carleton), J. Urrutia (U. Ottawa): *Domino Tilings of Orthogonal Polygons*

Roland Ulber (ETH Zurich): *On The Number Of Star-Shaped Polygons and Polyhedra*

J. Czyzowicz (U Quebec Hull), E. Kranakis (Carleton), J. Urrutia (U Ottawa): *Dissections, Cuts and Triangulations*

Christian Sohler (Uni-Paderborn): *Generating Random Star-Shaped Polygons*

P. Bose, E. Kranakis, D. Krizanc, D. Lessard (Carleton), J. Czyzowicz (Universite du Quebec a Hull): *Near-Optimal Partitioning of Rectangles and Prisms*

Adrian Dumitrescu (Rutgers U), Geza Toth (MIT & Hungarian Acad Sci): *Ramsey-type results for unions of comparability graphs and convex sets in restricted position*

E. D. Demaine, M. Demaine (Waterloo), D. Eppstein (UC, Irvine), E. Friedman (Stetson): *Hinged Dissections of Polyominoes and Polyiamonds*

David Bremner and Victor Klee (U Washington): *Inner diagonals of convex polytopes*

Workshop Descriptions

In what follows, we elaborate on the workshop topics to be held at PIMS and in some cases provide greater detail towards some of the anticipated activities. We also list potential organizers, and potential participants both from Canadian universities and from outside of Canada. These lists are meant only to give some idea of the possible interested participants but is unlikely to be a complete list.

Although we are only listing the PIMS workshops in detail, we anticipate substantial cooperation with Fields during this year in Graph Theory and Combinatorial Optimization.

Dynamic Graph Problems, University of Victoria, June 5–9, 2000

Organizers: Monika Henzinger (Google Inc.) and Valerie King (Computer Science, University of Victoria)

For any graph problem, we may ask: If a graph instance undergoes an on-line sequence of updates, can one make use of previous computation to recompute the solution after each update more quickly? The study of dynamic graph problems has recently undergone some dramatic developments. The goal of this workshop is to bring together experts on various topics in the area with interested students and researchers, to discuss the current state of the field, identify promising directions for research, and do some problem-solving. Topics include: proving lower bounds, problems in computational geometry, new and old problems for undirected and for directed graphs, problems on trees, and applications to networks, data bases and programming languages.

Speakers: Bob Tarjan (Princeton and Intertrust), Stephen Alstrup (ITU, Copenhagen), David Eppstein (UC Irvine), Faith Fich (U. Toronto), Leo Guibas (Stanford U.), Pino Italiano (U. degli Studi di Roma), Roded Sharan (Tel Aviv U.), Mikkel Thorup (AT&T Research)

Graph Decompositions, PIMS-SFU, June 19–30, 2000

Organizing Committee: Brian Alspach, Chair, (U. Regina), Reinhard Diestel (U. Hamburg), Herbert Fleischner (Austrian Academy of Science), Ron Gould (Emory U.), Chris Rodger (Auburn U.)

The workshop will consist of a series of invited instructional lectures whose purpose is to survey the current status of a variety of important graph decomposition problems. Graph decompositions is a topic at the heart of graph theory. Decomposition problems have a long history, have

spawned large areas of research, and continue to be studied by many people inside and outside of graph theory. Steiner triple systems were introduced early in the nineteenth century. When viewed as decompositions of complete graphs into complete graphs of order 3, their generalization leads to the well studied field of design theory. When viewed as decompositions of complete graphs into 3-cycles, their generalization leads to a wide range of problems dealing with decomposition of complete graphs into cycles.

Vertex coloring is a topic that was introduced in the middle of the nineteenth century, has generated considerable research over the years and has important scheduling applications. It corresponds to a particular kind of vertex decomposition of a graph. Edge coloring problems also have scheduling applications and have been studied extensively. They correspond to decompositions of graphs into 1-factors.

The preceding topics are still actively studied along with many new areas of investigation. G. Ringel's conjecture that K_{2n+1} can be decomposed into any fixed tree of size n directly led to the notion of a graceful labelling of a tree. That in turn spawned the very active area of graph labellings. The cycle double cover conjecture has attracted a lot of attention over the last twenty years. Isomorphic factorizations, orthogonal factorizations and ascending subgraph decompositions are other areas in which there are many unsolved problems and considerable research activity.

This workshop will address edge decomposition problems. The workshop will last two weeks. Approximately eight speakers will be chosen to present the background material, techniques and current directions for a particular topic. Each day there will be 2–3 hours of lectures. The two weeks will comprise an excellent graduate course for students and credit can be arranged. The workshop is a unique opportunity to create such a course.

Confirmed Speakers: Darryn Bryant (Univ. Queensland), Edward Dobson (Mississippi State), Mark Ellingham (Vanderbilt), Herbert Fleischner (Austrian Academy of Science), Ron Gould (Emory U.), Hans-Dietrich Gronau (U. Rostock), Jiuqiang Liu (Eastern Michigan U.), Chris Rodger (Auburn U.), Mateja Sajna (Capilano College)

Flows, Cycles, and Orientations, PIMS-SFU, July 3–14, 2000

Organizer: Luis Goddyn (SFU)

This workshop presents an opportunity for participants to identify and work collaboratively on current problems in graph/matroid theory which broadly fall into the above three categories. Topics may concern algorithmic, polyhedral, algebraic, probabilistic, or extremal aspects, and may involve embeddings, flow/colouring theory, circuit/bond covers, matroids and connectivity. Evidently the scope intersects those of the two adjacent workshops, so topics will chronologically flow from cycles to colourings.

There will be a series of invited presentations (about two per day) with plenty of time allotted for less formal interaction and some time slots for complementary talks or responses to the invited lectures.

Invited Participants: Noga Alon (Tel Aviv), Adrian Bondy (Claude Bernard - Lyon 1), Kathie Cameron (Wilfred Laurier), Gerard Cornuejols (Carnegie Mellon), Matt DeVos (Princeton), Jack Edmonds (Waterloo), Genghua Fan (Institute of Systems Science), Andras Frank (Eötös Lornd), Anna Galluccio (Consiglio Nazionale delle Ricerche), Jim Geelan (Waterloo), Bert Gerards (Centrum voor Wiskunde en Informatica), Isidoro Gitler (Centro ... del IPN), Bertrand Guenin (Georgia Institute of Technology), Gena Hahn (Montreal), Joan Hutchinson (Macalester College), Jan van den Heuvel (London School of Economics), Petr Hlineny (Georgia Institute of Technology), Winfried Hochstattler (Rutgers), Andreas Huck (Hannover), Bill Jackson (Goldsmiths College, London), Tommy Jensen (Odense), Alexander Kostochka (Sobolev Institute of Mathematics), Martin Loebl (Charles University in Prague), Wolfgang Mader (Hanover), Diestel Reinhardt (Hamburg), Bill McCuaig (Burnaby), Jenny McNulty (Montana), Bojan Mohar (Ljubljana), Jarik Nesetril (Prague), James Oxley (Louisiana State), Bruce Reed (Jussieu - Paris), Neil Robertson (Ohio State), Lex Schrijver (Centrum voor Wiskunde en Informatica), Gert Sabidussi (Montreal), Paul Seymour (Princeton), Andras Sebo (IMAG), Vera Sos (Budapest), Miki Tarsi (Tel Aviv), Robin Thomas (Georgia Institute of Technology), Carsten

Thomassen (Technical University of Denmark), Bjarne Toft (Odense), Dirk Vertigan (Louisiana State), Dominic Welsh (Oxford), Doug West (Illinois), Geoff Whittle (Victoria University of Wellington), Xingxing Yu (Georgia Institute of Technology), C-Q Zhang (West Virginia), Xuding Zhu (Taiwan)

Graph Colourings and Homomorphisms, PIMS-SFU, July 17–28, 2000

Organizing Committee: Pavol Hell (Chair, SFU), Jing Huang (UVic), Rick Brewster (Capilano College), Gena Hahn (Montreal)

Graph colourings are at the core of graph theory. Starting from the famous four colour conjecture, now theorem, all the way to applications in scheduling, graph theory developed along with the study of colourings. From both theoretical and algorithmic perspective, colourings have always played a central role.

Nowhere-zero flows were introduced by Tutte as an extension of chromatic number. Indeed a flow is the matroidal dual of a graph colouring. Many well-known graph colouring problems, such as the Four Colour Theorem, extend naturally to problems about flows. There are several outstanding problems about flows, such as Tutte's conjecture that every graph has flow number at most five. Circuit covers were introduced in 1979 when Seymour proposed the still-unsolved Circuit Double Cover Conjecture. This conjecture is closely related to the topic of Surface Embeddings of graphs. Relating these three areas together will be the focus of part of this workshop.

Recently, the theory of colourings has benefited from an introduction of algebraic techniques, through the vehicle of list homomorphisms. At the same time, generalizations of colourings, especially graph homomorphisms, have also enjoyed much popularity. List homomorphisms, like list colourings, exhibit certain properties that can be exploited in the design of efficient algorithms. Both list colourings and list homomorphisms owe a historical debt to constraint satisfaction problems (which in fact are more general than both these concepts), studied in artificial intelligence. In fact some of the AI techniques have only recently been rediscovered by graph theorists. Finally, any of these concepts lead naturally to practical applications in timetabling and scheduling.

The workshop will consist of a series of invited instructional lectures, addressed to graduate students, and highlighting recent developments in graph colourings and their generalizations, including circular and oriented colourings, and, more generally, graph homomorphisms. Algorithmic, combinatorial, and algebraic issues will all be discussed, as will applications in and connections to constraint satisfaction problems, scheduling, etc. Generous amounts of time will be reserved for informal talks and unstructured discussions. A very positive contribution will be bringing research communities together. For example, by bringing together people interested in constraint satisfaction problems with the graph colouring people important cross fertilization will occur. Graduate students should find the environment very stimulating.

Invited Speakers: Mike Albertson (Smith College), Noga Alon (Tel Aviv), Adrian Bondy (Lyon), Joan P. Hutchinson (Macalester College), Tommy Jensen (Hamburg), Bojan Mohar (Ljubljana), Jarik Nesetril (Prague), Andre Raspaud (Bordeaux), Bruce Reed (Paris), Gert Sabidussi (Montreal), Norbert Sauer (Calgary), Claude Tardif (Regina), Bjarne Toft (Odense), Peter Winkler (Bell Labs), Xuding Zhu (Taiwan)

Theme 2000 (B): Algebra and Related Areas

Group Theory plays a central role in just about all the branches of mathematics and continue to be a very active area of research.We are now witnessing the culmination of a 3 directional attack on the Burnside problems. The first consists of the geometric methods of Ol'Shanskii in producing finitely generated groups of finite exponent that are infinite. The second is the positive solution of the restricted Burnside Problem for residually finite groups by Zelmanov, and the third is the p-adic analytic methods in dealing with questions of linearity of residually finite groups by Lubotzky and Mann. There are also the remarkable advances made by Shalev, Lubotzky, and others on pro-finite groups and results of Segal and others for residually finite solvable groups.

Representation theory continues to be fundamental importance in mathematics and other sciences. There has been much recent progress, especially, on the representation theory of finite groups of Lie type, which ties together the Lie theory and group theory themes of the programme. Modular representation theory is also an area of considerable activity.

Programme Organizers:

Bruce Allison (U. Alberta)
Gerald Cliff (U. Alberta)
Robert Moody (U. Alberta)
Arturo Pianzola (U. Alberta)
Akbar Rhemtulla (U. Alberta)
M. Schlottman (U. Alberta)
Mazi Shirvani (U. Alberta)
Alfred Weiss (U. Alberta)

Robert Moody, Officer of the Order of Canada

Schedule of Events:

Lie School,
U. Alberta, June 19–23, 2000
Lie Workshop,
U. Alberta, June 26–30, 2000
Groups School,
U. Alberta, June 26–30, 2000
Groups Workshop,
U. Alberta, July 3–7, 2000
Aperiodic School,
U. Alberta, July 3–7, 2000
Aperiodic Workshop,
U. Alberta, July 10–14, 2000

The Summer School/Workshop will concentrate on three areas: groups and their representations, Lie theory, and the mathematics of aperiodic order. As its name suggests, the plan is to incorporate both an instructional and research components in each of the three broad areas.

Each area will be featured for a two week period and will have lecturers of international stature. The first week will be devoted to a series of introductory lectures, aimed at giving the students an introduction to the subject in question. The second week will be the workshop/conference which will be run at a research level and will welcome additional researchers and students who wish to participate. The programme is staggered (see below).

The School will be open to graduate students, recent Ph.D.'s, and advanced honours students. Financial support will be available to support selected participants. Students will be expected to participate in the teaching part of each of the three areas.

Main speakers will stay for the full 2 weeks of activity of their area and will be fully supported for travel and local expenses. On each of the 3 internal weekends, we plan to have a trip to Jasper. We plan to have accommodation there that will allow the groups to continue to have scientific interactions.

Lie Theory Component, U. Alberta, June 19–30, 2000

Canada has a strong representation in the algebraic side of Lie theory. The proposed meeting is to make sure that Canada's visibility in the international Lie theory community is maintained.

The timing of this event is particularly favorable because of the during the fall of 2000 there will be a semester at the Fields Institute on infinite dimensional Lie theory. It is our intention to use the minicourses of this conference to prepare the students for the Fields' activities.

Lecturers in the School:

A. Pianzola (U. Alberta): *Lie Algebras*

S. Donkin (Univ. of London): *Algebraic Groups.*

Confirmed Participants in the Workshop:

G. Benkart (University of Wisconsin)
N. Bergeron (York University)
S. Berman, (University of Saskatchewan)
Y. Billig (University of New Brunswick)
A. Broer (Univerité de Montréal)
C. Dong (Univ. of California, Santa Cruz)
S. Donkin (Queen Mary & Westfield College, London)
Y. Gao, (York University)
M. Gaberdiel (Cambridge University)
T. Gannon (University of Alberta)
Y.-Z. Huang (Rutgers University)
O. Mathieu (IRMA, Strasbourg)
K.-H. Neeb (Technische Universität Darmstadt)
E. Neher (University of Ottawa)
C. Schweigert (Université Paris VI)
O. Smirnov (Randolph-Macon)

Group Theory Component, U. Alberta, June 16 – July 7, 2000

Groups play a central role in just about all the branches of mathematics and continue to be a very active area of research as evidenced by the recent Field Medals awarded in the area.

At present we have the culmination of a three directional attack on the Burnside problems. The first consists of the geometric methods of Ol'Shanskii in producing finitely generated groups of finite exponent that are infinite (a vast improvement of Adian's construction which is one of the technically most difficult piece of a 300+ page work). The second is the positive solution of the restricted Burnside Problem for residually finite groups by Zelmanov, and the third is the p-adic analytic methods in dealing with questions of linearity of residually finite groups by Alex Lubotzky and Avinoam Mann. There are also the remarkable advances made by Aner Shalev, Lubotzky, and others on pro-finite groups and results of Dan Segal and others for residually finite solvable groups.

Representation theory continues of fundamental importance in mathematics and other sciences. There has been much recent progress, especially, on the representation theory of finite groups of Lie type, which ties together the

Lie theory and group theory themes of the programme. Modular representation theory is also an area of considerable activity.

The conference will present an excellent opportunity to get a broad picture of these manifold activities as told by the masters themselves to our graduate students and fresh Ph. D's. We wish to stress that the all main talks will be of the "colloquium" nature, reserving specialized talks for the afternoon sessions meant for the experts.

Lectureres in the School:

Michel Broué (Univ. de Paris VII): *Representations of Groups of Lie Type*

Peter Kropholler (Queen Mary & Westfield College, London): *Cohomological Methods*

Dan Segal (Oxford University): *Residually finite groups*

Aner Shalev (Hebrew University, Jerusalem): *Profinite and p-adic analytic groups.*

Confirmed Participants in the Workshop:

Michel Broué (Université Paris VII)
Steve Gersten (University of Utah)
Rod Gow (Dublin City University)
Peter Kropholler (Univ. of London)
A. Lubotzky (Hebrew University, Jerusalem)
A. Yu. Ol'shanskii (Moscow State University)
Geoffrey Robinson (University of Birmingham)
Dan Segal (Oxford University)
Aner Shalev (Hebrew University, Jerusalem)
Alex Turull (University of Florida)

Aperiodic Component, U. Alberta, July 3–14, 2000

Aperiodic order, as its name suggests, refers to the mathematical study of systems, typically in Euclidean spaces, that are highly ordered but are lacking in periodic translational symmetry. Stemming from the recent discoveries of such objects in mathematics (e.g. Penrose tilings) and physics (aperiodic crystals) the subject has blossomed into a new area of mathematics that cuts across many boundaries and has many fascinating possibilies for future research.

The course aims to provide the students with the background to understand the main ideas being used at present in the development of the mathematics of aperiodic order. One of the appealing aspects of this subject is the way in which it draws together a number of diverse subdisciplines of mathematics: discrete geometry, algebra, analysis, and measure theory and topological dynamics. For this reason the instructional part will be given by three or four speakers. It is our intention to give the students a reasonable feel for main ideas and to provide sufficient background and lots of pointers so that they may pursue it more deeply later on. All the speakers have agreed to be here for the full two weeks.

The conference/workshop part of the programme, which will occur in the second week, will focus on the most recent developments. We plan still to keep the pedagogical spirit and it is hoped that a number of the more interested students will stay on. We have already seen considerable interest in this event by other research workers in the mathematical and physical aspects of aperiodic order, and will have no trouble in making this into a very productive research oriented meeting.

Lectureres in the School:

M. Baake (Universität Tübingen): *Introduction to aperiodic order, tilings, and diffraction*

J. Lagarias (AT&T Labs), *Discrete geometry and aperiodic point sets*

B. Solomyak (University of Washington): *Dynamical systems and aperiodic order.*

Confirmed Participants in the Workshop:

Jean-Paul Allouche (CNRS, Orsay)
Michael Baake (Universität Tübingen)
Jean-Pierre Gazeau (Université Paris VII)
Uwe Grimm (Technische Universität Chemnitz)
Petra Gummelt (Universität Greifswald)
Jeff Lagarias (AT&T Labs)
Boris Solomyak (University of Washington)

Theme 2001 (A): Nonlinear Partial Differential Equations

Partial Differential Equations appear in the study of problems in material science, mathematical physics, fluid dynamics, Riemannian geometry, and many other related areas.

Differential Geometry has been a great source of problems and inspirational ideas for PDEs. Recent developments deal with harmonic maps, prescribed curvature problems, Monge-Ampère equations, Kahler-Einstein manifolds, Seiberg-Witten invariants and their connections to Gromov's invariants in Symplectic Geometry.

Concentration phenomena have been discovered in many different parts of science. Mathematically, they appear as vortices in Ginzburg-Landau equations, as spike-layers in biological diffusions, or as bubbles in geometrical problems occur.

Phase transitions often appear in material sciences problems such as the formation and evolution of grain boundaries in alloys, vortex states in superconducting materials, flame propogation, etc... The related equations include the Cahn-Hilliard equations, Allen-Cahn equations and again the Ginzburg-Landau equations.

The emphasized methods **(Variational and Viscosity solutions)** are very active areas of research, quite relevant to other areas of mathematics (Geometry, Topology, Analysis, Applied mathematics) with many applications in other disciplines (Physics, Chemistry, Biology, Economics and Engineering).

Programme Committee:

Jingyi Chen (UBC)
Michael Crandall (UC Santa Barbara)
Maria J. Esteban (U. Paris-Dauphine)
Nassif Ghoussoub (UBC)
Changfeng Gui (UBC)
Pierre-Louis Lions (U. Paris-Dauphine)
Wei-Ming Ni (U. Minnesota)
Paul Rabinowitz (U. Wisconsin)
Panagiotis Souganidis (U. Texas, Austin)

Workshops:

Viscosity Methods in Partial Differential Equations,
PIMS-UBC, July 2–10, 2001

Phase Transitions,
PIMS-UBC, July 11–18, 2001

Concentration Phenomena and Vortex Dynamics,
PIMS-UBC, July 19–27, 2001

Variational Methods and their Applications,
PIMS-UBC, July 30–August 07, 2001

Geometric PDEs,
PIMS-UBC, August 8–17, 2001

This upcoming thematic program of the Pacific Institute for the Mathematical Sciences will take place primarily at the PIMS Vancouver site during the summer of 2001. The program will concentrate on several interrelated topics originating in physics, chemistry, biology and material sciences as well as in geometry. The common feature of these topics is that they involve the interplay between nonlinear, geometric and dynamic components of partial differential equations. Our goal is to bring together some of the best researchers on these topics for an extended period of time at the Pacific Institute in Vancouver. There will be emphasis on: Viscosity methods in partial differential equations, Phase Transitions, Concentration Phenomena and Vortex Dynamics, Variational methods in partial differential equations as well as Geometric PDEs.

There will also be several related events happening at PIMS during the summer of 2001 which are in neighboring areas to this program. They are: a workshop on Theoretical and Numerical Fluid Mechanics, organized by Giovanni P. Galdi (Pittsburgh), John Heywood (UBC), Rolf Rannacher (Heidelberg) and the Second Canada-China Mathematics Congress which will have an important component in Geometry and PDEs. We plan to capitalize on this large gathering of expertise in Western Canada to create a favourable atmosphere for graduate training and collaborative research.

Programme Summary and Schedule:

The intent is to have five consecutive workshops in the period June to August, 2001. The program will end just before the second Canada-China Congress which will be also held in Vancouver at PIMS. This will give an opportunity for the Chinese geometers and analysts to come early before the congress in order to participate in the program. The fourth and fifth workshops of the program (Variational methods and Geometric PDE) have been positioned as such to reflect that fact. The other workshops are also consecutive as the overlap between them may be substantial and many participants will be involved with several events.

For each of the five workshops, there will be three series of three or four mini-lectures. These will run for one hour in the morning and one in the afternoon, each day for three or four consecutive days. These will be targetted at graduate students, postdocs and all non-specialists who are interested in learning a new active direction of research.

Each workshop will also have three mini-courses of up to four hours each. In addition, about 25 one-hour lecturers will be selected and invited by the program committee. People will be encouraged to give survey talks which should make them more valuable to the target audience.

In total, each workshop will have about 35 talks over seven days. The lecture schedule will end everyday at 3:00 pm so that participants can have ample time for interaction and collaboration afterward.

A related workshop on Theoretical and Numerical Fluid Mechanics will take place August 20–25, 2001.

Workshop Descriptions:

Following is an elaboration on the workshop topics to be held at PIMS, providing greater detail of the anticipated activities. We also list potential organizers, and potential participants both from Canadian universities and from outside of Canada. These lists are meant only to give some idea of the possible interested participants but is unlikely to be a complete list.

Viscosity Methods in Partial Differential Equations, PIMS-UBC, July 2–10, 2001

paragraphOrganizers: P. L. Lions (Paris), M. Crandall (Santa Barbara), P. Souganidis (Maddison-Austin)

This workshop will focus on the theory of viscosity solutions of differential equations and its applications. Viscosity solutions are the correct class of weak solutions of fully nonlinear first and

second order, possibly degenerate partial differential equations. As such they provide the tools which are necessary for the analysis and further understanding of such equations. Some of the problems in this general context which will be investigated are:

- the theory of fully non-linear stochastic PDEs;
- boundary value problems with non-standard boundary conditions for fully non linear elliptic PDEs;
- equations with singular coefficients and/or non standard growth conditions;
- various questions regarding the Stefan problems, which are related to the motion of moving interfaces with velocity depending upon the interface, positions, direction, curvature, gradient difference of the temperature, etc;
- the studies of ray theory for multiphase geometrical optics and of generalized characteristics which connect the theory of viscosity solutions to contact and symplectic geometry;
- regularity problems for nonlinear second order elliptic equations and free boundary problems.

There will also be an emphasis on the applications of the theory to Phase transition, Combustion, Control theory, mathematical finance, and image processing.

Phase Transitions, PIMS-UBC, July 11–18, 2001

Organizers: Nassif Ghoussoub (PIMS & UBC) and Changfeng Gui (UBC)

This workshop will focus on problems in phase transition such as formation and evolution of grain boundaries in alloys, vortex states in superconducting materials, etc. The related equations include Cahn-Hilliard equations, Allen-Cahn equations, Ginzburg-Landau equations, and others.

Concentration Phenomena and Vortex Dynamics, PIMS-UBC, July 19–27, 2001

Organizers: Changfeng Gui (UBC) and Wei-Ming Ni (Minnesota)

Concentration phenomena have been discovered in many different areas. Mathematically they appear in the forms such as vortices in Ginzburg-Landau equations, spike-layers in biological diffusions, etc. This workshop will focus on the up-to-date advances in these phenomena and the variatonal methods involved. Related equations include Ginzburg-Landau equations, nonlinear Schrodinger equations, Gierer-Meinhardt systems, and others.

Variational Methods and their Applications in PDEs, Hamiltonian Systems & Mathematical Physics, PIMS-UBC, July 30 – Aug. 7, 2001

Organizers: Maria J. Esteban (Paris), Nassif Ghoussoub (UBC), Paul Rabinowitz (Wisconsin)

This session will deal with modern variational methods which have been at the core of mathematics for a long time, yet still experiencing major development: Various infinite dimensional extensions of Morse theory, new "gluing" techniques and useful duality methods. Variational methods have had enormous new applications in the study of problems in phase transition, Hamitonian systems, pattern formation, fluid dynamics, Riemannian geometry, etc., as they are used to answer questions about existence, multiplicity, location, asymptotics, concentration, etc.

Geometric PDEs, PIMS-UBC, August 8–17, 2001

Organizers: Gang Tian (MIT) and Jingyi Chen (UBC)

This workshop will focus on PDE problems arising from geometry particularly in the study of Kahler-Einstein manifolds, minimal surfaces, scalar curvature, harmonic maps, and other phenomena.

Theme 2001 (B): Theoretical, Numerical and Industrial Fluid Dynamics

The mathematical **theory of waves** has a wide spectrum of cross-disciplinary applications. In geophysical contexts waves are a primary method by which energy is transported in fluids and they are thus responsible for global circulation of the atmosphere, the oceans and the earth's mantle. In biological contexts, waves are used in the study of haemodynamic neural networks and respiratory flows. Waves are also studied for their use in remote sensing and have been exploited to map our atmosphere from space, to explore and see the deep oceans and to detect biological disease by non-invasive methods.

The equations that describe the most fundamental behavior of a fluid were derived by Euler in 1755. They are the equations of conservation of momentum and conservation of mass of a fluid that is incompressible, has constant density and is inviscid. The initial boundary value problem for the **Euler equations** is surprising difficult and it is perhaps the most challenging of all problems in PDE that arises directly from physics. Incorporation of the effects of viscosity (for friction) leads to the **Navier-Stokes equations**. The fundamental open questions are all related to the issues of the formation of singularities in finite time.

Programme Organizers:

Giovanni P. Galdi (Pittsburgh)
John Heywood (UBC)
Rolf Rannacher (Heidelberg)
Bruce Sutherland (U. Alberta)
Andrew Bush (U. Alberta)
T. Bryant Moodie (U. Alberta)

Workshops:

3rd Annual PIMS Summer School in Industrial Fluid Dynamics,
U. Alberta, June 4–8, 2001

Wave Phenomena III: Waves in fluids from the microscopic to the planetary scale,
U. Alberta, June 11–15, 2001

Workshop on Theoretical and Numerical Fluid Mechanics,
Vancouver, August 20–25, 2001

3rd PIMS Summer School in Industrial Fluid Dynamics, University of Alberta, May 27 – June 8, 2001

Organizers: B. R. Sutherland and T. B. Moodie (U. Alberta)

This summer school offers an enriched learning environment in which the theoretical, experimental and computational aspects of fluid dynamics are synthesized. Participants attend a comprehensive series of lectures, and are given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory. In addition, they will run numerical simulations using research-level codes. Topics will include fluid dynamics fundamentals, industrial and environmental flows, geophysical fluid dynamics, turbulence modeling and computational fluid dynamics.

Wave Phenomena III: Waves in fluids from the microscopic to the planetary scale, University of Alberta, Edmonton, June 11–15, 2001

Conference Organisers: T. B. Moodie, Andrew Bush, Bruce Sutherland, Gordon Swaters (U. Alberta)

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

The previous two Wave Phenomena meetings were held in Toronto (1983) and in Edmonton (1992). For this meeting, the focus will be on the fluid medium for wave transmission. This was done, first because of the general importance of the subject area at this time with its relation to world climate change and our concerns with this change and secondly in order to better mesh with the topics of the Third Annual PIMS Summer School in Fluid Dynamics. The plenary speakers have been chosen for their prominence in the scientific community as well as their ability to communicate their ideas. From the list of confirmed Plenary Lecturers you can find the person who gave La Nina its name, the person who unravelled the mechanisms leading to the breakdown of the ozone layer, others with methods that bear their name, members of the National Academy of Sciences, the Royal Society of London, and the Royal Society of Canada.

Intended Audience:

This conference should appeal to all those researchers and their students with an interest in general fluid mechanics, geophysical fluid dynamics, wave propagation, and biofluiddynamics. These interested persons will come from departments of mathematics, physics, biology, atmospheric, oceanic and earth sciences, and also physiology.

It is our intention by juxtaposing the Third Annual PIMS Fluid Dynamics Summer School with the international meeting Wave Phenomena III: 'Waves in Fluids from the Microscopic to the Planetary Scale', to provide an unparalleled opportunity for the students attending the PIMS Summer School in Fluid Dynamics at the University of Alberta to benefit from the presence of a group of the world's top scientists in the various aspects of fluid dynamics.

Plenary Speakers:

Peter G. Baines (CSIRO, Australia)
David Benney (MIT)
Jerry L. Bona (Univ. of Texas at Austin)
Carlo Cercignani (Poli. di Milano)
Harindra Fernando (Arizona State Univ.)
Roger Grimshaw (Monash Univ.)
Emil J. Hopfinger (CNRS/UJF/INPG, Grenoble)
Herbert Huppert (Univ. of Cambridge)
Dick S. Lindzen (MIT)
Michael Longuet-Higgins (Univ. of California, San Diego)
Andrew Majda (Courant Institute)
Michael McIntyre (Univ. of Cambridge)
James C. McWilliams (Univ. of California, Los Angeles)
Robert Miura (UBC)
Alan Newell (Univ. of Warwick)
W. Richard Peltier (Univ. of Toronto)
S. George Philander (Princeton Univ.)
Raymond Pierrehumbert (Univ. of Chicago)
Peter Rhines (Univ. of Washington)
Colin Rogers (Univ. of New South Wales)
P. L. Sachdev (Indian Inst. of Science, Bangalore)
Theodore G. Shepherd (Univ. of Toronto)
Melvin Stern (Florida State Univ.)
Steve A. Thorpe (Univ. of Southampton)
John A. Whitehead (Woods Hole Oceanographic Inst.)

