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DE RECHERCHES
MATHÉMATIQUES

Annual Report
2007
2008



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2008



Centre de recherches mathématiques
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Presenting the Annual Report 2007 – 2008

It is a pleasure to present a brief overview of the CRM annual report for 2007–2008. The activities described were planned and then carried out under the directorship of François Lalonde. Since 2007–2008 was the last year of his term as director, I would like to take the opportunity here to express the appreciation and thanks of the CRM community for his four years of outstanding leadership. Thanks are due also to Odile Marcotte who did the bulk of the work in preparing this report.

The thematic program, as always the core of the year's scientific activity, consisted of two semesters covering complementary aspects of the broad field of Dynamical Systems. The first semester, Applied Dynamical Systems, went deeply into applications to physiology and mathematical biology. The second semester, Dynamical Systems and Evolution Equations, dealt with the recent dramatic use of dynamical system techniques, broadly interpreted, in the investigation of fundamental problems in differential geometry and mathematical physics. Each semester featured six workshops, several specialized courses, and two lecture series by distinguished Aisenstadt Chair holders (John J. Tyson and John Rinzel in the first, Gerhard Huisken and Jean-Christophe Yoccoz in the second semester). The CRM thanks the NSF and the Clay Institute for their support of American participants in these activities.

The CRM's general program of workshops and symposia was particularly diverse this year. It included many events specially organized by one or more of our constituent laboratories or by members of the CRM. Others were sponsored by the CRM together with partners as far away as Stanford University, or were part of a regularly recurring series of conferences. Four symposia were held in honour of distinguished colleagues (Donald Dawson, Yasha Eliashberg, Gert Sabidussi, and John Labute).

The multidisciplinary and industrial program is the CRM's main vehicle to organize activities with partners in the applied mathematical sciences such as GERAD, MITACS, ncm₂, and NPCDS. A highlight this year was the very successful First Montreal Industrial Problem Solving Workshop, funded mainly by the MITACS network. In 2007–2008, MITACS supported many activities at the CRM, including most of the workshops of the semester on Applied Dynamical Systems. The CRM is very grateful to MITACS for its generous support. The general and multidisciplinary programs are strongly influenced by the partnerships that the CRM maintains with a large number of institutions in pure and applied mathematics, and the present report includes a description of these partnerships.

The CRM series of "Grandes Conférences", begun in 2006, continued to great acclaim. It features lectures on mathematical topics by distinguished mathematicians and are aimed at a general public. One of our lectures this year, by Etienne Ghys on the "butterfly effect", stirred considerable interest in the local press.

The CRM provides support for educational activities at all levels in the mathematical sciences, with emphasis on the training of researchers. Our main partner in this area is the Institut des Sciences Mathématiques (ISM). In particular the CRM jointly with the ISM, and with input from the CRM laboratories, runs a prestigious postdoctoral program that draws a large number of applications from all over the world each year. Another instance of the cooperation with the ISM is the series of weekly joint colloquium lectures, one in mathematics and one in statistics.

The CRM awards four mathematical prizes each year, one on its own and three in partnership with other institutions. In 2007–2008 the CRM-Fields-PIMS Prize was awarded to Allan Borodin, the André-Aisenstadt Prize jointly to József Solymosi and Jonathan Taylor, the CAP-CRM Prize to Richard Cleve, and the CRM-SSC Prize to Paul Gustafson.

As part of its unique structure the CRM acts as an umbrella organization for a number of specialized research laboratories, nine in 2007–2008. They unite most researchers active in the mathematical sciences in Québec and are closely involved in all the CRM's programs. Their activities are described in a section of the present report.

Peter Russell

Thematic Program

The core of each year's scientific program at the CRM is its thematic program. In 2007–2008 (as in 2006–2007), the thematic program consisted of two semesters covering two complementary aspects of a particular field of mathematics. The topic of the first semester (June–December 2007) was *Applied Dynamical Systems*, and that of the second semester (January–May 2008) was *Dynamical Systems and Evolution Equations*.

The CRM is very grateful to the National Science Foundation for providing generous financial support to the young American mathematicians who attended the activities of the two thematic semesters. The CRM is also grateful to the Clay Mathematics Institute and MITACS (which provided support for six of the activities of the Thematic Semester on Applied Dynamical Systems). *The reports are presented in the language in which they were submitted.*

Thematic Semesters of the Year 2007–2008: Applied Dynamical Systems, and Dynamical Systems and Evolution Equations

Applied Dynamical Systems is a very broad field, and the first thematic semester of the year 2007–2008 focused on two themes: firstly, the use of dynamical systems in applications, principally in physiology, and secondly, the development of new numerical and dynamical systems tools needed in the study of problems arising in applications. In reality, however, applications, analysis, and numerical methods are all interconnected, and aspects of all three permeated all activities of the semester. Although a deep and beautiful theory of nonlinear dynamical systems has now been developed, systems arising in applications often fall outside the scope of this theory, because they contain generalizations of the dynamical systems paradigm (such as variable or state dependent delays or noise), or because they cannot be shown to satisfy conditions of the theory. Despite the difficulties, significant progress has been made in recent years in applying dynamical systems, particularly in the areas of mathematical biology and physiology. This has led to consideration of new problems, such as those with non-constant and distributed delays, and given rise to new analytical and numerical challenges.

The Thematic Semester on Applied Dynamical Systems featured one workshop in Halifax and the following activities, which took place at the CRM: five workshops, two minicourses, two advanced courses (“A Practical Introduction to SDEs”, by P. Tupper, and “Numerical Analysis of Nonlinear Equations”, by E. Doedel), and two lecture series by Aisenstadt Chairholders. The organizing committee of the semester consisted of John Appleby (Dublin City University), Jacques Bélair (Montréal), Henk Broer (Groningen), Hermann Brunner (Memorial), Stephen Coombes (Nottingham), Eusebius Doedel (Concordia), Anthony R. Humphries (McGill), Brian

P. Ingalls (Waterloo), André Longtin (Ottawa), Michael Mackey (McGill), Hinke Osinga (Bristol), Dmitry Pelinovsky (McMaster), Jonathan Rubin (Pittsburgh), Peter Swain (McGill), Laurette Tuckerman (PMMH-ESPCI), and Paul Tupper (McGill).

The Thematic Semester on Dynamical Systems and Evolution Equations focused on dynamical systems, interpreted in a broad sense so as to include applications to fundamental problems in differential geometry as well as in mathematical physics. The four principal topics of the semester were diverse areas of analysis and geometry, with the common theme that they involve the interplay between classical dynamical systems and the qualitative properties of solutions of partial differential equations. They had been chosen because of the recent dramatic achievements, representing progress on a number of the most basic and difficult questions in this field. Among these, we find the proofs of the Poincaré conjecture and Thurston's geometrization conjecture for 3-manifolds. Also, in Hamiltonian PDEs, the analytic methods of Hamiltonian mechanics are having an impact on the study of many of the principal nonlinear evolution equations of mathematical physics. These advances have had a broad impact on recent developments in geometry and topology, and they also shed light on the basic physical processes that are modelled by ordinary and partial differential equations.

There were six workshops during the semester. Several advanced-level courses, including two Aisenstadt Chair series of lectures, made advanced material available to new researchers in the field. The organizing committee of the semester consisted of Vestislav Apostolov (UQÀM), Hermann Brunner (Memorial), Octavian Cornea (Montréal), Walter Craig

(McMaster), Pengfei Guan (McGill), Dmitry Jakobson (McGill), Sergei Kuksin (Heriot-Watt and Ecole Polytechnique), Iosif Polterovich (Montréal), Leonid Polterovich (Tel Aviv), Christiane Rousseau (Montréal), Alina Stancu (Concordia), Felix Schlenk (Université Libre de Bruxelles), Alexander Shnirelman (Concordia), C. Eu-

gene Wayne (Boston), and Maciej Zworski (California, Berkeley). The semester was supported by the NSF and the Clay Mathematics Institute. The organizers are very grateful to Eugene Wayne, who accepted to pilot the application to the NSF.

Aisenstadt Chairholders in 2007 – 2008:

John J. Tyson, John Rinzel, Gerhard Huisken, and Jean-Christophe Yoccoz

The two André-Aisenstadt Chairholders for the Thematic Semester on Applied Dynamical Systems (June – December 2007) were John J. Tyson (Virginia Polytechnic Institute and State University) and John Rinzel (Center for Neural Science and Courant Institute of Mathematical Sciences, New York University). The two André-Aisenstadt Chairholders for the Thematic Semester on Dynamical Systems and Evolution Equations (January – May 2008) were Gerhard Huisken (Max-Planck-Institut für Gravitationsphysik), who visited the CRM in April, and Jean-Christophe Yoccoz (Collège de France), who visited the CRM in May.

John J. Tyson

Professor John J. Tyson was originally trained in chemistry (B.S.) and chemical physics (Ph.D.). His postdoctoral training in biophysical chemistry at the University of Göttingen with Manfred Eigen and in cell biology at Innsbruck was followed by his appointment at the Virginia Polytechnic University (Blacksburg, Virginia), where he is currently the University Distinguished Professor of Biology. Professor Tyson has held a number of major positions in the North American mathematical biology community, has received many national and international awards, and is the world leader in the development of quantitative mathematical models for the regulation of the eukaryote cell cycle.

Professor Tyson gave three lectures during his visit to the CRM in September 2007. The first lecture was geared towards a wide audience and entitled “Motifs and Modules in Protein Interaction Networks”; it was delivered during the minicourse on quantitative biology. Tyson presented a classification scheme for reaction “motifs” (simple patterns of activation and inactivation among small numbers of proteins), and showed that these motifs have distinct and identifiable dynamical functions within regulatory networks (i.e., they are functional regulatory

“modules”). Tyson then described some of the most important modules: toggle switch, sniffer, oscillator, cock-and-fire trigger, hysteresis loop, with illustrations from cell physiology.

In the second lecture, entitled “How Do Cells Compute?”, Tyson argued that cells are “information processing systems” (like digital computers or the human brain), but that the basis of information processing in cells (i.e., gene-protein interaction networks) is completely unlike silicon technology in computers or neuronal networks in brains. Tyson showed how interacting genes and proteins can create molecular switches and clocks, and how these components are integrated within the reaction networks of cells to carry out simple yet important information processing tasks. In the climax he argued that the mathematical theory of bifurcations of vector fields can be used to catalog a small number of fundamental “signal-response” curves from which all cellular information processing must be derived.

The third lecture, delivered during the Workshop on Deconstructing Biochemical Networks, was a technical description of differential equations used for “Modeling the Eukaryotic Cell Cycle”. He showed how to use one-parameter and two-parameter bifurcation diagrams to understand the molecular basis of cell growth and division in wild-type yeast cells and in mutants constructed by knocking out and/or over-expressing the genes encoding proteins of the regulatory system. He also presented a new model of the very unusual regulation of mitotic cycles during the early embryonic development of fruit flies.

John Rinzel

Dr. John Rinzel, Professor of Neural Science and Mathematics at the Center for Neural Science and the Courant Institute of New York University, is interested in the biophysical mechanisms and theoretical foundations of dynamic

neural computation. With a background in engineering (B.S., University of Florida, 1967) and applied mathematics (Ph.D., Courant Institute, New York University, 1973), he uses mathematical models to understand how neurons and neural circuits generate and communicate with electrical and chemical signals for physiological function. He especially relishes developing reduced, but biophysically-based, models that capture the essence of a neural system. Before joining New York University in 1997, he spent nearly 25 years at the Mathematical Research Branch of the National Institute of Health (NIH) in Bethesda (Maryland).

Many current research projects in the field of mathematical neuroscience find their origin in work that Professor Rinzel has carried out in the last decades, on topics such as mode-locking (with collaborators Keener and Hoppensteadt), dendrites (in collaboration with Rall), waves in excitable media (with Terman, Ermentrout, Miller, etc.), bursting, geometric techniques, high-speed auditory processing, and so on. The influence of Professor Rinzel in his field is considerable, and during his years at the NIH, he has participated in the training of many researchers who are now well-known leaders in the field. Perhaps more than anybody else, he has promoted the opening-up of the standard neuroscience publications (*J. Neuroscience*, *J. Neurophysiology*, plus *Science* and *Nature*) to mathematical modelling in neuroscience, thanks in large part to the great working relationships he has established with experimentalists.

Professor Rinzel gave three lectures during his stay at the CRM in September 2007. His first lecture, entitled “Dynamics of Visual Perception”, dealt with bistable perception when visualizing ambiguous scenes. The most famous example of this is the Necker cube. When viewing such scenes, our visual perception tends to flip between the valid interpretations. Professor Rinzel demonstrated this by subjecting the audience to ambiguous visual stimuli including various moving plaids. He also supplied the audience with 3D glasses to demonstrate the phenomenon of binocular rivalry, where each eye views different images, and perception alternates randomly between them, with a time scale of seconds. He then elegantly described the competing theories for this bistable perception, in which the two percepts correspond to separate firing patterns of higher-level neural networks. Some theories involve deterministic switching while others involve noise-induced switching between such firing patterns. This

lecture demonstrated the state-of-the-art in the constraining of mathematical modelling frameworks by neurophysiological data.

Professor Rinzel’s second lecture, “Timing Computations in the Auditory Brain Stem”, was delivered in the Workshop on Mathematical Neurosciences. It was geared towards specialists on sound localization, a phenomenon that involves precise temporal processing by neurons in the auditory brain stem. The first neurons in the auditory pathway to receive input from both ears can distinguish interaural time differences in the sub-millisecond range. Professor Rinzel used concepts from dynamical systems and coding theory to explain the phasic firing, the precise phase locking, and the extremely timing-sensitive coincidence detection involved in sound localization.

Professor Rinzel’s final lecture, “Modeling the rhythmic dynamics of developing spinal cord”, was part of the Workshop on Deconstructing Biochemical Networks, and was concerned with the spontaneous rhythmic activity exhibited by many developing neural systems, where episodes of many neurons firing (say for tens of seconds) are separated by long silent phases. He described models, developed in collaboration with experimentalists at NIH, for activity patterns in the chick spinal cord, where silent phases can be very long, of the order of ten minutes or so. This behaviour is network-mediated; a neuron model does not oscillate episodically if isolated. Mean-field models as well as cell-based networks of spiking neurons were used to understand the dynamics and to design experiments and then analyze results. The structural framework of the models (including bistability on the fast time scale) allows for fast/slow analysis of the emergent rhythmicity.