Workshop on Theoretical and Numerical Fluid Mechanics Vancouver, August 20–25, 2001

Organizers: Giovanni P. Galdi (Pittsburgh), John Heywood (UBC, chairman), Rolf Rannacher (Heidelberg)

The first purpose of this meeting is to bring together leading researchers from several areas of fluid dynamics to share recent developments, discuss their significance, and bring into focus new directions and problems. The topics to be considered will share a unifying theme, in that their theoretical starting points are in the mathematical theory of the Navier-Stokes equations. Specifically, we will focus on: Nonlinear Fluids, Turbulence, Viscous Compressible Flow, Classical Navier-Stokes Problems, and Numerical Methods for these various types of problems.

A second theme will be to bring to attention interesting problems for numerical computation. Presently, we have achieved the capability to compute two and three dimensional incompressible Navier-Stokes flow in complicated geometries, provided that the complexity of the solution (its range of scales) does not exceed the limitations of our hardware. We aim to promote the extension of current numerical methods to problems for compressible and nonlinear fluids, and also to the modeling of turbulent flow. Also, with improved computational ability, many classical Navier-Stokes problems have become suggestive of interesting situations for numerical computation. Many of these raise interesting questions concerning artificial boundary conditions, for the restriction of idealized problems to bounded computational domains. Other problems for numerical computation involve questions of stability and bifurcation, and of attractors, and of the statistical properties of attractors, and of the energy dissipation in different regions of the spectrum.

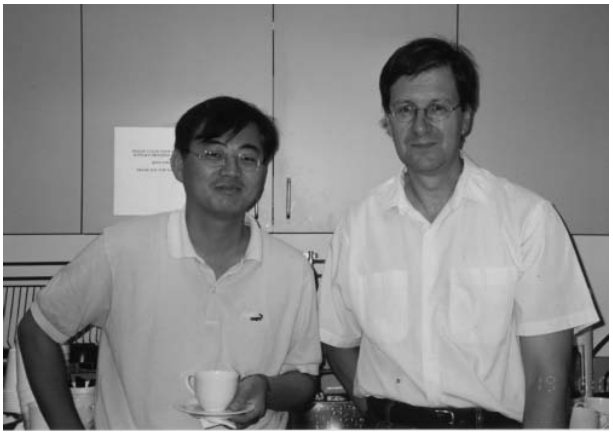
Finally, it is expected that this meeting will bring Canadian and American research in mathematical fluid dynamics into better contact with European and Japanese research.

Speakers and Participants: H. Amann (Zürich, Switzerland), T. Beale (Durham, USA), H. Beiro da Veiga (Pisa, Italy), Z. Chen (Tianjin, China), R. Finn (Stanford, USA), H. Fujita (Tokyo, Japan), V. Fursikov (Moscow, Russia), Y. Giga (Sapporo, Japan), R. Glowinski (Houston, USA), H. Han (Bejing, China), D. Hoff (Bloomington, USA), R. Illner (Victoria, Canada), G. Iooss (Nice, France), C. Johnson (Gothenberg, Sweden), A.V. Kazhikov (Novosibirsk, Russia), D. Kreiner (Freiburg, Germany), O. A. Ladyzhenskaya (St Petersburg, Russia), K. Masuda (Sendai, Japan), W. Nagata (Vancouver, Canada), J. Necas (Dekalb, USA/ Prague, Czech Republic), T. Nishida (Kyoto, Japan), M. Padula (Ferrara, Italy), K. Pileckas (Vilnius, Lithuania), O. Pironneau (Paris, France), A. Quarteroni (Milano, Italy), D. Sattinger (Logan, USA), N. Sauer (Pretoria, South Africa), H. Sohr (Paderborn, Germany), V. A. Solonnikov (St Petersburg, Russia), I. Straskraba (Prague, Czech Republic)

II. CORE SCIENTIFIC PROGRAMS:

1999–2001

Organizers of the **PIMS Mini-programme in Geometric Functional Analysis,** Nicole Tomczak-Jaegermann and Vitali Milman.



Taejin Lee and Gordon Semenoff, members of the organizing committtee of the 1999 **Frontiers in Mathemimatical Physics Workshop on Particles, Fields and Strings.**

Fields Medalist Tim Gowers with Vitali Milman.

PIMS Mini-Programmes

Geometric Functional Analysis, PIMS-UBC, June 27 – July 18, 1999

Organizers: Vitali Milman (Tel Aviv) and Nicole Tomczak-Jaegermann (University of Alberta)

Geometric Functional Analysis is concerned with geometric and linear properties of finite- and infinite-dimensional convex bodies. General framework and deep geometric, probabilistic and combinatorial methods developed here are used in many areas outside the field, in Analysis, Geometry and many others.
This workshop focused on asymptotic theory of finite-dimensional normed spaces and related topics of convexity, probability theory, isoperimetric inequalities, random matrices and others. Also, new connections with the theory of infinite-dimensional Banach spaces, and its recently developed asymptotic aspects, were examined.

The mini-programme in Geometric Functional Analysis also incorporated a satellite conference in honour of Vitali Milman's 60^{th} birthday.

Conference in Convex Geometric Analysis, PIMS-UBC, June 30 – July 3, 1999

Scientific Committee: Jean Bourgain (IAS), Timothy Gowers (Cambridge), Michail Gromov (IHES and Courant), Gilles Pisier (Paris VI and Texas), Nicole Tomczak-Jaegermann (Alberta)

Frontiers In Mathematical Physics Workshop on Particles, Fields, and Strings, PIMS-UBC, Aug. 2–20, 1999

Organizers:

Taejin Lee (Kangwon National U.)
Yuri Makeenko (ITEP, Moscow)
John Ng (TRIUMF)
Soonkeon Nam (APCTP, Seoul)
Chaiho Rim (APCTP, Seoul)
Alexander Rutherford (PIMS)
Gordon Semenoff (UBC)
K. S. Viswanathan (SFU)
Ariel Zhitnitsky (UBC)

The main scientific topic was recent developments in superstring theory. The two main themes were the IKKT matrix model of type IIB strings and the AdS/CFT correspondence. Other topics, such as the role of K-theory in string theory, the structure of supersymmetric Yang-Mills theory and some general questions about the solutions of supergravity were also discussed.

Michail Gromov (IHES and Courant Institute) at the **PIMS Mini-programme on Geometric Functional Analysis.**

Geometric Functional Analysis, PIMS-UBC, June 27 – July 18, 1999

Organizers: Vitali Milman (Tel Aviv), Nicole Tomczak-Jaegermann (University of Alberta)

Over the recent years, Geometric Functional Analysis noted several significant accomplishments. Marked by two Fields Medals by J. Bourgain, 1994 and T. Gowers, 1998; the Plenary Address at the European Congress of Mathematics, 1996 by V. Milman, and two Plenary Addresses at the International Congress of Mathematicians, 1998, by G. Pisier and M. Talagrand. Also, 4 invited lectures at the last two Congresses (Gowers, Odell-Schlumprecht, Milman, Tomczak) represented the spectrum of achievements from geometric purely infinite dimensional phenomena to high dimentional ones.

The workshop brought together top researchers in the field to exchange new ideas and present their recent results. Young researchers, postdocs and advanced Ph.D. students were in attendance, and an emphasis was placed on encouraging interactions between these young researchers and the senior mathematicians attending the meeting. In order to facilitate spontaneous discussions, the number of talks on each day of the workshop was typically limited to two.

Fields Medalist Jean Bourgain at the **PIMS Mini-programme on Geometric Functional Analysis.**

Speakers and Participants:

Dan Amir (Tel Aviv U.)

George Androulakis (Texas A & M): *Candidates for prime spaces*

Spiros Argyros (U. Athens)

Wojciech Banaszczyk (U. Lodz)

Franck Barthe (U. Marne-la-Vallee): *Brascamp-Lieb inequality and measure transportation* and *Isoperimetric inequalities for Gaussian type*

Sergey G. Bobkov (Syktyvkar U.): *On log-sobolev inequalities*

Apostolos Giannopoulos (U. Crete)

Efim D. Gluskin (Tel Aviv U.)

Yehoram Gordon (Technion): *Volume ratios and local theory*

W. Timothy Gowers (Cambridge)

Olivier Guedon (U. Paris VI): *Random methods in geometry of Schatten classes*

Petr Hajek (Texas A & M)

William B. Johnson (Texas A&M)

Nigel Kalton (U. Missouri)

Hermann Koenig (U. Kiel): *Variants of Khintchin inequality*

Alex Koldobsky (U. Texas at San Antonio): *Functional analysis approach to intersection bodies*

Rafal Latala (Warsaw U.): *S-conjecture*

Joram Lindenstrauss (Hebrew U.)

Alexander Litvak (U. Alberta)

Piotr Mankiewicz (Polish Academy of Sciences): *Convexified distance between random quotients of* l_1^n

Mathieu Meyer (U. Marne-la-Vallee): *Maximal volume sections*

Edward Odell (U. Texas at Austin)

Krzysztof Oleszkiewicz (Warsaw U.): *S-conjecture Between Sobolev and Poincare*

Alain Pajor (U. Marne-la-Vallee): *Questions on non-symmetry*

Gilles Pisier (U. Paris VI)

Aleksander Pelczynski (Polish Academy of Sciences): *Ellipsoidal sections of convex bodies*

Shlomo Reisner (Haifa U.): *Dropping a vertex or a facet from a convex polytope*

Haskell P. Rosenthal (U. Texas at Austin): *M-approximate identities for* X *in* Y*, with* $X \subset Y$

Mark Rudelson (U. Missouri): *Lipschitz embeddings of Levy families*

Gideon Schechtman (Weizmann Institute of Sciences): *Graph indexed random walks* and *Lewis' change of density revisited*

Thomas Schlumprecht (Texas A&M): *Asymptotic structures of Banach spaces (II)*

Carsten Schuett (U. Kiel): emphRandom polytops

Stanislaw Szarek (U. Paris VI)

Michel Talagrand (Ohio State U.)

Tony Tsolomitis (U. Crete)

Elisabeth Werner (Case Western Reserve)

Conference in Convex Geometric Analysis, June 30 – July 3, 1999

Scientific Committe: Jean Bourgain (IAS), Timothy Gowers (Cambridge), Michail Gromov (IFES and Courant), Gilles Pisier (Paris VI and Texas), Nicole Tomczak-Jaegermann (Alberta)

The mini-programme in Geometric Functional Analysis also incorporated a satellite conference in honour of Vitali Milman's 60^{th} birthday. Closely related to the workshop, this conference was intended to have a broader scientific content. The participants of the workshop were invited to attend, and a number of additional speakers ere welcomed. Unlike the workshop, a full day of talks was scheduled for each day of the conference.

Plenary Speakers:

Semyon Alesker (U. Paris VI and Tel Aviv U.): *Continuous valuations on convex sets*

Sergey G. Bobkov (Syktyvkar U.): *Concentration phenomena in Probability*

Jean Bourgain (IAS, Princeton): *Non-perturbative localization and semi-algebraic sets*

Nassif Ghoussoub (PIMS and UBC): *DeGiorgi's and Gibbons' Conjectures*

Apostolos Giannopoulos (U. Crete): *Isotropic positions of convex bodies*

W. Timothy Gowers (Cambridge): *Szemeredi's theorem*

Michail Gromov (IHES and Courant Institute)

William B. Johnson (Texas A & M)

Gideon Schechtman (Weizmann Inst. of Sciences)

Nigel Kalton (U. Missouri): *Local theory theory of Banach spaces and approximation of polynomials*

Joram Lindenstrauss (Hebrew U.): *Exceptional sets in Banach spaces*

Pierre Milman (U. Toronto): *All you ever wanted to know about resolution of singularities*

Vitali Milman (Tel Aviv U.): *Concentration phenomenon without metric; phase transitions in the asymptotic geometric analysis*

Edward Odell (U. Texas at Austin): *Asymptotic properties of Banach spaces under renormings*

Gilles Pisier (Univ. Paris VI and Texas A & M): *Similarity degree and random matrices*

Thomas Schlumprecht (Texas A & M): *Asymptotic properties of Banach spaces under renormings*

Nicole Tomczak-Jaegermann (U. Alberta): *Asymptotic finite-dimensional structure of infinite-dimensional Banach spaces*

Frontiers in Mathematical Physics Workshop on Particles, Fields, and Strings, PIMS-UBC, Aug. 2–20, 1999

Organizers: Taejin Lee (Kangwon National U.), Yuri Makeenko (ITEP, Moscow & NBI, Copenhagen), John Ng (TRIUMF), Soonkeon Nam (APCTP, Seoul), Chaiho Rim (APCTP, Seoul), Alexander Rutherford (PIMS), Gordon Semenoff (UBC), K.S. Viswanathan (SFU), Ariel Zhitnitsky (UBC)

The 1999 Frontiers in Mathematical Physics Workshop, entitled *Particles, Fields and Strings* took place at the Pacific Institute for Mathematical Sciences site at the University of British Columbia between August 2 and 20, 1999.

There were sixty-eight participants. Of these, sixteen were postdoctoral fellows, fourteen were graduate students and the remainder were more senior scientists. Participation in the workshop was truely international, with scientists from Russia, Korea, Japan, Taiwan, USA, Canada, Italy, France, England, Spain, Denmark and Ireland among the participants.

There were two seminars per day during the Workshop. The schedule provided a significant amount of time for discussions and scientific work. Collaborations were encouraged. The seminar speakers were a combination of invited speakers and other participants. The presence of invited speakers provided a scientific focus to the workshop and strengthened the quality of the seminars.

Among the invited lecturers, Igor Klebanov (Princeton) presented a series of three review lectures on the AdS/CFT correspondence and Joe Polchinski (ITP Santa Barbara) gave a series of two lectures discussing some more advanced issues in that subject.

Lecturers:

Emil Akhmedov (ITEP, Moscow)
Robert Brandenberger (Brown)
Paolo Cotta-Ramusino (Universita di Milano)

Alessandro d'Adda (INFN Torino)
David Fairlie (University of Durham)
Peter Horava (Caltech)
S. Hyun (KIAS)
Kimyeong Lee (Seoul National University)
Yoshihisa Kitazawa (KEK, Japan)
Igor Klebanov (Princeton)
Per Kraus (Chicago)
Peter Orland (Baruch College, CUNY)
Manu Paranjape (Université de Montréal)
Amanda Peet (ITP, Santa Barbara)
Joe Polchinski (ITP, Santa Barbara)
Mark van Raamsdonk (Princeton University)
S. Rajeev (Rochester)
Sang-Jin Sin, (Hanyang University)
Vinnakota Sreedhar (IAS, Dublin)
H. Sugino (KEK, Japan)
Richard Szabo (Niels Bohr Institute)
Konstantin Zarembo (UBC)

Participants:

Paul Percy (Princeton), Alex G. Quiroz Buelvas (D. F. T. — Trieste), Per Kraus (U. Chicago), David Fairlie (U. Durham England), Andrei Zelnikov (U. Alberta), Manu Paranjape (U. Montréal), Paulo Vargas Moniz (Physics Department, U. Beira), Richard Szabo (The Niels Bohr Institut), Anastasia Volovich (Harvard), Radu Tatar (Department of Physics, Brown U.), Anastasios Petkou (U. Thessaloniki, Greece), Alessandro D'Adda (INFN, Torino), Diego Navarro (Instituto de Fisica Corpuscular, Valencia), Kyungho Oh (Institution U. Missouri), Gordon Chan (UCLA), Giuseppe Carlino (U. Genova), Romuald Janik (CEA Saclay), Sreedhar Vinnakota (Dublin Institute for Advanced Studies), Robert Brandenberger (Brown and UBC), Richard Mackenzie (UBC), Ivo Klemes (McGill), Dongsu Bak (U. Seoul), Taejin Lee (Kangwon National U.), Hyunsoo Min (U. Seoul), Soonkeon Nam (APCTP/Kyunghee U.), Soo-Jong Rey (Seoul National U.), Sang-Jin Sin (Hanyang U.)

Participants in the 1999 **Frontiers in Mathematical Physics** workshop enjoy dinner.

Frontiers in Mathematical Physics on Workshop on String Cosmology, PIMS-UBC, July 24 – August 4, 2000

Organizers: Robert Brandenberger (Brown U.), Chaiho Rim (APCTP), Alexander Rutherford (PIMS), Bill Unruh (UBC) and Ariel Zhitnitsky (UBC).

The goal of the Workshop is to bring together experts in string theory, nonperturbative gauge field theory and cosmology to explore the consequences for cosmology of the recent breakthroughs in fundamental field and string theory. These consequences may lead to a greatly improved understanding of the early Universe, and to the resolution of some fundamental problems for cosmology left unanswered by the present theories of the early Universe.

This workshop is co-sponsored by PIMS, the Canadian Insitute for Advanced Research and the Asia Pacific Center for Theoretical Physics.

Invited Speakers:

Tom Banks (Rutgers),
Gia Dvali (New York U. and ICTP)
Nemanja Kaloper (CITA, U. Toronto)
Lev Kofman (CITA, U. Toronto)
Andrei Linde (Stanford U.)
Rob Myers (McGill)
Burt Ovrut (U. Pennsylvania)
Soo-Jong Rey (Seoul National U.)
Valery Rubakov (Inst. for Nuclear Research, Moscow)
Misha Shaposhnikov (U. Lausanne)
E. Shuryak (Stony Brook)
Dam Son (Columbia U.)
Paul Steinhardt (Princeton)
Neil Turok (DAMTP, Cambridge)
Gabriele Veneziano (CERN)

Pacific Northwest Seminar Series

These are annual or bi-annual meetings that bring together various regional groups of mathematicians in areas represented by strong communities in British Columbia, Alberta, Washington, Oregon and Northern California. Some of the scientific goals of the Pacific Institute, e.g. promoting communication and interactions among mathematical scientists, are served by *ad hoc* organizations formed in Western Canada and the U. S. Pacific Northwest.

PNW Probability Seminar

This is an annual seminar held by the probability groups at the University of British Columbia, University of Washington and Oregon State University. Traditionally it has alternated between UBC and UW although in the last few years it has been hosted by UW due to its central location. It usually attracts 25–30 participants including 8–10 from UBC and gives the groups a chance to interact with each other. As these are among the strongest probability groups in North America it has been easy to attract outstanding scientists as speakers. This is also a good way for these groups to share many of the visiting scientists with the other sites.

Scientific advisory committee: Martin Barlow (UBC), Richard Bass (UW), Chris Burdzy (UW), Ed Perkins (UBC), Ed Waymire (OSU).

The last conference was hosted by the University of Washington on March 4, 2000. The lectures were given by:

Christian Borgs (Microsoft Theory Group): *Partition function zeros: A generalized Lee-Yang theorem*

Xiaowen Zhou (University of British Columbia): *Sample path continuity of continuous-site stepping-stone models*

PNW Number Theory Seminar

The most recent PNW Number Theory Seminar was held at the University of Washington on April 17, 1999. The organizers are Joe Buhler (Reed College) and Ralph Greenberg (U. Washington). The invited speakers were Bill Casselman (UBC), Adrian Iovita (U. Washington), Karl Rubin (Stanford) and John Tate (U. Texas).

Previous sessions of the PNW Number Theory Seminar have been held at the Harbour Centre campus of Simon Fraser University. The organizers were Peter Borwein (SFU), David Boyd, (UBC) and Joe Buhler (Reed College). The speakers were Joe Buhler (Reed College) and Fernando Rodriguez Villegas (U. Texas, Austin), Michael Bennett (U. Illinois, Urbana-Champaign and Institute for Advanced Study), Rajiv Gupta (UBC), Chris Skinner (Institute for Advanced Study), and Fernando Rodriguez Villegas (U. Texas).

West Coast Optimization Seminar

The West Coast Optimization Meeting takes place twice each year, usually in April and November, and alternates between Vancouver and Seattle. In Vancouver, SFU/CECM and

UBC/Math share the hosting duties, with local contacts Jonathan M. Borwein and Philip D. Loewen. In Seattle, UW/Math and UW/Applied Math contribute the organizational personnel: R. T. Rockafellar and J. V. Burke do most of the work. The meetings involve an informal get-together for social and technical discussions on Friday evening, followed by a series of talks on Saturday. Speakers are drawn from the considerable body of optimization talent now gathered in the five PIMS partner sites, the University of Washington, and Washington State University; a featured guest from outside is usually invited to round out the programme.

PIMS sponsored the Spring 1999, which was held at the Harbour Centre Campus of Simon Fraser University on April 23–24, 1999. The speakers were:

Heinz Bauschke (Okanagan University College): *A weak-to-strong convergence principle for Fejer-monotone methods in Hilbert space*

Jane Ye (UVic): *Constraint Qualifications and Necessary Optimality Conditions for Optimization Problems with Variational Inequality Constraints*

Pierre Marechal (PIMS, SFU, CECM): *On Radon-type inverse problems*

Levent Tuncel (U. Waterloo): *Combinatorics and Optimization Cones of matrices and successive convex relaxations of nonconvex sets*

Marian Fabian (Czech Academy of Sciences): *Stegall's smooth variational principle and its applications*

Yves Lucet (PIMS, UVic): *How do you build a smooth convex interpolant?*

Grant Galbraith (U. Washington): *Cosmic Sub-Lipschitz Mappings and Applications*

The next meeting will be held on May 12–13, 2000 at PIMS-SFU. The speakers are:

Heinz Bauschke (Okanagan University College): *How JPEG Works*

Jim Burke (University of Washington): *Variational Analysis of Spectral Functions*

Lisa Korf (University of Washington): *Pricing Contracts Contingent on a Market: A Mathematical Programming Perspective*

Ivaylo Kortezov (SFU): *Some Generic Results on Non-attaining Functionals*

Yuri Ledyaev (Western Michigan University): *Sub- and Supergradients of Envelopes, Semicontinuous Closures and Limits of Functions*

Martin Puterman (UBC): *The Censored Newsvendor and the Optimal Acquisition of Information*

Jim Zhu (Western Michigan University): *Generalized Extremal Principle and its Applications*

PNW Geometry Seminar

The Pacific Northwest Geometry Seminar (PNGS) is a regional meeting for geometers of all kinds. It is held every quarter during the academic year, rotating among the University of British Columbia, Oregon State University, University of Oregon, Portland State University, University of Utah, and the University of Washington.

The most recent meeting was co-sponsored by PIMS and the National Science Foundation of the United States). It was held on May 6-7, 2000 at PIMS-UBC.

Organizers: Jim Carrell (UBC) and Jingyi Chen (UBC)

Speakers:

Gang Liu (UCLA): *The Equivalence of Ring Structures in Floer and Quantum Cohomology*

Stephan Stolz (Notre Dame): *Metrics of Positive Scalar Curvature*

Rahul Pandharipande (CalTech): *Integrals over the moduli space of curves*

Paul Yang (Princeton and USC): *A Fully Nonlinear Equation in Conformal Geometry and 4-manifolds of Positive Ricci Curvature*

Jim Carrell (UBC): *Which Schubert Varieties are Smooth*

Participants: Judith Arms (U. Washington), Boris Botvinuik (U. of Oregon), Jingyi Chen (UBC), Graham Denham (U. of Oregon), Sylvie Desjardins (OUC, Kelowna), Amy Ehrlich (U. Washington), Christine Escher (Oregon State University), Dan Fox (U. Washington), Marshall Hampton (U. Washington), Dylan Helliwell (U. Washington), Yau Heng Tom Wan(Chinese University of Hong Kong), Jochen Kuttler (Uni. Basel, Switzerland), Kee Y. Lam (UBC), Nicole Lemire (U. of Oregon), Gregory Landweber (Microsoft Research), John Lee (U. Washington), Jiayu Li (Academia Sinica, Beijing), Peter Littig (U. Washington), Gang Liu (UCLA), Daniel Pollack (U. Washington), Jesse Ratzkin (U. Washington), Stephan Stolz (Notre Dame University), Boris Tschirschwitz (UBC) Paul Yang (USC, Los Angeles)

PNW PDE Conference

Organizers : Richard Froese (UBC), Nassif Ghoussoub (PIMS and UBC) and Gunther Uhlmann (U. Washington)

The first Pacific Northwest meeting on Partial Differential Equations will be hosted on May 20, 2000 by the Pacific Institute of Mathematical Sciences at the University of British Columbia in Vancouver Canada. Future meetings will be held at the University of Washington, and at other universities in the Pacific Northwest.

Speakers:

Daniel Tataru (Northwestern): *Local well-posedness for nonlinear hyperbolic equations*

Tatiana Toro (U. Washington): *Potential theory and regularity of non-smooth domains*

Juncheng Wei (Chinese U. of Hong Kong): *On A Simple ODE and Anisotropic Curvature Flows*

Cascade Topology Seminar

This is a twice-yearly seminar which rotates among universities of the US Pacific Northwest, and western Canada. Its purpose is to gather topologists of the region, and present lectures on recent progress in the field, at an informal weekend meeting. It was originally modelled after the Pacific Northwest Geometry Seminar, and there is some overlap in the audiences. Like the PNGS, the Cascade seminars are very successful, and have been supported (for the US meetings only) by the US National Science foundation. The meetings are informal and friendly, and a special effort is made to encourage participation by graduate students by providing their housing costs.

The 24^{th} Cascade Toplogy Seminar was held at PIMS-UBC on October 2–3, 1999. It was in honour of Professor Erhard Luft, who recently retired from the Department of Mathematics at UBC. Approximately 50 participants attended from the PIMS universities, Oregon State University, the University of Oregon, Portland State University, the University of Washington and the Mathematical Sciences Research Institute. The seminar was jointly sponsored by PIMS and the National Science Foundation of the United States.

Speakers:

Alejandro Adem (U. Wisconsin): *Periodicity, Euler Classes and Group Actions*

Guillermo Moreno (Centro de Investigacion del IPN and U. Oregon): *The Zero Set of the Hopf Map*

John Palmieri (U. Washington): *Stable Homotopy Theory and the Steenrod Algebra*

Leila Schneps (ENS Paris): *Diffeomorphisms of Topological Surfaces and the Absolute Galois Group*

Denis Sjerve (UBC): *On the Mathematical Contributions of Erhard Luft*

The next Cascade Topology Seminar will be held at Portland State University on May 20–21, 2000.

Western Canada Linear Algebra Meeting (W-CLAM)

W-CLAM is a bi-annual sequence of meetings on linear algebra and related fields; previous meetings have been held in Regina, Lethbridge and Kananaskis. The objective is to foster research in linear algebra and its applications. While the primary purpose of W-CLAM is to enable researchers (including graduate students) from Western Canada to get together to present current work and to exchange ideas, the meeting is open to anyone.

The last meeting was held at the University of Victoria on July 30–31, 1998. The W-CLAM 2000 will be held at the University of Manitoba in Winnipeg on May 26–27. The principal invited speakers are:

Hans Schneider (University of Wisconsin)

Bryan Shader (University of Wyoming)

Henry Wolkowicz (University of Waterloo)

PIMS Lecture Series

- PIMS Distinguished Chairs
- PIMS Distinguished Colloquium Series
- IAM-PIMS Joint Distinguished Lecture Series in Applied Mathematics
- PIMS-MITACS Mathematical Finance Seminar
- PIMS String Theory Seminar
- PIMS Industrial Math. Seminar

PIMS Distinguished Chairs

PIMS has recently established a program of Distinguished Chairs, which serves to host emminent 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.

The inaugural visit was hosted at the University of Calgary in March and April, 2000 with the invitation of Prof. Yuri Matiyasevich (Steklov Institute) to a six week visit at the University of Calgary.

Prof. Matiyasevich is a distinguished logician and mathematician who is known for his outstanding research in logic, number theory and the theory of computer algorithms. One of his most famous results is the definitive solution to the tenth problem posed by mathematician David Hilbert at the 1900 International Congress of Mathematics, concerning the solution of certain polynomial equations. This, and related results, are fundamental to basic questions in modern computation on digital computers. Prof. Matiyasevich gave a series of six lectures that were attended to capacity by reserarchers and students in mathematics, statistics, and computer science. These lectures were video-taped, and are available on the web for viewing. Also, lecture notes are being prepared for publication.

Prof. Matiyasevich, holder of the 1999 PIMS Distinguished Chair at the University of Calgary.

PIMS Distinguished Chairs for 2000/2001

April 2000 – March 2001

Vladimir Turaev (CNRS Strasbourg VI)
Site: University of Calgary
Proposed Dates: 1 month in 2000

Stephen Donkin (University of London)
Site: University of Alberta
Proposed Dates: July, 2000

Herbert S. Wilf (University of Pennsylvania)
Site: University of Victoria
Proposed Dates: Summer 2000

David Brydges (University of Virginia)
Site: University of British Columbia
Proposed Dates: Sept. 1 to Oct. 15, 2000

Mete Soner (Princeton University)
Site: Simon Fraser University
Proposed Dates: Feb. 2000

April 2001 – April 2002

Gang Tian (MIT)
Site: University of British Columbia
Proposed Dates: August 2001

PIMS Distinguished Colloquium Series

Coordinator: Dale Rolfsen (PIMS & UBC)

Dale Rolfsen,
PIMS-UBC Site Director

PIMS started a distinguished colloquium series in 1996 featuring scientists from industry and academia. The lectures are often delivered from one of the PIMS sites while video links are provided to the others and at times to UNBC and to the University of Lethbridge. Recent lectures are:

Gilbert Strang (MIT): *Cosine Transforms and Wavelet Transforms and Signal Processing,* January 21, 1999.

Richard Karp (U. Washington): *The Design of Molecular Bar Codes: A Combinatorial Problem from Molecular Biology,* May 13, 1999.

Sir Andrew Huxley (Cambridge University): *The background to the Hodgkin-Huxley Equations,* August 19, 1999.

Israel Gohberg (Tel Aviv U.): *Infinite Systems Of Linear Equations,* September 30, 1999.