Gerhard Huisken

Gerhard Huisken pioneered the study of the mean curvature flow in the eighties and has been at the forefront of research in the area of curvature flows ever since. In the nineties, in his work with Ilmanen, Huisken developed the theory of weak solutions to the inverse mean curvature flow and applied it to prove the Riemannian Penrose Inequality: the total mass of an asymptotically flat three-manifold of nonnegative scalar curvature is bounded below in terms of the area of each smooth, compact, connected “outermost” minimal surface (i.e., not separated from infinity by any other compact minimal surface) within the three-manifold. Gerhard Huisken obtained his doctorate from the Univer-

sity of Heidelberg in 1983. He was an invited speaker at the International Congress of Mathematicians in 1998, and was awarded the Medal of the Australian Mathematical Society (1991) and the Leibniz Prize (2003), the highest honour awarded in German research. Since 2002, Dr. Huisken has been Director and Scientific Member at the Max Planck Institute for Gravitational Physics, in Potsdam (Germany).

Professor Huisken gave a series of four lectures, three of which were part of the Workshop on Geometric Evolution Equations organized in April 2008 by Vestislav Apostolov (UQAM), Pengfei Guan (McGill), and Alina Stancu (Concordia). The first lecture, entitled “Geometric Variational Problems in General Relativity”, was geared towards a wide audience and focused on the interaction between geometric analysis and physical concepts in the study of isolated gravitational systems. Professor Huisken showed how the Einstein equations governing the gravitational phenomena in General Relativity can be derived variationally on Lorentzian manifolds; it follows that other concepts related to gravitation are also best formulated within the framework of Lorentzian metrics.

The second lecture focused on the use of the mean curvature flow to derive isoperimetric inequalities. At the core of this argument lie monotonicity results that were revisited in Huisken’s third lecture for the inverse mean curvature flow. In the latter context, the monotonicity arguments found applications in conformal geometry and General Relativity. Gerhard Huisken’s last lecture, “An Isoperimetric Concept for the Mass in General Relativity”, brought together techniques from the three previous lectures to make precise a lower bound on the total mass of an isolated gravitational system and to prove that it is indeed a lower bound.

Jean-Christophe Yoccoz

The Aisenstadt Lectures of May 6-9, 2008, were delivered by Jean-Christophe Yoccoz, one of the leading mathematicians in the world, especially in the area of dynamical systems. Jean-Christophe Yoccoz was awarded the Fields Medal in 1994 and is a professor at the Collège de France. He delivered four in-depth lectures in the form of a series dedicated to the theory of interval exchange maps, the first lecture being in the style of a colloquium. On May 12, Professor Yoccoz gave a lecture on affine interval exchange maps, which was actually the first lecture in one of the main workshops of the Thematic Semester on Dynamical Systems and Evolution Equations.

The lectures were at a high level, but nonetheless accessible, and many CRM mathematicians, as well as mathematicians visiting Montréal for the thematic semester, derived great benefits from attending them.

The central theme of the lecture series was the analysis of interval exchange maps. The class of diffeomorphisms of the circle has been a classical topic of study in dynamical systems since the days of Poincaré, Denjoy, and their contemporaries. The results of Vladimir Arnold, Jürgen Moser, Michael Herman, and Jean-Christophe Yoccoz have given quite a refined picture of their conjugacy classes and their dependence upon rotation number and smoothness. The category of (generalized) interval exchange maps can be seen as the extension of this study to cases of piecewise-increasing discontinuous maps of the interval with more than one discontinuity. More specifically, a (standard) interval exchange map (IEM) is a bijective map of the interval $[0, 1]$ that is locally a translation except at finitely many discontinuities. For example, if the number d of discontinuities equals 1, then the IEM is a rigid rotation.

New and fascinating dynamical questions arise when d is at least 2. Up to a point, the dynamics of IEMs are similar to the dynamics of rotations on the circle: one can introduce a generalized rotation number, and when this number is irrational, all orbits of the map are dense. A major part of the lecture series was devoted to the detailed presentation of the theory of the generalized rotation number (in the setting of interval exchange maps). Professor Yoccoz also described the construction of Riemann surfaces that support a translational flow; these surfaces can be viewed as suspensions of IEMs and their genus is closely related to the complexity of the orbit structure of the IEM group.

At the level of parameter space, there is a continued fraction algorithm discovered by Rauzy, Veech, and Zorich, which generalizes the classical continued fraction algorithm of Gauss and corresponds to a renormalization process. The dynamics of this algorithm are hyperbolic and the corresponding Lyapunov exponents have been investigated by Forni, Avila, and Viana. These dynamics are related to the surprising behaviour of the Birkhoff sums of a typical IEM, known as the Zorich phenomenon. The study of IEMs uses a wide range of techniques and draws from several areas: complex analysis, dynamical systems, and number theory.

The last lecture given by Professor Yoccoz dealt with affine interval exchange maps and stressed the similarities and differences between them and IEMs. The rotation number can be defined for affine interval exchange maps in the same way as for IEMs. However, while an IEM possesses no wandering interval, Yoccoz and his colleagues Marmi and Moussa showed that an affine interval exchange map may possess a wandering interval. More precisely, they proved that *for combinatorial data of genus $g > 1$, for almost all rotation numbers, and for most slopes, an affine interval exchange map possesses a wandering interval.*

Aisenstadt Chair

The Aisenstadt Chair was endowed by Montréal philanthropist Dr. André Aisenstadt. Under its auspices, one or more distinguished mathematicians are invited each year for a period of at least one week, ideally one or two months. During their stay the lecturers present a series of lectures on a specialized topic. They are also invited to prepare a monograph (see

the section on publications in the present report for a list of these monographs). At the request of Dr. Aisenstadt, the first lecture given by an Aisenstadt Chairholder should be accessible to a wide audience. Previous holders of the Aisenstadt Chair are: Marc Kac, Eduardo Zaran-tonello, Robert Hermann, Marcos Moshinsky, Sybren de Groot, Donald Knuth, Jacques-Louis Lions, R. Tyrrell Rockafellar, Yuval Ne’eman, Gian-Carlo Rota, Laurent Schwartz, Gérard Debreu, Philip Holmes, Ronald Graham, Robert Langlands, Yuri Manin, Jerrold Marsden, Dan Voiculescu, James Arthur, Eugene B. Dynkin, David P. Ruelle, Robert Bryant, Blaine Lawson, Yves Meyer, Ioannis Karatzas, László Babai, Efim I. Zelmanov, Peter Hall, David Cox, Frans Oort, Joel S. Feldman, Roman Jackiw, Duong H. Phong, Michael S. Waterman, Arthur T. Winfree, Edward Frenkel, Laurent Lafforgue, George Lusztig, László Lovász, Endre Szemerédi, Peter Sarnak, Shing-Tung Yau, Thomas Yizhao Hou, Andrew J. Majda, Manjul Bhargava, K. Soundararajan, Terence Tao, Noga Alon, Paul Seymour, and Richard Stanley.

Activities Held During the Two Thematic Semesters

SMS – NATO ASI 2007 Summer School Hamiltonian Dynamical Systems and Applications

June 18–29, 2007, Université de Montréal
Sponsored by NATO, the CRM, ISM, and the
Département de mathématiques et de
statistique de l’Université de Montréal

Organizers: Dario Bambusi (Milano), Walter Craig (McMaster), Sergei Kuksin (Edinburgh), and Anatoly Neishtadt (Space Research Institute, Russia)

Speakers: Andrei Agrachev (SISSA/ISAS, Italy), Dario Bambusi (Milano), Massimiliano Berti (Napoli Federico II), Alain Chenciner (CNRS, France), Chong-Qing Cheng (Nanjing), Walter Craig (McMaster), Rafael de la Llave (Texas at Austin), Hakan Eliasson (Paris 7), Sergei Kuksin (Edinburgh), Anatoly Neishtadt (Space Research Institute, Russia), Jürgen Pöschel (Stuttgart), Paul Rabinowitz (Wisconsin at Madison), Laurent Stolovitch (Toulouse), Dmitry Treschev (Moscow State), C. Eugene Wayne (Boston), Xiaoping Yuan (Fudan)

Number of participants: 89

The 2007 NATO Advanced Study Institute took place during the two-week period from June 18 to June 29, 2007, and attracted almost 90 participants from around the world, in particu-

lar groups of students from France, Italy, Spain, the United States, and Canada. The program of lectures occupied two complete weeks, with five or six one-hour lectures every day, so that in total 57 hours of courses were delivered.

The topic of the 2007 NATO ASI was “Hamiltonian Dynamical Systems and Their Applications”, that is, mathematical problems arising from physical and mechanical systems of evolution equations. Many aspects of the modern theory of this subject were covered during the ASI, including low-dimensional problems as well as the theory of Hamiltonian systems in infinite-dimensional phase space and its applications to problems in continuum mechanics and partial differential equations. Applications to several important areas of research were also presented, including applications to celestial mechanics, control theory, partial differential equations in fluid dynamics, and adiabatic invariants.

Physical laws are for the most part expressed in terms of differential equations, and the most natural classes of these have the form of conservation laws or arise from problems of the calculus of variations for an action functional. These problems can typically be posed as Hamiltonian systems, whether dynamical systems on finite-dimensional phase space as in classical mechanics, or partial differential equations (PDE) that

are of infinitely many degrees of freedom in a natural way. For instance, the well-known n -body problem is still of great relevance to modern mathematics and more broadly to science; indeed, the design of missions in interplanetary exploration regularly uses the gravitational boost of close encounters to manoeuvre the spacecraft (this technique was first used for the Mariner-10 mission, in 1974).

The n -body problem has also been very important on a theoretical level, ever since the work of Laplace, Lagrange, and Poincaré. Modern successes in this regard go back to the celebrated theory of Kolmogorov, Arnold, and Moser (KAM) (1954/1961/1963). Recent mathematical progress includes the discoveries of new choreographies of many-body orbits (Chenciner and Montgomery, 2000), and the constructions of Poincaré's second species orbits (Bolotin and MacKay, 2001). Additionally, the last several years have seen major progress in the long outstanding problem of Arnold diffusion, with the advent of Mather's variational techniques in 2003 (related to a generalized Morse-Hedlund theory), with Cheng's subsequent work, and with the geometrical approach to the "gap problem", due to de la Llave, Delshams, and Seara (2006).

Over the last decade, the field of Hamiltonian systems has taken on completely new directions with the extension of the analytical methods of Hamiltonian mechanics to partial differential equations. The results of Kuksin, Wayne, Pöschel, Craig, Bambusi, and Bourgain have introduced a new paradigm for the study of partial differential equations of evolution, where research focuses on the fundamental structures underlying the dynamics of the PDE in an appropriate phase space of functions. Two examples of this direction of enquiry are on one hand the development of KAM theory, and on the other the stability results of Nekhoroshev for systems with infinitely many degrees of freedom.

These considerations show an exciting and extremely promising connection between Hamiltonian dynamical systems and harmonic analysis techniques in PDE. A case in point is the relationship between upper bounds on the growth of higher Sobolev norms of solutions of nonlinear evolution equations, and the bounds on orbits given by Nekhoroshev theory; similarly there is a possibly surprising connection between lower bounds on such growth and the existence of solutions of PDEs that exhibit phenomena related to Arnold diffusion. Research on

evolution equations and Hamiltonian systems is one of the most active and exciting fields within the study of PDEs; before our ASI, however, there had not been any course of study in which advanced students or otherwise interested researchers could obtain an overview of the field and the necessary background to enter the field. The top international leaders in the subject were speakers at our ASI, which provided a unique opportunity for junior mathematicians to learn about Hamiltonian dynamical systems and evolution equations.

Here is a detailed list of the lectures: Hamiltonian systems and optimal control (Agrachev); Birkhoff normal form and almost global existence for some Hamiltonian PDEs (Bambusi); Nonlinear oscillations in Hamiltonian PDEs (Berti); The n -body problem (Chenciner); Variational methods for the problem of Arnold diffusion (Cheng); The transformation theory of Hamiltonian PDE and the problem of water waves (Craig); Geometric approaches to diffusion and instability (de la Llave); KAM for the nonlinear Schrödinger equation (Eliasson); Three theorems on perturbed KdV (Kuksin); Averaging methods and adiabatic invariants (Neishtadt); Periodic KdV equation in weighted Sobolev spaces (Pöschel); The forced pendulum as a model for dynamical behaviour (Rabinowitz); Normal forms of holomorphic dynamical systems (Stolovitch); Hamiltonian dynamical systems (Treschev); Infinite-dimensional dynamical systems and the Navier-Stokes equations (Wayne); and KAM theory with applications to nonlinear wave equations (Yuan).

Minicourse

Advanced Algorithms and Numerical Software for the Bifurcation Analysis of Dynamical Systems

June 30 – July 1, 2007, CRM

Sponsored by MITACS

Organizers: Eusebius Doedel (Concordia) and Hinke Osinga (Bristol)

Minicourse lecturers: Eusebius Doedel (Concordia), Yuri Kuznetsov (Utrecht), Dirk Roose (Leuven), André Vanderbauwhede (Ghent)

Minicourse computer session experts: Mark Friedman (Alabama at Huntsville), Willy Govaerts (Ghent), Kirk Green (VU Amsterdam), Reza Khoshshiar Ghaziani (Ghent), Francisco Javier Muñoz Almaraz (Universidad Cardinal Herrera), Bart Oldeman (Concordia), Frank Schilder (Surrey), Róbert Szalai (Bristol)

Number of participants: 46

The four lecturers introduced the basic concepts and algorithms of numerical bifurcation analysis, including examples of actual use of the available software packages: AUTO-07p, MatCont, and DDE-BIFTOOL. The relevant theoretical background from Dynamical Systems was also touched upon in the lectures.

In the work sessions the participants gained hands-on experience with the software packages. Given the introductory nature of the mini-course, this mainly consisted of performing basic calculations, following the instructions of the workshop leaders. Although many participants were using the software packages for the first time, almost all were able to carry out the basic calculations without much difficulty. The experience has helped many participants to take the first step towards future use, within their own research, of these powerful and complex software packages. The possibility of obtaining hands-on experience as part of the mini-course even attracted several senior academics, although the participants were mostly at the PhD level. The organizers received extremely positive feedback from the participants, who were appreciative of the fact that the authors of the software packages were present and helped even with the most basic problems.

Workshop

Advanced Algorithms and Numerical Software for the Bifurcation Analysis of Dynamical Systems

July 2–6, 2007, CRM
Sponsored by MITACS

Organizers: Eusebius Doedel (Concordia) and Hinke Osinga (Bristol)

Speakers: David Barton (Bristol), Wolf-Jürgen Beyn (Bielefeld), Sue Ann Campbell (Waterloo), Harry Dankowicz (UIUC), Fabio Dercole (Politecnico di Milano), Gábor Domokos (Budapest), Jorge Galán-Vioque (Seville), Willy Govaerts (Ghent), Kirk Green (VU Amsterdam), John Guckenheimer (Cornell), Alex Haro (Barcelona), Michael Henderson (IBM Watson Research Center), Yannis Kevrekidis (Princeton), Reza Khoshsiar Ghaziani (Ghent), Bernd Krauskopf (Bristol), Yuri Kuznetsov (Utrecht), Kurt Lust (Groningen), Bart Oldeman (Concordia), Dirk Roose (Leuven), Andrew Salinger (Sandia), Frank Schilder (Surrey), Jan Sieber (Aberdeen), Róbert Szalai (Bristol), André Vanderbauwhede (Ghent), Alexander Vladimírsky (Cornell), Sebastian Wiczorek (Exeter), Claudia Wulff (Surrey), Lennaert van Veen (Concordia)

Number of participants: 59

The workshop was organised in daily themes, i.e.: partial differential equations, structured dynamical systems, delay and functional differential equations, manifolds, and ordinary differential equations and multiple time scales. Each theme consisted of an introductory survey talk followed by more technical presentations with very interesting new material. About one third of the speakers were asked specifically to give a “demonstration” instead of a “lecture.” The demonstration consisted of working with a particular software package, or showing details of the implemented codes, while solving problems of interest. This format was found to be very successful, as it stimulated subsequent discussions. In fact, the idea of showing computations in real time was adopted by many speakers, also for lectures that were not necessarily demonstrations. The general feedback received from the participants during the workshop was that basically all presentations (lectures and demonstrations) were of excellent quality. Clearly, each lecturer had spent considerable effort preparing his or her talk, both in terms of its substance and its delivery.

Unlike many other workshops, this one had a relaxed schedule and pace. Presentations typically lasted about 30 minutes, followed by another 15 minutes of well-used discussion time. The many breaks, the long lunch, and the free late afternoon and evening hours were used for informal discussions and cooperative work. Most importantly, the workshop strengthened existing research connections and initiated new work. Several participants arrived early, or stayed longer, for cooperative research. Here is a sample of new directions or new projects that started during the extended workshop period: new algorithms and their implementation for the continuation of generic and non-generic branch points in boundary value problems; implementation and use of methods for detecting homoclinic and heteroclinic connections between periodic orbits; the theoretical study of methods for the computation of invariant manifolds; two-parameter continuation methods, specifically in the context of computing Arnold tongues; and study of new bifurcation phenomena in population models.

The last two days celebrated Sebius Doedel’s 60th birthday, starting with a presentation by John Guckenheimer on “Computing Multiple Timescale Dynamical Systems” and culminating with a celebratory dinner and the surprise presentation to Sebius of a book on “Numerical Continuation Methods for Dynamical Systems”,

published especially for the workshop and for celebrating his continuing influence in the field. Sebius' surprise doubled when he opened the book and discovered that he had unknowingly supplied the first chapter! Herb Keller, who passed away on January 26, 2008, wrote the foreword to the book, and this meeting was, sadly, the last occasion to meet him for many of us.

Workshop

Mathematical Neurosciences

September 16–19, 2007, CRM

Sponsored by MITACS

Organizers: Stephen Coombes (Nottingham), André Longtin (Ottawa), and Jonathan Rubin (Pittsburgh)

Speakers: Amitabha Bose (NJIT), Paul C. Bressloff (Utah), Ian Bruce (McMaster), Gal Chechik (Stanford), Stephen Coombes (Nottingham), Steven Cox (Rice), Mingzhou Ding (Florida), Mounya Elhilali (Maryland), G. Bard Ermentrout (Pittsburgh), Warren Grill (Duke), David Hansel (CNRS), Philip Holmes (Princeton), Axel Hutt (Humboldt, Berlin), Benjamin Lindner (Max-Planck-Institut für Physik Komplexer Systeme), Yuri Maistrenko (Jülich Research Centre), Cameron McIntyre (Cleveland Clinic Foundation), Georgi Medvedev (Drexel), Paul Miller (Brandeis), Néstor Parga (Universidad Autónoma de Madrid), Magnus Richardson (Warwick), John Rinzel (New York University), Michael Rosenblum (Potsdam), Eric Shea-Brown (Courant), Frances Skinner (University Health Network), Peter Tass (Jülich Research Centre), David Terman (Ohio State), Yulia Timofeeva (Warwick), William C. Troy (Pittsburgh), J. Leo van Hemmen (Technische Universität München), Martin Wechselberger (Sydney)

Number of participants: 71

Mathematical neuroscience is an interdisciplinary field of research where mathematics are used to analyze neural systems. The goal of this field is to organize data from neural systems and model their behaviour and function under normal or pathological conditions. Hopefully, through such investigations, we shall gain fundamental knowledge about the principles of neural function at various spatial and temporal scales, new experiments will be proposed, and new therapies will be derived for correcting neurological disorders. The goal of this workshop was to highlight neuroscience research that is pushing applied mathematics forward, especially in the areas of nonlinear dynamics and partial differential equations.

The workshop brought together some of the top theoreticians in mathematical neuroscience. The three-and-a-half day event also included two half-day theme sessions designed to give an overview of mathematical modelling issues in two specific areas: information processing in the auditory system and Parkinson's disease. During the theme sessions the participants, especially the students and postdoctoral fellows, learned how to tackle a given problem using a range of mathematical approaches. Generally speaking, the workshop succeeded very well in achieving its goals. The good ambiance during talks and coffee breaks led to open and lively discussions, and the different sessions were well attended throughout the whole workshop. Many participants expressed a very high level of satisfaction with the workshop.

The first morning of the workshop focused on single cell properties and their influence on network activity. Ermentrout analyzed how mixed mode oscillations arise from slow currents in neurons coupled weakly by electrical (gap) junctions, while Wechselberger discussed similar oscillations in the entorhinal cortex and their origin in canard phenomena. Bose explained how fixed phase relationships between neurons can be maintained in central pattern generators using depressing synapses. Medvedev showed how Poincaré maps can be used to understand bursting induced by random perturbations of periodic firing.

Sunday afternoon was dedicated to patterns of activity such as propagating waves and synchronous firing in neural excitable media. Troy showed how multi-pulse, periodic, and rotating waves can occur in the Pinto-Ermentrout neural field model. Coombes discussed novel brain wave equations that could lead to more realistic models for connectivity, axonal delays, and fatigue. Hutt presented a stochastic center manifold framework with adiabatic elimination to study the stabilizing effect of spatial noise on Turing bifurcations in neural field models. Shea-Brown showed how correlations and synchrony are shaped by successive neural layers and discussed the implications of this relation for coding.

The theme session on Parkinson's disease was held on Monday morning. Hansel explained the feedback loops that interact in the basal ganglia, and presented a theory to explain how disrupted loop competition can be the origin of pathology. Terman focused on the intrinsic synchrony and irregularity that can arise via the interaction of subthalamic nuclei and the

globus pallidus. Grill gave an overview of the deep brain stimulation (DBS) strategies to alleviate tremors of various origins and our understanding of the associated mechanisms. His modelling and clinical studies suggest that patterns of neural activity (rather than simply firing rates) are altered in pathology. McIntyre described a computational framework to understand DBS that includes anatomical and physiological data (augmented by electric field modelling). Finally Tass presented an analysis of long-term desynchronization techniques and the modelling of the phase dispersion they produce between coupled oscillators.

On Monday afternoon the lectures focused on synchronization transitions. Rosenblum presented a theoretical and computational analysis of the effect of delayed and non-delayed feedback on neural synchrony. Maistrenko investigated how the plasticity in the connections between neurons leads to multistability and affects the Kuramoto transition. Skinner analyzed how electrical (gap) coupling between cells can control synchrony when this coupling is far from the cell body. Of special note is the Aisenstadt Lecture given by John Rinzel (see above for a description of the three Aisenstadt lectures by John Rinzel).

On Tuesday morning the session was dedicated to the auditory system. Bruce presented methods for analyzing the influence of noise on spike initiation and showed how such threshold fluctuations can be obtained in electrical stimulation from cochlear implants. Rinzel used concepts from dynamical systems and coding theory to explain the phasic firing, precise phase locking, and extremely timing-sensitive coincidence detection involved in sound localization. Chechik presented a study of redundancy reduction and information transfer for the spectrotemporal content of auditory stimuli, showing how redundancy decreases as one moves to higher brain centers. Elhilali discussed a computational framework, based on temporal coherence, for segregating sounds into meaningful streams. Van Hemmen presented a theory, called Supervised Spiking Time Dependent Plasticity, that explains how inputs from one sense can act as a learning supervisor for another sense; he also proved that under very general conditions, Supervised STDP converges to stable synaptic weights, thus leading to a reconstruction of primary sensory input.

Stochastic dynamics took the stage on Tuesday afternoon. Lindner provided an analysis of the moments of the neuron voltage fluctua-

tions when driven by shot noise. Miller combined multi-electrode recordings with hidden Markov analysis to uncover noise-induced transitions between discrete states in neurons involved in decision making and time estimation. Richardson described a new method (applicable to any nonlinear integrate-and-fire model) for computing the modulation of the firing rate by a periodic stimulus, as well as a method for extracting the nonlinear current-voltage relation from intracellular spiking data. Parga provided a novel analysis of stochastic transitions between up and down states using integrate-and-fire models with a nonlinear membrane current.

On the final morning Ding presented a method to determine the anatomical origin of cortical oscillations by using multisite data, and discussed its implications for oscillation modulation by attention. Holmes proposed a model for omitted stimulus response in retinal ganglion cells stimulated by dark flashes, and showed how transient calcium concentration tunes the resonant frequency. Timofeeva presented a sum-over-trips technique to construct the Green's function for a resonant branched dendritic tree that can support subthreshold dynamics. Cox described an adjoint method to solve the inverse problems of calcium channel density estimation and localization from imaging data. The conference concluded with a novel model of protein receptor trafficking on cylindrical dendrites with partially absorbing traps located on spines (which are small protrusions). Singular perturbation theory enabled a good description of the steady-state distribution of receptors, and, amazingly, an exact solution of the mean first passage time problem for a single receptor was also provided.

The workshop also featured fourteen poster presentations that were on display throughout the conference, and were given special focus during a welcome reception.

Minicourse

Quantitative Biology

September 22 – 23, 2007, CRM

Sponsored by MITACS

Organizers: Brian Ingalls (Waterloo), Michael C. Mackey (McGill), and Peter Swain (McGill)

Speakers: Brian Ingalls (Waterloo), Mads Kaern (Ottawa), Theodore J. Perkins (McGill), Peter Swain (McGill), John Tyson (Virginia Polytechnic)

Number of participants: 36

The minicourse was well attended, with more than thirty graduate students, postdocs, and other researchers present. Given the interdisciplinary nature of the workshop on Deconstructing Biochemical Networks (see below), the minicourse was an indispensable introduction to some of the fundamental concepts in the field of systems biology. The first session was given by the Aisenstadt Chair John Tyson, and was an introduction to the use of ordinary differential equations in the modelling and analysis of dynamical systems. The following sessions took up a number of timely topics in the theoretical analysis of cell biological systems: stochastic modelling, methods for data fitting, synthetic biology, and control theory. This wide range of subjects made the minicourse a valuable learning experience for both new and seasoned researchers (including the presenters!). Feedback from the minicourse was uniformly positive. A number of participants commented that it greatly enhanced their appreciation of the talks and discussions in the ensuing workshop.

Workshop

Deconstructing Biochemical Networks

October 24–28, 2007, CRM

Sponsored by MITACS

Organizers: Peter Swain (McGill), Brian Ingalls (Waterloo), and Michael C. Mackey (McGill)

Speakers: Eric Cytrynbaum (British Columbia), Michael Ellison (Alberta), Tim Elston (North Carolina), Eldon Emberly (Simon Fraser), James E. Ferrell, Jr. (Stanford), Jeff Hasty (California, San Diego), Martin Howard (Imperial College), Pablo Iglesias (Johns Hopkins), Brian Ingalls (Waterloo), Mads Kaern (Ottawa), Edda Klipp (Max Planck Institute for Molecular Genetics), Andre Levchenko (Johns Hopkins), David McMillen (Toronto), Stephen Michnick (Montréal), Nick Monk (Nottingham), Felix Naef (Swiss Institute for Experimental Cancer Research), Theodore J. Perkins (McGill), Sharad Ramanathan (Harvard), Chris Rao (Illinois at Urbana-Champaign), John Rinzel (New York), Andrew Rutenberg (Dalhousie), Anirvan Sengupta (Rutgers), Eric Siggia (Rockefeller), Peter Swain (McGill), John Tyson (Virginia Polytechnic), Alexander Van Oudenaarden (MIT), Jose Vilar (Memorial Sloan-Kettering Institute), Jackie Vogel (McGill), Ron Weiss (Princeton), Ned Wingreen (Princeton)

Number of participants: 78

The workshop was highly successful in attracting a large number of high-profile speakers, and almost half of the audience presented

their work. Many of the talks addressed how important biological problems could only be solved with a combination of mathematics and experiments. Two major mathematical themes emerged: the need to model stochastic dynamics, and the need to identify simple, underlying dynamical systems driving the dynamics of large networks of interacting genes and proteins. The following topics were raised by many participants and thoroughly discussed: the origin of oscillations with robust periods in biochemical networks, and the manner in which cells process information in their stochastic intracellular environments. Speakers included experimental biologists, applied mathematicians, informaticians, control engineers, and biophysicists. The meeting culminated in a busy poster session, which allowed nearly all the students and postdoctoral fellows to present their work. Many attendees expressed an interest in the development of the research projects presented during the workshop, and asked for the meeting to be held again in a few years' time.