Ray Reiter (U. Toronto): *Cognitive Robotics,* November 25, 1999.

Sir Christopher Zeeman: *Geometric Unfoldings of a Difference Equation,* March 21, 2000.

IAM-PIMS Joint Distinguished Colloquium Series for 1999/2000

This new series of seminars is co-hosted by the Institute for Applied Mathematics at UBC and PIMS; all takes take place on the UBC campus.

Organizer: Anthony Peirce (UBC)

Anthony Peirce, Director of the IAM

Modeling neuronal Dynamic in the Visual Cortex

Michael Shelley (The Courant Institute), September 27, 1999

The primary visual cortex (V1) of the mammalian brain marks the first site of selective response of individual neurons to elementary features of visual scenes, such as the orientation or spatial frequency of a pattern. Despite 40 years of intense research effort, a detailed accounting of the neural basis for such selectivity remains elusive. I will discuss the anatomical architecture of the V1 visual cortex — which is complex and fascinating — and some of its response properties. I will then turn to a mathematical model that my collaborators and I have been constructing. This model is consistent with anatomical data, and

is designed to capture the dynamics of a neuronal network in a subregion of V1 where visual information is first received and processed. Through large-scale simulation and mathematical analysis we have found operating regimes of the model where response properties — such as sharpening of orientation selectivity, and "linearization" — are recovered. Our results suggested that under stimulation, the visual cortex acts as an overdamped system.

Transition to Turbulence in Wall-bounded Sheare Flows: the Role of Uncertainty

Bassam Bamieh (UC Santa Barbara), October 25, 1999

The problem of describing transition in wall bounded shear flows such as channel and boundary layer flows is an important and old problem in Hydrodynamic Stability. Classical linear hydrodynamic stability theories provides prediction that are at odds with most experiments where "natural" transition occurs. However, in the past decade it has become recognized that a new analysis of the linearized Navier-Stokes equations yields much more satisfactory answers. It turns out that the non-normality of the linear dynamical operator in strongly sheared flows plays a much more important role in stability than do its eigenvalues.

In this talk, we will review this new hydrodynamic stability theory from the point of view of quantifying uncertainty. The linearized Navier-Stokes equations in strongly sheared flows exhibit remarkable sensitivity to dynamical perturbations and external forcing or noise. We will argue that the right kind of stability analysis must take this uncertainty explicitly into account. We will also point out important connections with modern Robust Control Theory, where analysis of uncertainty effects on stability have been heavily studied.

We will show how this theory predicts the large perturbation energy growth observed in boundary layer flows, and the ubiquitous coherent structures of streamwise vortices and streaks. We will also illustrate how distributed wall roughness can act as a generator of flow disturbances which then initiate transition scenarios. Finally, our results motivate us to propose an input-output theory of shear flow turbulence.

Multisclae Finite Element Computations for Flow and Transport in Strongly Heterogeneous Porous Media

Tom Hou (Caltech), November 22, 1999

We introduce a multiscale finite element method for computing flow and transport in strongly heterogeneous porous media which contain many spatial scales.

The method is designed to effectively capture the large-scale behaviour of the solution without resolving all the small-scale features. This is accomplished by constructing the multiscale finite element base functions that incorporate local microstructures of the differential operator. Our method is applicable to general multiple-scale problems without restrictive assumptions on scale separation and periodicity. Convergence of our method has been established in the case of periodic oscillatory structures. The rate of convergence is shown to be independent of the small scales of the solution. We demonstrate the accuracy and robustness of our method through extensive numerical experiments, which include the scale-up of two-phase flows with strongly shear random permeability, wave propagation through heterogeneous media, and convection enhanced diffusion. Steady conduction through fiber composites and flows through random media with normal and fractal porosity distributions will also be considered. Parallel implementation and performance of the method will be addressed.

Analysis of Krylov Space Methods for Solving Linear Systems

Anne Greenbaum (U. Washington), January 31, 2000

The development of iterative methods for solving large sparse linear systems has been an active area of research for the past several decades. There are still a number of fundamental unanswered questions, however. For example, it still is not fully understood why some of the methods for nonhermitian linear systems — the BiCG, QMR, and BiCGSTAB methods — perform as well as they do. I will discuss this problem and provide at least a qualitative explanation.

Another interesting open question is the effect of nonnormality on the performance of iterative methods. Unlike normal matrices, for which the eigenvalues determine the behaviour of iterative methods such as GMRES, there is no simple characteristic property of nonnormal matrices that is known to govern their behaviour. This question is of importance in a number of other areas as well, and I will discuss various approaches to the analysis of the behaviour of nonnormal matrices.

Mathematics and Statistics of Human DNA Polymorphisms: Forward and Backwards to History

Marc Feldman (Stanford), February 28, 2000

One of the most variable classes of DNA in humans consists of repeated motifs of DNA pairs, triplets, or quadruplets. Mathematical models for the evolution of such loci in finite populations subject to mutation are analyzed. Statistics for within- and between-population analysis are described and applied to problems of estimating dates of divergence of African and non-African modern humans. Methods for detecting signals of population growth or decline have been derived and applied to large sets of di-, tri-, and tetra-nucleotide repeats. Genealogical methods provide a powerful way to analyze samples of alleles at non-recombining loci. The non-recombining part of the Y chromosome has yielded a number of polymorphisms,

both short tandem repeats and single nucleotide polymorphisms. We have made a statistical analysis of these and find the mean of the time since the most recent common ancestor of human Y chromosome is much shorter than previously thought.

Nonlinear Science: Past, Present and Future

Alwyn Scott (U. Arizona and U. Denmark), March 13 2000

Following a brief introduction to the concept of "emergence", the history of this concept in the physical and biological sciences over the past two centuries will be sketched. Then the scope of present research activity in the area will be presented, providing a basis for some speculations about where nonlinear science may be going in the future.

PIMS-MITACS Mathematical Finance Seminars

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

Seminars for 1999/2000

Organizer: Ulrich Haussmann (UBC)

Ulrich Haussmann
(Math, UBC)

Ulrich Haussmann (UBC): *Two Factor Model for Commodity Prices,* January 15, 1999

Ulrich Haussmann (UBC) *Forward and Future Contracts,* January 22, 1999

Owen Walsh (FinancialCAD): *Some Challenging Problems in the Area of Mathematical Finance,* January 28, 1999

Daniel Ng (UBC): *Commodity Pricing: Arbitrage Approach,* February 5, 1999

John Walsh (UBC): *Term Structures of Interest Rates and Random Fields,* February 12, 1999

Lawrence Luo: *Barrier, Double Barrier and Window Barrier Options and Their Applications,* March 5, 1999

Joel Friedman (UBC): *An Introduction to Statistical Arbitrage,* March 18, 1999

Jian Liu: *Portfolio Formation and Risk Management,* March 25, 1999

R. Stamicar (MITACS PDF, UBC): *The early exercise boundary for the American put near expiry: numerical approximation,* June 29, 1999

E. Morrison (Powerex): *Electricity Price Modeling and the Impact on VaR,* July 13 1999

T. Wang (UBC): *Dynamic Risk Measure,* July 27, 1999

Shaun Hatch (TransAlta Corp): *Power Price Derivatives at TransAlta,* August 10, 1999

Andy Ho (UBC): **A survey of models for electricity commodity prices,** August 24, 1999.

David Heath (Carnegie-Mellon University): *Futures-Based Term-Structure Models,* September 30, 1999

A. Lari-Lavassani (University of Calgary): *A Methodology for Pricing Swing Options,* October 24, 1999

I. Karatzas (Columbia University): *Probabilistic Aspects of Finance,* October 26, 1999

G. Stoica (MITACS PDF, UBC): *Mathematical Tools for Jump Models in Electricity Prices,* October 29, 1999

N. G. Dokuchaev (St. Petersburg State University): *Investment problem for stochastic market models with unknown parameters,* November 16, 1999

J. Chadam (Pittsburgh University): *The Exercise Boundary for an American Put Option: Analytical and Numerical Approximations,* November 25, 1999

G. Stoica (MITACS PDF, UBC): *Calibration of the 2-factor electricity model,* January 27, 2000

Y. Zhao (UBC): *Portfolio selection with minimum wealth requirement,* February 10, 2000

Ulrich Haussmann (UBC): *Optimal portfolio selection with limited diversification,* February 24, 2000

N. Dokuchaev (St. Petersburg State University): *Optimal portfolio selection based on historical prices,* March 2, 2000

J. Chadam (Pittsburgh University): *The Exercise Boundary for an American Put Option: Analytical and Numerical Approximations,* March 9, 2000

J. Cvitanic (USC) *Methods of partial hedging,* March 16, 2000

R. Uppal (UBC): *Risk Aversion and Optimal Portfolio Policies in Partial and General Equilibrium Economies,* March 30, 2000

H. Geman (Paris Dauphine), April 2000

R. Stamicar (MITACS PDF, UBC): *A Survey of Stochastic Volatility Models,* May 2, 2000

PIMS String Theory Seminar for 2000

This is a series of lectures on String theory held approximately once per week at the PIMS facility at UBC.

Organizer: Konstantin Zarembo (PIMS PDF, UBC)

Joel Erickson (UBC): *T-duality,* January 25, 2000

W. Mueck (SFU): *Discouraging Facts about the Randall-Sundrum Metric: Geodesics and Newton Law,* February 8, 2000

E. Akhmedov (UBC): *Black Holes in String Theory,* February 29, 2000

Emil Akhmedov (UBC): *Black Holes in String Theory (continued),* March 7, 2000

Peter Matlock (SFU): *Compactification, Supergravity Domain Walls and Brane World Scenario,* March 14, 2000

Andrew DeBenedictis (SFU): *Introduction to the Weyl Anomaly,* March 21, 2000

Noureddine Hambli (UBC): *A Holographic Renormalization Flow in String Theory,* March 28, 2000

Joel Erickson (UBC): *Orbifolds of Conformal Field Theories,* February 1

Damien Easson (Brown University): *The Limiting Curvature Hypothesis and Nonsingular Dilation Cosmology,* April 4, 2000

Stephon Alexander (Brown University): *A String/M Theory Inspired Alternative to Inflation (VSL Scenario),* April 11, 2000

Noureddine Hambli (UBC): *A Holographic Renormalization Flow in String Theory (continued),* April 1, 2000

Gordon Semenoff (UBC): *Matrix Theory Interpretation of the World Sheet of DLCQ String,* May 2, 2000

PIMS Scientific Personnel

PIMS Research Fellows

The PIMS Partnership Programme provides some teaching relief to mathematical scientists in the five founding universities to enable them to participate in, or organize PIMS projects. These include scientific programmes, joint projects with an industrial partner or educational projects. Funding and support for this programme is shared by PIMS and the participating departments.

- D. Boyd (Math, UBC), 98/00
- F. Diacu (Math, SFU), 99/01
- N. Ghoussoub (Math, UBC), 96/00
- A. Gupta (CS, SFU), 96/99
- M. Lamoureux (Math & Stat, UC), 98/01
- T. B. Moodie (Math, UA), 98/01
- R. Miura (Math, UBC), 99/00
- D. Rolfsen (Math, UBC), 96/01
- F. Ruskey (CS, UVic), 98/99

PIMS Postdoctoral Fellows

Seventeen PIMS Postdoctoral Fellowships have been awarded in 99/00 and twenty two in 2000/01 to well deserving young researchers in the mathematical sciences who are within five years of their Ph.D. The nominations came from scientists affiliated with PIMS.

1999/2000 Academic Year

The selection in the 1999/2000 competition was made by David Boyd (Chair), Nick Pippenger (UBC), Charmaine Dean (SFU), Robert Moody (U. Alberta), Rex Wesbrook (U. Calgary) and Pauline van den Driessche (U. Victoria).

1. **Siva Athreya**
   Department of Mathematics, UBC
   Sponsor: Ed Perkins, Martin Barlow, John Walsh
2. **Ioan Bucataru**
   Department of Mathematical Sciences, U. Alberta
   Sponsor: Peter Antonelli
3. **Ricardo Carretero**
   Department of Math. and Statistics, SFU
   Sponsor: Keith Promislow
4. **Alexandra Chavez-Ross**
   Department of Mathematics, UBC
   Sponsor: Leah Keshet
5. **Tahir Choulli**
   Department of Math. and Statistics, U. Calgary
   Sponsosr: Larry Bates, Ali Lari-Lavassani
6. **Igor Fulman**
   Department of Math. and Statistics, U. Calgary
   Sponsors: Berndt Brenken, Michael Lamoureux
7. **Sam Lightwood**
   Department of Math. and Statistics, U. Victoria
   Sponsors: Chris Bose, Ian Putnam
8. **Madhu Nayakkankuppan**
   Department of Mathematics, UBC
   Sponsors: Philip Loewen, Jonathan Borwein, Rene Poliquin
9. **Gengsheng Qin**
   Department of Math. and Statistics, U. Victoria
   Sponsor: Min Tsao
10. **Michael Segal**
    Department of Computer Science, UBC
    Sponsors: David Kirkpatrick, Jack Snoeyink
11. **Sujin Shin**
    Department of Math. and Statistics, U. Victoria
    Sponsors: Christonpher Bose, Ian Putnam
12. **Ladislav Stacho**
    School of Computer Science, SFU
    Sponsor: Tom Shermer
13. **Ulrike Stege**
    Department of Computer Science, U. Victoria
    Sponsors: Mike Fellows, Wendy Myrvold, Valerie King
14. **Bret Stevens**
    Department of Math. and Statistics, SFU
    Sponsor: Brian Alspach
15. **Agnes Szanto**
    Department of Math. and Statistics, SFU
    Sponsors: Brian Alspach, Jonathan Borweim, Peter Borwein, Luis Goddyn, Michael Monagan
16. **Bert Wiest**
    Department of Mathematics, UBC
    Sponsor: Dale Rolfsen
17. **Konstantin Zarembo**
    Department of Physics, UBC
    Sponsor: Gordon Semenoff

2000/2001 Academic Year

The selection in the 2000/2001 competition was made by David Boyd (Chair), Nick Pippenger (UBC), Charmaine Dean (SFU), Terry Gannon (U. Alberta), B. Salkauskas (U. Calgary) and Pauline van den Driessche (U. Victoria).

1. **Siva Athreya**
   Department of Mathematics, UBC
   Sponsor: Ed Perkins, Martin Barlow, John Walsh
2. **Ji-Guang Bao**
   Department of Mathematics, UBC
   Sponsor: Nassif Ghoussoub
3. **Nils Bruin**
   Department of Math. and Statistics, SFU
   Sponsors: Peter Borwein, David Boyb, Imen Chen, Rajiv Gupta, Nike Vastal
4. **Ricardo Carretero**
   Department of Math. and Statistics, SFU
   Sponsor: Keith Promislow
5. **Yin Chen**
   Department of Mathematical Sciences, U. Alberta
   Sponsors: Anthony Lau, Laurent Marcoux
6. **Wai-Shen Cheung**
   Department of Math. and Statistics, U. Calgary
   Sponsors: Peter Lancaster
7. **Antal Jarai**
   Department of Mahtematics, UBC
   Sponsor: Gordon Slade
8. **Benjamin Klopsch**
   Department of Mathematical Sciences, U. Alberta
   Sponsor: Akbar Rhemtulla
9. **Luis Lehner**
   Department of Physics, UBC
   Sponsors: Matt Choptuik, Bill Uhruh
10. **Sam Lightwood**
    Department of Math. and Statistics, U. Victoria
    Sponsors: Chris Bose, Ian Putnam
11. **Matthias Neufang**
    Department of Mathematical Sciences, U. Alberta
    Sponsor: Volker Runde
12. **Gengsheng Qin**
    Department of Mathematics, U. Victoria
    Sponsor: Min Tsao
13. **Miro Powojowski**
    Dept. of Geology and Geophysics, U. Calgary
    Sponsor: Laurence Bentley
14. **Jorgen Rasmussen**
    Department of Physics, U. Lethbridge
    Sponsor: Mark Walton
15. **Sujin Shin**
    Department of Math. and Statistics, U. Victoria
    Sponsors: Christonpher Bose, Ian Putnam
16. **Ladislav Stacho**
    School of Computer Science, SFU
    Sponsor: Tom Shermer
17. **Joachim Stadel**
    Department of Physics, U. Victoria
    Sponsors: Arif Babul, Julio Navarro
18. **Sumati Surya**
    Department of Physics, U. Alberta
    Sponsors: Kristin Scleich, Don Page, Eric Woolgar
19. **Bert Wiest**
    Department of Mathematics, UBC
    Sponsor: Dale Rolfsen
20. **Yuqing Yang**
    Department of Mathematics, UBC
    Sponsors: Yue-Xian Li, Robert Muira
21. **Yoji Yoshi**
    Department of Mathematical Sciences, U. Alberta
    Sponsors: Bruce Allison, Arturo Painzola, Terry Gannon
22. **Konstantin Zarembo**
    Department of Physics, UBC
    Sponsor: Gordon Semenoff

PIMS Industrial Fellowships

Jointly supervised by PIMS scientists working in concert with their industrial counterparts, PIMS Industrial Postdoctoral Fellows split their time between the university and the company, exchanging intellectual ideas between these two domains. They are expected to participate in industrial workshops and conferences, thereby acting as the conduit for dissemination of knowledge between the industrial partner and the university research group. The following projects have been supported in 1999/2000.

1. **Jie Cheng**
   Industrial Partner: Siemens Research Corporation
   Sponsors: Math, U. Alberta
   Project: Fault Diagnosis in Power Plants
2. **Ruishrng Li**
   Industrial Partner: Lockheed Martin Canada
   Sponsor: Michael Kouritzin (Math, U. Alberta)
   Project: Low Observable Multiple Target Tracking
3. **David Lyder**
   Industrial Partner: VisionSmart
   Sponsors: Michael Kouritzin (Math, U. Alberta)
   Project: Real Time Industrial Process Control and Quality Assurance
4. **Mark Solomonovitch**
   Industrial Partner: Canadian Rural Restructuring Foundation
   Sponsors: (Math, U. Alberta)
   Project: Sustatainability for Rural Economic Systems
5. **Hongtu Zhu**
   Industrial Partners: Pacific Forestry Centre
   Sponsors: Julie Zhou (Math, U. Victoria)
   Project: Modeling the Impact of Climate Change on Vegetations

III. GENERAL SCIENTIFIC EVENTS:

1999–2001

At the *First Canada-China Congress,* August 23–27, 1999, in Beijing, Dr. Tom Brzustowski, President of the Natural Sciences and Engineering Research Council of Canada (NSERC) is shown with the Canadian and Chinese delegations.

Extra-Thematic Scientific Workshops

Due to its unique structure, PIMS is able to move quickly to produce and promote the latest advances in the mathematical sciences and involve PIMS' scientists in them. Rather than centering all its scientific activities around a few topics for an entire academic year, thus tying up resources and limiting participation, PIMS also runs shorter, more intensive programmes to emphasize rapidly developing areas. The flexibility of this structure improves communication between PIMS' members and the larger scientific community, resulting in better trained personnel and establishing vigourous dialogue between the mathematical sciences and the other disciplines.

This section describes the extra-thematic scientific activities of the institute. Each workshop has its own organizing committee and they are mostly held in the various PIMS sites. The selection and funding decisions are made by the Scientific Review Panel.

XIVth Householder Symposium on Numerical Linear Algebra, Chateau Whistler, June 14–18, 1999

Local Organizer: Jim Varah (UBC)

The Householder Symposia originated in a series of meetings organized by Alston Householder, Director of the Mathematics Division of Oak Ridge National Laboratory and Ford Professor at the University of Tennessee. These international meetings were devoted to matrix computations and linear algebra and were held every three years at Gatlinburg, Tennessee. They had a profound influence on the subject.

The last "Gatlinburg" conference was held in 1969 on the occasion of Householder's retirement. At the time it was decided to continue the meetings but vary the place. Since then meetings have been held at three year intervals at Los Alamos, USA; Hopfen am See, Germany; Asilomar, USA; Oxford, England; Waterloo, Canada; Fairfield Glade, USA; Tylosand, Sweden; Lake Arrowhead, USA; and Pontresina, Switzerland.

The meetings, which last for five days, are restricted to about 125 people. They are intensive, with plenary talks in the day and special sessions in the evenings. To encourage people to talk about work in progress, no proceedings are published, although extended abstracts are circulated. The response of the participants to the meetings has been uniformly enthusiastic.

The conferences are run in tandem by a permanent organizing committee and a local arrangements committee. Although attendance is restricted, anyone, including students, can apply. Selection is made by the organizing committee, generally by ballot.

The meeting is also the occasion for the award of the Householder prize for the best thesis in numerical linear algebra. This prize is entirely (and well) supported by contributions solicited at the Symposium banquet.

Programme Committee: Pete Stewart (Maryland), Ake Björck (Linköping), Angelika Bunse-Gerstner (Bremen), Tony Chan (Los

Angeles), Chandler Davis (Toronto), Alan George (Waterloo), Nick Higham (Manchester), Dianne O'Leary (Maryland), Paul Van Dooren (Louvain-la-Neuve), Charles Van Loan (Cornell)

First Canadian Conference on Nonlinear Solid Mechanics, University of Victoria, June 16–20, 1999

Organizer: E. Croitoro (Math & Stat, UVic)

Intended to attract engineers, applied mathematicians, physicists, chemists, software experts, and industrial practitioners, this conference provides an international forum for communicating recent and projected advances in various areas of Nonlinear Solid Mechanics by assembling researchers working on common themes from complementary perspectives.

Plenary Speakers:

T. Belytschko (Northwestern): *A Unified Stability Analysis of Meshless Particle Methods*

M. S. Gadala (UBC): *Arbitrary Lagrangian-Eulerian Formulation in Nonlinear Solid Mechanics: Challanges and Potentials*

M. Hayes (University College Dublin): *On Bell-Constrained Materials*

R. W. Ogden (University of Glasgow): *Dynamics of Surface Coated Elastic Solids at Finite Strain*

A. J. M. Spencer (University of Nottingham): *Plasticity Theory for Fabric-Reinforced Composites*

Mini-Symposia Organizers:

C. O. Horgan (U. Virginia)

Debra P. Warne (U. Tennessee)

Carlos Garcia Garino (Nat. U. of Cuya, Argentina)

M. Hayes (University College Dublin)

A. D. Drozdov (Inst. for Indust. Mathematics, Israel)

M. S. Gadala (UBC)

M. Epstein (U. Calgary)

M. A. Slawinski (U. Calgary)

Peter Schiavone (U. Alberta)

The two Proceedings volumes (ISBN 1550581953) contain the edited version of the papers presented at the Conference including Plenary Lectures, invited presentations within Mini-Symposia and Contributed papers — 147 authors from 24 countries and five continents.

The response from the research community was extremely positive commending the excellence of the authors, the high level of presentations, the format of the conference, and the organisation of the technical and social programme.

The second CanCNSM will take place in 2001 in Vancouver and it will be organised by Professor M. S. Gadala of the University of British Columbia.

Workshop on Smoothing Applications, UBC, June 23–25, 1999

Organizers: Nancy Heckman (UBC), Kiros Berhane (U. Southern California), Hans Mueller (UC Davis), Jane-Ling Wang (UC Davis), Doug Nychka (North Carolina State U. and National Center for Atmospheric Research), Jim Ramsay (McGill), John Rice (UC Berkeley)

The emphasis of the workshop was on the applications of smoothing methods to data. Several sessions were centered around discussion of specific datasets.

Variable Stars: Variable stars are stars for which the intensity of the emitted energy changes over time; for periodic variable stars the change of intensity is periodic over time. Common types of periodic variable stars include eclipsing binaries, RR Lyraes, and Cepheids.

Biological Curve Data: There are three data sets. Two consist of medfly mortality curves for different cohorts. The third gives voltage versus force in chewing in a dental experiment. Mortality curves of medflies are similar in shape,

modulo a possible deformation of the time scale. A general "goal" is exploratory, to provide a representation of the mortality curves for each cohort using few parameters or nonparametric functions. A representation would be satisfactory if one could predict individual processes from summary data such as mean life span. The medfly data file medfpnas.dat contains data for 4 different types of cohorts, made from two factors (sex, diet) in a crossed design. The goal, as in ANOVA, is to study/explain the differences observed in life expectancy in terms of the curves.

Weather Data: There are two data sets: North American Preciptiation and Ocean Wind Field. The first contains monthly precipitation observations at a large number of irregular spaced locations. The precipitation field is non-Gaussian in its distribution and also is not stationary over space. The second involves spatial data with a multivariate response (East-West and North- South components of the wind vector). Surface wind measurements come from two sources: low resolution gridded vectors processed from observational data by numerical models and high resolution, irregularly spaced, satelite data.

Air Pollution and Asthma Data: This is a sample from a large longitudinal dataset with a generalized additive model structure. Data consist of air pollution measurements and yearly measurements on 1600 school children in Southern California. There are two goals of the analyses: to assess the impact of asthma on lung growth in children and to assess the impact of air pollution on the relationship between asthma and lung growth.

Participants:

Chul Ahn (University of Texas Health Science Centre)
Laurie Ainsworth (SFU)
Dieter Ayers (UBC)
Denise Babineau (SFU)
Kiros Berhane (University of Southern California)
John Brewster (University of Manitoba)
Jochen Brumm (UBC)
Sun Lai Ellen Chan (SFU)
Charmaine Dean (SFU)
Yulia D'yachkova (British Columbia Cancer Agency)
Joel Dubin (University of California, Davis)
Min Gao (St. Paul's Hospital)
Eva Germann (UBC)
Isabella Ghement (UBC)
Debashis Ghosh (University of Washington)
Paramjit Gill (Okanagan University College)
Priscilla Greenwood (UBC)
Phil Gregory (UBC)
Jaroslaw (Jarek) Harezlak (Indiana University)
Nancy Heckman (UBC)
Peter Hooper (University of Alberta)
Jianhua Huang (University of Pennsylvania)
Piet de Jong (UBC)
Nathan Johnson (UBC)
Golam Kibria (UBC)
Debashis Ghosh (University of Washington)
Edward Kim (SFU)
Charles Kooperberg (Fred Hutchinson Cancer Research Centre)
May K. Lee (SFU)
Yi Lin (University of Wisconsin)
Richard Lockhart (SFU)
Brad Love (University of California, Davis)
Colin MacLeod (SFU)
Ying C. MacNab (SFU)
Liam Mao (Zeneca Pharmaceuticals)
Emily Marino (University of Washington)
Hans-Georg Mueller (University of California, Davis)
Uschi Mueller (University of Bremen)
Kayvan Najarian (UBC)
James Hung-Man Ngai (Minisoft System Consulting Company)
Doug Nychka (Nat. Center for Atmospheric Research)
Charles Joel Paltiel (SFU)
Gregory Pond (SFU)
Norman Phillips (British Columbia Cancer Agency)
Kathryn Prewitt (Arizona State University)
Daniel Rainham (University of Alberta)
Jim Ramsay (McGill University)
John Rice (University of California, Berkeley)
Richard Routledge (SFU)
Robert St-Aubin (UBC)
John Spinelli (UBC)
Joan G. Staniswalis (University of Texas at El Paso)
Huiying Sun (UBC)
Jianguo (Tony) Sun (University of Missouri)
Li Sun (UBC)
Jane-Ling Wang (University of California, Davis)
Steven Wang (UBC)
Dong Xiang (SAS Institute)

Workshop on Invariants of Three Manifolds, Nakoda Lodge, Alberta, July 18–22, 1999

Local Organizers: John Bryden, David Hobill, Peter Zvengrowski (U. Calgary)

During the past summer the University of Calgary was the place to be — especially for topologists! There was great excitement with the hosting of a summer research programmqe on invariants of 3-manifolds. The principal visitors were Vladimir Turaev, Research Director of CNRS Strasbourg and creator of topological quantum field theory as well as the theory of WRT-invariants of 3-manifolds, along with the brilliant young mathematician Florian Deloup of CNRS Toulouse. The primary objective of the programme was to investigate the geometric and topological nature of the WRT-invariants, which is currently a wide-open research problem.

In conjunction with this summer programme, PIMS and the University of Calgary sponsored an advanced research workshop at Nakoda Lodge in the Kananaskis area on July 18–22. The workshop brought together top experts in the areas of low-dimensional topology, algebraic topology and mathematical physics, to discuss the topics of topological quantum field theories, the structure and properties of the WRT-invariants, and surgery on low-dimensional manifolds. Among the top international experts in attendence were L. Crane, R. Lawrence, T. Le, R. J. Milgram, D. Rolfsen, L. Rozansky, A. Tralle, V. Turaev, and H. Zieschang.

The plenary lectures at the workshop featured announcements of entirely new theories, notably including Turaev's Homotopy Quantum Field Theory and Crane's innovative Categorical Model for Quantum General Relativity, which uses techniques from topological quantum field theory. Additionally, there a number of introductory talks for graduate students and for specialists from related areas, as well as a series of research discussion session which resulted in a number of new, innovative ideas and have led to several ongoing collaborative research efforts. The proceedings of the workshop will appear as a special volume of the journal *Topology and its Applications.*

All of the scientific goals of the summer programme were met and the universal consensus by the participants was that it was a very successful time. Indeed, preparation are underway to repeat the programme within the next 16 months.

International Symposium on Symbolic and Algebraic Computation, SFU Harbour Centre, July 28–31, 1999

Organizing Committee: Keith Geddes, (U. Waterloo, General Chair), Bruno Salvy (INRIA Rocquencourt, Programme Chair), Michael Monagan (SFU, Local Arrangements)

ISSAC is a yearly international symposium that provides an opportunity to learn of new developments and to present original research results in all areas of symbolic mathematical computation. Topics of the meeting include, but are not limited to:

Algorithmic mathematics: Algebraic, symbolic, and symbolic-numeric algorithms including: simplification, polynomial and rational function manipulations, algebraic equations, summation and recurrence equations, integration and differential equations, linear algebra, number theory, group computations, and geometric computing;

Computer science: Theoretical and practical problems in symbolic mathematical computation including: computer algebra systems, data structures, complexity of computer algebra algorithms, problem solving environments, programming languages and libraries for symbolic computation, user interfaces, software architectures, parallel or distributed computing, mapping algorithms to architectures, concrete anal-

ysis and benchmarking, automatic differentiation and code generation, mathematical data exchange protocols;

Applications: Problem treatments incorporating algebraic, symbolic or symbolic-numeric computation in an essential or novel way, including engineering, economics and finance, physical and biological sciences, computer science, logic, mathematics, statistics, and use in education.