Joint AARMS-CRM Workshop

Recent Advances in Functional and Delay Differential Equations

November 1–5, 2007, Dalhousie University

Sponsored by AARMS, CRM, and MITACS

Organizers: Hermann Brunner (Memorial), Anthony R. Humphries (McGill), and Dmitry Pelinovsky (McMaster)

Local organizers: Patrick Keast (Dalhousie) and Paul Muir (Saint Mary's)

Speakers: Mohit Adhikari (New Mexico), Jacques Bélair (Montréal), Alfredo Bellen (Trieste), Dimitri Breda (Udine), Hermann Brunner (Memorial), Luciano Buono (University of Ontario Institute of Technology), Sue Ann Campbell (Waterloo), Jayme De Luca (São Carlos), Christopher E. Elmer, Wayne Enright (Toronto), Nicola Guglielmi (Università degli Studi di L'Aquila), István Györi (Pannonia), Ferenc Hartung (Pannonia), Anthony R. Humphries (McGill), Gérard Iooss (Nice), Tibor Krisztin (Szeged), Guillaume Lajoie (McGill), Jean-Philippe Lessard (Rutgers), Jianfu Ma (York), Michael C. Mackey (McGill), John Mallet-Paret (Brown), Stefano Maset (Trieste), Chunhua Ou (Memorial), Cesar Palencia de Lara (Valladolid), Panayotis Panayotaros (IIMAS-UNAM), Arvet Pedas (Tartu), Dmitry Pelinovsky (McMaster), Gergely Röst (Szeged), Vassilis Rothos (Thessaloniki), Hadi Susanto (Massachusetts Amherst), Anna Vainchtein (Pittsburgh), Erik S. Van Vleck (Kansas), Rossana Vermiglio (Udine), David

J.N. Wall (Canterbury), Hans-Otto Walther (Giessen), Jianhong Wu (York), Xiaoqiang Zhao (Memorial), Xingfu F. Zou (Western Ontario)

Number of participants: 45

A fairly mature theory of constant delay equations as infinite-dimensional dynamical systems has been developed. Models in physical and biological applications, however, are increasingly encompassing features that do not fit this theory, because they often have non-constant and state-dependent delays, or advanced arguments. Volterra functional (integral and integro-differential) equations are also applied with increasing frequency. The theory of such problems is still far from complete, though significant progress is being made. A large gap also exists in the numerical analysis and computation of solutions of such functional equations. This workshop brought together researchers and students who had applied, numerical, and theoretical viewpoints, and provided them with a broad perspective on recent results and current research and open problems in these overlapping fields.

The workshop featured five plenary talks: “Localized waves in lattices of Fermi-Pasta-Ulam type” (by Gérard Iooss); “Runge-Kutta convolution quadrature methods for linear homogeneous Volterra equations” (by Cesar Palencia); “Numerics of delay differential equations” (by Nicola Guglielmi); “Differential equations with state-dependent delay” (by Tibor Krisztin); and “Neural computation with periodic attractors: memory and time lags” (by Jianhong Wu). All participants were invited to give a talk, and nearly all did, which necessitated parallel sessions one afternoon. One theme that ran through the workshop was the use of delay equations in applications, particularly biological applications. Here it would be natural for the delays to be state-dependent, but most models treat delays as constant, mainly because of the lack of techniques and theory for the state-dependent problems. Clearly, if mathematicians can supply the theory and methods to solve state-dependent delay problems, they will be applied to many new problems of this type arising in biology.

On the theoretical side, the workshop featured presentations on existence results for periodic solutions, in particular slowly oscillating periodic solutions (with a period larger than twice the delay); those existence results were presented under a variety of situations, including negative and positive feedback problems. Numerical methods are also under development

for state-dependent problems, and in this context the problem of solution termination for neutral problems has come under investigation. In these problems there is no smoothing of the initial function, and breakpoints where the solution has a discontinuous derivative arise at solution-dependent time values that cannot be precomputed; the solution may terminate at these points.

Solutions can be continued beyond termination by using either a Filipov-like set-valued extension of the differential equation, or by regularization. The relevance of these methods was shown in an example where a solution passed through several terminations before converging to an attractive periodic orbit in a region of phase space without terminations. Another area where recent progress has occurred in both theory and numerics concerns stability of fixed points, where efficient methods for the numerical computation of characteristic values were presented at the workshop. The presentations also addressed the theory for linking nonlinear and linear stability of fixed points for state-dependent problems; this is a much harder problem than in the case of constant delay equations.

The talks on Volterra integral, integro-differential, and more general functional equations illuminated the state-of-the-art of the numerical treatment of such equations. In particular, a general approach based on the abstract representation of the numerical solution of Volterra equations (of parabolic or non-parabolic type) in terms of the analytical solution leads to a comprehensive numerical stability analysis. In the case of Volterra integral or integro-differential equations with weakly singular kernels, it appears advantageous to subject them to a “smoothing transformation”; this improves the regularity of the solutions and leads to more efficient numerical methods. Many numerical issues still need to be solved, however, including the analysis of efficient methods for Volterra equations with highly oscillatory kernels, and the design of reliable numerical codes for Volterra-type functional differential and integral equations, especially for problems with state-dependent delays.

Also of considerable interest are nonlinear travelling wave problems on lattices, arising from materials science, atomic physics, and nonlinear optics. These lead to dissipative or Hamiltonian advanced-retarded equations on the entire axis with homoclinic, heteroclinic, or periodic solutions. In the Hamiltonian case, recent progress has been made using center man-

ifold reductions and normal form transformations. Because homoclinic and heteroclinic orbits arise from a multiple zero eigenvalue bifurcation in the presence of non-zero purely imaginary eigenvalues, the existence of these solutions is subject to a set of constraints. Melnikov integrals determine conditions under which non-trivial bifurcations occur, and numerical evaluation of these integrals (also related to Stokes constants in beyond-all-order asymptotics) is a subject of much study.

Other talks were devoted to variational characterization of periodic travelling waves in lattices and time-periodic forcing of localized waves due to diffraction management in Hamiltonian lattices. If the original physical system is governed by dissipative reaction-diffusion equations, nonlinear travelling waves are solutions of dissipative advanced-delay equations. Several talks were devoted to propagation failure for front (heteroclinic) solutions of scalar nonlinear heat equations, which have recently been investigated in much detail. Many other problems and results were presented, but we only mention two more: partial differential equations with delays (where there is potential for significant future research), and the Wheeler-Feynman problem of classical electrodynamics, which involves the solution of an implicitly state-dependent neutral advanced-delay differential equation.

The meeting was jointly organized by AARMS and CRM and took place in Halifax, initially at Dalhousie University. There was a strong turnout of the Canadian delay equations community, and many participants travelled from Europe, and some from as far afield as Brazil, New Zealand, and Estonia. The workshop was a great opportunity for researchers from different fields and countries to interact. One unwelcome guest was Hurricane Noel, whose remnants swept across Halifax on Saturday night, soaking everyone walking back to the hotel after the seminars. Worse still, we lost our venue on Sunday morning because Dalhousie was without electrical power. Fortunately Pat Keast, to whom we are very grateful, saved the conference by arranging an alternative venue at the Lord Nelson Hotel, at less than an hour's notice. In all, it was a very memorable workshop!

Workshop

Dynamical Systems and Continuum Physics

November 14–16, 2007, CRM

Organizer: Laurette Tuckerman (PMMH-ESPCI, France)

Speakers: Dwight Barkley (Warwick), Jessica Conway (Northwestern), Olivier Dauchot (CEA-Saclay), John R. de Bruyn (Western Ontario), Michael Dennin (California, Irvine), Bruno Eckhardt (Philipps-Universität Marburg), Cristian Huepe (Northwestern), Edgar Knobloch (California, Berkeley), Patrice Le Gal (Technopôle de Château-Gombert), Juan Lopez (Arizona State), Francisco Marques (Universitat Politècnica de Catalunya), Philippe Marmottant (Université Joseph Fourier), Stephen Morris (Toronto), Laurette Tuckerman (PMMH-ESPCI), Charles Radin (Texas at Austin), Jorge Viñals (McGill)

Number of participants: 25

Dynamical systems theory provides astonishingly faithful representations of systems from continuum physics. This workshop focused on recent research in laminar and turbulent hydrodynamics and in some more discrete systems, notably granular media and foams. In laminar hydrodynamics, transitions in rotating, sheared, and heated fluids provided motivation for the development of bifurcation theory during much of the 20th century. The successive transitions in Taylor-Couette flow and Rayleigh-Bénard convection have long been classified as pitchfork and Hopf bifurcations. Attention has shifted to more complicated scenarios involving tori and heteroclinic orbits, and to open flows such as wakes and shear layers.

Three half-day sessions were held on bifurcations and patterns in laminar hydrodynamics. Three talks addressed rotating flows. Juan Lopez proposed a method to control vortex breakdown, which creates a stagnation point rotating flow and can have serious consequences in aerodynamics. Francisco Marques spoke about complex dynamical processes (bursting, heteroclinic, and homoclinic orbits) in Taylor-Couette flow between differentially rotating concentric cylinders. Patrice Le Gal showed how several different instabilities could be viewed as manifestations of unifying general principles in rotating flows.

Three more talks addressed pattern formation in convection. Edgar Knobloch presented his discovery of convectons, which are localized regions of convection that grow by adding rolls via homoclinic "snaking". Stephen Morris spoke on electroconvection in smectic liquid crystals, which produces two-dimensional vortices. Laurette Tuckerman described an analogy between the linear and nonlinear problems of binary fluid convection, whereby both the growth rates and the energy are roots of quadratic equations that

undergo avoided crossing or complex coalescence.

Another session was devoted to the patterns formed on the surface of a vertically vibrated fluid layer, known as the Faraday problem, which again became the focus of research in the early 1990s when it was discovered that temporal oscillations that combined more than one frequency led to spatial quasipatterns. Cristian Huepe has analyzed the temporal forcing function with the WKB approximation, and has applied this analysis to the “inverse Faraday problem”, i.e., the problem of finding a forcing that produces a given spatial wave pattern. Jessica Conway discussed superlattice patterns and their stabilization. Finally, Jorge Viñals discussed the dynamics and patterns of diblock copolymers, that is, macromolecules comprising two chemically distinct and mutually incompatible covalently bonded segments (monomers), which have applications to micro-electronics and biomedicine. Under applied shear, these materials form “sheets” that may be parallel, perpendicular, or transverse to the shear.

The Navier-Stokes equations continue to govern turbulent hydrodynamics; the challenge is to explain the transition to chaotic behaviour (i.e., turbulence) displayed by these well-known deterministic equations, especially in the absence of linear instability. Phenomenological laws developed for engineering purposes cannot be derived from first principles, and, in addition, do not predict or describe transition. Patterns involving multiple turbulent structures or the coexistence of turbulent and laminar regions provide interesting new puzzles. One session was devoted to phenomena occurring near transition to turbulence in wall-bounded flows. Bruno Eckhardt spoke on unstable steady states and periodic orbits and fractal basin boundaries in pipe flow. Dwight Barkley spoke of patterns of oblique laminar and turbulent stripes in plane Couette flow (the flow between infinite translating plates).

Granular media and foams, at the cutting edge of continuum physics, are not as well understood as hydrodynamics. Granular media display patterns such as segregation, lattices and waves, as well as various apparent paradoxes. Efforts have been made to formulate equations governing granular media at appropriate scales (between the scales of molecular dynamics and continuum fields). In foams, the elementary constituents are bubbles, governed by the competition between surface tension and pressure. One encounters similar themes in highly vis-

cous fluids. One session was devoted to each of these new forms of media. Stephen Morris discussed the well-known but poorly understood phenomenon of segregation, whereby a mixture of grains of different sizes separates when it is shaken, stirred, or turned. Olivier Douchot investigated spatial and temporal correlations in granular media via experiments involving clusters, relaxation, ageing, jamming, and flow. Charles Radin discussed the relationship between static sand piles and sphere packings (both ordered and random).

In the session on foams, Philippe Marmontant described attempts to formulate continuum equations, which combine elastic, plastic, and viscous properties. Michael Dennin discussed recent experiments on “rafts” of bubbles floating on water, which shed light on solid, liquid, and plastic properties of foams. John de Bruyn presented experiments that seek to measure drag in foams. The workshop closed with a colloquium talk by Charles Radin on packings of spheres that are merely dense rather than densest, and their applications to granular media.

Workshop

Chaos and Ergodicity of Realistic Hamiltonian Systems

December 11 – 14, 2007, CRM

Organizers: Henk Broer (Groningen) and Paul Tupper (McGill)

Speakers: Luis Benet (UNAM), Nawaf Bou-Rabee (California Institute of Technology), Stephan De Bièvre (Lille 1), Antonio Giorgilli (Milano), Wayne Hayes (California, Irvine), Michael Shub (Toronto), Carles Simo (Barcelona), Robert D. Skeel (Purdue), Paul Tupper (McGill), Aernout van Enter (Groningen)

Number of participants: 13

In this workshop experts in dynamical systems from mathematics, physics, and computer science presented their work on Hamiltonian systems. Two main types of models were considered: atomistic dynamics and celestial mechanics. The topics falling within the first category ranged from detailed molecular dynamics simulations of biochemical systems to systems for probing the foundations of statistical mechanics. The topics in the second category ranged from the dynamics of interacting galaxies to the subtle mechanisms that form Saturn’s rings.

The concept of ergodicity usually considered in dynamical systems (such as that shown for geodesic flows on manifolds of negative curvature and dispersive billiards) does not appear to be appropriate for systems arising in many

applications. Many investigations presented at the workshop revealed that the physically important statistical behaviour occurs on a long, but finite, time scale. If the infinite time limit of the system were considered, the system would have a very different behaviour. Computational experiments revealed this to be true in the case of many systems, and a theoretical example was presented in the talk of Michael Shub on “Stable Ergodicity”. One result of this theory is that generic high-dimensional systems may be ergodic as long as they are coupled, no matter how weakly, to a sufficiently strongly hyperbolic system. The time scale on which this ergodicity would be observed, however, is immense; it would likely be beyond the time scales of theoretical interest for many applications.

A theme parallel to the previous one is the following: given a high-dimensional Hamiltonian system, what low-dimensional functions of the system does one observe? Ergodicity is framed in terms of time averages of virtually all observables of a system. Many of the speakers showed that the statistical behaviour observed depended to a large extent on which functions were considered. An especially interesting example of this was the talk of Antonio Giorgilli on the Fermi-Pasta-Ulam problem, where measures of mixing in the equilibrium state depend on which observables are considered.

Perhaps the most realistic Hamiltonian systems discussed during the workshop were presented by Wayne Hayes, who discussed chaos in the solar system. A long-standing question in celestial mechanics is whether the solar system is chaotic or not. Two well-respected computational groups have attacked this problem and come up with different answers. Hayes’ detailed study of the system using high-accuracy numerical methods has resolved the apparent contradiction. It appears that the equations modelling the solar system have trajectories with both zero (non-chaotic) and non-zero (chaotic) Lyapunov exponents. Surprisingly, the current state of the solar system is not known accurately enough to determine which type of trajectory the system follows. The two groups started with slightly different initial conditions, which are both consistent with the data, and thus arrived at different conclusions.

Young Mathematicians’ Conference

January 18–19, 2008, CRM

Organizers: Walter Craig (McMaster), Adrian Nachman (Toronto), Nilima Nigam (McGill),

Dmitry Pelinovsky (McMaster), Mary Pugh (Toronto), and Catherine Sulem (Toronto)

Speakers: Michael Chapwanya (Simon Fraser), Walter Craig (McMaster), Thierry Daude (McGill), Ivar Ekeland (British Columbia), Clement Gallo (McMaster), Meijiao Guan (British Columbia), Jun-Fang Li (McGill), Amir Moradifam (British Columbia), Tadahiro (Choonghong) Oh (Toronto), Roland K.W. Roeder (Toronto), Ben Stephens (Toronto), Xiangjin Xu (McGill), Zhenbin Yan (McGill)

Number of participants: 19

This workshop was the Fifth Annual Young Mathematicians’ Conference. For the first time it took place in Montréal. The conference is geared towards junior researchers in the areas of Partial Differential Equations (PDEs) and Dynamical Systems, and its goals are to encourage scientific exchange, to create an opportunity for mathematicians at an early stage of their career to speak at a major conference, and to enable them to learn about one another’s work. The conferences in this series raise the profile of talented young mathematicians, encourage high standards of research and presentation, widen the horizons of the participants, and help to foster a feeling of community in the discipline. The present workshop lived up to the high standards set by the previous conferences.

The workshop featured two plenary talks, given respectively by Ivar Ekeland and Walter Craig, and eleven twenty-five minute talks, given by junior mathematicians (advanced graduate students and postdoctoral fellows). The latter speakers were chosen through a nomination procedure that involves the mathematical community; each year the conference organizers request suggestions for junior speakers from this community, which also provides some financial support to defray the speakers’ expenses. The organizers are grateful to the mathematical community for the support received over the past five years.

The workshop was very successful. Ivar Ekeland’s talk was a workshop lecture as well as a CRM-ISM Colloquium, and he had a large and appreciative audience. He spoke on the foundations of microeconomic theory and the role that the calculus of differential forms plays in this theory. Of course this topic is related to his own work with Louis Nirenberg on the characterization of utility functions. Walter Craig spoke on his recent work with Andrei Biryuk (a former junior YMC speaker) on new estimates for weak solutions of the Navier-Stokes equations, and the implications that they have on

the Kolmogorov-Richardson picture of the energy cascade and the power law behaviour of the energy spectral function in fully developed turbulence. The talks given by the young mathematicians ranged from numerical modelling of fingering in porous media flows (by Michael Chapwanya), to complex dynamical systems (by Roland Roeder) and a survey of recent results related to the Minkowski problem for convex domains and their generalizations (Jun-Fang Li). The latter talk included a priori estimates for solutions of equations of Monge-Ampère type and their generalizations.

Workshop on Initial Conditions

January 24–25, 2008, CRM

Organizers: Walter Craig (McMaster), Pengfei Guan (McGill), and Christiane Rousseau (Montréal)

Speakers: Octav Cornea (Montréal), Denis G. Gaydashev (Kungliga Tekniska högskolan), Pengfei Guan (McGill), Başak Gürel (Montréal), Dmitry Jakobson (McGill), Pavao Mardesic (Bourgogne), Elena Naidenova (Academy of Sciences of Moldova), Christiane Rousseau (Montréal), Alexander Shnirelman (Concordia), Xiangjin Xu (McGill), Zhenbin Yan (McGill)

Number of participants: 18

The purpose of this workshop was to start off the thematic semester on Dynamical Systems and Evolution Equations, and to get the organizers and the participants, in particular the associated postdoctoral fellows, to know one another and to have an introduction to one another's research. The first lecture of the workshop was given by Pavao Mardesic, who was the invited lecturer of the workshop. The other lectures were given by the organizers of the core workshops and the CRM postdocs associated to the semester. The workshop ended with a CRM-ISM Colloquium given by Christiane Rousseau and entitled "The Conformal Equivalence Problem and Bisection Problem for Curvilinear Angles".

Workshop

Spectrum and Dynamics

April 7–11, 2008, CRM

Organizers: Dmitry Jakobson (McGill) and Iosif Polterovich (Montréal)

Speakers: Nalini Anantharaman (École Polytechnique), Pavel Bachurin (Toronto), Dmitry Dolgopyat (Maryland), Harold Donnelly (Purdue), Frédéric Faure (Université Joseph Fourier), Luc Hillairet (Nantes), Bernard Helffer (Paris-Sud), Michael Hitrik (California, Los Ange-

les), Victor Ivrii (Toronto), Konstantin Khanin (Toronto), Gerhard Knieper (Ruhr-Universität Bochum), Yuri A. Kordyukov (Russian Academy of Sciences), Michael Levitin (Cardiff), Stéphane Nonnenmacher (CEA-Saclay), Leonid Parnovski (University College London), Peter A. Perry (Kentucky), Ioannis Petridis (University College London), Yuri Safarov (King's College London), Roman Schubert (Bristol), Lior Silberman (IAS), Alexander Strohmaier (Loughborough), John A. Toth (McGill), Steve Zelditch (Johns Hopkins)

Number of participants: 45

The central theme of the meeting was the interplay between the theory of dynamical systems and spectral geometry, and the conference brought together the leading experts in these two fields. In particular, the workshop focused on applications of dynamics to the study of spectral asymptotics. The main topics covered were the following: spectral asymptotics on negatively curved manifolds and hyperbolic dynamics, Laplace and length spectra, elliptic operators on vector bundles and partially hyperbolic flows, billiards and spectral theory on manifolds with boundary, ergodic theory of group actions, and the theory of thermodynamic formalism.

The program of the workshop included two minicourses. Stéphane Nonnenmacher gave a minicourse on recent spectacular results on the entropy of chaotic eigenstates, obtained by Nalini Anantharaman, himself, and Herbert Koch. They showed that the entropy of semiclassical measures (limit measures associated to a sequence of chaotic eigenstates) is bounded from below by approximately half the maximal entropy. This implies that high-energy chaotic eigenstates are "at least half-delocalized". This partially answers a long-standing question in the theory of quantum chaos. Roman Schubert gave an introduction to his work on long-time behaviour of wave propagation on negatively curved manifolds. Until recently, wave propagation in chaotic systems was well understood up to logarithmic times only: this is the so-called Ehrenfest time barrier in quantum mechanics. Schubert's results can be viewed as the first step towards understanding wave propagation up to polynomial times, which is an outstanding problem in mathematical physics.

The minicourses continued during the week following the workshop. A poster session was organized during the first four days of the conference. The proceedings of the conference will be published in the CRM Lecture Notes series, and will be edited by Dmitry Jakobson, Stéphane Nonnenmacher, and Iosif Polterovich.

Workshop

Geometric Evolution Equations

April 16–27, 2008, CRM

Organizers: Vestislav Apostolov (UQÀM), Pengfei Guan (McGill), and Alina Stancu (Concordia)

Speakers: Xiaodong Cao (Cornell), Albert Chau (British Columbia), Jingyi Chen (British Columbia), Xiuxiong Chen (Wisconsin Madison), Nassif Ghoussoub (British Columbia), Bo Guan (Ohio State), Weiyong He (British Columbia), Gerhard Huisken (Tübingen), Spiro Karigiannis (Oxford), Julien Keller (Aix-Marseille 1), Li Ma (Tsinghua), Rafe Mazzeo (Stanford), Robert McCann (Toronto), Lei Ni (California, San Diego), Artem Pulemotov (Cornell), Natasa Sesum (Columbia), Jacob Sturm (Rutgers), Gábor Székelyhidi (Imperial College), Valentino Tosatti (Harvard), McKenzie Y. Wang (McMaster), Mu-Tao Wang (Columbia), Brian Weber (Stony Brook), Ben Weinkove (Harvard), Burkhard Wilking (Münster), Eric Woolgar (Alberta), Xiaohua Zhu (Beijing)

Number of participants: 41

The focus of this workshop was the study of various evolution equations in geometry and general relativity, including intrinsic curvature flows (especially Ricci and Kähler-Ricci flows) and extrinsic curvature flows (mean and inverse mean curvature flows, homogeneous and non-homogeneous Gauss curvature flows, relativity). The workshop was attended by over 40 participants, most of whom were physicists, geometers, or analysts. Most participants gave lectures and most attended every talk. Many new results were reported for the first time during the workshop and many participants left Montreal ready to work on new projects.

We now highlight the four lectures series; in each the lecturer did a wonderful survey of a vibrant field. Gerhard Huisken gave a cycle of four lectures (which were actually Aisenstadt Chair lectures), providing a comprehensive survey of geometric variational problems in General Relativity, including aspects of the mean and inverse mean curvature flows and different concepts of mass and their relationship to isoperimetric inequalities. Burkhard Wilking lectured on Ricci flow and its spectacular applications to the recent resolution of classical curvature pinching conjectures in Riemannian geometry, including the $1/4$ pinching sphere theorem.

Lei Ni gave a far-reaching introduction to Ricci flow with a special attention to solitons. After explaining the Li-Yau-Hamilton Harnack

inequalities for Kähler-Ricci flows, he presented a detailed study of gradient Ricci solitons and their canonical forms. Xiuxiong Chen surveyed the exciting recent breakthrough in the theory of extremal Kähler metrics, due to Tian and himself; indeed, they proved their uniqueness within a fixed Kähler class, as well as the boundedness of the (relative) K -energy, by using suitable approximations of the geodesics in the space of Kähler metrics. He linked these results to the convergence of the Kähler-Ricci and Calabi flows.

Thus, in ten intensive days, the program succeeded in tying together most of the new results in the subject and a variety of new projects were born. The participants affirmed frequently and spontaneously that the program was a great success.

Minicourse

Singularities, Hamiltonian and Gradient Flows

May 5–9, 2008, CRM

Organizers : Walter Craig (McMaster), Christiane Rousseau (Montréal), and Alexander Schnirelman (Concordia)

Speakers: Richard Montgomery (California, Santa Cruz), Laurent Stolovitch (Université Paul Sabatier), Jean-Christophe Yoccoz (Collège de France)

The Workshop on Singularities, and Gradient and Hamiltonian Flows (see below) was preceded by a series of three short courses, of three or four hours apiece. The three series were given respectively by Jean-Christophe Yoccoz, Laurent Stolovitch, and Richard Montgomery. The lectures by Jean-Christophe Yoccoz actually fell under the purview of the André-Aisenstadt Chair, and for a description of these lectures, we refer the reader to the beginning of the present section on the André-Aisenstadt Chairholders.

Laurent Stolovitch gave lectures on the classification of Poisson structures, in the holomorphic and the C^∞ category. The results he presented are the resolution of a program dating from the early 1980's and due to Weinstein and Marsden; they classify the singular Poisson structures up to holomorphic (respectively, smooth) conjugacy, under a diophantine condition on the linearization at the singular point in question. Surprisingly enough, the problem to be solved is a small divisor problem, which explains the presence of the diophantine requirement. Stolovitch went on to discuss the similarity of this problem and the Siegel problem of conjugacy of holomorphic vector fields. Fi-

nally he developed his ideas on extensions of this work to various settings of simultaneous conjugacy of bivector fields.

Richard Montgomery talked on the classification of distributions, discussing the problem of distributions with large growth vector and the constructions used to prolong a distribution, and giving an introduction to the theory of Legendrian curves. His talks described the extension of the classical ideas of Cartan using an infinitary suspension method that he termed the “friendly monster”. He is otherwise known for his work with Alain Chenciner on the discovery of beautiful figure-eight “choreography” solutions to the classical n -body problem.

Workshop Singularities, Hamiltonian and Gradient flows

May 12 – 16, 2008, CRM

Organizers: Walter Craig (McMaster), Christiane Rousseau (Montréal), and Alexander Schnirelman (Concordia)

Speakers: Dario Bambusi (Milano), Michael Bialy (Tel Aviv), Kuo-Chang Chen (National Tsing Hua University), Walter Craig (McMaster), Peter De Maesschalck (Hasselt), Freddy Dumortier (Hasselt), Hakan Eliasson (Paris 7), Bernold Fiedler (Freie Universität Berlin), Denis G. Gaydashev (Montréal), Vassili Gelfreich (Warwick), Jiansheng Geng (McMaster), Hidekazu Ito (Kanazawa), Vadim Kaloshin (Maryland), Markus Keel (Minnesota), Christiane Rousseau (Montréal), Andrey Sarychev (Firenze), Reinhard Schäfke (Strasbourg), Alexander Shnirelman (Concordia), Laurent Stolovitch (Toulouse), Susanna Terracini (Milano), C. Eugene Wayne (Boston), Jean-Christophe Yoccoz (Collège de France)

Number of participants: 41

This workshop was attended by specialists from around the world talking on a broad set of topics, around the general theme of singularities of dynamical systems and the role they play in ODEs and PDEs. Among the participants were specialists working in the following areas: geometrical methods in differential equations, the analysis of Hamiltonian systems and Hamiltonian PDEs, summability techniques in complex dynamics, small divisors and KAM theory, and applications of dynamical systems to PDEs. Generally speaking, the lecture room was quite full, and the audience consisted of CRM visitors, postdoctoral fellows, workshop speakers and their own graduate students, and interested mathematicians from the Montréal area.

With lively question and answer periods, and even more lively social events, the workshop provided ample opportunity for mathematical interactions.

A number of lectures concerned results on the n -body problem and Arnold diffusion. Vadim Kaloshin, the Clay Lecturer for the workshop, gave two lectures on this topic. In the first one, geared towards a broad audience, he discussed special types of solutions of the 3-body problem and their Hausdorff dimension, while in the second one, he presented an example of Arnold diffusion. The n -body problem was also discussed by Susanna Terracini and Kuo-Chang Chen. Susanna Terracini discussed collision solutions via variational methods, while Kuo-Chang Chen discussed the stability of satellite solutions. In his lecture, Vassili Gelfreich described an example of Arnold diffusion in a non-integrable billiard; in this example the diffusion is produced by a heteroclinic connection between two periodic orbits of the billiard. The methods developed can be applied in the more general context of slow-fast Hamiltonians.

A number of talks discussed singularities of dynamical systems. The lecture of Peter de Maesschalck gave general theorems for the existence of invariant manifolds in the analytic or Gevrey class. The neat proofs of his theorems make them very appropriate for the teaching of graduate courses. Two talks were concerned with the moduli spaces of analytic classifications of singular objects. The talk of Reinhard Schäfke dealt with the construction of operators allowing the realization of given moduli, while the talk of Christiane Rousseau gave the moduli space for generic unfoldings of parabolic points of codimension 1.