International Workshop on the Analysis of Vibrating Systems, Canmore, Alberta, Sept. 26–28, 1999

Local Organizers: Peter Lancaster, Marc Paulhus, Marian Miles (U. Calgary)

Scientific Program Committee: Graham Gladwell (Civil Eng., U. Waterloo), Keith Glover (Engineering, Cambridge), Peter Lancaster (Chair) (Math & Stat, U. Calgary), Heinz Langer (Math, Techical U. Vienna), Jerrold Marsden (Control & DYN Systems, Caltech), Jonathan Wickert (Mech. Eng., Carnegie Mellon)

The objectives for this intensive three day workshop were the discussion of recent advances in the analysis of vibrations (including discrete and distributed systems and symmetry groups), and the identification of developing problem areas in the analysis of vibrations. In particular, there were exchanges of ideas between those working with linear and non-linear models with vibrations being the common ground, as well as dialogue between researchers in engineering, the mathematical sciences, and industry. The topics included Control, Stability, Sound and Vibration, Inverse Problems, Perturbation Theory, Nonlinear Systems, Hamiltonian Systems, Gyroscopic Systems, the role of Operator Theory and Industrial Problems.

Speakers:

Vadim Adamyan: *Sturm-Liouville Operators on Directed Graphs*

Shuh-Jye Chern: *Stability Analysis for Dissipative Hamiltonian Systems*

Graham Gladwell: *Some Qualitative Properties of Vibrating Systems*

Israel Gohberg: *State Space Methods in Problems of Mathematical Analysis*

Peter Hagedorn: *Vortex Excited Vibrations of Overhead Transmission Lines Modeling and Numerical Problems*

Naomi Leonard: *Stabilization with Controlled Lagrangians*

Alexander Lipton: *Spectral Properties of Differentially Rotating Stars*

Joyce McLaughlan *Using Selected Mode Shape Data to solve Inverse Problems*

Sri Namachchivaya: *Nonlinear Dynamics of Gyroscopic and Aeroelastic Systems*

Jim Woodhouse: *Self-excited Vibration of Bowed Strings and Modeling the Playing of Violins*

10^{th} International Workshop and Conference in Stochastic Geometry, Stereology & Image Analysis, University of Calgary, August 24–28, 1999

Local Organizers : Ernest Enns (Math & Stat), Peter Ehlers (Math & Stat), and John Matyas (Anatomy)

This meeting was aimed at active research workers in the fields of Stereology, Stochastic Geometry and Image Analysis. This includes statisticians, mathematicians, pathologists, material scientists and computational experts. Graduate students were supported to participate in the workshop. The workshop made use of the Stereology Resource Centre at the University of Calgary, which was formed in 1996 primarily to meet the practical needs of biomedical researchers who need to make unbiased estimates of biological structure.

The meeting was comprised of a total of 44 full-time participants, including graduate students, post-doctoral fellows and faculty members

from 11 countries. The meeting was opened by President Terry White who acknowledged PIMS support of mathematical research at the University of Calgary. An article was also published in the *Calgary Herald,* describing the meeting and acknowledging the role of PIMS in fostering such valuable research activities in Alberta.

The meeting was a resounding success both scientifically and intellectually, and its success coupled with the rich environment here in Alberta virtually assures that we will be asked again to host a similar meeting. The world's leading scientists in Stereology and Stochastic Geometry were here and gave presentations. This includes people such as Professor Hans Gundersen from Denmark, holder of the only Stereology Chair in the World; Professor Eva Jensen from Denmark and Adrian Baddeley from Australia, the two leading theoreticians in Stereology and Stochastic Geometry; Professors Wolfgang Weil and Rolf Schneider from Germany, the premier mathematicians in convexity and integral geometry, not to mention many other leading mathematical luminaries.

One of the very successful features of this conference were the *Conference Research Collaboration Presentations.* This session was open to anyone who had a problem for the group of experts to ponder or to present some preliminary research started during the last three days of the conference. Several people presented and it was a lively session, as the world experts were in attendance. This is an idea to carry forward to other meetings.

West Coast Operator Algebra Symposium, University of Victoria, October 16–17, 1999

Organisers: Bruce Blackadar (Nevada, Reno), Ed Effros (UCLA), John Phillips (UVic), N. C. Phillips (Oregon), I. Putnam (UVic.) and D. Voiculescu (UC Berkeley)

This meeting is an annual forum for the large group of researchers currently working in the field of operator algebras on the west coast of North America. The meeting is held over a weekend each fall. Usually, there are about seven talks of about one hour each. The speakers are usually established people from the community, graduate students who are finishing their degrees, post-doctoral fellows and shorter term vistors to the region. Time is also allowed for informal interactions between participants. The intended audience is the research community on the west coast of North America in the field of operator algebras. There is opportunity for finishing Ph.D. students to speak on their work and also informally interact with senior researchers.

This meeting represents a broad and very active community. There are people and research groups at all of the following West Coas' institutions: UC San Diego, Cal. State San Bernadino, UCLA., UC Santa Barbara, UC Berkeley, Arizona State U., U. Nevada Reno, U. Oregon, UVic, UNBC, U. Calgary, and U. Alberta. Most years, most of these are represented. The conference usually attracts about sixty participants.

Speakers:

T. Banica (Berkeley): *Hopf Algebras and a Class of Commuting Squares*

T. D. Bisch (Santa Barbara): *Subfactors with Property T Standard Invariant*

T. J. Boersema (Northwestern College): *The K-theory of Tensor Products of Real C*-algebras*

T. A. Carey (Adelaide): *An Analytic Approach to Spectral Flow in Type II von Neumann Factors*

T. G. Gong (Puerto Rico): *Classification of Simple Inductive Limit C*-algebras*

T. H. Lin (Oregon): *Classification of Simple Nuclear C*-algebras and Some Applications*

Second Annual PIMS PDF Meeting, PIMS-UBC, December 4–5, 1999

Organizer: Alexander Rutherford (PIMS)

The Second Annual PIMS PDF Meeting was held at the PIMS-UBC facility on December 4–5, 1999. At this workshop PIMS Postdoctoral

Fellows presented seminars on their research. It also provided an opportunity for the PDF's, who have their offices at the five PIMS sites, with an opportunity to interact both scientifically and socially. Lectures presented at the workshop were:

Speakers:

Siva Athreya (UBC): *Connections Between Partial Differential Equations, Probability and Stochastic Differential Equations*

Ioan Bucataru (U. Alberta): *Voltera-Hamilton Production Models with Discounting: General Theory and Concrete Examples*

Ricardo Carretero (SFU): *Reconstructing Spatiotemporal Chaotic Dynamics from Observations*

Alexandra Chavez-Ross (UBC): *Aggregation Models for Beta-amyloid Plaque Formation in Alzheimer's Disease*

Tahir Choulli (U. Calgary): *A Class of Stochastic Processes and Applications to Mathematical Finance*

Igor Fulman (U. Calgary): *Ideals in Non-selfadjoint Algebras Associated to Semidynamical Systems*

Madhu Nayakkankuppam (UBC, SFU, UA): *Optimization Over Symmetric Curves*

Miro Powojowski (U. Calgary): *The Imaging Problem in Electric Resistivity Tomography (ERT)*

Gengsheng Qin (UVic): *Empirical Likelihood Ratio Confidence Interval for the Trimmed Mean*

Michael Segal (UBC): *Piercing and Center Problems*

Ladislav Stacho (SFU): *New Upper Bounds for Chromatic Number of a Graph*

Bret Stevens (SFU): *Mathematics and Literature*

Konstantin Zarembo (UBC): *Gauge Fields and Anti-de-Sitter Supergravity*

Northwest Dynamics Symposium, U. Victoria, May 6–8, 2000

This workshop will cover a variety of topics, including ergodic theory, symbolic dynamics, topological dynamics, aperiodic tilings and K-theory. The principal speakers that have confirmed to date are Mike Boyle (U. Maryland), Bob Burton (Oregon State U.) Robert Moody (U. Alberta) and Dan Rudolph (U. Maryland). The organizers are Chris Bose (UVic), Doug Lind (U. Washington) and Ian Putnam (UVic).

Second International Workshop on Scientific Computing and Applications, Kananaskis, Alberta, May 28 – June 1, 2000

Organisers: P. Minev and Y. Lin (U. Alberta)

The Second International Workshop on Scientific Computing and Applications will continue the tradition of the highly successful workshop held at the City University of Honk Kong in December 1998. The aim is to bring together mathematicians, scientists and engineers working in the field of scientific computing and its applications to solve scientific and industrially oriented problems. The workshop is sponsored by PIMS and the University of Alberta

Invited Speakers:

W. Allegretto (U. Alberta)
O. Axelsson (Catholic U. Nijmegen)
R. Ewing (Texas A&M)
M. Fortin (U. Laval)
K. Y. Fung (Hong Kong Polytechnic U.)
P. Gresho (Lawrence Livermore Laboratory)
R. Lazarov (Texas A&M)
B. Lee (NRC, Ottawa)
S. L. Lyons (Mobil Technology)
W. Sun (City University of HK)
T. Tang (Hong Kong Baptist U.)
Zhong-Ci Shi (Academia Sinica)

Meeting in Honour of Cindy Greenwood, UBC, June 2, 2000

There will be a meeting on the afternoon of Friday, June 2nd to commemorate the retirement of Professor P. E. Greenwood. Lectures will be presented by Ildar Ibragimov (St. Petersburg) and Jim Pitman (Berkeley).

Cindy Greenwood
(Math, UBC)

CECM/MITACS/PIMS Live Collaborative Mathematics on the Net, Simon Fraser University, June 19–20, 2000

This one and a half day workshop brings together people from academia and industry involved in mathematical computation, visualization, teaching and learning. This includes issues relating to communication, publication, and commerce using the Internet and related technologies. The half-day session on June 20 will be dedicated to talks and tutorials on topics in Parallel Computing.

Peter Borwein,
PIMS-SFU Site Director

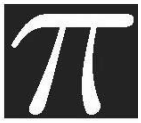
Victoria Computational Cosmology Conference, University of Victoria, August 21–26, 2000

This conference will bring together leading and well-established astrophysicists as well as young researchers. The goal of the conference is to discuss the interface between state-of-the-art observations and theory, particularly from the area of computational cosmology. Each day of the workshop will be devoted to one of the following five topics:

1. The Milky Way Galaxy as the Product of a Merger Sequence
2. The Cosmological Assembly and Evolution of Galaxies
3. The Impact of the Environment on Galaxies: Clusters, Groups, Filaments, and the Field
4. The Impact of Galaxies on Their Environments: the ICM and the IGM
5. The Ly-Alpha/Galaxy Connection: From Absorption Lines to Full-Fledged Galaxies

The maximum number of participants is limited to 100, with applications from graduate students encouraged.





Joint CRM-Fields-PIMS Initiatives

The Fields Institute for Research in Mathematical Sciences, the Centre de Recherches Mathématiques and the Pacific Institute for the Mathematical Sciences jointly sponsored the following events.

27th Canadian Operator Theory and Operator Algebras Symposium, University of PEI, May 20–24, 1999

The 1999 Canadian Operator Theory and Operator Algebras Symposium was sponsored by the Atlantic Association for Research in the Mathematical Sciences in conjunction with the Fields Institute, CRM and PIMS.

Organizer: Gordon MacDonald (UPEI)

Invited Speakers:

Ken Davidson (University of Waterloo)
George Elliott (University of Toronto)
Liming Ge (University of New Hampshire)
Don Hadwin (University of New Hampshire)
David Handelman (University of Ottawa)
David Larson (Texas A & M)
Steve Power (University of Lancaster)
Ian Putnam (University of Victoria)
Heydar Radjavi (Dalhousie University)
Mikael Rordam (University of Copenhagen)

International Conference and Workshop on Valuation Theory, University of Saskatchewan, July 26 – August 11, 1999

Organizers: Andrew Carson, Franz-Viktor Kuhlmann, Salma Kuhlmann, Murray Marshall (U. Saskatchewan), Deirdre Haskell (College of the Holy Cross), Hans Schoutens (Wesleyan U.)

This conference was dedicated to Paulo Ribenboim, in recognition of his extensive contributions to the subject. Tutorials were given on July 26 and 27, with the conference held from July 28 through August 4. There was also a special session in honour of Paulo Ribenboim on July 31, and an informal workshop from August 5 through August 11.

The conference covered recent developments in valuation theory and its applications: algebraic geometry (especially local uniformization), real algebraic geometry (and quadratic forms), Galois theory, rigid analysis and curves over valuation rings, model theory of valued fields (especially in positive characteristic), o-minimal expansions of the reals (and Hardy fields), ultrametric spaces and spherically complete fields, p-adic numbers, non-commutative valuation theory.

The main topics of the Workshop were local uniformization and resolution of singularities, model theory of valued fields in positive characteristic and its connections with resolution of singularities, the theory of valued function

fields, approximate roots and related subjects, o-minimal expansions of the reals and Hardy fields. In addition to these subjects, the workshop offered an opportunity to discuss other recent developments and open problems which are connected to the scientific programme of the conference.

The Conference Proceedings, *Valuation Theory and its Applications,* will appear in the Fields Institute Communications Series published by the American Mathematical Society.

Main Speakers:

Shreeram S. Abhyankar: *The Role of Valuation Theory in Resolution of Singularities*

Francesca Acquistapace: *A strict positivstellensatz for global analytic functions*

Carlos Andradas: *Complexity of global semianalytic sets*

Serban A. Basarab: *Arboreal structures on Pruefer domains and applications*

Eberhard Becker: *Valuations in real algebra and real algebraic geometry*

Luc Belair: *Model theory of pseudovaluation domains*

Isabelle Bonnard: *Algebraically constructible functions*

Ron Brown: *Frobenius groups: it's all algebraic number theory*

Antonio Campillo: *Valuative invariants of singularities*

Gilles Christol: *Radius of convergence of differential modules over valued rings: old and new*

Vincent Cossart: *Abhyankar's irreducibility criterion: a geometric point of view*

Michel Coste: *Real spectrum, finiteness results and definable trivialization in o-minimal structures*

Tom Craven: **-valuations and hermitian forms on skew fields*

Dale Cutkosky: *Local and global monomialization of morphisms*

Charles N. Delzell: *Nonexistence of C^∞ or formal power series variation in solutions to Hilbert's 17th problem*

Radoslav Dimitric: *Valuated vector spaces and trees*

Nikolai Dubrovin: *Spectrum and Ideal Theory of Chain Rings*

Antoine Ducros: *Rational points on the special fibre of a scheme over a valuation ring*

Yuri Ershov: *Model theory of valued fields*

Rafel Farré: *A Nullstellensatz for Henselian fields with real-closed residue field*

Carlos Galindo: *The graded algebra of a valuation over a two dimensional local Notherian domain*

Tim Gardener: *Model theory of valued fields (tutorial)*

Joachim Gräter: *Dubrovin Valuation Rings and Orders in Central Simple Algebras*

Barry Green: *Automorphisms of formal power series rings over a valuation ring*

Urs T. Hartl: *Rigid analytic Picard varieties, Néron-Severi Group, linebundles on polystable fibrations of formal schemes*

Yannick Henrio: *Order p automorphisms of p-adic annuli*

Roland Huber: *Swan representations and rigid analytic curves*

Johan Huisman: *The algebraic fundamental group of real algebraic curves*

Sudesh Kaur Khanduja: *Valuations of function fields and their applications*

Hagen Knaf: *Regularity on varieties over non-noetherian valuation rings*

Jochen Koenigsmann: *Composite valuations and valuation topologies (tutorial)* and Galois characterization of henselian fields,

Gerard Leloup: *Formal power series with cyclically ordered exponents*

Henri Lombardi: *Constructive Theory of Pruefer Rings*

Francois Lucas: *The order structure of real spectra*

Dugald Macpherson: *o-minimality (tutorial)*

James J. Madden: *The Pierce-Birkhoff Conjecture*

Mohammad Mahdavi-Hezavehi: *Valuations and Maximal Subgroups of D**

Hidetoshi Marubayashi: *A classification of primary ideals in a non commutative valuation ring*

Ruth I. Michler: *Invariants of Isolated Singularities and Valuations on Curves (tutorial)*

Jan Minac: *Group cohomology and field theory*

Jean-Philippe Monnier: *Signature Map and Unramified Cohomology*

Guillermo Moreno-Socias: *Testing analytic irreducibility: an implementation*

Jack Ohm: *On the curves $y^2 = f(x)$, without Riemann-Roch*

Enver Osmanagic: *Prime Segments in Simple Artinian Rings*

Freddy Van Oystaeyen: *Valuations on Quantum Algebras*

Daniel Panazzolo: *Desingularization of three-dimensional vector field having a meromorphic first integral*

Helene Pennaneac: *Algebraically constructible homology*

Herve Perdry: *Computations in the Henselisation of a valued field* and *A generalization of Hensel's Lemma*

Pedro González Pérez: *On Toric Resolution of Quasi-ordinary Surface Germs*

Olivier Piltant: *Graded algebra of a valuation*

Konstantin Ponomaryov: *Covers of algebraic varieties and elimination of quantifiers in local fields*

Florian Pop: *Birational anabelian geometry*

Patrick Popescu-Pampu: *Approximate roots*

Victoria Powers: *Real holomorphy rings and sums of 2n-th powers in fields and rings*

Alexander Prestel: *Valuation theory, Positivity and the Moment Problem*

Sibylla Priess-Crampe: *Generalized Ultrametric Spaces*

Maria Jesus de la Puente: *Baer-Krull theorems for the complex spectrum of a field*

Marius van der Put: *Valuation theory in rigid geometry and curves over valuation rings* and *Dessins d'enfants and the Riemann - Hilbert problem*

Ana Reguera: *Valuations on surfaces*

Peter Roquette: *On the History of Valuation Theory*

Mohamed Saidi: *On the specialisation homomorphism of fundamental groups for algebraic curves in characteristic $p > 0$*

Thomas Scanlon: *Quantifier Elimination for the Relative Frobenius*

Claus Scheiderer: *Principal homogeneous spaces over function fields of p-adic curves*

Erwin Schörner: *Ultrametric Fixed Point Theorems and Applications*

Niels Schwartz: *Real closed rings*

Anthony Seda: *The Fixed-Point Theorem of Priess-Crampe and Ribenboim in Computational Logic*

John Shackell: *Hardy Fields and Applications to Symbolic Asymptotics*

Tara L. Smith: *Generalized Orderings on Fields*

Patrick Speissegger: *Valuation theory of polynomially bounded o-minimal structures*

Tohsuke Urabe: *Resolution of singularities of germs in characteristic positive associated with valuation rings of iterated divisor type*

Peter Vámos: *Ordered Grothendieck groups for valuation domains*

A. R. Wadsworth: *Valuation theory on finite-dimensional division algebras*

AARMS Combinatorics Workshop, Memorial University, May 24–28, 1999

The 3 institutes supported this Combinatorics Workshop at the CMS Summer Meeting. This event, which is organized by the *Atlantic Association for Research in the Mathematical Sciences,* focuses on problems in combinatorial designs and applications. The organizers of the workshop were J. Brown (Dalhousie), R. Nowakowski (Dalhousie), A. Punnen (UNB) and N. Shalby (Memorial).

Seminaire de Mathématiques Superieures, Integrable Systems: From Classical to Quantum, Université de Montréal, July 26 – August 6, 1999

This purpose of this seminar was to review recent developments in Integrable Systems, particularly in the quantum domain. The principal lecturers will give mini-courses of 4 or 5 lectures that will be accessible to graduate students and young researchers newly entering the domain. The Canadian organizers are John Harnad (Concordia), Luc Vinet (CRM) and Pavel Winternitz (U. de Montréal).

Principal Speakers:

Denis Bernard (Saclay)

Boris Dubrovin (SISSA, Trieste)

John Harnad (Concordia University and CRM)

Alexander Its (Indiana University)

Vladimir Korepin (SUNY at Stony Brook)

Andre Leclair (Cornell University)

Tetsuji Miwa (RIMS, Kyoto)

Alexios Polychronakos (University of Ioannina, Greece)

Nicolai Reshetikhin (Univ. of California, Berkeley)

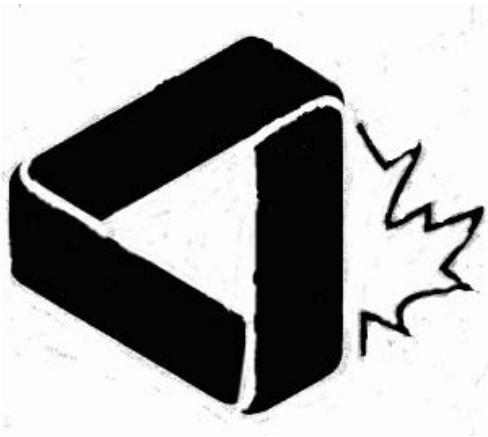
Simon Ruijsenaars (Amsterdam)

Evgueni Sklyanin (St. Petersburg and University of Leeds)

Craig A. Tracy (University of California, Davis)

Pavel Winternitz (Université de Montréal)

Special Session on Mathematical Physics at the CMS Winter Meeting, Université de Montréal, December 11–13, 1999



PIMS was one of the sponsors of the Special Session on Mathematical Physics at the 1999 CMS Winter Meeting. This session, which was organized by George Bluman (UBC), Michel Grundland (UQTR), and Gordon Slade (UBC) featured talks on:

I. Probability methods and applications

II. Group theory methods and application

Speakers:

Mary Beth Ruskai (U. Massachusetts): *Pauli Exchange Errors in Quantum Computation*

Yvan Saint-Aubin (U. Montréal): *Boundary states for a free boson defined on finite geometries*

Christian Borgs: (Microsoft Research) *Partition function zeros for first order phase transitions*

Almut Burchard (U. Virginia): *Minimal and random spanning trees in two dimensions*

Neal Madras (York): *Self-avoiding walks with drift*

Jeremy Quastel (U. Toronto): *Hydrodynamic Limits*

Pavel Winternitz (U. Montréal): *Nonlinear differential and difference equations with superposition formulas*

Stephen C. Anco, (Brock U.): *Conservation Laws of Field Equations*

Greg Reid (UWO): *Deformations and Symmetries of Nonlinear Differential Systems*

Paul Bracken (U. Montréal et McGill): *The Generalized Weierstrass system for mean curvature surfaces and the completely integrable sigma model*

Martin Légaré (U. Alberta): *Low dimensional integrable systems and topological Yang-Mills theories*

Nicky Kamran (McGill): *Non-existence of time-periodic or quasi-periodic solutions of the Dirac operator in stationary axisymmetric black hole geometries*

John Harnad (Concordia): *The bilinear differential equations satisfied by Fredholm determinants appearing in random matrices*

Francois Lalonde (UQAM): *Vers une géomtrie intrinsèque sur le groupe des difféomorphismes hamiltoniens et ses relations avec la cohomologie quantique*

Jiri Patera, (U. Montréal): *Non-standard exploitation of cut and project point sets ('quasicrystals for cryptography')*

National Programme Committee

In 1999 the three Canadian Institutes in the Mathematical Sciences, CRM, Fields and PIMS, initiated a new programme for the support of joint activities in the mathematical sciences. This programme is administered by a National Programme Committee, which makes recommendations to the Directors of the three institutes. For the year April 1, 2000 to March 31, 2001 the three institutes will jointly allocate up to $100,000 for activities under this programme.

In December 1999, the Committee approved support for the following slate of scientific activities:

Activities 1999/2000:

Western Canada Linear Algebra Meeting
University of Manitoba, May 26 – 27, 2000
Contact: P. ven den Driessche (UVic)

Special Functions 2000
Arizona State University, May 29 – June 9
Contact: L. Vinet (McGill)

Statistical Society of Canada, 2000 Conference
Ottawa, June 4–7, 2000
Contact: D. Murdoch (UWO)

Math 2000 Meeting
McMaster University, June 10–13, 2000
The National Programme Committee is providing support for: CAIMS Sessions, CMS Session in Mathematical Biology, and CMS Session in Symplectic Geometry.

Topological and Variational Methods in Nonlinear Analysis
Warsaw, Poland, June 19–23, 2000
Contact: W. Krawcewicz (U. Alberta)

First Prairie Industrial Problem Solving Workshop
Brandon, Manitoba, August 7–11, 2000
Contact: L. Batten, (U. Manitoba)

Mathematical Year 2000 meeting
May 5–7, 2000
Universite Laval
Contact: Frederic Gourdeau

Approximation, Complex Analysis and Potential Theory
July 3–7, 2000
Université de Montréal
Contact: Aubert Daigneault

12th Canadian Conference on Computational Geometry
August 2000
Fredericton, New Brunswick
Contact: David Bremner

CITA/ICAT Meeting
August 26–30, 2000
Toronto, Ontario
Contact: J. Richard Bond

Biophysics and Biochemistry of Motor Proteins
August 27 – September 1, 2000
Banff Conference Centre
Contact: Jack Tuszynski

CMS Winter 2000 Meeting
Vancouver, December 10–12, 2000
Contact: Dale Rolfsen (UBC)

International Initiatives

First Canada-China 3×3 Math Congress, Tsinghua University, August 23–28, 1999

Organizers: N. Ghoussoub (Director, PIMS), K. C. Chang (President, Chinese Math Society), L. Peng (Director, Math Institute, Beijing University), D. Cai (Director, Math Institute, Tsing Hua University), X.-W. Zhou (Director, Math Institute, Nankai University), S. Halperin (Programme Leader, MITACS), D. Dawson (Director, Fields Institute), R. Kane (President, Canadian Math Society), L. Vinet (Director, CRM)

This congress was the starting point for the establishment of scientific collaboration and provided clear directions for specific future projects. The first Canada-China 3×3 Mathematics Congress was an unqualified success. The Canadian delegation consisted of sixty of the best mathematical scientists in Canada and was accompanied by NSERC's President Tom Brzustowski.

The opening ceremony involved the Presidents of the Universities of Peking, Tsinghua, Nankai and Fudan as well as the head of the math section of the Academia Sinica and the vice-president of the NSFC. Dr. T. Brzustowski and Dr. N. Ghoussoub spoke on behalf of the Canadian delegation.

The week ended with a closing ceremony in which Nassif Ghoussoub invited all participants to the Second Canada-China Congress, which will be held at Vancouver in 2001. Finally, a large reception was given by the Canadian Ambassador, Howard Balloch in the Elvin Hamilton Room at the Canadian Embassy in honour of the Presidents of NSERC and NSFC. It was attended by over 140 guests including the University Presidents mentioned above as well as several other senior officials. The visit was particularly productive for President Tom Brzustowski who was able to to have discussions with several senior Chinese officials including the deputy Prime minister for Science and Technology.

List of Canadian Participants:

University of Toronto: John Friedlander, John Bland, Jeremy Quastel, George Elliott, Jim Arthur
University of British Columbia: Changfeng Gui, JingYi Chen, Kai Behrend, John Walsh, Brian Wetton, Dale Rolfsen, Anthony Peirce, Uri Ascher
University of Alberta:
Arturo Pianzola, Byron Schmuland, N. Tomczak-yaegermann
University of Calgary: Claude Laflamme, Michael Lamoureux
Queen's University: H.E.A. Campbell, James Mingo
McGill University: Nicky Kamran, Jacques Hurtubise
McMaster University: Shui Feng
Université du Québec à Montreal: Steve Boyer, Francois Lalonde
Université de Montréal: Abraham Broer
Fields Institute for Research in Mathematical Sciences: Don Dawson, Andrew Dean, W.F. Langford, Guihua Gong
Pacific Institute for the Mathematical Sciences: Nassif Ghoussoub, Huaxiong Huang, Rob Scharein
York University: Tom Salisbury
University of Waterloo: Sue Ann Campbell
Simon Fraser University: Robert D. Russell, Brian Alspach, Kathy Heinrich
Universite Laval: Michel Fortin
Memorial University of Newfoundland: Herman Brunner
University of Ottawa: Thierry Giordano
University of Western Ontario: Richard Kane, Massoud Khalkhali
Dalhousie University: Shigui Ruan
SUNY at Buffalo: Xingru Zhang

The Future of Mathematical Communication, MSRI Berkeley, December 1–5, 1999

Scientific Committee: Francois Bergeron (CRM), Jonathan Borwein (PIMS & CEIC co-chair), Joe Buhler (MSRI co-chair), Bradd Hart (FI), Martin Groetschel (IMU & CEIC), Peter Michor (EMS & CEIC), Andrew Odlyzko

Jonathan Borwein, CECM Director

This workshop explored the probable evolution of mathematical communication in coming years. It was sponsored by the Mathematical Sciences Research Institute (MSRI), the Centre de Recherches Mathmatiques (CRM) , the Fields Institute (FI), the Pacific Institute for the Mathematical Sciences (PIMS), and the International Mathematical Union (IMU) with secondary sponsorship from the American Mathematics Society (AMS), the Canadian Mathematical Society (CMS), Cambridge University Press, Springer-Verlag, Wolfram Research, Inc., and Waterloo-Maple, Inc.

The workshop took place almost exactly five years after the 1994 MSRI meeting on "The Future of Mathematical Communication" and provided a snapshot at the start of the millennium of the present state of mathematical communication and a provocative look at the future — from various perspectives and engaging diverse stake-holder groups. It provided precursor to world-wide mathematical activities in the World Mathematical Year, WMY 2000, as the IMU has designated the year 2000.

The conference had several disparate associated events: a half-day training workshop on on the use of streaming video, a one-day symposium on electronic publishing in the sciences, aimed at attracting a broader audience, and a session of talks and discussion sponsored by the IMU's Committee on Electronic Information and Communication (CEIC). The schedule includes:

December 1: A half-day training workshop, run by David Hoffman at MSRI, on setting up and maintaining streaming video.

December 1-3: The workshop itself, with talks on "publishing" and "tools." Both were broadly construed covered issues such as: preprint servers, journals, books, subscription models, intellectual property, copyright, protocols and languages for scientific communication, metadata and search mechanisms, multi-media, interactive tools, computational packages, etc. Speakers include: Thorsten Bahne, Olga Caprotti, Rob Corless, Jim Crowley, Michael Doob, John Ewing, Martin Groetschel, Jeremy Gunawardena, Eberhard Hilf, Loki Jorgenson, Ulli Kortenkamp, Ursula Martin, Peter Michor, Andrew Odlyzko, Ulf Rehmann, Robby Robson, Nathalie Sinclair, Paul Wang and Bernd Wegner.