There were several talks on normal forms near singularities of ODEs and PDEs and their applications to describe the qualitative behaviour of solutions of PDEs of small norms. The talk of Laurent Stolovitch discussed normal forms of singular points of vector fields with non-diagonal linear part and conditions guaranteeing the convergence of the normalizing transformations. Other lectures on the subject were given by Dario Bambusi (who spoke on wave equations) and Hidekazu Ito. Singular perturbations in planar vector fields were discussed in the talk of Freddy Dumortier: he described conditions under which at least two limit cycles are born when several critical values of the slow curve coalesce. Bernold Fiedler discussed the global qualitative dynamics of the scalar reaction-advection-diffusion PDE on the unit in-

terval. He showed how the global attractor of the PDE consists of all equilibria and heteroclinic orbits between them, where each heteroclinic orbit connects two points whose Morse indices differ by 1 (exactly).

Applications of dynamical systems methods to PDEs were discussed in a number of talks. Schrödinger equations were discussed by Hakan Eliasson and Markus Keel. The lecture of Markus Keel was concerned with the energy transfer and its growth to infinity in the presence of resonances. Eugene Wayne discussed the existence of travelling wave solutions of the Fermi-Pasta-Ulam model coming from a pair of counterpropagating waves and ending in such a pair. Michael Bialy discussed the periodic solutions of a model of quasi-periodic solutions given by Benney chains, together with a conjecture that all the periodic solutions are standing waves.

Walter Craig exploited a dynamical systems argument to give new estimates on weak solutions of Navier-Stokes equations; this argument yields nontrivial bounds on the Kolmogorov spectrum of solutions. Denis Gaydashev introduced a machinery that is an alternative to KAM and uses renormalization and universality for Hamiltonian flows. A geometric approach to controllability and optimal control of multiparticle systems was discussed by Andrey Sarychev; the method was illustrated on a system of N interacting particles on a straight line, but can be extended to other types of nonlinear systems.

Workshop

Floer Theory and Symplectic Dynamics

May 19–24, 2008, CRM

Organizers: Octav Cornea (Montréal), Leonid Polterovich (Tel Aviv), and Felix Schlenk (Université Libre de Bruxelles)

Speakers: Alberto Abbondandolo (Pisa), Mohammed Abouzaid (MIT), Peter Albers (Courant), Denis Auroux (MIT), Paul Biran (Tel Aviv), Frédéric Bourgeois (Université Libre de Bruxelles), Lev Buhovsky (Tel Aviv), Yuri Chekanov (Moscow Center for Continuous Mathematical Education), Michael Entov (Technion), Urs Frauenfelder (München),

Kenji Fukaya (Kyoto), Viktor Ginzburg (California, Santa Cruz), Richard Hind (Notre Dame), Yael Karshon (Toronto), Ely Kerman (Illinois at Urbana-Champaign), Samuel Lisi (Stanford), Guangcun Lu (Nankai), Alexandru Oancea (Strasbourg), Kaoru Ono (Hokkaido), Yaron Ostrover (MIT), Dietmar Salamon (ETH Zürich), Matthias Schwarz (Leipzig), Claude Viterbo (Ecole Polytechnique), Eduard Zehnder (ETH Zurich)

Number of participants: 68

The main theme of the workshop was symplectic topology and Hamiltonian dynamics. Here are some of the topics covered during the workshop: various homology theories arising in symplectic and contact topology, their algebraic and analytic aspects, and their applications and ramifications (Abbondandolo, Abouzaid, Bourgeois, Frauenfelder, Ginzburg, Lisi, Oancea, Ostrover, Ono, Salamon, Schwarz); new results on Lagrangian tori (Auroux, Biran, Chekanov, and Fukaya); Hofer's geometry (Karshon, Kerman); rigidity of Poisson brackets (Buhovsky, Entov); symplectic homogenization (Viterbo); Weinstein conjecture (Albers); and rigidity or flexibility of symplectic embeddings (Hind).

Particularly impressive was Edi Zehnder's talk about surfaces of section for Reeb flows in dimension three, which started with the work of Poincaré and ended with recent and strong results on closed orbits of Reeb flows. Another touching moment was Guangcun Lu's lecture on the Conley conjecture in cotangent bundles, which showed that the symplectic community forms a big family all over the world.

The meeting was held in a rather informal and very stimulating atmosphere. There were many PhD students, who helped to keep the meeting lively and proved that symplectic topology is a growing and very active field of research. The many positive feedbacks that we received indicate to us that the participants were very happy to have come to this conference. They benefited from the many interesting and carefully presented lectures, as well as from the individual discussions and the opportunities to meet and collaborate with their colleagues at an international level.

Past Thematic Programs

The Centre de recherches mathématiques has organized thematic activities every year since 1993. From 1987 to 1992, the CRM organized various types of activities, including special semesters, concentration periods and thematic activities. Here is a list of the main activities organized by the CRM since 1987.

January – June 2007 Recent Advances in Combinatorics

June – December 2006 Combinatorial Optimization

2005 – 2006 Analysis in Number Theory

2004 – 2005 The Mathematics of Stochastic and Multiscale Modelling

2003 – 2004 Geometric and Spectral Analysis

2002 – 2003 Mathematics in Computer Science

2001 – 2002 Groups and Geometry

2000 – 2001 Mathematical Methods in Biology and Medicine

1999 – 2000 Mathematical Physics

1998 – 1999 Number Theory and Arithmetic Geometry

1997 – 1998 Statistics

1996 – 1997 Combinatorics and Group Theory

1995 – 1996 Applied and Numerical Analysis

1994 – 1995 Geometry and Topology

1993 – 1994 Dynamical Systems and Applications

1992 Probability and Stochastic Control (special semester)

1991 – 1992 Automorphic Forms in Number Theory

1991 Operator Algebras (special semester)

1990 Nonlinear PDEs and Applications (concentration period)

1988 Shimura Varieties (special semester)

1987 Quantum Field Theory (special semester)

1987 – 1988 Fractals: Theory and Application

1987 Structural Rigidity (special semester)

General Program

THE CRM's general program funds a wide variety of scientific events, both on the premises of the CRM and elsewhere in Canada. Whether it be for specialized workshops attended by a small number of researchers or large meetings attended by hundreds of participants, the general program promotes research in the mathematical sciences at all levels. The program is quite flexible, allowing projects to be considered as they arise. *The reports are presented in the language in which they were submitted.*

CRM activities

Scientific Meeting

Journée de statistique Montréal-Québec

June 1st, 2007, CRM

Organized by the Statistics Laboratory

Organizers: Christian Léger (Montréal), Alejandro Murua (Montréal), Aurélie Labbe (Laval)

Speakers: Martin Bilodeau (Montréal), Nicolas Bousquet (Laval), Simon Guillotte (Montréal), Félix Labrecque-Synnott (Montréal), Naâmane Laib (Paris 6 and Concordia), Bruno Rémillard (HEC Montréal)

Number of participants: 40

Le 1er juin 2007 a eu lieu la première Journée de statistique Montréal-Québec regroupant des statisticiens de toutes les régions du Québec. Les conférences principales furent données par Martin Bilodeau et Bruno Rémillard, et elles portaient respectivement sur « les statistiques de A -dépendance pour l'indépendance mutuelle et sérielle entre variables catégorielles » et les « tests d'indépendance sérielle ». De plus, quatre étudiants et stagiaires postdoctoraux ont présenté leurs travaux devant une quarantaine de participants.

Short Program on Moduli Spaces of Riemann Surfaces and Related Topics

June 4 – 15, 2007, CRM

Sponsored by CIRGET and the Mathematical Physics Laboratory

Organizers: Marco Bertola (Concordia) and Dmitri Korotkin (Concordia)

Minicourse instructors: Indranil Biswas (Tata Institute), Boris Dubrovin (SISSA), Sergei K. Lando (Moscow Independent University), Todor Milanov (Stanford), Ian Morrison (Fordham), Robert Penner (Southern California), Leon Takhtajan (Stony Brook), Ravi Vakil (Stanford), Scott Wolpert (Maryland), Peter Zograf (Steklov Institute, Saint Petersburg)

Speakers: Simonetta Abenda (CIRAM, Bologna), Rui Albuquerque (University of Évora, Portugal), Igor Artamkin (MPI, Bonn and Moscow State University), Tom Baird (Toronto), Alex Bene (Southern California), Leonid Chekhov (Steklov Institute, Moscow),

Norman Do (Melbourne), Evgeny Gorsky (Moscow State University), Tamara Grava (SISSA), Ian P. Goulden (Waterloo), Claus Hertling (Mannheim), Jacques Hurtubise (McGill), Ilia Itenberg (Université Louis Pasteur, Strasbourg), Maxim Kazarian (Moscow Independent University and Steklov Institute), Christian Klein (MPG, Leipzig), David Klein (Toronto), Alexey Kokotov (Concordia), Andrew McIntyre (CRM and Concordia), Emma Previato (Boston), Victor Przyjalkowski (Steklov Institute, Moscow), Brad Safnuk (McMaster), Sergey Shadrin (Zürich), Mikhail Shapiro (Michigan State), Vasilisa Shramchenko (Oxford), Ian Strachan (Glasgow), Richard A. Wentworth (Johns Hopkins), Ken-Ichi Yoshikawa (Tokyo), Dimitri Zvonkine (Paris 6)

Number of participants: 59

Moduli spaces of Riemann surfaces, as well as other similar objects (Hurwitz spaces, spaces of holomorphic differentials, etc.) are extremely rich objects in themselves, but are also related to many other areas of mathematics and have important applications in physics. During the last forty years many fundamental results were obtained on moduli spaces, including the study of compactification of these spaces (beginning with the work of Deligne and Mumford), the computation of Euler characteristics by Harer and Zagier, the investigation of differential geometric properties by Wolpert et al., the study of intersection theory on moduli spaces initiated by Witten, Kontsevich, and others. It is impossible even to list all the main ramifications of the theory of moduli spaces! In physics moduli spaces play a central role in Polyakov's formulation of perturbative string theory and in some other areas where Riemann surfaces come in families (dynamical systems, statistical mechanics, random matrices, integrable systems, etc.). Topological field theory led to the development of the theory of Frobenius manifolds by Dubrovin, which turned out to be also closely related to moduli spaces.

The theory of moduli spaces has many different aspects: analytical, differential geometric, algebro-geometric, group theoretical, etc. The

fast growth of the theory of moduli spaces in various directions has led to the increasing specialization of researchers working on the various aspects of the theory. The main goal of this short program was to bring together the experts studying the moduli spaces from different points of view. The series of pedagogical lectures by I. Biswas, I. Morrison, and R. Vakil were devoted to the algebro-geometrical approach to moduli spaces. Two lectures of Vakil contained a general introduction to the algebro-geometric theory of moduli spaces and Hurwitz spaces (spaces of meromorphic functions over Riemann surfaces). In his lecture series, Morrison gave an introduction to the birational geometry of moduli spaces of pointed curves. The series of lectures by Biswas was devoted to moduli spaces of holomorphic connections over Riemann surfaces, and their relationship to moduli spaces of Higgs bundles, moduli spaces of stable vector bundles, and other topics.

Differential geometric aspects of moduli spaces were discussed in the lecture series given by S. Wolpert, which was devoted to the CAT(0) geometry of the Teichmüller spaces, and the relationship between the geometric properties of moduli spaces, the spectral properties of the Laplacian over Riemann surfaces, and geodesic lengths. The lecture series given by R. Penner was devoted to ideal cell decompositions of decorated moduli spaces invariant with respect to the action of the mapping class group, and related topics. The relationship between moduli spaces, integrable hierarchies, and Frobenius manifolds was discussed by B. Dubrovin. The lectures of T. Milanov were devoted to the computation of Gromov-Witten invariants for orbifolds, and the proof of the Toda conjecture for the generating function of these invariants. S. Lando presented a solution of the classical combinatorial problem of computing the Hurwitz numbers, i.e., the numbers of inequivalent coverings of the Riemann sphere with given branch points. The answer to such a question can be given in terms of various cohomology classes.

The series of lectures given jointly by L. Takhtajan and P. Zograf was devoted to the links between the differential geometry of moduli spaces and the spectral properties of the Laplacian. P. Zograf described the connection between the Weil-Petersson metric on moduli spaces of Riemann surfaces and the determinant of the Laplacian. He also presented a new analog of this result, showing that the Kähler potential of a natural Kähler metric on Hurwitz spaces is also given by the determinant of a certain differential

operator. L. Takhtajan also presented new results on moduli of parabolic vector bundles over Riemann surfaces.

While the morning sessions were mostly devoted to pedagogical lecture series, the afternoon sessions were mainly devoted to research talks. Four talks (by C. Hertling, S. Shadrin, V. Shramchenko, and I. Strachan) were devoted to Frobenius manifold structures associated with moduli spaces. C. Hertling spoke about tt^* geometry in relation to Frobenius manifolds. S. Shadrin discussed the genus expansion of Frobenius manifolds. V. Shramchenko presented an explicit solution of a class of Riemann-Hilbert problems associated with Hurwitz Frobenius manifolds. I. Strachan discussed duality correspondence between different Frobenius structures.

In several talks (P. Zograf, L. Takhtajan, A. Kokotov, A. McIntyre), the authors discussed the relationship between the spectral characteristics of moduli spaces (for instance the determinant of the Laplacian) and the moduli spaces themselves. In particular, A. Kokotov presented the holomorphic factorization formula for the determinant of the Laplacian on polyhedral Riemann surfaces; A. McIntyre presented a holomorphic factorization formula for the determinant of the Laplacian on a Riemann surface in the Poincaré metric. In the talk by C. Klein, the determinant of the Laplacian was used as a Morse function on moduli spaces of genus-two Riemann surfaces. The problem of computing the Hurwitz numbers was addressed in the talks of M. Shapiro and I. Goulden: M. Shapiro discussed the so-called “double Hurwitz” numbers, a natural generalization of the ordinary Hurwitz numbers. I. Goulden and M. Kazarian discussed 1) proofs of various conjectures (in particular, the Witten conjecture) using the Ekedahl-Lando-Shapiro-Vainshtein formula for Hurwitz numbers (considered as a Hodge integral), and 2) the relation of these Hodge integrals to the KP hierarchy.

L. Chekhov discussed natural ways of quantizing Teichmüller spaces of Riemann surfaces with punctures and holes. The talk by I. Itenberg was devoted to a slightly different subject: he gave an overview of the rapidly growing area of tropical geometry. T. Grava spoke about integrable systems of hydrodynamic type and flat metrics on Hurwitz spaces. J. Hurtubise gave a talk on the relation between moduli spaces of monopoles and calorons and a special subclass of Hurwitz spaces — the spaces of rational functions. The relation of intersection theory on the

spaces of r -spin curves to integrable hierarchies of KdV-type equations was discussed in the talk of D. Zvonkine. B. Safnuk explained how localization techniques from symplectic geometry can be applied to cohomology calculations on moduli spaces. I. Artamkin discussed differential equations satisfied by generating functions of modular graphs (i.e., graphs enumerating the strata of Deligne-Mumford compactifications of moduli spaces of pointed curves).