December 4: A one-day symposium entitled, The Future of Electronic Publishing in the Sciences was held in the Anderson Auditorium on the UC Berkeley campus. Four talks were presented by Phil Agre, Pamela Samuelson, Hal Varian and Will Hearst.

December 5: The IMU's Committee on Electronic Information and Communication (CEIC) held public talks and discussions.

The Second Pacific Rim Conference on Mathematics, Taipei, Taiwan, January 4–8, 2001

Robert Miura (Math, UBC)

Organizing Committee: Shui-Nee Chow (National University of Singapore), Craig Evans (University of California, Berkeley), Fon-Che Liu (Academia Sinica, Taiwan), Masayasu Mimura (Hiroshima University), Robert Miura (PIMS), Ian Sloan (University of New South Wales), Roderick S.C. Wong (Liu Bie Ju Centre for Mathematical Sciences, Kowloon)

The Second Pacific Rim Conference on Mathematics (PRCM) will be a general mathematics meeting specifically organized to bring mathematicians from Pacific Rim countries together. This second Conference is open to all areas of mathematics. As with the First Pacific Rim Conference on Mathematics, there will be a focus on several specific areas of mathematics, namely Combinatorics, Computational Mathematics, Dynamical Systems, Integrable Systems, Mathematical Physics, and Nonlinear Partial Differential Equations. These specific topics were chosen since they represent areas of strength in Pacific Rim countries. The scientific objectives of this Conference are to disseminate recent research results to a wide audience and to develop stronger ties between mathematicians around the Pacific Rim.

Canadian Plenary and Invited Speakers: Joel Feldman (UBC), Horng-Tzer Yau (Courant Institute), I. Michael Sigal (U. Toronto), Ian Affleck (UBC), Gordon Semenoff (UBC), Vojkan Jaksic (U. Ottawa), Robert McCann (U. Toronto), Izabella Laba (UBC and Princeton University), Michio Jimbo (Research Institute for the Mathematical Sciences), Takashi Hara (Tokyo Institute of Technology)

III. INDUSTRIAL PROGRAMME:

1999–2001

Participants in the **1st PIMS Summer School in Industrial Fluid Dynamics**

PIMS/MITACS Industrial Partners

- Advanis
- Alberta Geological Survey
- Alberta Research Council
- Amber Computer Systems
- APPEGA
- Ballard Power Systems Inc.
- Barrodale Computing
- Bayer Inc.
- BC Cancer Research Center
- BC Hydro
- BioTools
- The Boeing Company
- Canadian Airline
- Canadian Cable Labs
- Canadian Energy Res. Institute
- Canadian Institute for Climate Studies
- Canadian Marconi
- Charles Howards & Associates
- Chemex Labs
- Computer Modeling Group
- Corel Corporation
- Creo Corporation
- CREWES (Consortium for Research in Elastic Wave Exploration Seismology)
- Crystar Research Inc.
- Diagnostic Engineering Inc.
- Dynapro
- Eastman Kodak
- Enbridge
- Environment Canada
- FinancialCAD Corporation
- Firebird
- Harley Street Software
- Hongkong Bank of Canada
- Hughes Aircraft
- Husky Oil
- IBM Canada Ltd
- IBM T. J. Watson Res. Center
- ICBC
- Imperial Oil
- In Silico
- ISE Research Ltd.
- Itres Research Ltd.
- Integrated Flight Systems
- Kinetek Pharmaceuticals Inc.
- Itres Research Ltd.
- Lockheed Martin Canada
- Lockheed Martin Tactical Defense Systems
- Maple
- Math Resources Inc.
- MathSoft
- MacDonald-Dettwiler Assoc.
- MacMillan Bloedel Ltd.
- McMillan-McGee
- MDSI
- Menex Technologies
- Merak
- Michelin
- NALCO Canada Inc.
- NORTEL Networks
- Novacor
- Pacific Forestry Centre
- PanCanadian Petroleum Ltd.
- Petro Canada
- Progas
- Powerex
- Powertech Labs Inc.
- Precision Biochemicals
- Prestige Telecommunications
- Pulp and Paper Research Center
- Quatronix Media
- Raytheon
- RSI Technologies
- Searle
- Shell
- Shaw Cable
- Siemens Research
- Simons International Copr.
- SmithKline BeeCham Pharma
- Sperry-Sun
- Soundlogic
- StemCell Technologies Inc.
- StemSoft Software Inc.
- Stentor
- Stern Stewart & Co.
- Sun Microsystems
- Syncrude
- Telecom. Research Labs
- Telus
- TransAlta
- Veritas DGC
- VisionSmart
- Vortek Industries Ltd.
- Waterloo Maple Inc.
- Worker's Compensation Board

Industrial Problem Solving Programme

The format of the **Industrial Problem Solving Workshops** is mainly based on the Oxford Study Group Model, in which problems of relevant and current interest to the participating companies are posed to the workshop participants by experts from industry. The participating graduate students and academics will spend five days working on the problems and the results will be published in the workshop's proceedings. The advantages for participating students and academics are:

- The challenge of applying one's skills to new and relevant problems directly applicable to industry.
- The opportunity for continued collaboration with the workshop's academic and industrial participants.
- Help PIMS and mathematics in general, by showing businesses and governments the tangible benefits of supporting the mathematical sciences.

3rd PIMS Industrial Problem Solving Workshop (IPSW 3)

University of Victoria, May 31–June 4, 1999

Organizers:
C. Bose (U. Victoria)
R. Edwards (U. Victoria)
H. Huang (PIMS/UBC)
M. Paulhus (PIMS/UC)

Industrial Participants:
Searle
Syncrude
Charles Howard & Associates
Chemex Labs
Merak
Enbridge

4th PIMS Industrial Problem Solving Workshop (IPSW 4)

University of Alberta, May 29–June 2, 2000

Organizers:
J. Macki (U. Alberta)
B. Moodie (U. Alberta)
M. Paulhus (PIMS/UC)

Industrial Participants:
Stern Stewart & Company
McMillian-McGee
Imperial Oil
Vision Smart
Michelin

PIMS Industrial Problem Solving Workshop (IPSW 3), University of Victoria, May 31 – June 4, 1999

Organizers: C. Bose (UVic), R. Edwards (UVic), H. Huang (PIMS), M. Paulhus (Calgary and PIMS)

The format of the workshop was essentially the same as the previous workshops in Vancouver and Calgary and involved six industrial problems and about one hundred academic participants.

Industrial Participants:

Searle: There are a staggeringly large number of "drug-like" chemical compounds which can be made, and the number of unique molecular structures may very well be in the order of $10^{1}00$. To date, only on the order of 107 compounds have been made and characterized. The main hope in a classification is the existence of a similarity pattern in the chemical structure, called "pharmacophore". Compounds matching the same pharmacophore interact with biological molecules (enzymes, receptors, etc) in a similar fashion, and a classification of these pharmacophores would be considered an enormous breakthrough in drug discovery, providing access to a "key" to every "lock". An immediate question is to estimate the number of these pharmacophores. Mathematically, this is a question about how an object with a small, fixed number of pharmacophoric features fills a cavity, but also an exploration of the minimum set of objects required to display all pharmacophoric elements in all possible geometric arrangements.

RSI: Syncrude operates a large oil-sand mine in northern Alberta and owns several of the world's largest mining excavators. The boom and bucket, which look somewhat like those of a standard construction excavator, are driven by by large hydraulic cylinders operating at up to 30MPa (4350psi).

Operators of these large machines would benefit from real-time knowedge of (1) the payload in the bucket, and (2) the digging force at the bucket teeth. In order to be a viable product, this information must be related to the operator without the need to stop the motion of the machine or do anything that would hinder the production. To be useful, the information should be available to the operator with at most one second latency and should be accurate to within 5% of the payload. Furthermore, a commercial product would be easily applied to any excavator without the need for extensive modeling.

Previous approaches to this problem have followed a traditional robotics/dynamics approach. A dynamic model of the boom and cylinders was developed. Readings from hydraulic pressure sensors and joint angle sensors were fed through the model to determine the payload. However, there are serious limitations of this approach since it is impractical to develop a detailed dynamic model of every machine to which the product would be applied.

The company is interested to know of another approach which can produce the required performance without the need to develop a more detailed dynamic model.

Charles Howard & Associates: The problem is to determine water quality in a water distribution network as a function of time and location. The mathematical problem can be visualized (vaguely) as a system of equations that describe the spatial and temporal transport and dilution of a contaminant injected at a specific location.

Municipal water distribution systems are unsteady flow, nonlinear networks. In general, the unknowns are: the pressures (after eliminating elevation differences) at each node, the consumption at each node, and the frictional characteristics of each link. The flow in a link is a derived variable that depends on the difference in pressure across the link and the frictional characteristic of the link. In special cases some of the unknowns are known from field measurements, but in general the number of unknowns exceeds the number of equations that can be written (one equation of flow continuity for each node). In practice measurements are expensive so many of the unknowns are assumed to be known.

The main interest of the company is to determine the distribution of the contaminant volume, ie, its mass and concentration, as a function of time — who gets to drink it, for how long, and when. It is desirable to develop first, a closed form mathematical solution for an approximation to the real problem, and second, a numerical method that could be used to determine the range of applicability of the mathematical method. Then use the mathematical method to solve the inverse problem — given time varying measurements (of concentration and some of the pressures) determine the likely source(s) of the contaminant.

Chemex Labs.: Analytical methods were many elements are determined simultaneously present special difficulties in quality control. The use of individual control charts for each variable (element) is generally not effective due to the combinative aspect of the variation. If there are n elements and the error on each is independent, the probability that all the results will fall within their respective 95% confidence limits is $(0.95)\,n$. If $n = 30$ (multi-element analytical packages typically have 25 to 40 elements) this probability is equal to $(0.95)\,30$ or 0.2146. In other words there will be one or more elements out of bounds in 78.53% of all batches, which on a simplistic interpretation suggests that about two-thirds of all batches will be rejected when nothing is actually wrong with the sample data.

In practice there will normally be both correlated error, (due to instrument variations that affect all elements

or groups of elements) and independent error which is due to variations in the individual element measurement channels. Could the workshop come up with some realistic and efficient control algorithm?

Merak: Foreign production sharing contracts dictate tax rates or payment schedules based on the production from a "ring fence" around a group of wells. Once the tax rate(s) and/or payment(s) are determined, these are applied back to the individual wells. This can cause a variety of interesting mathematical problems when risking or portfolio analysis efforts are made.

Enbridge: The mechanics of batch interfaces is well understood based upon our years of experience in batching fluids. But we have little information that is based upon theory and mathematically modeling. If it were possible to calculate batch interfaces or even to better understand how they happen, grow and stabilize, it may be possible to optimize batch shipments to reduce the product degradation due to batch interface mixing. This would have an economic advantage.

PIMS Industrial Problem Solving Workshop (IPSW 4), University of Alberta, May 29 – June 2, 2000

Organizers : J. Macki (U. Alberta), B. Moodie (U. Alberta), M. Paulhus (PIMS/UC)

This workshop will follow the same highly successful format as PIMS' previous three Industrial Problem Solving Workshops held in Vancouver, Calgary and Victoria. Graduate students are encouraged to attend the *Graduate Modeling Workshop* in preparation for the *Industrial Problem Solving Workshop.*

International Experts:

Dr. J. DeWynne (Oxford University)
Dr. H. Huang (York University, Toronto)
Dr. J. King (Nottingham University)
Dr. D. Ross (Kodak University)

Workshop Problems:

Designing Incentive-Alignment Contracts in a Principal-Agent Setting in the Presence of Real Options. Stern Stewart & Co. is a global consulting firm that specializes in helping client companies in the measurement and creation of shareholder wealth through the application of tools based on modern financial theory. The company pioneered the development of its proprietary EVA (Economic Value Added) framework, which offers a consistent approach to setting goals and measuring performance, communicating with investors, evaluating strategies, allocating capital, valuing acquisitions, and determining incentive bonuses that make managers think like owners.

In many situations it is in a company's best interest to manage its business in such a way as to optimize the value of its real options. One example we consider here a firm considering outsourcing its Information Technology (IT) needs to a specialist firm, such as an Integrated Service Vendor (ISV). The challenge is to construct a contract that does not destroy the real options value. More generally, real options present an interesting twist on the classical principal-agent problem where the shareholders want to offer management incentives that are not in conflict with the presence of the real options.

Wellbore Modeling — Boundary Value Problems in the Recovery of Petroleum Fluids from an Oil Reservoir. McMillian-McGee is a Calgary based engineering company. The company works according to its motto: "The Power Behind Energy".

This practical problem falls into the area of Boundary Value Problems and Mathematical Physics. It is a practical problem in the recovery of petroleum fluids from an oil reservoir using electrical energy. Physical properties will be provided at the conference. The exercise is to solve the transient or steady state temperature distribution in the axial and radial direction, and consequently determine the increase in flow velocity along the length of the wellbore. The definition of the boundary conditions, the symmetry for the problem, definition of regions, and dimensional coupling of the physical space are probably the most important issues to solving the problem. The initial approach would be to define the governing partial differential equations in each region. Transform these equations into Laplace Space. The transformed partial differential equations are now ordinary differential equations and can be solved directly (from the boundary values). Finally, use a numerical inversion algorithm to invert the Laplace Space into the time domain (for example the Stehfest algorithm).

Complex System Modelling: Application to Imperial Oil's Cold Lake Oil Sands Facilities. Imperial Oil is Canada's largest producer of crude oil and a major producer of natural gas. It is also the largest refiner and marketer of petroleum products – sold primarily under the Esso brand – with a coast-to-coast supply network. As well, the company is a major supplier of petrochemicals. Imperial Oil shares (IMO) are listed on the Toronto stock exchange and are admitted to unlisted trading on the American Stock Exchange.

At Cold Lake, Alberta, Imperial Oil uses a cyclic steam stimulation process to produce heavy oil from oil sands formations. High pressure steam is generated at central plant facilities. The steam is distributed through a pipeline system and injected into the reservoir at wells located at a distance from the central plant facilities. Steam injection continues until the oil viscosity is such that the oil can be pumped to surface. Oil, water and

gas are produced during the production part of the cycle and are returned to the central plant facilities. Produced water is mixed with make-up water and is treated and reused as feed water for the steam generators. The produced gas supplements the purchased natural gas used as fuel for the steam generators. The produced oil is processed to remove sand and water. It is then diluted with a lighter hydrocarbon ("diluent") to meet pipeline viscosity specifications. The diluted bitumen is sold to refiners.

There are three central plant facilities at Cold Lake. A total of 3500 wells have been drilled to date of which 3200 are still active. Each well is associated with a single plant. The older wells have completed up to 10 cycles of steaming and production. New wells are periodically added. The duration of the steaming and production phases depends on the age of the well. The steaming phase lasts from 28 to 150+ days. The production cycle lasts from 100 to 1600 days.

Imperial Oil would like to be able to optimize the performance of the overall Cold Lake system. Given the interdependencies of the system and the fact that the time delays vary, we believe that dynamic system modelling is the answer. How would you approach this problem?

The Tennis Ball Problem. VisionSmart is a group of engineering professionals specializing in solving difficult industrial scanning problems. The company strives to provide customers with cost-effective, highly customized solutions integrating high-speed digital signal processing with state-of-the-art machine vision technology.

This is a problem of geometry, of sampling and of error. Imagine that you wish to track the location of an object in 3-space. As always in the real world, you are short of resource, so you choose to use just two cameras. Each camera contains a two dimensional array. Each array produces an image, unfortunately rather than being continuous these images are composed of discrete pixels, say 640 x 480.

These two cameras both watch the tennis ball (or the missile, or the projectile) as it leaves the ball machine. They acquire a series of frames at discrete time intervals (say 1/120th of a second for a 100 mph tennis ball). What the observer is then left with are a series of images which suggest the ultimate trajectory of the tennis ball.

The problems are as follows. The cameras all have distortion. Do we model this with Riemannian or other curved space geometry to simplify distortions and geometric effects? The mathematical formulations of general relativity are well developed and may represent a direct approach. Or, do we try to model with corrections to the distorted and angularly granularized data to take us back to our rigid Euclidian 3-dimensional world?

Because of the discrete sampling we may only have 5 - 10 images. If we had perfect calibration data we would have a perfect model. How do we calibrate this system well enough so we can fit our limited data to get a reasonable estimate of trajectory? It turns out that a one pixel error in estimating the ball's position can lead to errors in the trajectory estimate of many metres. Again the problem is one of fitting, and modeling with imperfect sampled data. The imperfections are present in both the calibration data and the real time data; they are 'amplified' because of the leverage of distance. What is surprising is that even though the physics of the projectiles is very well understood, it is often difficult to incorporate it into the model in a way which helps the data set to become more self-coherent. It is also worth remembering that real balls have spin, and therefore tend to take slight deviations from a ballistic trajectory.

We have a tennis ball machine. We have cameras. We can produce data live, or attempt to implement solutions live.

General Statistical Design of Experimental Problem for Harmonics. The Michelin Group of companies make tires for all types of vehicles: from bicycles to the space shuttle, including cars, trucks, motorcycles, earthmover equipment, buses, subway trains and aircraft. Every day they produce more than 830,000 tires over a broad product range, with the smallest under 200 grams (0.5 pounds) and the biggest over 5 tons.

Tires are subjected to a variety of force measurements that are stored as periodic waveforms. Harmonic components of these waveforms are related to tire performance characteristics such as noise and comfort and hence the control and reduction of the amplitudes of these harmonics is an important activity of manufacturing. Technicians may choose to perform designed experiments on their production processes to understand better their impact on the resulting force harmonics. It could be advantageous to have a general design of experiment methodology which allows technicians to choose optimal designs for their studies.

To make this more concrete consider two types of forces (F and G). F is characterized by 5 harmonics F1-F5 and G is characterized by 10 harmonics (G1-G10). Practically the technician might have 20 different process elements (P1-20) that can be rotated within the construction of the tire and which can affect the force measurements. It is assumed that rotation of a production process will result in the equivalent rotation of the force measurement and that superposition of P1 and P2 will result in a corresponding superposition of resulting F1s. In general the movement of any process element such as P1 may affect all harmonics and forces (F1-F5 and G1-G10).

The general problem is to choose the angles of rotation for a set of Ps so that the harmonic effects are well estimated and the cost of experimentation is minimized. Note that the variance of the estimates is related to the angles chosen (for example choosing 180 degrees prevents the estimation of the even harmonics) and that the cost of a study is proportional to the number of angles that are used in the design. Other features of interest include the reparability/extensibility of designs, identifying sets of competitors/surrogates and allowing different precision for different harmonics.

Industrial Training Programme

Basic Components of the Programme:

The PIMS Graduate Industrial Mathematics Modeling Camp: Graduate students from Canadian universities come to learn various aspects of high-level techniques for solving industrial mathematics problems. The camp prepares them for:

The PIMS Industrial Problem Solving Workshop where, in the week following the Graduate Modeling Camp, the students will participate in a larger problem solving workshop with academics and industrial researchers.

The PIMS Summer School in Industrial Fluid Dynamics: The participants attend a comprehensive series of graduate-level lectures and are also given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes.

The IAM-PIMS School in Industrial Math for Senior Undergraduates shows students how the mathematics they are learning can be useful. Faculty mentors lecture on various industrial problems to all the participants. Subsequently, the students have the option of choosing one or more problems to work on during the three-day workshop.

The Industrial Workshops and Mini-courses with topics of interest to both industry and academia serve to disseminate newly developed mathematical tools that can be of use in industry. The workshops are more interactive than the mini-courses.

2nd PIMS Graduate Industrial Math Modeling Camp
University of Alberta, May 24–28, 1999
Coordinator: Gordon Swaters (U. Alberta)

3rd PIMS Graduate Industrial Math Modeling Camp
SFU, May 22–26, 1999
Coordinator: Keith Promislaw (SFU)

1st IAM-MITACS-PIMS Senior Undergraduate Industrial Math Workshop
UBC, February 18–20, 2000
Organizers: Anthony Peirce (UBC) and Michael Ward (UBC)

1st PIMS Summer School in Industrial Fluid Dynamics
University of Alberta, August 7–20, 1999
Organizers: B. R. Sutherland (U. Alberta) and T. B. Moodie (U. Alberta)

2nd PIMS Summer School in Fluid Dynamics
University of Alberta, July 30 – August 11, 2000
Organizers: B. R. Sutherland (U. Alberta) and T. B. Moodie (U. Alberta)

CACR Information Security Workshop
SFU at Harbour Centre, June 9, 1999
Organizer: The University of Waterloo's Centre for Applied Cryptographic Research (CACR)

2nd PIMS Graduate Industrial Math. Modeling Camp, University of Alberta, May 24–28, 1999

Coordinator: Gordon Swaters (U. Alberta)

The second annual Camp adopted a novel approach to introducing graduate students to the mathematical techniques that arise in industrial R&D. Rather than tutoring students through solutions to artificially posed problems or to problems that have already been solved, this Camp asked students to tackle a set of six, unsolved, modelling problems brought to them by industrial mentors. These problems arose directly from the R&D activities of the mentor's organization. Based on team-project approach, each group of six students, a faculty partner and an industrial mentor, worked together to solve one of the six problems.

Judging from the written feedback, the Second PIMS Graduate Industrial Math Modeling Camp was an unqualified success for all the six project teams. Everyone praised the Camps impeccable organization. The Industrial Mentors were unanimous in their praise of the Camp's concept and execution. The industrial mentor from Lockheed Martin Canada wrote that the results of the Camp exceeded his expectations. The industrial mentor from Telecommunications Research Laboratories, one of Canada's leading industrial telecommunications research organizations, was unequivocal in his assessment: "I think it's all a terrific idea. I overwhelmingly salute the whole initiative". The graduate students got the satisfaction of making meaningful progress on mathematical questions of timely interest to industry. As one student from Montreal put it: "I really enjoyed working on a concrete problem". Mathematicians tend to work alone. Doing research as part of team was a new and rewarding experience for the students. For one of the students in Project #4, "It was amazing how well we worked together...we got a lot out of it and I know we are all happy with our report". Another student in Project #1 appreciated the experience of "learning how to contribute ideas with other students and write a report together". Through the interaction with the graduate students and faculty partners, the industrial mentors developed new perspectives on their modelling problems. But most important, the Camp exposed all the participants to the rewarding possibilities that collaboration between mathematicians and industry can

As with any undertaking, success starts with the quality of the people involved. Camp was fortunate to have had enlisted senior members from some of Canada's most prominent organizations to act as "industrial mentors". The six mentors were:

Speakers:

Dr. Stefan Bachu (Senior Advisor, Alberta Energy Utilities Board)
Dr. Wayne Grover (Chief Scientist: Network Systems, for TRLabs Ltd.)
Dr. Mike Lipsett (Senior Researcher, Syncrude Ltd.)
Dr. John Oliver (Pulp & Paper Unit, Alberta Research Council)
Mr. Don Scott (Supervisor of Pipeline Dynamics, Enbridge Pipelines Ltd.)
Dr. Pierre Valin (Expert Advisory Member, Lockeheed Martin Canada Ltd.)

The faculty partners were critical to the success of this Camp. They provided the needed bridge between the mentor's industrial expertise and the graduate students' mathematical skills. PIMS wants to give special thanks to all the faculty partners listed below for their selfless participation:

Dr. Abel Cadenillas (University of Alberta)
Dr. Doug Kelker (University of Alberta)
Dr. Mike Kouritzin (University of Alberta)
Dr. Henry Leung (University of Calgary)
Dr. Bryant Moodie (University of Alberta)
Dr. Bruce Sutherland (University of Alberta)
Dr. Yanhong Wu (University of Alberta)

Finally, the Camp's success was assured by the participation of bright and motivated graduate students. Thirty students were selected for this year's Camp. They were a diverse group whose backgrounds ranged from pure and applied mathematics to statistics. They

were also geographically heterogeneous group: four from Quebec, one from Ontario, one from Saskatchewan, nine from Alberta, and fifteen from British Columbia. PIMS is particularly pleased that a Camp on Industrial Mathematics attracted as many women as it did men.

3rd PIMS Graduate Industrial Math Modeling Camp, Simon Fraser University, May 23–27, 2000

Organizers: K. Promislow (SFU), M. Kropinski (SFU), S. Jungic (SFU)

Preparations for this year's modeling camp are underway. Mentors include:

Brett Stevens (IBM): *Combinatorial Graph Theory*
Rachel Kuske (University of Minnesota): *Applied Mathematics*
Colin Please (University of Southampton): *Continuum Mechanics*
David Ross (Kodak): *Industrial Processes*
Donald Schwendeman (Renssalar Polytechnic Institute): *Scientific Computing*

The problems to be examined over the course of the program are:

- Queue Compatability for Gray Codes
- Disk Controllers
- Optimal Design of a Micro-Electro-MechanicalSystems Actuator
- Dynamical Behaviour of Catalytic Converters

IAM-MITACS-PIMS Senior Undergraduate Industrial Math Workshop, University of Brtish Columbia, February 18–20, 2000

Organizers: Anthony Peirce (UBC) and Michael Ward (UBC)

The workshop's goal was to show students how the mathematics they are learning can be useful. It ran for three days during which time faculty mentors firstly outlined each of the industrial problems (such as a tumor imaging problem) to all the participants. Each one of the students had the option of choosing one or more problems to work on during the three day workshop. Lectures on each of the problems were presented by the mentors in which the tools for the modeling and analysis of the problem were developed. The mentors then helped groups of approximately eight students to develop the models and answer the questions posed. The workshop culminated with a brief presentation by each of the groups working on the chosen problems. The mathematical tools used in the workshop were accessible to third and fourth year undergraduates in mathematics, applied mathematics, physics and applied science. The workshop also proved to be an excellent opportunity to meet students from across BC and Canada.

1st PIMS Summer School in Industrial Fluid Dynamics, University of Alberta, August 7–20, 1999

Organizers: B. R. Sutherland (U. Alberta) and T. B. Moodie (U. Alberta)

This summer school offers an enriched learning environment in which the theoretical, experimental and computational aspects of fluid dynamics are synthesized. This summer school is one of three summer schools in the world on fluid dynamics. The others are at the University of Cambridge and Woods Hole Oceanographic Institute. The PIMS school is unique in that it emphasizes computation fluid dynamics. The first PIMS Summer School was highly successful, with 28 participants, the maximum number that can be accommodated in the laboratory facilities.

Invited Speakers:

G. Lawrence UBC
P. Morrison UBC
W. R. Pelletier U. Toronto

Core Lecturers:

A. B. G. Bush (Atmos. Sciences, U. Alberta)
J. C. Bowman (Math Sciences, U. Alberta)
P. D. Minev (Math Sciences, U. Alberta)
T. B. Moodie (Math Sciences, U. Alberta)
B. R. Sutherland (Math Sciences, U. Alberta)
G. E. Swaters (Math Sciences, U. Alberta)

2nd PIMS Summer School in Fluid Dynamics, University of Alberta, July 30 – August 11, 2000

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

Participants at the Second Annual PIMS Summer School in Fluid Mechanics will attend a comprehensive series of lectures and will be given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes. Topics will include fluid dynamics fundamentals, industrial and environmental flows, geophysical fluid dynamics, turbulence modelling and computational fluid dynamics. Subjects will be taught at the graduate level.

Invited Speakers:

Paul F. Linden (UC San Diego)
James C. McWilliams (UCLA)
Frans T. W. Nieuwstadt (Delft University of Technology)

Core Lecturers:

John C. Bowman, *Turbulence Modelling*
Andrew B. G. Bush, *Climate Modelling*
Peter Minev, *Computational Fluid Dynamics*
T. Bryant Moodie, *Wave Theory*
Bruce R. Sutherland, *Stratified Flows*
Gordon E. Swaters, *Physical Oceanography*

CACR Information Security Workshop, SFU at Harbour Centre, June 9, 1999

Organizer: The University of Waterloo's Centre for Applied Cryptographic Research (CACR)

The series has been established to provide a highly focused content and programme covering topics of interest to the potential and sponsors' customers, and employees. The targeted attendee has a solid background in public-key technology/information security, and in deploying information security solutions and other applications. This individual understands the issues in this area and attends the workshop in order to gain the exposure to different approaches.

This workshop focused on specific issues such as authority certificates, on and off-line certificate validation, certificate revocation and related topics, in particular, investigating current and proposed protocols, processes and technology that will help provide solutions to meet short to long-term requirements in these areas.

Invited Speakers:

Bill Lattin (Certicom)
Joe Kovara (CyberSafe)
Michael Myers (VeriSign)
Peter Williams (ValiCert)
Mary Horrigan (Scotiabank)
Michael Versace (Bank of Boston)
Jonathan Callas (Kroll-O'Gara, ISG)

This workshop was co-sponsored with Certicom Corporation, Mondex International, Mastercard International, MITACS, and Pitney Bowes.

Industrial Collaborative Projects

The Industrial Collaborative Program supports innovative research in the mathematical sciences which is driven by industrial applications and which will lead to new, creative mathematical and statistical results to be available to industry and for wide dissemination. A critical component in these collaborative projects is the active involvement of both academic researchers to guide the scientific research, and industrial partners to focus the project on industrially relevant problems. The PIMS contribution is directed towards the support of highly qualified personnel (graduate students, postdoctoral fellowa and research assistants) in the mathematical sciences working directly on the activity.