The talk of S. Abenda was devoted to the properties of geodesics on quadrics and their relationship to hyperelliptic curves. E. Previato discussed various relations (Fay-type formulas, differential equations) for a special class of hyperelliptic curves called Burchnell-Chaundry curves. R. Wentworth surveyed recent activity in the study of surface group representations into symmetric spaces. Several young participants gave 30 to 40-minute research talks. R. Albuquerque described the properties of the symplectic twistor space associated with a Riemann surface. V. Przyjalkowski discussed the Gromov-Witten theory for the minimal Fano varieties. N. Do showed the audience a new path to Witten's conjecture, via hyperbolic geometry. The talk by E. Gorsky was devoted to an equivariant Euler characteristic of moduli spaces of genus-two Riemann surfaces with punctures. T. Baird spoke about moduli spaces of flat connections over nonorientable surfaces, and D. Klein discussed the Goldman flows on these moduli spaces.

In general, the short program consisted of a very natural combination of pedagogical and research components; the combination of subjects covered during the workshop was also very fruitful. Between three and five leading experts on each major topic (algebraic-geometric methods in moduli spaces, spectral properties of Riemann surfaces and moduli spaces, Frobenius manifolds, enumeration of branched coverings) participated in the short program. A strong interaction within each group was very naturally complemented by the interaction between different groups. The vast majority of lecture series and research talks led to substantial discussion among the participants. The lecture series given by S. Wolpert and L. Takhtajan, as well as the results on new Kähler metrics on Hurwitz spaces reported by P. Zograf, were especially impressive. The meeting was extremely successful by any standard, to the deep satisfaction of the organizers.

“Probability and Stochastic Processes” Symposium in honour of Donald A. Dawson’s work, on the occasion of his 70th birthday

July 5–8, 2007, Carleton University
Sponsored by the Fields Institute, CRM,
Carleton University, and the Laboratory for
Research in Statistics and Probability (Carleton)

Organizers: Miklós Csörgő, Antal A. Járai, and
Yiqiang Zhao (Carleton)

Plenary Speaker: Donald Dawson (Carleton)

Speakers: Theodore Cox (Syracuse), Colleen
Cutler (Waterloo), Shui Feng (McMaster), Klaus
Fleischmann (Weierstrass-Institut, Berlin), Jür-
gen Gärtner (Technische Universität Berlin),
Peter Glynn (Stanford), Luis Gorostiza (CIN-
VESTAV, Mexico), Andreas Greven (Universität
Erlangen-Nürnberg), B. Gail Ivanoff (Ottawa),
Michael Kouritzin (Alberta), Reg Kulperger
(Western Ontario), Thomas G. Kurtz (Wiscon-
sin Madison), Neal Madras (York), Peter March
(Ohio State and NSF), Peter Mörters (Bath), Carl
Mueller (Rochester), Leonid Mytnik (Technion,
Haifa), Edwin Perkins (UBC), Bruno Rémil-
lard (HEC Montréal), Tom Salisbury (York),
David Sankoff (Ottawa), Byron Schmuland (Al-
berta), Gordon Slade (UBC), Wei Sun (Concor-
dia), Anton Wakolbinger (Goethe Universität),
Feng-Yu Wang (Beijing Normal University), Hao
Wang (Oregon), Jie Xiong (Tennessee), Xiaowen
Zhou (Concordia)

Number of participants: 58

Don Dawson’s keynote lecture, *Reflections on probability and stochastic processes 1957-2007*, gave an exciting, personal perspective on developments in the field of probability over the last half-century, in particular, how it grew to become a very diverse and mature part of mathematics. Probability, which was barely recognized as an important part of pure mathematics when it started, has seen by now profound theoretical advances. As Don pointed out, this has largely been due to stimulating and difficult problems coming from applications, such as those arising in physics and biology. Of particular interest was the second part of Don’s presentation, which addressed probabilistic models in biology, with emphasis on recent progress on the emergence of rare mutants.

Most of the talks in the conference centered around spatial branching models and superprocesses, bringing the audience up to date on recent developments in this area. These included: uniqueness for singular SDEs (Edwin Perkins); uniqueness for SPDEs (Leonid Mytnik); scal-

ing limits of particle systems (Theodore Cox); oriented percolation (Gordon Slade); occupation times for particle systems (Luis Gorostiza); conditioned super-Brownian motion (Tom Salisbury); Poisson representations of superprocesses (Thomas Kurtz); the parabolic Anderson model (Peter Mörters, Jürgen Gärtner). Other highlights were talks on: Harnack-inequalities (Feng-Yu Wang); effect of moments vs. tail behaviour in queueing systems (Peter Glynn); polymer models (Neal Madras, Peter March). The meeting drew a large number of participants, many of them graduate students and postdoctoral fellows.

Conference on New Challenges and Perspectives in Symplectic Field Theory

June 25–29, 2007, Stanford University

Sponsored by the Mathematics Research Center of Stanford University, the American Institute of Mathematics, the National Science Foundation, and CRM

Organizers: Miguel Abreu (Instituto Superior Técnico, Lisbon), Ralph Cohen (Stanford), Alexander Givental (UC Berkeley), François Lalonde (Montréal), Robert Lipshitz (Columbia), Leonid Polterovich (Tel Aviv), Richard Schoen (Stanford)

Speakers: Paul Biran (Tel Aviv), Frédéric Bourgeois (Université Libre de Bruxelles), Kai Cieliebak (Munich), Octavian Cornea (Montréal), Tobias Ekholm (Southern California), David Gabai (Princeton), Étienne Ghys (École Normale Supérieure de Lyon), Emmanuel Giroux (École Normale Supérieure de Lyon), Robert Gompf (Texas at Austin), Helmut Hofer (Courant Institute), Ko Honda (Southern California), Eleny Ionel (Stanford), Eric Katz (Duke), Dusa McDuff (SUNY Stony Brook), Tomasz Mrowka (MIT), Yong-Geun Oh (Wisconsin-Madison), Kaoru Ono (Hokkaido), Peter S. Ozsváth (Columbia), Rahul Pandharipande (Princeton), Joshua Sabloff (Haverford College), Dietmar Salamon (ETH, Zürich), Matthias Schwarz (Leipzig), Paul Seidel (MIT), Clifford Taubes (Harvard), Gang Tian (MIT), Claude Viterbo (École Polytechnique, Palaiseau), Katrin Wehrheim (MIT)

Number of participants: 130

New Perspectives and Challenges in Symplectic Field Theory, a conference in honour of Yasha Eliashberg's 60th birthday, took place at Stanford University from June 25 to June 29, 2007. The conference, colloquially known as "Yashafest", was organized by Miguel Abreu, Ralph Cohen, Sasha Givental, François Lalonde,

Robert Lipshitz, Leonid Polterovich, and Rick Schoen, and was underwritten by the Mathematics Research Center (at Stanford University), the American Institute of Mathematics, the NSF, and the CRM. The Yashafest was well attended, with over 130 participants, and drew speakers from as far away as Sweden and Japan.

Reduced to its essence, Symplectic Field Theory (SFT) is the study of holomorphic curves in symplectic manifolds with cylindrical ends. It contains Gromov–Witten theory as the special case where the manifold has no ends, and symplectic Floer homology as the special case of holomorphic cylinders in the product of the closed symplectic manifold and a twice-punctured sphere. The general case, however, is far more subtle than either of these examples. In their seminal *Introduction to Symplectic Field Theory*, Eliashberg, Givental, and Hofer outlined the geometric phenomena that should occur in SFT. They also sketched a rich algebraic formalism, in terms of infinite-dimensional Poisson algebras, which captures these geometric phenomena. (The formalism is so rich, for example, that it leads to remarkable new examples of infinite hierarchies of integrable systems.) Since then, several other formalisms capturing parts of the SFT package have emerged. These have led to striking relationships with other classes of invariants.

Despite the still limited understanding of its general technical underpinnings, SFT and related concepts have already had substantial practical impact. SFT and its immediate ancestors have provided the first modern tools for answering many questions of symplectic and contact topology. Applications include, for instance, distinguishing contact manifolds and their Legendrian submanifolds, answering classical existence questions for embedded Lagrangian submanifolds in symplectic manifolds, providing information about the contactomorphism group of contact manifolds and the symplectomorphism group of symplectic manifolds, revealing properties of closed Reeb orbits in contact manifolds (including many cases of the Weinstein conjecture), defining new topological invariants of three-manifolds and knots inside them, and providing contact analogues of the symplectic non-squeezing theorems.

Related fields include, among others, gauge theory and the many gauge-theoretic Floer homologies, Lagrangian intersection Floer homologies and cluster homology, enumerative invariants in algebraic geometry including Gromov–Witten theory and Donaldson–Thomas theory,

quantum topology and string topology. Symplectic field theory, thus, touches on many other fields of modern geometry and topology. The conference touched on many of these, with talk topics ranging from foundational issues of symplectic field theory, to talks in related fields such as enumerative algebraic geometry, Floer homology, symplectic and contact topology, low-dimensional topology, and gauge theory. Many talks explored the often surprising and always rich connections between these fields.

Research talks were given by Dusa McDuff, Helmut Hofer, Gang Tian, Dietmar Salamon, Ko Honda, Emmanuel Giroux, Paul Biran, Claude Viterbo, Robert Gompf, Peter Ozsváth, Eric Katz, Eleny Ionel, Matthias Schwarz, David Gabai, Rahul Pandharipande, Kai Cieliebak, Tom Mrowka, Yong-Geun Oh, Kaoru Ono, Paul Seidel, Cliff Taubes, and Étienne Ghys. I would single out the talks by Cieliebak, by Taubes, and by Ghys as representative of the breadth of topics covered. Cieliebak presented a new construction he and Klaus Mohnke first announced in December 2006, whereby they define a version of the Gromov – Witten invariants without making use of the polyfold theory of Hofer, Wysocki, and Zehnder. The idea is to introduce marked points to track intersections of pseudoholomorphic curves with a symplectic hypersurface of high degree (which exists by a result of Donaldson). This allows Cieliebak and Mohnke to overcome the classical difficulty of obtaining transversality in the presence of multiply covered spheres with negative Chern number.

Cliff Taubes presented his ground-breaking proof of the Weinstein Conjecture, establishing the existence of a periodic orbit for any Reeb vector field on any contact 3-manifold. His proof relates the existence of periodic orbits to that of solutions to a perturbed form of the Seiberg – Witten equations. This is closely connected to his ongoing project with Michael Hutchings to show that Seiberg – Witten Floer Homology and Embedded Contact Homology are equivalent. Despite the highly technical nature of the argument, he was able to provide an accessible overview of the key ideas, with some bonus tax advice on the side.

Étienne Ghys closed the conference with an engaging (and multimedia) talk about a new class of volume preserving flows, potentially the next class to consider beyond Reeb flows. Indeed, it follows from a series of results (Weinstein, Rabinowitz, Hofer, . . . , Taubes) that all Reeb flows in dimension three admit a periodic orbit. However, a construction due to G.

Kuperberg proves the existence of a volume preserving flow on the 3-sphere with no periodic orbits. To define this new class, Ghys built on Arnold’s asymptotic Hopf invariant. Using this, he then sketched a proof that, in a suitable sense, the periodic orbits in the Lorenz attractor form an “infinite fibred link”, with a “fibration” compatible with the flow.

The conference also featured a minicourse in Symplectic Field Theory, aimed at graduate students (but well attended by all). Tobias Ekholm, Frédéric Bourgeois, Joshua Sabloff, and Katrin Wehrheim provided a lucid overview of various aspects of SFT, presenting new insights and new interpretations of the various elements of the theory. The conference proceedings have appeared in the series “CRM Proceedings and Lecture Notes”, published by the American Mathematical Society. The banquet held in honour of Yasha Eliashberg’s birthday was well attended, and featured the customary roast. It was clear, during the roast and throughout the conference, that Yasha is highly esteemed not only for his habitually innovative mathematics, but also for his warmth, generosity, and great kindness.

Conference

Banach Algebras 2007

July 4 – 12, 2007, Université Laval

Organizers: Frédéric Gourdeau and Thomas Ransford (Laval)

Invited Plenary Speakers: David Blecher (Houston), Isabelle Chalendar (Lyon), Garth Dales (Leeds), Jean Esterle (Bordeaux), Pamela Gorkin (Bucknell), Matthias Neufang (Carleton), Narutaka Ozawa (Tokyo and UCLA), Alexei Pirkovskii (Moscow), Charles Read (Leeds), Sergei Treil (Brown), George Willis (Newcastle, Australia)

Invited Speakers: Jeronimo Alaminos (Granada), Razvan Anisca (Lakehead), John Bachar (Long Beach), Christoph Barbian (Universität des Saarlandes), Zohra Bendaoud (Laghout), Paurus Bharucha (ANU), Ariel Blanco (Belfast), Abdellatif Bourhim (Laval), Matej Bresar (Maribor), Philip Brooker (ANU), Yemon Choi (Manitoba), Constantin Costara (Laval), Ken Davidson (Waterloo), Matthew Daws (Oxford), Étienne Desquith (Abidjan), José Extremera (Granada), Joel Feinstein (Nottingham), Brian Forrest (Waterloo), José Galé (Zaragoza), Fereidoun Ghahramani (Manitoba), Mahya Ghandehari (Waterloo), Julien Giol (Texas A&M), Sandy Grabner (Pomona), Colin Graham (UBC), Edmond Granirer (UBC), Niels Gronbaek (Copenhagen), Matthew Heath (Nottingham), Alexander

Helemskii (Moscow), Monica Ilie (Lakehead), Kinvi Kangni (Abidjan), Derek Kitson (Trinity College, Dublin), Julia Kuznetsova (Moscow), Niels Jakob Laustsen (Lancaster), Rick Loy (ANU), Zinaida Lykova (Newcastle, United Kingdom), Hakimeh Mahyar (Tehran), Javad Mashreghi (Laval), Martin Mathieu (Belfast), Sonja Mouton (Stellenbosch), Thomas Vils Pedersen (Copenhagen), Sandra Pott (Glasgow), Paul Ramsden (Leeds), Jean Roydor (Besançon), Volker Runde (Alberta), Mohammad Sal Moslehian (Mashad), Ebrahim Samei (Waterloo), Bert Schreiber (Wayne State), Andrzej Soltysiak (Poznan), Nico Spronk (Waterloo), Venta Terauds (Newcastle, Australia), Richard Timoney (Trinity College, Dublin), Thomas Tonev (Montana), Hans-Olav Tylli (Helsinki), Armando Villena (Granada), Griffith Ware (ANU), Michael White (Newcastle, United Kingdom), Jafar Zafarani (Isfahan), Wieslaw Zelazko (Warsaw), Jaroslav Zemánek (Warsaw), Yong Zhang (Manitoba)

Number of participants: 113 (including 40 postdoctoral fellows and graduate students)

This conference was the eighteenth in a series of international conferences on Banach algebras, the first of which took place in 1974 at UCLA. These conferences have led to many fruitful interactions between the neighbouring areas of Banach algebras, operator theory, operator spaces, harmonic analysis (both commutative and non-commutative), topological homology, and amenability. In this report we describe a sample of the lectures, thus conveying an idea of the range of topics covered.