Industrial Collaborative Projects For 1999/2000:

Interfacial Mixing in Laminar Pipe Flows
Project Leader: B.S. Sutherland (Mathematical Sciences, U. Alberta)
Project Members: T.B. Moodie, D. Van Vliet, and K. Dohan (U. Alberta)
Industrial Partner: Imperial Oil

An AirCare Repair Wizard
Project Leader: J. Meloche (Statistics, UBC)
Project Members: J. Zidek (UBC), Steve Stewart (ICBC)
Industrial Partner: ICBC

Modeling the Impact of Climate Change on Vegetation
Project Leader: M. Tsao (Mathematics and Statistics, U. Victoria) Project Members: F. He, M. Lesperance, W. Reed, J. Zhou, Hongtu Zhu
Industrial Partner: Pacific Forestry Centre

Low Observable Multiple Target Tracking
Project Leader: M. Kouritzin (U. Alberta)
Project Members: D. Blount (Arizona State University), Ruisheng Li, and B. Schmuland (U. Alberta)
Industrial Partner: Lockheed Martin Tactical Defense Systems, Lockheed Martin Canada

Mathematical Modeling for Real Time Industrial Process Control and Quality Assurance
Project Leader: D. J. Kenway (VisionSmart)
Project Members: D. Lyder (VisionSmart), W. A. Armstrong, B. Sutherland, S. Shen (University of Alberta)
Industrial Partner: VisionSmart

Netback Formula Development, Questionaire Development and Analysis
Project Leader: Rita Aggarwala (U. Calgary)
Project Members: Peter Ehlers, Ernest Enns
Industrial Partner: Progas, APPEGA

Industrial Postdoctoral Fellowship Programme

Central to the PIMS strategy is the identification of industrial projects that can be tackled by young mathematical scientists. Five Industrial Fellowships were awarded for 1999.

Jointly supervised by PIMS scientists working in concert with their industrial counterparts, PIMS postdoctoral fellows split their time between the university and the company, exchanging intellectual ideas between these two domains. The PDFs are expected to participate in the PIMS industrial workshops and confer-

ences. They act as the conduit for dissemination of knowledge between the industrial partner and the university research group.

PIMS Industrial Postdoctoral Fellowships for 1999/2000

(See the chapter on *PIMS Scientific Personnel* for a list of the PIMS Industrial Fellows for 1999/2000.)

PIMS Industrial Fellowships for 2000/2001

The following postdoctoral fellowships will be awarded during the years 2000-2002. They are jointly funded by PIMS and by some of its industrial partners. The PIMS support for this programme comes from the Government of Alberta through the Alberta Ministry of Innovation and Science and from the Government of British Columbia through the Science and Information Technology Agency (ISTA).

1. PIMS/InSilico PDF (UBC)
2. PIMS/Ballard PDF (UBC/SFU)
3. PIMS/Powerex PDF (UBC)
4. PIMS/IBM PDF (SFU)
5. PIMS/Mathsoft PDF (UBC)
6. PIMS/Quatronix PDF (UBC/SFU)
7. PIMS/Lockheed-Martin PDF (U. Alberta)
8. PIMS/VisionSmart PDF (U. Alberta)
9. PIMS/Siemens PDF (U. Alberta)
10. PIMS/PanCanadian PDF (U. Calgary)
11. PIMS/Transalta PDF (U. Calgary)
12. PIMS/APPEGA PDF (U. Calgary)

MITACS: A Network of Centers of Excellence in the Mathematical Sciences

Arvind Gupta, MITACS Program Leader

Mathematics of Information Technology and Complex Systems (MITACS) is one of the three new Networks of Centers of Excellence (NCE) created in 1998. The MITACS NCE is a joint venture of the three Canadian mathematical sciences institutes: the Centre de Recherches Mathématiques, the Fields Institute in Mathematical Sciences and the Pacific Institute for the Mathematical Sciences. MITACS harnesses mathematical power for the benefit of the Canadian economy. The network brings together more than 150 researchers at 22 Canadian universities with more than 70 Canadian industrial, medical, and financial organizations. The network comprises 23 projects addressing problems in five sectors of the Canadian economy, including two new projects funded in 2000.

The creation of the MITACS network provides an exceptional opportunity for the mathematical sciences community to develop a large scale systematic programme for research, HQP training and the development of partnerships with key business, industrial and health care sectors across the country. The five main themes of the network are:

The Mathematics of the Trading and Finance Sector: Topics of research in this theme include: Risk measurement and models for nonstandard commodity markets; Default risk: value-at-risk and credit risk; Interest rate models; Portfolio allocation models; and Pricing of derivatives (parametric and nonparametric). The shared mathematical methodologies include: Stochastic Modeling, Information reduction in high-dimensional statistical models; Inference in parametric and nonparametric models; Monte Carlo, numerical and calibration methods.

The Mathematics of the BioMedical Sector: The projects in this theme are concerned with issues of human health and disease: Understanding of physiological and disease mechanisms; Understanding of the mechanisms of drug therapy and other interventions; Development of accurate and cost-effective methods of diagnosis; Design of individual and population interventions, such as drug and gene therapies, vaccines and public health programmes prevention, diagnosis, remediation and control of disease. They also share common mathematical methodologies: Development of mathematical, statis-

tical, and computer models for complex nonlinear systems; application of techniques to detect patterns in high-dimensional, temporal and spatial data; use of biologically relevant computer simulation, mathematical approximation, and asymptotics need for methods of statistical inference to interpreting variability.

The Mathematics of the Information Technology Sector: The objective of this theme is to identify and resolve strategically important mathematical problems that are central to the development, organization, and utilization of integrated systems. This includes the next generation of telecommunication networks, concurrent and real-time reactive systems, new tools to extract knowledge from high dimensional data sets, and new algorithms and software designs for symbolic analysis. Methodologies include: stochastic modeling, regression analysis, algebraic computation, constructive logics, and others.

The Mathematics of the Commercial Industrial Sector: As commercial processes become more complicated, large scale optimization packages are essential for industrial resource allocation. This theme consists of specific projects with the collaboration of numerous industrial partners dealing with problems such as personnel planning and scheduling, natural resources management and the development of a dynamic transportation infrastructure for industrial just-in-time delivery systems. Techniques from many disciplines, from operations research to computer science and statistics, will be used to solve these problems. One strategy will be to develop decomposition techniques for the large problem formulation domain to reduce complexity and to explore new techniques for developing better approximation algorithms, drawing on research in discrete optimization and algorithm design.

The Mathematics of the Manufacturing Sector: Even though this theme deals with more traditional applications of the mathematical sciences, it was included in MITACS Phase 1 for two reasons: First, it is needed in order to maintain and strengthen Canada's leading edge in some emerging industries like in building cellular automata using semiconductor nanostructures and in developing efficient fuel cells by Ballard Powersystems. Secondly, it can also be considered as a supporting theme as the teams involved in its projects (e.g., the broad based proposal "Mathematical Modeling and Scientific Computation") consist of well established applied mathematicians, mathematical modelers and computational scientists who have the skills to solve industrial problems from a variety of different fields and who will assist and support many other MITACS projects.

New MITACS Projects

In March 2000, two new projects were awarded funding from the MITACS NCE, with startup of research activities to begin in July. Both projects will be managed through PIMS.

Pseudodifferential Operator Theory in Seismic Imaging

Leaders: Dr. M. Lamoureux (Math), Dr. G. Margrave (Geophysics), University of Calgary

Members: R. Aggarwala (Math, U. Calgary), W. Allegretto (Math, U. Alberta), J. Bancroft (Geophysics, U. Calgary), L. Bentley (Geophysics, U. Calgary), P. Binding (Math, U. Calgary), A. Calvert (Earth Sciences, SFU), R. Ferguson (Chevron), S. Gray (Veritas D.G.C.), C. Laflamme (Math, U. Calgary), P. Lancaster (Math, U. Calgary), L. Lines (Geophysics, U. Calgary) , E. Nyland (Physics, U. Alberta), M. Slawinski (Mechanical Eng, U. Calgary), M. Sacchi (Physics, U. Alberta), J. Sniatycki (Math, U. Calgary), D. R. Westbrook (Math, U. Calgary)

Industrial Affiliates: Consortium for Research in Elastic Wave Exploration Seismology, including AEC, BP-Amoco, Chevron, Pan Canadian, Petro-Canada, Talisman, Veritas D.G.C., Imperial Oil, Shell and others.

Problem Statement: The theory of geoseismic imaging (migration) is built upon fundamental solutions to either the scalar or elastic wave equations for acoustic propogation within a solid. There are many imaging methods in use today and most are based upon, and limited by, mathematical techniques that have been in common use in physics since the early part of this century. Examples

include Kirchhoff migration, based on Green's function theory, f-k migration, based on separation of variables, and finite difference methods. Despite the existence of a large body of literature in the mathematics community concerning the use of pseudodifferential operators with hyperbolic partial differential equations, there has been very little application of these techniques in geophysics. Work already completed at CREWES has shown that pseudodifferential operator methods are potentially superior to any other imaging technique.

This project is designed to develop a seismic imaging theory and numerical methods based on pseudodifferential operators and Fourier integral operators. It is expected that these methods will improve the accuracy, relative to existing techniques, of estimation of the earth's subsurface parameters. The potential benefits to the petroleum industry and to the Canadian economy from higher fidelity seismic images are substantial. Current petroleum reservoir recovery rates are around 40% of the oil-in-place. If such images lead to better reservoir and pore fluid definition, they could improve recovery rates by a few percent. Even such a small improvement is literally worth billions of dollars.

Goals of the research are to improve the theoretical foundation for existing acoustic one-way wavefield extrapolators, extend the theory to predict higher-order one-way extrapolators and two-way extrapolators in fully anisotropic and inhomogeneous elastic media. Techniques to develop stationary phase or other approximations to the oscillatory integrals and create efficient numerical approximations to the pseudodifferential operators based on the theoretical development will be undertaken. Numerical code developed from the thoery will be tested in a variety of settings. For example, physical modeling data could be compared to the forward-modelled numerical data and could be migrated with the inverse code. Real seismic datasets from industry will also be used.

Mathematical Modeling in Pharmaceutical Development

Leader: Dr. J.A. Tuszynski, Physics, U. Alberta

Members: Dr. G. de Vries (Math, U. Alberta), Dr. G. A Dumont (Elec. & Computer Engg., UBC), Dr. M. Klobukowski (Chemistry, U. Alberta), Dr. B. MacLeod (Anaesthesia, Pharmacology & Therapeutics, UBC), Dr. J. Muldowney (Math, U. Alberta), Dr. K. Rubenson (CHET, Education, UBC), Dr. J. Samuel (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. Y. Tam (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. D. Wiens (Stats Centre, U. Alberta), Dr. D. Bevan, Dr. D. Quastel, Dr. C. Ries, Dr. M. Sutter, Dr.M. Walker, Dr. J. Wright

Industrial Affiliates: Drs. Y.K. Tam and D. Ridgway (Kinetana), Dr. R.R. Koganty (Biomira, Inc.), Mr. Willaim Gough (Universal Dynamics Technologies), Dr. M. Huzmezant (M.I.H. Consulting Group), Dr. W. de Brouwer (Starlab, Belgium)

Other Affliates: Canadian-European Research Initiative on Nanostructure (Belgium), Drs. P.L. Christiansen and E. Mosekilde (Inst. of Math. Modeling, Danish Technical University), Dr. Y. Engelborghs (Biomolecular Dynamics, K. University of Leuven), Dr. M. Kimmel (Stats, Rice University) Jim Laukes (Psychology, U. Arizona), Dr. E. Unger (Molecular Biotechnology, Jena, Germany),

Problem Statement: In the past century, a vast array of drugs have been developed which have brought major benefits to humanity. With recent and expected future advances in biotechnology, such as the sequencing of the complete human genome, the new millenium offers expanded possibilities of new treatments based on molecular models for various diseases and their pathways. Unfortunately, parallel to the advance in medical sciences, health care costs have also been rising, driven in part by the spiralling cost of new drug development. Unless means are found to control drug development costs, future advances in drug-based therapy will be threatened. There are two interlinked domains leading to a new drug-based therapy: drug discovery, i.e. the identification of a candidate substance, and drug development, the series of laboratory tests and clinical trials before a substance is approved for use. The process is lengthy and expensive, requiring 11 to 15 years and about $500 million dollars for each new drug brought to market, which places severe economic limitations on the kinds of conditions for which it is feasible to develop drugs. Even small improvements in this process could have a substantial impact on public health in addition to an economic return.

In order to be useful as a drug, a chemical must possess two important characteristics: 1) it must exhibit sufficient binding to the target receptor, i.e. it must have efficacy at the site of action, and 2) sufficient quantities of the chemical must reach the site of action and remain there long enough for the desired theraputic effect, i.e. it must have desirable pharmacokinetics. This requires the drug to be absorbed into the body, distributed to the site of action, and remain in the body long enough for its benefits to emerge.

In each of these areas, mathematical modeling has an important and underappreciated role to play. This project will study several interrelated problems in drug discovery and development, linked by a common theme of applying physical principles, mathematical modeling, computer-intensive simulations and statistical validation methods to problems of interest to our industrial affiliates and pushing the boundaries of the applied mathematical sciences. The various subprojects that will be developed by our group range from pharmacokinetics, the study of the absorption, distribution, metabolism, and excretion of drugs in the body to molecular modeling of the action of specific anti-cancer drugs.

The ultimate objective is to provide an integrated approach to the preclinical drug evaluation process with a molecular analysis of drug interactions with proteins and

enzymes as the first element, followed by pharmacokinetic modeling performed at a statistical level. Thus the goal is to fully integrate mathematical modeling into the pharmaceutical development process - from potency at site of action to bioavailability and prediction of whole-body kinetics, eventually to population statistics of potency and toxicity. Finally, using the recent advances of process control analysis the UBC node intends to automate anesthetic drug administration.

Ongoing MITACS Projects at PIMS

There are 21 ongoing MITACS projects across the country in five themes. Here are the current 11 projects coordinated by PIMS:

Modeling, Trading and Risk in the Market

Leader: U. Haussmann (Math, UBC)

Members: L. Bates (Management, University of Calgary) M. Barlow (Math, UBC) M. Buchko (Trader, Powerex Corporation) D. Druce (Research Scientist, BC Hydro) D. Glassco (Chairman & CEO, Financial CAD Corporation) C. Gui (Math, UBC) A. Lari-Lavassani (Math, University of Calgary) J. Liu (Math, UBC) N. Ghoussoub (Math, UBC) M. Margolis (Head Trader, Powerex Corporation) A. Peirce (Math, UBC) E. Perkins (Math, UBC) G. Sick (Finance, University of Calgary) J. Walsh (Math, UBC) O. Walsh (Director of Financial Engineering, Fiancial CAD Corporation)

Industrial Affiliates: Financial CAD, Powerex Corporation, BC Hydro, Transalta

Biomedical Models of Cellular and Physiological Systems in Health and Disease

Leader: L. Keshet (Math, UBC)

Members: Dr. G. de Vries (Math, UA), Dr. D. Finegood (Kinesiology, SFU), Dr. R. Miura (Math, UBC), Dr. J. Piret (Biotech Lab, Chemical Eng, Bioresource Eng, UBC), Dr. E.Puil (Pharmacology, UBC) Dr. D. Schwarz (Research Director, Dept of Surgery, UBC), Dr. C. Shaw (Opthalmology, UBC), Dr. Y. Xian Li (Math, UBC) Dr. M. Mackey (Math, McGill)

Industrial Affiliates: Bayer Inc., InSilico Biosciences, Kinetek Pharmaceuticals, Precision Biochemicals, Stem-Cell Technologies, SmithKline Beecham, BC Cancer Research Center.

Symbolic Analysis

Leader: P. Borwein (Math & Stats, SFU)

Members: F. Bergeron (Math, Université de Québec à Montréal), J. Borwein (Math & Stats, SFU), R. Corless (Math, UWO), S. Devitt (Waterloo Maple Inc), D. Jeffrey (Math, UWO), L. Jorgenson (Math & Stats, SFU), M. Lamoureux (Math & Stats, University of Calgary), M. Monagan (Math & Stats, SFU), J. Stafford (Math, UWO), S. Watt (Math, UWO)

Industrial Affiliates: Math Resources, Sun Microsystems, Waterloo Maple

Mathematical Methods for Modeling, Verification and Testing in Information Technology

Leader: B. Kapron (CS, University of Victoria)

Members: M. Cheng (CS, University of Victoria), J. Delgrande (CS, SFU), M. Greenstreet (CS, UBC), A. Hu (CS, UBC), P. Panangaden (CS, McGill)

Industrial Affiliates: Nortel Networks

Prediction in Interacting Systems

Leader: M. Kouritzin (Math, University of Alberta)

Members: D. Blount (Math, Arizona State University), J. Bowman (Math, University of Alberta), D. Dawson (Director, Fields), R. Eliott (Math, University of Alberta), S. Feng (Math, McMaster), K. Fleischmann (Math, University of Alberta), E. Gombay (Math, University of Alberta), A. Heunis (Engineering, Waterloo), A. Jouan (Research and Development, Lockheed Martin-Montial), B. Kapron (CS, University of Victoria), B. Leininger (Lockheed Martin Tactical Defence Systems at Eagan), R. Mahler (Lockheed Martin Tactical Defence Systems at Eagan), C. Poling (Lockheed Martin Tactical Defence Systems at Eagan), N. Prasad (Math, University of Alberta), B. Remillard (Université du Québec à Trois Rivihres), B. Schmuland (Math, University of Alberta), E. Shahbazian (Lockheed Martin-Montréal), S. Shen (Math, University of Alberta), Y. Shu Wong (Math, University of Alberta),

Industrial Affiliates: Advantis, Lockheed Martin Canada, Lockheed Martin Tactical Defence, VisionSmart

Facility Location Optimization

Leader: B. Bhattacharya (School of Computer Sciences, Simon Fraser University)

Members: P. Bose (CS, Carleton University), J. M. Keil (CS, University of Saskatchewan), D. Kirkpatrick (CS, UBC), T. Shermer (CS, SFU), J. Snoeyink (CS, UBC), G. Toussaint (CS, McGill University)

Industrial Affiliates: Soundlogic, Quatronix.

The Mathematics of Resource Allocation and Scheduling

Leader: P. Hell (CS and Math & Stats, SFU),

Members: B. Alspach (Math & Stats, SFU), J. M. Bourjolly (Concordia), W. Cunningham (C & O, University of Waterloo), L. Goddyn (Math & Stats, SFU), A. Gupta (CS, SFU), L. Hafer (CS, SFU), R. Krishnamurti (CS, SFU), W. Pulleyblank (Director, Mathematical Sciences, T.J.Watson Labs, IBM), M. Queyranne (Manag. Sci, UBC)

Industrial Affiliates: Amber Systems, HA Simons, IBM, Prestige Telecommunications

Probabilistic Mathematical Models for Complex Industrial Systems

Leader: M. Puterman (Commerce, UBC)

Members: D. Atkins (Commerce, UBC), J. Bookbinder (Waterloo), C. Boutilier (CS, UBC), H. Chen (Commerce, UBC), M. Gendreau (Université de Montréal), B. Lamond (Université Laval), J. McGill (Queen's University), D. Lawson (Commerce, UBC),

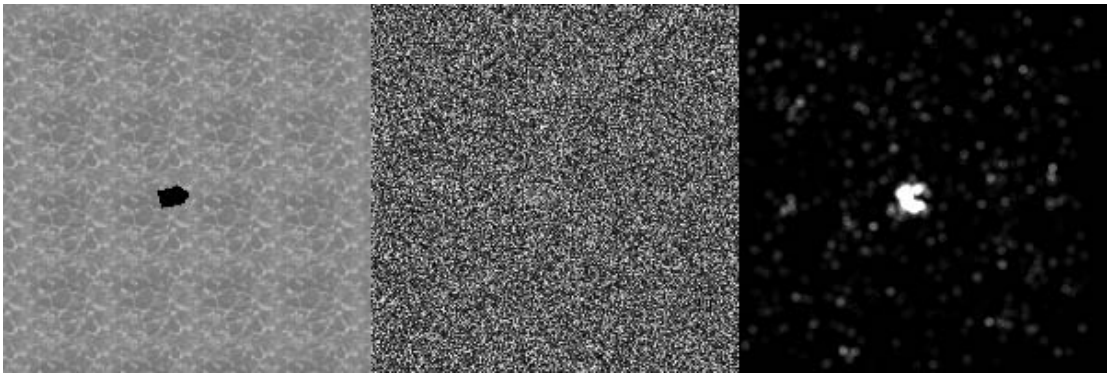
Industrial Affiliates: BC Tel, Canadian Airlines, Workers Compensation Board of BC

Mathematical Modeling and Scientific Computation

Leader: B. Wetton (Math, UBC),

Members: R. Choksi (Math & Stats, SFU), H. Huang (Math, York U.), M. C. Kropinski (Math & Stats, SFU), A. Peirce (Math, UBC), K. Promislow (Math & Stats, SFU), B. Russell (Math & Stats, SFU), B. Seymour (Math, UBC), M. Ward (Math, UBC), R. Westbrook (Math & Stats, University of Calgary)

Industrial Affiliates: Ballard Powersystems, Powertech Labs, Vortek Industries

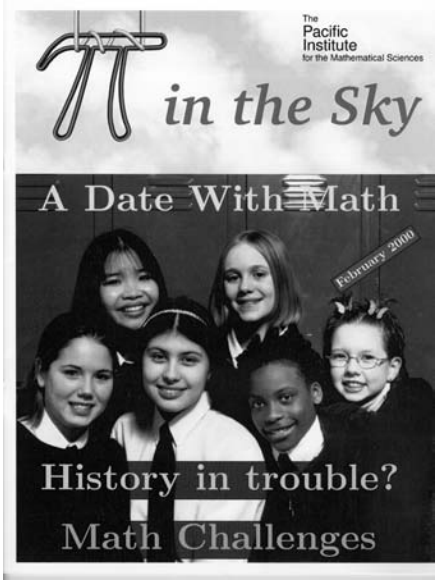


The MITACS project, **Prediction in Interacting Systems**, is doing mathematical research into realistic and computer tractable prediction and tracking strategies. Most involve a search and rescue application that has been formulated as a tracking problem. A number of particle filtering methods have been implemented to solve this problem and a new particle method has been introduced. This new method is demonstrated above, where a signal process (left) undergoes a noisy, corrupting observation process (middle), but is still tracked by the particle filter (right).

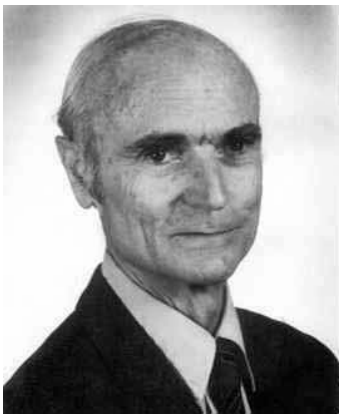
IV. MATHEMATICS EDUCATION PROGRAMME:

1999–2001

Klaus Hoechsmann (PIMS Education Facilitator) with the Grade 7 winners at the PIMS Elementary School Math Contest: #1 Irene Yu (Berkshire Park), #2 Michael Li (MacCorkindale), #3 Paul Collier (Kitchener)



First Issue of *Pi in the Sky*



H. S. M. Coxeter spoke on *The Mathematics the Art of M. C. Escher* at **Changing the Culture 2000.**

Initiatives for K-12 Students

PIMS is continuing to bring members of the scientific community and the community at large closer together through an increasing number and variety of events. Events have continued during the 1999/2000 academic year in both Alberta and British Columbia.

Activities for Elementary Schools

Alternative Mathematics Education Events

This programme consists of regular evenings on "Alternative Math Education" where Faculty and Staff from the PIMS Universities present "fun" methods for teaching math and computer science to children (and adults!) using games and art. Typically included in the presentations are soap bubble demonstrations, constellations as 2D networks, geometry and paper, the Set Game, Computer Science Unplugged and MegaMath, a binomial probability experiment using pennies, and exciting geometrical models from straws and paper. Other demonstrations involve chess games, parallel algorithms of network sorts, and recursive methods in mathematical puzzles. These events attract around 300 students and parents each evening.

The events in 1999 and 2000 were

1. **Rogers Elementary School, Victoria** on February 25, 1999.
2. **Sydney Elementary School, Vancouver** on November 23, 1999.
3. **Math Mania at Burnside Community School, Victoria** on March 1, 2000.

People who regulary participated in these events are Kathy Beveridge (Victoria), Charlie Burton (UVic), Malgorzata Dubiel (SFU), Mike Fellows (UVic), Denton Hewgill, Reinhard Illner (UVic) and David Leeming (UVic).

Mathematics Unplugged

This is a Student Mathematics Conference. Elementary students attend a full day math conference, including workshops chosen by themselves following a keynote address. Workshops are presented by all levels of instructors, including university professors, school district personnel, school staff, parents and Science World staff. Just as Eric Clapton and Rod Stewart "unplugged" their music, PIMS will provide students with an opportunity to see that mathematics can be an exciting and enjoyable topic, and that it is all around them! The goals for the conference are to:

- show students that Mathematics is in all aspects of everyday life.
- show that there is a lot of Mathematics in other subject areas.
- offer as many exciting math workshops as possible.
- show students that Mathematics is more than what they can find in school textbooks.
- keep the number of students in workshops small (20 or less), therefore lots of hands-on experiences.
- utilize expertise from the community

Four sessions of Mathematics Unplugged have been held at the Westwook Elementary School in Coquitlam. The first one was held on May 30th, 1997 with a keynote address by Dr. Kathy Heinrich (SFU). Over 350 students and 15 teachers participated in the event.

The second was held on April 23, 1998 with a keynote address given by Dr. Maria Klawe (UBC), and a third on April 30, 1999 again with a keynote address given by Dr. Kathy Heinrich (SFU).

This year's event was held on April 27, 2000 with the keynote address given by Dr. Mike Fellows (UVic) and Dr. Fran Rosamond (Victoria U., New Zealand), on *Dots and Lines: How Scientists Use Dots and Lines for Just About Everything.*

All events were organized by Pamela Hagen (Westwood Elementary) along with Ron Coleborn (Past President of the BCAMT), Blair Yochim (Science World), Kevin Akins (SD #43 Coquitlam), Gloria Gustafson (SD #43 Coquitlam), as well as members of the parent and school community. This programme on an annual basis, and the intention is to attract students from other schools and also multiply this initiative to other schools.

Activities with High School Students

The PIMS education panel is organizing a number of events aimed at high school students. Here we describe two such events, highlighting the breadth of activities that PIMS offers.

Math Fun Night

In May 1999 the Strathmore High School, Calgary hosted a Math Fun Night for 40 participants with PIMS support, and co-organized with the Calgary PIMS Education Coordinator, Dr. Indy Lagu. The objectives were for participants to enjoy themselves in a group setting while thinking mathematically. Even though the problems posed were difficult, the enthusiastic students eventually solved them.

Junior High Math Nights Mount Royal College, Calgary January 31 – March 27, 2000

Supported by PIMS, these events were organised by Dr. Jean Springer of Mount Royal College. On six consecutive Mondays, students, parents and teachers are provided with the opportunity to engage in mathematical exploration. Discussions took place under the following titles: *Facts about Five*, *Map Colouring*, *Sorting out Sorting*, *The Secret of NIM*, and *Nothing But Zeros and Ones*. This event is biannual, resuming again in the fall.

SFU Evening of Mathematics

The Department of Mathematics and Statistics, SFU and The Pacific Institute for the Mathematical Sciences hosted Grades 11 and 12 students, their teachers and parents, and other interested participants to an evening of lectures on some of the newest applications of mathematics. The most recent event took place Tuesday, March 2, 2000 at Fletcher Challenge Theatre, SFU at Harbour Centre. The first talk, on the Mathematics of Fuel Cells was given by Dr. Keith Promislow (Mathematics and Statistics, SFU and consultant to Ballard Power Systems). The talk explained mathematical models of fuel cells developed in conjunction with engineers at Ballard Power Systems. The second talk, *Mathematics and Literature: Beyond Alice in Wonderland,* was presented by Dr. Brett Stevens (Mathematics and Statistics, SFU, and PIMS/IBM Post Doctoral Fellow). The talk examined a connection between Samuel Beckett's "Quad" and Dante's "Divine Trilogy" that poses a very deep and hard combinatorial question about Gray Codes, and an application of Mutually Orthogonal Latin Squares by French Oulipoian author Georges Perec to the plot structure of his novel *Life: a Manual.* The evening was organized by Dr. Malgorzata Dubiel (Department of Mathematics and Statistics, SFU).

An earlier event was held on November 16, 1999 in Images Theatre, Simon Fraser University. The first talk was *How your digital radio*

knows where its dials are set: Eulerian tours, from the Bridges of Konigsberg to modern digital electronics by Dr. Brett Stevens (Mathematics and Statistics, SFU). Next was *Mathematics of fuel cells* by Dr. John Stocki (Mathematics and Statistics, SFU and consultant to Ballard Powersystems). Finally, *Moving Boundaries: Capturing the splash of a wave, the morphing of images and theevolution of other shifting shapes* by Dr. Steven Ruuth (Mathematics and Statistics, SFU).

Mathematics Competitions

Traditionally, mathematics skill and interest can be uncovered in students by exposure to challenging mathematical exams and contests. PIMS sponsors Alberta and BC participation in a number of such national and internation competitions. A number of such are listed below:

CMS Regional Math Camps

To identify and nurture future members for the Canadian team for the International Mathematical Olympiad, the CMS, Esso, and PIMS sponsor this yearly event where students in grades 8 to 10, as well as exceptional elementary grade students are invited based on merit. Topics in Combinatorics, Number Theory, Algebra and Geometry will be covered at the difficulty level of the Olympiad. This is part of a long-range goal of the CMS to develop mathematical talent in Canadian students to compete on the world stage.

In 1999, the camp was held at the University of Calgary from July 17 to July 23. Twenty-eight students from the western provinces attended.

The next math camp will be held August 16–23, 2000 at the University of Alberta. This year's feature event will be a media day on August 17, with Lieutenant Governor Lois Hole of Alberta attending. The camps are held alternately at the Calgary and Edmonton PIMS sites.

Tournament of Towns

An international mathematics contest originating in Russia and held in the spring and fall each year, is a challenging exam written around the world. PIMS provides support to Dr. Bill Sands of the University of Calgary to help encourage young Albertans to take part in the mathematical contest and introduce them to the wider mathematical community. Although the *Tournament of Towns* has been written in Edmonton for several years, Dr. Sands has been developing more Calgary participation. It is anticipated that Edmonton and Calgary will alternate hosting both the contest and awards ceremony for Alberta.

Alberta High School Contest

An annual contest held in the spring, with the awards ceremony scheduled for late March in Calgary. PIMS will be providing funding to ensure participation for students across the province.

Annual PIMS Elementary Grades Math Contest

This contest — organized by PIMS under the guidance of Dr. Cary Chien of David Thompson Secondary School, in collaboration with the BCAMT and volunteers from Lower Mainland schools of all levels — is open to students in Grades 5 to 7. It provides an opportunity for them to experience mathematics as an exciting sport. This year, 180 students participated in the second annual event, which took place on May 13, 2000 at UBC.

In this year's competition there were three divisions, so that students from each of the grades 5, 6, and 7 will compete in a separate division. The contest is modelled after the successful *MathCounts* competitions (which are also supported by PIMS). However, there are some important differences, because it is aimed at younger students, many of whom will likely "graduate" to MathCounts once they get to high school. There they will learn to work collaboratively in the Team Round, which has here been

replaced by a Problem Solving Round. The latter not only relieves the competitive pressure for a while, but also affords an opportunity for learning some mathematics in a state of heightened awareness and motivation. The other rounds are designated Sprint, Target, and Countdown, each with their own special characteristics.

The top three winners in the grade 5 division at the PIMS Elementary School Math Contest: #1 Connor Wagner (Port Guichon), #2 Sebastian Crema (Boundary Community), #3 Serena Ip (Boundary Park)

The top three winners in the grade 6 division at the PIMS Elementary School Math Contest: #1 Sam Wang (Mount Pleasant), #2 George Yuan (Harold Bishop), #3 Charles Leung (St.George's)

PIMS Math Fair Programme

BC Science Fair Foundation:

Once again PIMS is sponsoring a programme of developing mathematical exhibits in the framework of the Science Fair Foundation (BC). This is particularly suitable for students in Grades 7 to 12 who are looking for longer term projects, to get a feel for the adventure of a self-directed exploration. At the Greater Vancouver Regional Fair, which took place on April 6–7, 2000, at UBC, PIMS supplied judges, mathematical expertise, and prizes.

Unlike, say, sports or music, mathematics does not offer many extracurricular activities in school, except for various kinds of contests, which — for all their admirable motivating qualities — stress just one side of mathematics: the quick grasp. And yet, most mathematical work could be more aptly likened to a marathon than to a sprint. The steadfast persevering quest, so vital to the subject, is minimally represented in the school environment.

The use of science fairs as a vehicle for popularising and teaching mathematics might eventually prove to be a way of filling this void. It is still in its infancy — the wheel has not yet been invented. Mathematics is traditionally not a showy subject. When we get a problem to work on, we retreat into a corner like a squirrel with a nut and come back into the light of day only when we have cracked it. Sure enough, we need some time for quiet concentration. But must it be unrelieved solitary confinement? There ought be a better way – and preparing projects for public display might help push us in the right direction.

Katie McAllister (Grade 9, Point Grey Mini School), winner of the Math Division at the 1999 Vancouver Regional Science Fair and silver medal winner at the Canada-wide Science Fair.

The projects usually fall under one of the

following three headings, although many will present a mixture of two or even all three of them.

Original Research: There are lots and lots of open problems in mathematics. However, most of them lie on the outskirts which can only be reached by air. Since the field is so old, most of the rocks near the centre have been turned over more than once, so finding something really new there is a very lucky break. Nevertheless it happens now and again — and, hey, you never know!

Applications: There is an inexhaustible supply of problems of all shapes and sizes in science, in technology, and even in the arts. Many of them are close to home. The challenge here is to tease out the interesting ones (say, the geometry of rose petals) and not get bogged down in mere routine (like counting them) or too engrossed in extraneous activities (like smelling them).

Exposition: Again and again it happens that somebody gives an old hat a brand-new twist — and most of the time, a new insight comes with it. There are hundreds of ready made proofs of the Pythagorean Theorem, but some people are still rolling their own. The area of the regular dodecagon inside a unit circle (3 square units) had been known for many centuries before recent beautiful proofs were found.

Whichever flag it sails under, a project should always aim at engaging the visitors' minds, not only their eyes. In this connection, a low-tech, home-spun implementation is sometimes more successful than a glitzy computerized one – which might impress without enlightening, unless special care is taken.

Edmonton Elementary Math Fairs

PIMS will sponsor math fairs at Clara Tyner Elementary and Terrace Heights Elementary in Edmonton during the Spring of 2000. At these fairs, students will participate in solving math problems and subsequently create a table-top display to present the problem to other students. All students at the school were involved. This is not a competition, but rather an enjoyable learning experience.

Taiwanese Summer Camp University of Alberta, August, 2000

Initiated by Andy Liu and Wen-Ssieu Sun, this yearly camp provides an opportunity for Taiwanese students to learn both english and mathematics in Canada. This year for the second time, thirty students, mostly thirteen years old, are visiting the University Alberta, where they will be engaged in problem solving in diverse areas of mathematics. On August 4 to 6, a trip to the Rocky Mountains is planned and on August 17, a media day is held with attendance by the Lieutenant Governor of Alberta, Lois Hole.

Initiatives with K-12 Teachers

With new mathematics curricula being developed across Western Canada, PIMS scientists have found considerable demand for teacher training and retraining. Teachers are also interested in exchanging ideas with academics.

PIMS Conferences on Changing the Culture

Organized by M. Dubiel (SFU), P. Hagen (Westwood Elementary), K. Heinrich (SFU), B. McAskill (BC Ministry of Education), E. Perkins (UBC), these conferences are intended to forge closer ties between the mathematics community, mathematics teachers and the industry. Erasing barriers between these communities and looking for common ground is an essential step in any attempts at changing the mathematics culture.

Changing the Culture II, SFU at Harbour Center, Feb. 19-20, 1999

The second annual conference again brought together mathematics researchers, educators and school teachers from all levels to work towards narrowing the gap between mathematicians and teachers of mathematics, and between those who enjoy mathematics and those who think they don't.

The conference in 1999 opened with a plenary talk by Leah Keshet (UBC), *The Study of Living Things: So, What's Math Got To Do With It??* showing an abundance of mathematical models in biology. The first day closed with a public lecture by Doris Schattschneider (Moravian College, Pennsylvania), *Ingenious mathematical amateurs: M.C. Escher (artist) and Marjorie Rice (homemaker)*, describing how two talented and persevering amateurs made substantial contributions to the field.

The pivotal event on Friday was a two hour panel discussion on the question: To what extent is an appreciation of mathematics possible without mathematical training? The three very different positions taken by the panelists Kanwal Neel (BCAMT), Mike Fellows (UVic), and Jeremy Quastel (U of T) elicited a lively exchange with the audience — including the moderator, Klaus Hoechsmann.

In the morning, three discussion groups had been formed to ponder the questions: (1) Can biology be a major context for math classes? (2) How do visualization and logic interact in mathematics? (3) Is applied math easier than pure math? They were led by the organizers of the conference: Malgorzata Dubiel (SFU), Pamela Hagen (Westwood Elementary), and Klaus Hoechsmann (UBC), with the assistance of Bob Camfeld, Djun Kim, and Natasa Sirotič, respectively. After the panel discussion, they met again and extended their deliberations to the additional common question: (4) Can people be taught to like mathematics?

Saturday's opening talk was given by Adrian Lewis (University of Waterloo), *Would Pythagoras have liked Mozart?* showing, among other things, that one of Mozart's last quartets begins with a musical square root of two. It was followed by a panel, moderated by Malgorzata Dubiel, which examined the question: Mathematics and the Arts: where do they meet? Owen Underhill (SFU) spoke about music — in particular, his opera Star Catalogues — Doris Schattschneider explained her mathematics course for Fine Arts Majors, and Ron Coleborn (BCAMT) enlivened his plea for a thinned out curriculum by

his considerable acting talent.

Changing the Culture III, SFU at Harbour Center, April 28, 2000

The Third Annual Conference, organized and sponsored by PIMS, brings together mathematics researchers, educators and school teachers from all levels to work towards narrowing the gap between those who enjoy mathematics and those who think they don't. Its theme this time is Visualising Mathematics.

What is the question? The advent of affordable computers with huge storage and communication capabilities seems to promise a golden age of mathematical visualisation. The question is to what extent it can relieve us of the laborious doodling and imagining that has always been an integral part of mathematical activity.

When asked about the nature of his thinking, Einstein once replied that it was a mixture of visual and kinesthetic elements. The plausibility of that reply is corroborated by any observation of people grappling with mathematics — say, students taking an exam. When they are not busy writing or drawing, they tend to stare into space or at the ceiling, stab or stroke the air, drum or scribble with their fingers, and the like.

Our question therefore has two parts: (1) what exactly is going on there, and (2) how can computers be integrated into that process?

Programme:

- Keynote lecture by Walter Whiteley (York University): *Visual Work and the Mathematics Classroom*
- Three concurrent workshops: *Hi-tech*, *Lo-tech*, *No-tech*.
- Panel Discussion: What role can visualisation play in the teaching of mathematics? Panel: Peter Borwein, Chair (SFU), Sue Haberger (Centennial Secondary), Nancy Heckman (UBC), Susan Oesterle (Douglas College), Walter Whiteley (York University)
- Public lecture: H. S M. Coxeter (University of Toronto): *The Mathematics in the Art of M. C. Escher*

The Workshops:

Hi-tech: Cinderella is a new constructive geometry program along the lines of Geometer's Sketchpad but with an enlarged and differently designed arsenal of tools. June Lester, University of New Brunswick, will give a demonstration of it and lead a couple of workshops for those interested in a closer acquaintance.

Lo-tech: Malgorzata Dubiel, SFU, is one of Canada's leading exponents in constructing geometric models on the crucial hands-on level. She is also the main organiser this conference. Her workshop will include pop-up fractals, origami, polyhedra, and more.

No-tech: The third workshop will re-examine high school geometry in the light of the Geometry Resource Package released by the BC Student Assessment and Program Evaluation Branch in September 1999. It will be led by Bill Casselman (UBC).

PIMS-CECM Workshop on Emerging Java Technologies for Math Education, Simon Fraser University, August 5–6, 1999

Drawing on a repository of components from the Escot project this workshop introduced teachers and others invoved in math education at the secondary level to Java based technologies for creating interactive web applets for math education. While the Escot repository encompasses three major components, JavaSketchpad, SimCalc (or MathWorlds) and AgentSheets this workshop focussed on the use of one of them: JavaSketchpad.

JavaSketchpad is a companion to Geometer's Sketchpad that allows educators and students to take simulations developed in Geometer's Sketchpad and convert them into applets. The history of the CECM's involvement with Java components for math education includes two major initiatives: the Centre's participation with Island Pacific School in a middle school geometrical transformations unit and the Centre's recent association with the ESCOT group based at SRI in the states. The structure of this workshop follows ESCOT's "integration team" model for software development.

IPS Experience: Using javabeans to create a suite of learning activities for geometrical transformations; working with students to create their own games, activities, and learning resources.

Escot project: Component architectures, modular software, middle school focus, interdisciplinary trend, internet and applets, Math Forum POWs, Show-me center, JavaSketchpad, Agentsheets, MathWorlds, Educational object economy.

Integration teams: Second workshop, first in Canada. working as teams (researchers, programmers and teachers) to develop effective, reuseable, flexible learning resources.

PIMS Technology Workshop

Organizer: Mike Stone (U. Calgary)

PIMS is hosting a visit by Stuart Moskowicz (Humbolt State) to the University of Calgary on May 24–26, 2000. Dr. Moskowicz will be addressing an audience of about 25 math educators on the appropriate use of programmable graphing calculators in the mathematics curriculum of the schools. The mathematical content of the workshop will range from introductory problems in graphing simple functions to application in university level calculus. The course also includes calculator programming, use of TI Graph Link software, testing and pedagogical issues, and Internet information.

Teacher Association Meetings

Annual meeting of teacher associations provide an important venue for connections between PIMS researchers and school teachers. Two recent events are highlighted here.

ATA Meetings

The PIMS Calgary Education Coordinator, Dr. Indy Lagu (Mount Royal) and Dr. Mike Stone (U. Calgary) attended the Alberta Teachers Association's annual conference in Jasper, October 1999. to promote PIMS as a mathematical resource accessible to the educators. Dr. Lagu also gave a lecture, *Colour Your World,* to an audience of teachers from all divisions, as an introduction to recent work in combinatorics and graph theory.

BCAMT Meetings

At the annual meeting of the British Columbia Association of Mathematics Teachers, October 22, 1999, held at Killarney Secondary School in Vancouver, PIMS sponsored a presentation by Sharon Friesen (MathWorks, Calgary) who reported on experiments in teaching and professional development. PIMS also hosted an information booth and collaborated on presentations by Cary Chien concerning math contests for elementary grades, and by Cynthia Nicol on the use of drama in teaching mathematics.

PIMS will also participate in the next meeting of the BCAMT in October, 2000.

Elementary School Teacher Meetings, Sunnyside Elementary School, Calgary, January – May, 2000

Organized by Dr. Indy Lagu (PIMS Education Coordinator in Calgary) these meetings provide

an opportunity for teachers to be exposed to interesting problem solving activities. The main goal of the programme is to improve the general attitude of teachers towards mathematics. Due to the unanimous positive response, this event is rescheduled for the fall.

Two series of encounters are in progress:

Sunnyside Elementary School: A series of monthly meetings have begun in January 2000 with the primary school teachers. The participants have expressed interest in organizing mathematics nights for students at the school beginning in April.

West Dalhousie Elementary School: The unexpected usefulness of mathematics as social mortar was also noticeable in the math workshop which filled an entire professional day (May 3) at West-Dalhousie Elementary in Calgary. Under the leadership of their principal **Judy Gray,** the teachers of that school have set themselves the task of developing a *perspective* on mathematics (as they have on other subjects), to give coherence and momentum to their teaching. At their request, PIMS supplied mathematician Indy Lagu to lead their workshop and help anchor their discussions. The event was so well received that a repeat is planned for next year.

The contact between PIMS and West-Dalhousie was made through *MathWorks*, a remarkable experiment in professional development, invented and maintained by **Sharon Friesen,** a Calgary middle school teacher (and recent winner of the Prime Minister's Teaching Award) with a long-standing connection to the local PIMS team. Attended by teachers from several schools, each monthly meeting of MathWorks is built around a math workshop, which, whenever possible, involves a mathematician — usually from PIMS.

Using Graphing Calculators in the Classroom University of Calgary May 24–26, 2000

PIMS will sponsor a workshop for K-12 teachers to demonstrate techniques for using graphing calculators effectively in teaching mathematics.

Communication of the Math. Sciences

Mathematics is Everywhere

Coordinator: Klaus Hoechsmann (PIMS)

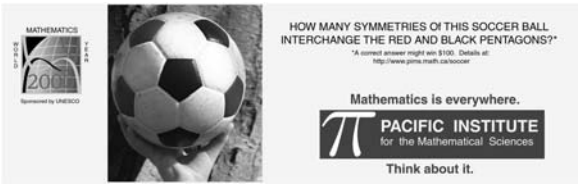
Mathematics is Everywhere is a poster campaign featuring the ever growing importance of Mathematics in modern society and its ubiquity in the world around us. A series of eye-catching posters in a mathematical theme are placed in public transport systems in Vancouver and Victoria and in public schools in Calgary. These will also appear in schools, exhibitions, calendars, etc.

Mathematics is Everywhere is part of PIMS' contribution to the World Mathematical Year 2000 sponsored by UNESCO and the IMU and is one of the many activities in PIMS' continuing Mathematics Awareness Campaign.

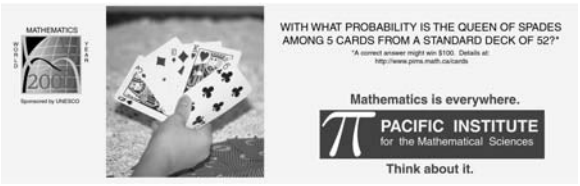
A new poster comes out at the start of every month. Each poster contains an interesting math question and invites the viewer to visit a web page to learn more about the problem. Also on the web page it is possible to submit a solution to the problem. Those submitting a correct solution are elgible for a prize at the end of the month. The first five posters were on the subjects of "The Sunflower Spiral Count," "The Violin String," "Soccer Ball Symmetries," "Chance and Randomness," and "Telling Time by the Sun and the Moon".

February Poster on "The Sunflower Spiral Count"

March Poster on "The Violin String"



April Poster on "Soccer Ball Symmetries"



May Poster on "Chance and Randomness"

June Poster on "Telling Time by the Sun and Moon"

Pi in the Sky

Pi in the Sky is A mathematical newsletter targeted at the Junior and Senior High School students and educators, "Pi in the sky" is produced by mathematicians at the University of Alberta, for distribution across the BC and Alberta. This new and popular semi-annual publication promotes all aspects of the mathematical sciences. The first issue is available online through the PIMS website. The editorial board includes Wieslaw Krawcewicz and Nassif Ghoussoub (Editors in Chief), John Bowman (Associate Editor) and Peter Borwein, Michael Lamoureux, Florin Diacu, Klaus Hoechsmann, Ted Lewis, (Assistant Editors).

Pi in the Sky is a periodical designated for high school students in BC and Alberta with the purpose of promoting mathematics, establishing direct contact with teachers and students, increasing the involvement of high school students in mathematical activities, and promoting careers in mathematical sciences.

This journal, aimed at an average student, has the following objectives:

- to promote meaningful and exciting mathematics;
- to influence teachers;
- to inform students and teachers about mathematical sciences;
- to increase participation of students in math related activities;
- to promote programs in mathematical sciences;
- to encourage girls to get involved in mathematical sciences;
- to establish a dialog between students, teachers and academics;
- to promote new and/or innovative teaching methods;
- to change a negative stereotype image of math.

Hypatia's Street Theatre, Frederic Wood Theatre, UBC December 10, 2000

As a special event at the Winter Meeting of the Canadian Mathematics Society in Vancouver, PIMS will host the premier of a new play about mathematics to be shown to the general public at the Frederic Wood Theater at UBC. The play, entitled *Hypatia's Street Theatre,* is co-authored by PIMS Education Facilitator, Klaus Hoechsmann and playwright Ted Galay. It represents an experiment of mathematical exposition in a theatrical context.

Hypatia was one of the (probably THE) leading Alexandrian intellectuals of her time: not only an accomplished mathematician and astronomer (books on the works of Diophantus, Ptolemy, Apollonius, Euclid) but also the main proponent of Neo-Platonism. Not content to stay in academe, where she was universally admired, she was known to mingle with the crowds and engage in philosophical discussions. The play imagines her, toward the tragic end of her life, turning away from philosophy — which was increasingly mired in verbiage and ideology — and carrying her message of clarity and openness to the public in the form of mathematical skits.

Initiatives for Undergraduate Students

PIMS Graduate Weekends

The purpose of the weekends is to let the students know about many of the very exciting research projects and initiatives taking place in the Mathematical Sciences departments.

PIMS Graduate Weekend II, U. Alberta and U. Calgary, January 19–24, 1999

Organizers: G. Swaters (U. Alberta), R. Westbrook (U. Calgary)

The 1999 PIMS Graduate Weekend was held at the campuses of the University of Calgary and the University of Alberta on January 19–24, 1999. Students from across Canada were flown into Calgary on the 19th, where they attended a number of information sessions and met with University of Calgary faculty members on the following day. They had the opportunity to listen to four different sessions describing various research opportunities in the mathematical and statistical sciences. On the 21st, they were bused to Edmonton to visit the University of Alberta, where they attended another 12 sessions describing research opportunities in Algebra, Geometry & Topology, Classical & Functional Analysis, ODEs & PDEs, Fluid Dynamics, Computational Sciences, Statistics and Mathematical Biology, Finance, and Physics. In addition to the University of Alberta and University of Calgary speakers, there were presentations by representatives from Simon Fraser University and the University of British Columbia.

Social activities included a welcoming reception held at their hotel on the evening of the students' arrival in Edmonton. A luncheon was also provided the following day for all of the attendees, as well as the current graduate students in the Department of Math. Sciences, University of Alberta. The attendees very much enjoyed the chance to speak on an informal basis with a group of current graduate students. The attendees also were treated to a formal banquet at the University of Alberta Faculty Club, which was attended by Dean R. Peter, Faculty of Science, University of Alberta.

PIMS Graduate Weekend III, SFU-UBC, February 12–13, 2000

Organizers: Kori Inkpen (SFU), Randy Sitter (SFU), Denis Sjerve (UBC), Sandy Rutherford (PIMS)

This year the PIMS Graduate Weekend was held at UBC and SFU on February 12–13. PIMS hosted 43 of the top undergraduates in mathematics, computer science and statistics from across Canada. The students attended a variety of lectures and presentations on graduate programmes in the mathematical sciences at the PIMS universities.

On Saturday, the students visited SFU. In the morning they attended presentations by Peter Borwein, Kori Inkpen, Luis Goddyn and Charmain Dean from SFU. Pauline van den Driesche spoke about the graduate programmes in the mathematical sciences at the University of Victoria and Michael Lamoureux presented information on graduate studies at the University

of Calgary. In the afternoon the students toured some of the research facilities at SFU and ended the day with a buffet dinner at the Diamond University Club.

On Sunday, the students visited the University of British Columbia, where they were hosted at the PIMS-UBC facilities. Presentations were made to the students by Denis Sjerve, Goerge Bluman, Nassif Ghoussoub, Anthony Peirce, Robert Miura, Dave Boyd, Dale Rolfsen, Martin Barlow, Alan Wagner and Nancy Heckman. Samuel Shen, from the University of Alberta, gave a presentation on the benefits of doing graduate work at the University of Alberta. After lunch, the students broke up into small groups to tour the research facilities and discuss with faculty members.

IAM-MITACS-PIMS Senior Undergraduate Industrial Math Workshop,UBC, February 18–20, 2000

Organizers: Anthony Peirce (UBC), Michael Ward (UBC)

(See chapter on *Industrial Training Programme.*)

Initiatives for Graduate Students

Graduate Industrial Math Modeling Camps

Each spring, the Pacific Institute for the Mathematical Sciences (PIMS) sponsors a five day workshop for graduate students on mathematical modeling. The goal of the Mathematical Modeling Camp is to provide experience in the use of mathematical modeling as a problem solving tool for graduate students in mathematics, applied mathematics, statistics, and computer science.

The Mathematical Modeling Camp is one of two components of the annual PIMS Industrial Forum. The other component is the Industrial Problem Solving Workshop. At this Workshop, industrial and academic mathematicians work together to solve particular problems posed by industrial sponsors. Graduate students who are accepted to the Mathematical Modeling Camp are also invited to this Workshop.

Students work together in teams, under the supervision of invited mentors. Each mentor poses a problem arising from an industrial or engineering application and guides his or her team of graduate students through a modeling phase to a resolution. At the end of the workshop, reports are presented and a written summary of conclusions is made available for distribution.

Outstanding graduate students at both the Masters and PhD level in the fields of mathematics, applied mathematics, statistics, and computer science, or related disciplines, are invited to apply.

2nd Annual Graduate Industrial Math Modeling Camp,
University of Alberta,
May 24–28, 1999

Organizer: G. Swaters (U. Alberta)

(See chapter on *Industrial Training Programme.*)

3rd Annual Graduate Industrial Math Modeling Camp,
Simon Fraser University,
May 23–27, 2000

Organizer: K. Promislow (SFU), M. Kropinski (SFU), S. Jungic (SFU)

(See chapter on *Industrial Training Programme.*)

1st PIMS Summer School in Fluid Dynamics,
University of Alberta,
August 7 – 20, 1999

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

(See chapter on *Industrial Training Programme.*)

2nd PIMS Summer School in Fluid Dynamics,
University of Alberta,
July 30 – August 11, 2000

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

(See chapter on *Industrial Training Programme.*)

Technology-based Mathematics

The Pacific Institute is working to provide a useful, comprehensive collection of tools for teaching, learning and promoting mathematics and disseminating research with computers. Examples of such resources will include on-line interactive courses and modules, reusable software components, research and computational tools and an interactive electronic mathematics journal. The target user group includes mathematicians, scientists, educators (mostly secondary and post-secondary) and students of the mathematical sciences.

A number of technology projects have received PIMS funding in the past and are continuing under their own resources. One ongoing project, described below, is indicative of the objectives of Pims technological innovations.

The KnotPlot Project

Coordinator: Bob Scharein (UBC)

This project builds on the research described in the author's doctoral dissertation *Interactive Topological Drawing*. In particular, one goal is to make the large amount of experimental data obtained during the thesis research widely available to the mathematical community at large via the World Wide Web (WWW). A second goal was to make the software used to obtain the data (principally KnotPlot) available for academics and other researchers, or for artists and people with a general interest in knots.

KnotPlot Download Site

The KnotPlot program has been ported to a variety of computers and operating systems. Versions of the program for

1. Windows 85/98/NT
2. Macintosh (PowerPC)
3. Linux
4. Silicon Graphics workkstations
5. Sun workstations

can be downloaded from

www.math.ca/knotplot/download.html.

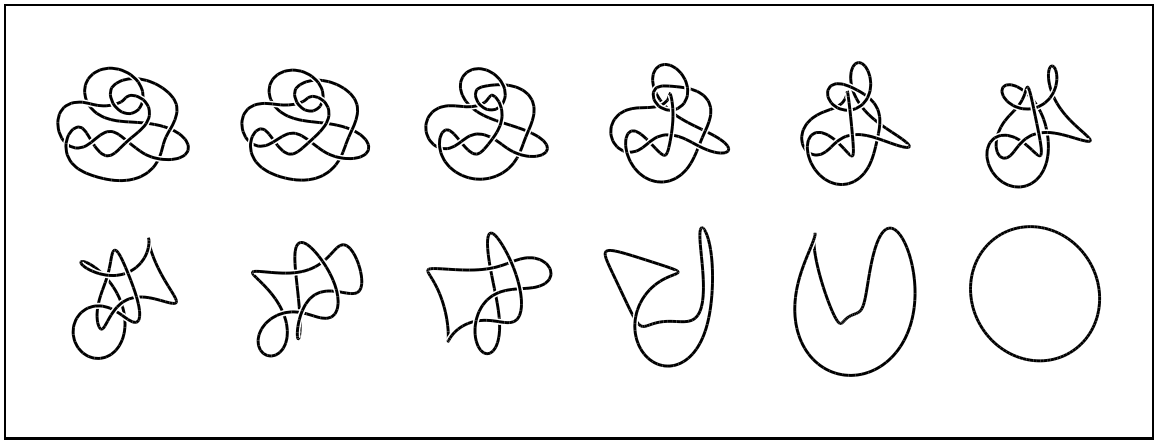
Knot Theory on the World Wide Web

The web site provides mathematicians with a comprehensive encyclopaedia of information on cataloged knots and links. Initially, this will be limited to the nearly 400 knots and links found in Appendix C of D. Rolfsen's book, *Knots and Links*. In addition to providing images of each knot (in several different formats), the database will also contain topological information of use to knot theorists. In particular the following topological and geometric data will be available:

- Crossing number, stick number, unknotting number
- Signature, Arf invariant, knot group
- Fourier coefficients
- Closed braid description(s)

- Conway number
- Alexander, Jones, HOMFLY, Kauffman and other polynomials
- Known symmetries along with a catalogue of interesting symmetric presentations (both for smooth version and minimal stick version)
- Sufficient invariants to distinguish from any other knot in the Rolfsen catalogue
- Vertex data giving an instance of the knot type

In addition to providing a resource for research mathematical scientists, the knot theory website will also provide an on-line, high-quality, and interactive instructional tool for learning knot theory and its relation to other areas of mathematics and science. The pedagogical section of the knot theory website will be accessible to wide audience and suitable in some degree for instructional purposes for students from K through 12 and beginning university level. Activity areas will include being able to draw your own knot and obtain output, learning about tying simple knots with real rope (this will include animations of knot tying), and knot art in which the students will learn appreciation for mathematics through beautiful images of knots.



This sequence of knot diagrams produced by KnotPlot shows how it can be used to relax the apparent knot at upper left to the unknot at lower right.

The UBC Sun SITE Project

Coordinator: Bill Casselman (UBC)

The SITE is one of about eight in North America, among them some of the most useful and popular Internet sites for University users. The official goal of Sun's project is for each SITE to operate as "a library, a publishing house, a distribution center and a technology showcase." In this vein, the aims of the UBC SITE include the introduction of more professional standards in high-tech electronic mathematics publication as well as involving local groups in a collaborative effort to produce high quality Internet material for use in the Mathematics community at large. The location of the UBC Sun SITE is: *sunsite.ubc.ca*.

New advances in programming languages—for example, Java, Postscript and HTML—together with the interconnectivity of the World Wide Web are providing mathematicians with unique opportunities to express their ideas in

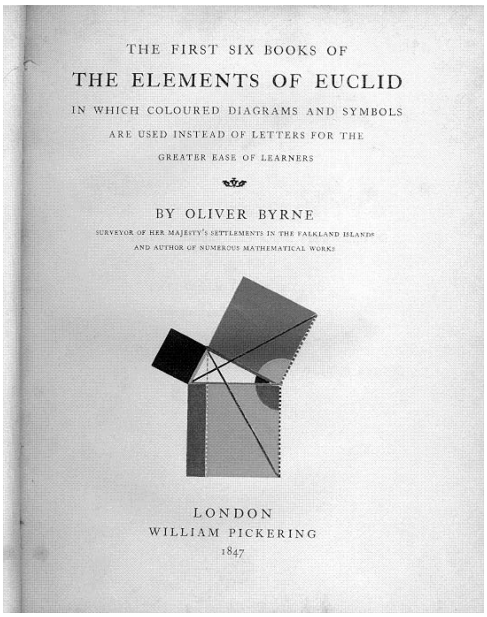
novel ways and to a wider audience. Although the role of the Internet in explaining mathematics is already beyond easy comprehension, the Sun SITE at UBC hopes to make a small start in raising standards. We hope to find a role as a moderator in the development of this new medium by providing a forum for the electronic publication of suitable work and by providing guidance through technical assistance and by example.

As one of roughly fifty Sun SITEs worldwide, the UBC project is the only Sun SITE serving primarily mathematical content. Because the SITEs are authorized by Sun and are known to have generally high standards, these sites have a tremendous number of users.

The Digital Mathematics Archive

This is a digital collection of mathematical sources including papers, letters, manuscripts, and computer rendered images and computations. Many of today's source documents are much more ephemeral than the documents of the previous century. This archive will allow some of this material to be preserved while giving it a wide distribution.

1. At the moment the main item in the Archive is a growing collection of the professional correspondence of Professor Robert P. Langlands of the Institute for Advanced Study, once himself an undergraduate at UBC, as well as a selection of previously unpublished work and published work now out of print. One of the first documents in this collection is a 17 page hand-written letter to Andre Weil, written while Langlands was at Princeton University, outlining what quickly became known as 'the Langlands conjectures'. The SITE presents large-format digitized images of the original letters together with .dvi and .pdf format transcriptions. It is hoped that this project will eventually include other work of a similar nature.
2. A second example is a digital version of Oliver Byrne's 1847 graphical edition of *Euclid's Elements*. This will be reproduced at the highest quality affordable, in contrast to many casual digital mathematical images on the Internet. It is hoped that it will serve as a nucleus for local educational projects concerned with Euclid and geometry.


THE FIRST SIX BOOKS OF
THE ELEMENTS OF EUCLID
IN WHICH COLOURED DIAGRAMS AND SYMBOLS
ARE USED INSTEAD OF LETTERS FOR THE
GREATER EASE OF LEARNERS
BY OLIVER BYRNE
SURVEYOR OF HER MAJESTY'S SETTLEMENTS IN THE FALKLAND ISLANDS
AND AUTHOR OF NUMEROUS MATHEMATICAL WORKS
LONDON
WILLIAM PICKERING
1847

Appendix A: PIMS Management

Board of Directors

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

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

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

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

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

Dr. Bruce Clayman received his PhD from Cornell University in 1968. He is currently a professor of Physics at Simon Fraser University as well as the Vice-President Research. His past administrative duties include Dean of Graduate Studies, President of the Canadian Association for Graduate Studies and Acting Dean of Science. He is a member of the Sigma Pi Sigma Physics Honour Society. His research interests include superconductors, impurity states in solids, and layered compounds. He has published over 80 papers in refereed journals and refereed conferences.

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

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

Dr. Denney is Manager, Information Services at Syncrude Canada-Ltd, providing telecommunications and computing infrastructure for Syncrude's operations in Fort McMurray, Alberta. Dr. Denney spent 10 years at Syncrude Research developing On-line Sensors and applying Pattern Recognition techniques to data analysis. His current interest is information management to support condition-based maintenance programs.

Mr. Kenneth Foxcroft served on the board of Directors of Factors Limited, Toronto Dominion Securities (USA) Inc., and of the Ontario Securities Advisory Commission. He has also held the positions of Chairman for Commodity Futures and President for the Forex Association of Canada. Presently, Mr. Foxcroft is the Deputy Chairman & Chief Trading Officer for TD Securities Inc.

Dr. Nassif Ghoussoub is a Professor of Mathematics at the University of British Columbia. He did his undergraduate degree at the Lebanese University in Beirut and obtained his Doctorat détat in 1979 from the Universié Pierre et Marie Curie in Paris. He is a fellow of the Royal Society of Canada and is the current Director of the Pacific Institute for the Mathematical Sciences. His present research interests are in non-linear analysis and partial differential equations.

He was the recipient of the Coxeter-James prize in 1990 and of a Killam senior fellowship in 1992. He was chair of NSERC's grant selection committee for mathematics in 1995-1996 and vice-president of the Canadian Mathematical Society from 1994 to 1996. He is on the editorial board of various international journals and is currently the co-Editor-in-Chief of the Canadian Journal of Mathematics.

Dr. Maria Klawe is currently the Dean of Science at the University of British Columbia, having served as Head of the Department of Computer Science from 1988 to 1995 and Vice-President of Student & Academic Services from 1995 to 1998. Her responsibilities as the Dean of Science are the leadership of the Faculty of Science. Dr. Klawealso holds the NSERC-IBM Chair for Women in Science and Engin eering, one of five regional chairs across Canada. Dr. Klawe's chair is responsible for British Columbia and the Yukon, and emphasizes increasing the participation of women in information technology careers.

Prior to joining UBC, Dr. Klawe spent eight years with IBM Research in California, and two years at the University of Toronto. She received her Ph.D. (1977) and B.Sc. (1973) in Mathematics from the University of Alberta. She has made significant research contributions in several areas of mathematics and computer science including functional analysis, discrete mathematics, theoretical computer science, and interactive-multimedia for mathematics education. She is the founder and director of the Electronic Games for Education in Math and Science (E-GEMS) project, a large-scale collaborative project involving computer scientists, mathematics educators, teachers, children and professional game developers. She has also served on many boards and advisory councils, including the Board of Trustees of the American Mathematical Society (chair 1995-96), the Computing Research Association (vice-chair 93-95), and the BC Premier's Advisory Council on Science and Technology (93-present). Dr. Klawe was elected as a Fellow of the Association of Computing Machinery in 1995, and received the Vancouver YWCA Women of Distinction Award in Science and Technology in 1997.

Dr. Prabha Kundur holds a Ph.D in Electrical Engineering from the University of Toronto and has over 30 years of experience in the electric power industry. He is currently the President and CEO of Powertech Labs Inc., the research and technology subsidiary of BC Hydro. Prior to joining Powertech in 1993, he worked at Ontario Hydro for 25 years and was involved in the planning, design and operation of power systems.

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

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

Dr. Peter Lancaster is a Professor Emeritus and Faculty Professor in the Department of Mathematics and Statistics of the University of Calgary. He has doctoral degrees from from the University of Singapore and the University of Liverpool, England, as well as five years experience in the aircraft industry in the 1950's. He came to Canada in 1962 and was elected to the Royal Society of Canada in 1984. His research interests are in matrix and numerical analysis especially as applied to vibrations, systems theory, and signal processing. He is the author or co-author of several texts and monographs and serves on a number of editorial boards. He has completed terms as Vice-President and as President of the Canadian Mathematical Society, and as Vice-President of the Canadian Applied Mathematics Society. He has also served (or is serving) on numerous committees of NSERC and the Royal Society of Canada.

Dr. Barry McBride is the Vice-President Academic and Provost of the University of Britsih Columbia since 1999. He received his Ph.D. from the University of Illinois (Urbana) in 1970. He was the Dean of Science at the University of British Columbia from 1990 to 1999, Department Head of the Microbiology Department at UBC from 1986 to 1989 and Department Head of the Oral Biology Department at UBC from 1981 to 1986. He has consulted with Cominco, Energy Mines and Resources Canada, the National Institute of Health, USA and Ventures West. He is a member of many Professional Committees including the Medical Research Council (where he is also on the Executive Committee), the Standing Committee on Manpower (MRC), Scientific Advisory Council - Alberta Council - Alberta Heritage Foundation for Medical Research and the Canadian Institute for Advanced Research - Research Advisory Council. His major area of research is in ecology and pathogensis of the microbial flora of man with specific reference to pathogens of the

mouth.

Dr. Stephen Ng received his Bachelor and Master degrees in Engineering Physics from McMaster University in 1973 and 1974 respectively and received his Ph.D. degree in Electrical Engineering from University of Waterloo in 1977. His research interests are in queuing and stochastic processes in multiple access communication systems. Since 1997, he is Senior Manager of Nortel Networks Global External Research program.

After spending three years in Bell Canada's Computer Communications Group from 1978, he joined Bell-Northern Research (BNR) in 1981. He was involved in systems engineering and strategic planning for data communication networks and Advanced Services (Advanced Intelligent Network services) for the voice networks and most recently with the Internet. He was also involved in standards work in Europe and in the establishment of research facilities in China for Nortel Networks.

Dr. Edwin Perkins is Professor of Mathematics at the University of British Columbia where he was first appointed as a postdoctoral fellow in 1979. He did is his undergraduate degree at U. of Toronto and obtained his doctoral degree from the U. of Illinois. His research interests in probability include the general theory of processes, Brownian motion, stochastic differential equations and partial differential equations, interacting particle systems, measure-valued diffusions and stochastic models in population genetics. He has won numerous awards for his research including the Coxeter-James Lectureship (1986) and G. de B. Robinson Award (1996) (Canadian Math. Society), the Rollo Davidson Prize (1983) (Cambridge U.) and a Steacie Fellowship (1992-93) (NSERC). He is a Fellow of the Royal Society of Canada and currently sits on the Academy of Science Council. He is presently on the editorial boards of the Canadian J. of Mathematics, the Annals of Applied Probability, the Annales de l'Institute Henri Poincaré, and Probability Theory and Related Fields. He has given several invited lectureships including an invited address at the 1994 International Congress of Mathematicians in Zurich.

Dr. Richard E. Peter received a B.Sc. in Biology from The University of Calgary in 1965 and a Ph.D. from the University of Washington in 1969. Following postdoctoral research in Pharmacology at the University of Bristol, he took up an appointment in the Department of Zoology, University of Alberta, in 1971. Promoted to Professor in 1979, he served as Chairman of Zoology from 1983-1992, and became Dean of Science in 1992. His research is on the brain regulation of reproduction and growth in fish, an area in which he has over 260 publications. Dr. Peter has received numerous honours and awards, including the E.W.R. Steacie Memorial Fellowship in 1980, election as a Fellow of the Royal Society of Canada in 1985 and the Pickford Medal for outstanding contributions to comparative endocrinology. A kit to induce spawning of farmed fish, based on his research, is marketed as OVAPRIM by Syndel Laboratories Ltd., Vancouver.

Dr. Martin Taylor has a BA in Geography from the University of Bristol (UK), and an MA and PhD from the University of British Columbia. He was appointed at McMaster in 1974. He was Chair of Geography (1991-1997), founding Director of the Institute of Environment and Health (1991-96), and Acting Vice-President Research (1994-95). 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 moved to UVic in July 1998 to be the University's first Vice-President Research as well as being a full professor in the Geography Department.

The *Steering Committee* of the Board consists of D. Peter (Chair), J. Delgrande, N. Ghoussoub, P. Lancaster, M. Taylor and E. Perkins.

PIMS Director, Dr. Nassif Ghoussoub with PIMS Board member and Provost & VP Academic of UBC, Dr. Barry McBride at the inauguration of the PIMS Central Office at UBC.

Scientific Review Panel

The Scientific Review Panel is responsible for:

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

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

David Boyd received his Ph.D. in Mathematics from the University of Toronto in 1966. At that time he worked in harmonic analysis and in particular interpolation theory for rearrangement invariant spaces. Subsequently his work shifted into number theory, particularly the theory of Pisot and Salem numbers and Mahler's measure. He is particularly interested in the role of computation in pure mathematics. After his Ph.D., he spent a year at the University of Alberta, then moved to the California Institute of Technology where he spent the next four years, and finally moving to the University of British Columbia where he has been a Professor of Mathematics since 1974. He was awarded the 1978 E.W.R. Steacie Prize in Science for his work on Pisot sequences and Salem numbers. He was the Canadian Mathematical Society's Coxeter-James lecturer for 1979 and was elected to the Royal Society of Canada in 1980.

David Brillinger is a researcher in the area of time series, which involves him in the analysis of random processes in the biological and physical sciences. He has made contributions to the theory and application of statistical methods in subject areas including neurophysiology (the analysis of neural spike trains), seismology, and demography. He is the author of Time Series Analysis: Data Analysis and Theory, former editor of the International Statistical Review, and current President of the Institute of Mathematical Statistics. He is a member of the American Academy of Arts and Sciences and is a Fellow of the Royal Society of Canada.

Richard Ewing is Dean of the College of Science and Professor of Mathematics and Engineering at Texas A & M University. He also is Director of the Institute for Scientific Computation and the Academy for Advanced Telecommunications & Learning Technologies at Texas A & M. Prof. Ewing is an expert in scientific computation. His recent research deals with the multitude of problems that arise from numerical simulation and modeling of multiphase flow and transport in porous media as applied to ground water contaminants and reservoir modeling. He has an extensive background in consulting/advising with the public and private sector especially the petroleum industry.

Ronald Graham is currently Chief Scientist of AT&T Research. He was President of the American Mathematical Society from 1993-95. His other current obligations include: membership of the Scientific Advisory Committee of the Santa Fe Institute, of the National Research Council, Mathematical Sciences Education Board, and of the Joint Policy Board on Mathematics. He is Treasurer of the National Academy of Sciences (1996-2000). Dr. Graham's academic awards include: Membership in the National Academy of Sciences and Fellowships in the American Academy of Arts & Sciences, the New York Academy of Sciences, and the American Association for the Advancement of Science. He was the Scientist of the Year, World Book Encyclopedia in 1981, and won the Polya Prize in Combinatorics in 1972, the Carl Allendorfer Award of the Math. Assoc. of America in 1990, a Lester Ford Award of the Math. Assoc. of America, in 1991, and the Euler Medal of the Institute of Combinatorics in 1994. Ron Graham's current mathematical interests include combinatorics, number theory, graph theory, discrete and computational geometry, theoretical computer science, and applications thereof. In all of these areas he has made fundamental contributions. He is also a very gifted juggler.

Richard M. Karp was born in Boston, Massachusetts in 1935 and was educated at the Boston Latin School and Harvard University, where he received his Ph.D. in Applied Mathematics in 1959. From 1959 to 1968 he was a member of the Mathematical Sciences Department at the IBM Thomas J. Watson Research Center. From 1968 to 1994 he was a professor at the University of California, Berkeley. From 1988 to 1995 he was also associated with the International Computer Science Institute in Berkeley. In 1994 he retired from Berkeley and was named University Professor (Emeritus). In 1995 he moved to the University of Washington, where he has appointments in Computer Science and Molecular Biotechnology. The unifying theme in Karp's work has been the study of combinatorial algorithms. His 1972 paper "Reducibility Among Combinatorial Problems," demonstrated the wide applicability of the concept of NP-completeness. Much of his subsequent work has concerned the development of parallel algorithms, the probabilistic analysis of combinatorial optimization problems, and the construction of randomized algorithms for combinatorial problems. His current research is concerned with strategies for sequencing the human genome. Karp has received the U.S. National Medal of Science,Turing Award (ACM), the Fulkerson Prize(AMS and Math. Programming Society), the von Neumann Theory Prize(ORSA-TIMS), the Lanchester Prize (ORSA) the von Neumann Lectureship (SIAM) and the Distinguished Teaching Award (Berkeley). He is a member of the National Academy of Sciences and the National Academy of Engineering, and holds four

honorary degrees.

Alistair Lachlan obtained his Ph.D. from the University of Cambridge in 1964 and is currently a Professor of Mathematics at Simon Fraser University. Prof. Lachlan was elected as a Fellow of the Royal Society of Canada in 1974. He has served as the Vice-President of the Canadian Mathematical Society (1985–1987), was a member of the NSERC math GSC (1984–1987), was a member of the selection panel for speakers in Mathematical Logic at the 1990 ICM, and served on the steering committee for the CRM (1991–1995). He is and has been an editor for a number of journals including annals of pure and applied logic and the lecture notes in logic.

Bernard J. Matkowsky presently holds the John Evans Chair in Applied Mathematics at Northwestern University. He received his Ph.D. from New York University in 1966. He was at Rensselaer Polytechnic Institute until 1978 and has been at Northwestern University since then. He is the editor of 7 journals (SIAM J. Appl. Math., European J. Appl. Math., Int'l. J. Wave Motion, Random and Computational Dynamics, J. Materials Synthesis and Processing, Int'l. J. SHS, Applied Math. Letters) and one book series (Springer Appl. Math. Sci. series). His honors include being a Fulbright-Hayes Fellow in 1972-1973 and a Guggenheim Fellow in 1982-1983. His research areas include asymptotic and perturbation methods for ordinary and partial differential equations, nonlinear stability and bifurcation theory, stochastic differential equations, and applications to fluid dynamics, elasticity, combustion, flame propagation, and solid state physics.

Robert V. Moody is Professor of Mathematics at the University of Alberta. He received his Ph.D. from the University of Toronto in 1966 and spent most of his academic career at the University of Saskatchewan before coming to Alberta in 1989. He is best known for the discovery, independently with V. Kac, and subsequent investigations of the Kac-Moody Algebras, for which he was awarded the 1994-1996 Eugene Wigner Medal jointly with Kac. He has presented both the Coxeter-James Prize Lecture (1978) and the Jeffrey-Williams Prize Lecture (1995) to the Canadian Mathematical Society. He has served nationally on the Scientific Advisory Boards of both the Centre de Recherches de Mathematique and the Fields Institute for Research in the Mathematical Sciences, and on the Council of the Academy of Science, Royal Society of Canada.

Nicholas Pippenger received his Ph.D. from MIT in Electrical Engineering in 1974. Prior to joining UBC Computer Science department as a professor in 1988, he was a staff member at IBM for sixteen years and at Draper Laboratories for three years. For his last two years at IBM he was an IBM Fellow. His other distinctions include a 1991 UBC Killam Research Prize, a 1983 IBM Outstanding Technical Achievement Award, and a 1981 IBM Outstanding Innovation Award. He has published over 90 research articles in the theory of computation and communication and discrete mathematics.

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 professor in the Department of Mathematics and Statistics. His research concerns the interactions between topological dynamics and C*-algebras. He has received the Israel Halperin Prize and the Andre Aisenstadt prize. He is a Fellow of the Royal Society of Canada.

Gordon Slade received his Ph.D. from the University of British Columbia, in Mathematics, in 1984. Before joining UBC Mathematics Department as a professor in 1999, he was a professor in the Mathematics department at McMaster University. He was the 1995 Coxeter-James Lecturer of the Canadian Mathematical Society, and was one of five Canadian mathematicians invited to give addresses at the 1994 International Conference of Mathematicians in Zurich. In joint work with T. Hara, he has given a rigorous proof of the long-standing conjecture that percolation (and also other important models in statistical physics) exhibit mean-field behaviour in high dimensions.

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 full professor. He is currently a professor in Massachusetts Institute of Technology. Prof. Tian is a recipient of the Alfred P. Sloan research fellowship (1991-1993). He presented a 45-minutes invited address at the International Congress of Mathematicians in Kyoto in 1990 and the Bergmann Memorial Lecture at Stanford University in 1994. The same year, he received the 19th Alan Waterman Award from the National Science Foundation. In 1996, Prof. Gang Tian received the Veblen Prize of the American Mathematical Society.

Executive Committee

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

Director: Nassif Ghoussoub, (UBC, Math)
SFU Site-Dir.: Peter Borwein (SFU, Math)
UVic Site-Dir.: Florin Diacu (UVic, Math)
UBC Site-Dir.: Dale Rolfsen (UBC, Math)
UC Site-Dir.: Michael Lamoureux (UC, Math)
UA Site-Dir.: Bryant Moodie (UA, Math)

Director's Office

Director: Nassif Ghoussoub
Deputy Director: Michael Lamoureux
Scientific Executive Officer: Alexander Rutherford
Financial Officer: Katrina Soh
Education Coordinator: Klaus Hoechsmann
MITACS Aministrator: Clarina Chan
PIMS/MITACS Website Admin: Kelly Choo
Communication & System Manager: Patsy Wong
Secretary: Leslie MacFadden
Programme Coordinator: Sabrina French
Housing Coordinator: Shannon Perkins

PIMS Industrial Facilitators in BC and Alberta

These mathematical scientists are spending time interacting with both university researchers and industrial partners thus facilitating contacts between industry and persons who have expertise in the various research groups at the five universities. They are also assisting as the administrators and coordinators of industrial workshops. An essential task performed by the facilitators is that of identifying industries that may require mathematical expertise and making initial contact with the research and development personnel of these industries. They have already enabled collaboration of several projects between the academics and the industries. They play a crucial role in soliciting problems from industries for the workshops. The present and recent facilitators are:

Dr. Huaxiong Huang, Director's Office
Marc Paulhus, U. Calgary site-office
John Vardalas, U. Alberta site-office

M. Paulhus and J. Vardalas are responsible for the Calgary and Edmonton areas, respectively. Dr. Huang was responsible for UBC and SFU and coordinated industrial activities between the central office and site offices; he has moved to a permanent faculty position at York University.

Education and Communication

Education Facilitator: Klaus Hoechsmann (UBC)

Local Committees

The Local Coordinator for each site is indicated by an asterisk.

University of Victoria:
Kelly Choo
David Leeming*
Bill Pfaffenberger

University of BC:
Andrew Adler*
Phillip Loewen
Edwin Perkins

Simon Fraser University:
Malgorzata Dubiel*
Loki Jorgenson
Rina Zaskis

University of Alberta:
Hans Brungs
Ted Lewis*
Andrew Liu

University of Calgary:
Claude Laflamme
Indy Lagu*

Local Steering Committees

SFU

Site Director: Peter Borwein
Admin. Assistant: Sadika Jungic
Education Coordinator: Malgorzata Dubeil
Len Berggren (Math)
Jonathan Borwein (Math)
Rustum Choksi (Math)

Charmaine Dean (Math)
Jim Delgrande (CS)
Cecil Graham (Math)
Arvind Gupta (CS)
Lou Hafer (CS)
Pavol Hell (Math & CS)
Mary-Catherine Kropinski (Math)
Alistair Lachlan (Math)
Thomas O'Shea (Education)
Steven Pearce (CS)
Keith Promislow (Math)
Steve Ruuth (Math)
Randy Sitter (Math)
Rina Zazkis (Education)

UA

Site Director: T. Bryant Moodie
Admin. Assistant: Lina Wang
Assistant Industrial Facilitator: Andrew Kobos
Education Coordinator: Ted Lewis
Andy Bush (Earth & Atmospheric Sci)
Gerald Cliff (Math Sci)
Gerda de Vries (Math Sci)
Anthony Lau (Math Sci)
Peter Minev (Math Sci)
Russ Greiner (CS)
Jack Tuszynski (Math Sci)

UBC

Site Director: Dale Rolfsen
Administrative Assistant: Leslie MacFadden
David Austin (Math)
Uri Ascher (CS)
George Bluman (Math)
Elizabeth Croft (Mech Eng)
Uli Haussmann (Math)
Bent Jorgensen (Stat)
Ed Jull (ECE)
Leah Keshet (Math)
David Kirkpatrick (CS)
Robert Miura (Math)
Doug Oldenburg (Earth & Ocean Sci)
Dinesh Pai (CS)
Anthony Peirce (Math)
Ed Perkins (Math)
Martin Puterman (Commerce & Business Admin.)
Bryan Seymour (Math)
Bernie Shizgal (Chemistry)
Douw Steyn (Geography)
Michael Ward (Math)
Matthew Yedlin (Geophysics and ECE)

UC

Site Director: Michael Lamoureux (Math & Stat)
Admin. Assistant: Marian Miles
Industrial Facilitator: Marc Paulhus
Education Coordinator: Indy Lagu
Rita Aggarwala (Math & Stat)
Rod Blais (Geomatics)
Ted Bisztriczky (Math & Stat)
Ernest Enns (Math & Stat)
Lisa Higham (CS)
Claude Laflamme (Math & Stat)
Peter Lancaster (Math & Stat)
Ali Lari-Lavassani (Math & Stat)
Jon Rokne (CS)
Mike Stone (Math & Stat)
Gordon Sick (Management)
Jedrzej Sniatycki (Math & Stat)
Mike Stone (Math & Stat)
Peter Zvengrowski (Math & Stat)

UVic

Site Director: Florin Diacu
Admin. Assistant: Irina Gavrilova
Web Page Administrator: Kelly Choo
Education Coordinator: David Leeming
Arif Babul (Physics)
Chris Bose (MAth & Stat)
Reinhard Illner (Math & Stat)
Valerie King (CS)
David Leeming (Math & Stat)
Mary Lesperance (Math & Stat)
Gary Macgillivray (Math & Stat)
Ian Putnam (Math & Stat)
William Reed (Math & Stat)
Frank Ruskey (Math & Stat)
Ahmed Sourour (Math & Stat)
Pauline van den Driessche (Math & Stat)

National Programme Committee of the Canadian Mathematical Sciences Institutes

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

- Allocating funds provided by the three institutes to support conferences and workshops in the mathematical sciences across Canada. These will primarily be activities that fall outside of the main purview of the three institutes.
- Allocating funds for the support of activities that are held at the meetings of the three Canadian mathematical science societies - the Canadian Mathematical Society, the Canadian Applied and Industrial Mathematical Society, and the Statistical Society of Canada.
- Annually coordinating the organization of three Institute Sessions to be held at the meetings of the Canadian Mathematical Society.
- Providing support for graduate students to attend the scientific meetings of the National Societies.
- Coordinating international programmes and other ventures where it is advantageous for the three Institutes to act as a whole.

The committee consists of:

Chair: Michael Lamoureux (Deputy Director of PIMS)
Jacques Belair (Deputy Director of CRM)
Bradd Hart (Deputy Director of the Fields Institute)
Martin Barlow (Mathematics, UBC)
Niky Kamran (Mathematics, McGill)
David Sankoff (CRM)

Michael Lamoureux, PIMS Deputy Director and Chair of the National Programme Committee

Appendix B: Financial Report

During the fiscal year 1999/2000, PIMS has established base funding from NSERC, the Provinces of Alberta and British Columbia and the 5 founding universities in BC and Alberta. The PIMS fiscal year runs from April 1 of the current year to March 31 of the subsequent year. In this section we outline the PIMS budget for the fiscal year 1999–2000. PIMS has supported its activities on base funding from:

- The five founding PIMS institutions (SFU, U. of Alberta, UBC, U. of Calgary, U. of Victoria) and the affiliated Institutions (U. of Lethbridge and U. of Northern British Columbia).
- The Government of Canada through the Natural Sciences and Engineering Research Council.
- The Government of Alberta through the Alberta Ministry of Innovation and Science.
- The Government of British Columbia through the Science and Information Technology Agency

	1999–2000	
	Cash	**In-kind**
NSERC	**$630,000**	
BC (BC-ISTA)	**$297,500**	
Alberta (Innovation & Science)	**$200,000**	
Universities		
SFU	$75,000	$150,000
UAlberta	$70,000	$60,000
UBC	$115,000	$180,000
UCalgary	$61,000	$60,000
UVictoria	$60,000	$60,000
U Lethbridge	$5,000	
UNBC	$5,000	
Total	**$391,000**	**$510,000**
Total	**$1,5185,00**	**$510,000**

Income for 1999–2000

Notes: Each founding university makes an annual cash contribution equivalent to one full time faculty position at the respective university. Also, scientific personnel are released under the PIMS research fellowship programme to provide the scientific leadership in the institute. PIMS is only required to make up the course buy-out for these individuals. The universities also make considerable in-kind contributions through office space at the five campuses and computer labs.

SFU: SFU made an annual cash contribution of $75,000. In-kind support in the form of a 4000 square feet research facility is estimated at $150,000 per annum.

UA: The University of Alberta made an annual cash contribution of $70,000. In-kind support of offices totals $60,000.

UBC: The University of British Columbia made an annual cash contribution of $115,000. In-kind support in the form of a 4800 square feet research facility is estimated at $150,000 per annum. As well, the university maintains PIMS financial accounts at an estimated in-kind annual cost of $30,000.

UC: The University of Calgary made an annual cash contribution of $61,000 and released the Deputy Director half-time. In-kind support of offices totals $60,000.

UVic: The University of Victoria makes an annual cash contribution of $60,000. In-kind support of offices totals $60,000.

U Lethbridge: The University of Lethbridge, as an affiliate university of PIMS, makes annual cash contributions of $5,000.

UNBC: The University of Northern British Columbia, as an affiliate university of PIMS, makes annual cash contributions of $5,000.

Other Contributions

In the table below, we have only outlined the operating budget of PIMS. However, this tells only a part of the story since it does not describe the contributions to PIMS scientists and events that did not flow through the PIMS central accounts. Here is a brief description of such indirect contributions.

University Infrastructure: PIMS has offices at all five campuses. Computational facilities and some administration is also provided. Beginning June 1999, the PIMS central office at UBC will be using a 4,800 sq.ft research facility that will accomodate up to 30 offices as well as a scientific computing Lab and a reading room for about 20 researchers. Similarly, SFU has provided PIMS 4,000 sq.ft. of office space that will allow up to 20 scientists to be accomodated.

BC/NCE Infrastructure Support: This amounts to over $150,000 in infrastructure support for the PIMS and MITACS research facilities at the University of British Columbia and Simon Fraser University. These funds are made available through offices of the Vice-president Research at UBC and SFU to match and support the federally funded NCE activities.

Additional support for Industrial PDFs: The PIMS contributions to the industrial postdoctoral fellows ($15K each) have essentially been matched (on a 1 to 1 basis) by the corresponding industrial partners.

Additional support for Scientific PDFs: The PIMS contributions to the other 20 postdoctoral fellows ($18,000 each) have essentially been matched (on a 1 to 1 basis) by research grants from their supervisors and by stipends for teaching from their associated departments. .

Conference support: Most conferences have also been supported by registration fees and have sometimes been co-sponsored by other organizations.

Corporate support: This has materialized through contributions towards official receptions and banquets connected to the scientific events.

Industrial support: The *Problem Solving Workshop*, the *Workshop on computer security*, the *workshop on coding theory and cryptography* (among others) have also been partially supported by direct contributions from the industrial participants.

Education support: Most educational events have been also co-sponsored by schools, provincial ministries of education and professional societies.

Pre-audited Financial Statement

PIMS Operating Budget 1999/2000

	NSERC	ISTA	ASRA	Univ.	Total
Scientific Personnel					
PIMS Research fellows				97,500	97,500
Postdoctoral Fellows	162,000	126,000		18,000	306,000
Scientific programs	341,143			71,610	412,753
Industrial Programs					
Problem Solving Programme		34,995			34,995
Indust. Training Programme		8,281	25,812		34,093
Industrial facilitators (BC)		34,921			34,921
Indust. facilitators (Alberta)			27,904		27,904
Indust. Collaborative.Projects		30,000	60,000		90,000
Education Programs					
Education Coordinators			12,000	26,876	38,876
Education initiatives	1,500		17,587	28,848	47,935
Administration					
Personnel Salaries			36,755	96,386	133,141
Office expenses				63,897	63,897
Board&Executive meetings				23,924	23,924
Reserve Fund				50,000	50,000
Total Expenses	**504,643**	**234,197**	**180,058**	**477,041**	**1,395,939**
Operating Fund.99/00	**630,000**	**297,500**	**200,000**	**391,000**	**1,518,500**

Three Sisters Peaks in Kananaskis Country, Alberta *Photo kindly provided courtesy of Douglas Leighton*

The Pacific Institute for the Mathematical Sciences is sponsored by:

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

http://www.pims.math.ca