Charles Read set the conference under way with an account of his recent solution (with Manuel De La Rosa) of a famous problem in operator theory; he showed that the direct sum of a hypercyclic operator with itself need not be hypercyclic. David Blecher covered a large territory in the field of operator algebras, providing motivations for many questions that will be considered by specialists of Banach algebras and harmonic analysis in their work. Matthias Neufang gave a survey on recent developments in abstract harmonic analysis, in which he went beyond the usual framework of locally compact groups by discussing semigroups, non-locally compact topological groups, and locally compact quantum groups. In particular, he introduced a representation theory for locally compact quantum groups, developed jointly with M. Junge and Z.-J. Ruan, that hitherto existed only for locally compact groups and their quantum group duals.

Narutaka Ozawa presented his recent work, partly with Sorin Popa, on rigid factors and the classification of group von Neumann algebras for countable, discrete, and non-amenable groups. Sergei Treil spoke on the famous Carleson corona problem and presented his new results, which give extremely sharp conditions on functions u having the following property: whenever f is an n -tuple in H -infinity, every g in H -infinity satisfying $|g| < u(|f|)$ lies in the ideal generated by f .

Nico Spronk extended to general locally compact groups a construction carried out by Hans Feichtinger for abelian, locally compact groups; the latter construction is apparently of interest in signal processing. His approach makes a pivotal use of operator space theory. Matej Brešar described his recent work with Peter Šemrl, which uses deep ideas from ring theory in order to prove the following result: if T is a linear, spectrum-preserving bijection between semisimple Banach algebras such that $T(x)$ always commutes with $T(x^2)$, then T is a Jordan morphism. This promises to be a significant step towards solving a famous open problem of Kaplansky and Aupetit.

The conference was preceded by a one-day workshop on research-based mathematics education, organized by Frédéric Gourdeau, Niels Gronbaek, Thomas Vils Pedersen, and Kjeld Bagger Laursen. Towards the end of the conference, there was an hour-long problems session, in which participants had the opportunity to make short presentations of open questions. These problems have been posted on the conference website, where one can also find much information about the conference (newton.mat.ulaval.ca/ba07/).

Workshop

Statistical Methods for Modelling Dynamic Systems

July 9–13, 2007, CRM

Sponsored by MITACS and CRM

Organizers: David Campbell (McGill), Giles Hooker (Cornell), James Ramsay (McGill)

Speakers: Lorenz Biegler (Carnegie Mellon), David Campbell (McGill), Jiguo Cao (McGill), Sy-Miin Chow (Notre Dame), Robert Clewley (Cornell), Michael Dowd (Dalhousie), Stephen Ellner (Cornell), Giles Hooker (Cornell), Edward Ionides (Michigan, Ann Arbor), Theodoro Koulis (JSS Medical Research), Subhash R. Lele (Alberta), Michael C. Mackey (McGill), Kim McAuley (Queen's), Michael Osborne (Australian National University), Caroline Palmer

(McGill), James Ramsay (McGill), Johannes Schlöder (Heidelberg), Cosma Shalizi (Carnegie Mellon), Jesse Spencer-Smith (Illinois at Urbana-Champaign), Hulin Wu (Rochester), Manshu Yang (Notre Dame), Ji-Yun Zu (Notre Dame)

Number of participants: 51

The goals of the workshop were:

- to discuss the statistical aspects of working with dynamic systems as models, including parameter estimation, confidence regions for parameters, and tools for selecting models;
- to foster exchanges about statistical problems encountered among researchers working in diverse areas of application;
- to stimulate the interest of young researchers (in statistics and other fields) in dynamic systems modelling;
- to provide information about the latest developments in computation and statistical methodology in the field of dynamic systems modelling.

The organizers opted for a slightly unusual conference format, in that all speakers were invited and carefully selected by the organizers to further these goals. They wanted to avoid too great a concentration of topics in specific areas, and to ensure that the speakers had the communication skills to make their work intelligible and interesting to new researchers. Lectures were arranged into three sessions per day (each lasting one hour and a half), two in the morning and one at the end of the afternoon, with most speakers having the entire time to themselves. In this way, the organizers wanted to ensure that more than enough time was available for discussion. The early afternoon was given over to contributed poster sessions and software demonstrations, so that anyone would have a chance to show the conference what they were working on, or to display computing and other useful resources.

Judging by the reactions of the participants and the fact that full participation was maintained throughout the workshop, the goals of the workshop were met. In fact, a general review session on Friday afternoon produced a consensus that the workshop should be held at least every two years. The participants included a dozen or so graduate students and even one undergraduate, as well as a number of new researchers, and they were stimulated by the discovery of this area and by the great deal of new knowledge they acquired at the workshop. The first day was given over to applications involving relatively simple dynamic systems in order to provide an easy introduction to the field.

A number of collaborations were framed among the participants during the week. The discussions after talks and throughout the afternoon were lively and involved all the participants, and the organizers were especially pleased that the younger participants were able to interact with senior well-known investigators. We were delighted, too, that no trace of the critical, argumentative, or competitive exchanges that one sees too often at conventional conferences was present during the week. Variations in expertise, sophistication, technical level, and so on, were taken as natural and as providing opportunities for support and encouragement. As a consequence, a number of graduate students and new researchers indicated that they would like to concentrate their coming research efforts within this field.

Highlights of the workshop included:

- presentations of recent computational advances by Larry Biegler and Johannes Schlöder, along with dramatic software demonstrations showing huge improvements in speed for optimization problems using automatic differentiation (AMPL, IPOPT), as opposed to the usual procedures involving Matlab;
- exciting displays of new dynamic modelling problems in psychology by Sy-Miin Chow and Jesse Spencer-Smith;
- the discovery that almost all dynamic systems over a wide range of areas were of the first-order bilinear form $DX = AX + X'BX + CU$, with, in some cases, matrices A , B , and C being also time-varying;
- the use of dynamical phenomena such as bifurcations and limit cycles to explain apparent behavior in physiological and ecological systems, and the need for statistical methods targeted at confirming these in a quantitative manner;
- the presentation of recent work read to the Royal Statistical Society on collocation methods for system and parameter estimation (by Campbell, Cao, Hooker, and Ramsay).

The organizers wish to thank Louis Pelletier of the CRM for the impeccable local arrangements, and Patrick McNeil and Daniel Ouimet for the computer support. Absolutely everything worked, was on time, and beautifully presented; the Aisenstadt building itself along with its surroundings and view was often commented on, and contributed to the mood of collegiality and contentment. Finally, the organizers wish to thank MITACS and MathWorks for their support.

Workshop**Non-linear integral transforms:****Fourier-Mukai and Nahm**

August 27–31, 2007, CRM

Organizers: Benoit Charbonneau (Duke), Jacques Hurtubise (McGill), Marcos B. Jardim (Campinas), Eyal Markman (Massachusetts Amherst)

Speakers: Claudio Bartocci (Genova), David Ben-Zvi (Texas at Austin), Philip Boalch (École Normale Supérieure, Paris), Ugo Bruzzo (SISSA), Andrei Caldararu (Wisconsin Madison), Sergey Cherkis (Trinity College, Dublin), Gábor Étesi (BUTE), Christopher Ford (independent), Oscar Garcia-Prada (CSIC), Daniel Hernández Ruipérez (Salamanca), Marcos B. Jardim (Campinas), Eyal Markman (Massachusetts Amherst), Ruxandra Moraru (Waterloo), Thomas Nevins (UIUC), Daniel Nogradi (Wuppertal), Paul Norbury (Boston), Tony Pantev (Pennsylvania), Nuno Romão (MIT and Aarhus), Justin Sawon (Stony Brook), Mark Stern (Duke), Szilárd Szabó (Alfréd Rényi Institute of Mathematics), Carlos Tejero Prieto (Salamanca), Misha Verbitsky (Glasgow), Kota Yoshioka (Kobe)

Number of participants: 31

The transforms that were the subject of this workshop operate on moduli spaces, either of holomorphic objects or of gauge fields, and have been extensively developed over the past twenty years as the tools of choice in the area. The Nahm transform was initially introduced by Nahm in the early 80s to study magnetic monopoles. It developed over the years into a duality among instantons that are invariant under the action of a subgroup of translations of R^4 . The Fourier–Mukai transform was also introduced in the early 80s by Mukai as a duality among sheaves on abelian varieties. In the late 80s it was realized that both constructions are actually equivalent in certain circumstances. Another feature that is common to both constructions is their role in mathematical physics, notably gauge theory and string theory.

The workshop brought together a diverse group of people working on this fairly focused but current topic. Among them were algebraic geometers, differential geometers, and mathematical physicists. The topics of the talks were also varied and demonstrated the deep relevance of the ideas first introduced by W. Nahm and S. Mukai twenty-five years ago. We believe the workshop was a great success. A large number of new ideas on Nahm transform,

Fourier–Mukai transform, ADHM equations, translation-invariant instantons, instantons on ALF spaces, and elliptic varieties emerged in the various talks. Most participants gave lectures and most of them attended every talk. Many participants left Montréal ready to start working on new projects. In our opinion, the workshop will give rise to some collaborations and there will be a need for a follow-up conference in a couple of years.

Graph Theory and Algebra**A conference in honour of Gert Sabidussi**

September 7, 2007, CRM

Organizers: Gena Hahn (Montréal) and Benoît Larose (Champlain College and Concordia)

Speakers: Bernhard Banaschewski (McMaster), Herbert Fleischner (Wien), François Genest (Concordia), Pavol Hell (Simon Fraser), François Laviolette (Université Laval), Claude Tardif (Royal Military College of Canada)

Number of participants: 14

Cette conférence d'une journée en l'honneur de Gert Sabidussi, pour souligner son départ à la retraite, a réuni plusieurs de ses anciens étudiants ainsi que quelques-uns de ses plus proches collaborateurs. Quatre de ses anciens étudiants (F. Genest, P. Hell, F. Laviolette et C. Tardif), ainsi que deux de ses collaborateurs (B. Banaschewski et H. Fleischner), ont été invités à donner des exposés : les uns ont rappelé certains de leurs travaux avec Gert Sabidussi, et les autres ont présenté des survols de résultats récents dans leurs domaines d'expertise. Cette rencontre assez informelle avait pour but de célébrer la carrière d'un membre illustre du département de mathématiques et de statistique de l'Université de Montréal.

Scientific Meeting**Using Statistics for the Management of Natural Resources**

October 19, 2007, CRM

Organized by the Statistics Laboratory

Organizer: Louis-Paul Rivest (Université Laval)

Speakers: Thierry Duchesne (Université Laval), Anne-Catherine Favre (INRS, Centre Eau, Terre et Environnement), Simon Guillotte (Montréal), Pierre-Olivier Julien (Laval), Luc Perreault (IREQ), Louis-Paul Rivest (Laval)

Number of participants: 59

Cette rencontre comporta des présentations sur l'hydrologie statistique, sur l'utilisation des méthodes statistiques en foresterie et sur la statistique pour la gestion des ressources halieutiques. En avant-midi, Anne-Catherine Favre

et Luc Perreault présentèrent un exposé sur l'apport de la statistique à la production hydro-électrique. Pendant l'après-midi, Thierry Duchesne parla de l'impact de la stochasticité sur les populations de poissons et Louis-Paul Rivest de l'utilisation de modèles linéaires mixtes pour l'estimation des volumes de bois. Pierre-Olivier Julien présenta une comparaison de modèles statistiques pour prévoir la croissance du pin gris. Finalement, Simon Guillotte présenta un estimateur bayésien pour la fonction de dépendance d'une distribution bivariable de valeurs extrêmes.

Conference in honour of John Labute

November 15 – 16, 2007, McGill University and CRM

Organized by CICMA

Sponsored by McGill University and CRM

Organizers: Henri Darmon (McGill) and Eyal Goren (McGill)

Speakers: Nigel Boston (Wisconsin Madison), Michael Bush (Smith College), Farshid Hajir (Massachusetts Amherst), Manfred Kolster (McMaster), Cameron McLeman (Arizona, Tucson), Jan Minac (Western Ontario), Ravi Ramakrishna (Cornell), Romyar Sharifi (McMaster), Lloyd Simons (Saint Michael's College), John Tate (Texas at Austin)

Number of participants: 34

To mark the retirement of John Labute from the Department of Mathematics of McGill University, his friends and colleagues (Henri Darmon and Eyal Goren, especially) organized a two-day workshop on subjects that were of interest to Dr. Labute throughout his career. On Thursday, November 15, six speakers gave lectures at McGill University on varied topics from several areas: Galois modules, Galois groups, Hecke algebras, asymptotically good families of number fields, the Coates-Sinnott conjecture, and relative class number formulas. On Friday, November 16, three more lectures (on class field tower groups, random pro- p groups and random Galois groups, and mild groups) were followed by a colloquium talk. The colloquium speaker, John Tate, spoke on the symmetries of the field of algebraic numbers.

The 5th Montréal Scientific Computing Days

April 30 - May 2, 2008, CRM

Organized by the Applied Mathematics Laboratory

Sponsored by MITACS

Organizers: Michel Delfour (Montréal), André Fortin (Laval), Thomas P. Wihler (McGill)

Speakers: Paul-Louis George (INRIA Paris-Rocquencourt), Yousef Saad (Minnesota), Jaap van der Vegt (Twente)

Number of participants: 70 (including 37 students and postdoctoral fellows)

An ambitious move by the Applied Mathematics Laboratory in 2007-2008 was the extension of the successful format of the Montréal Scientific Computing Days to a three-day event. The goals of this scientific activity were

- to foster scientific exchanges within the scientific computing community;
- to train senior undergraduate and graduate students, postdoctoral fellows, and young researchers by means of three minicourses given by world-recognized experts in the general areas of scientific computing in Science, Engineering, and Medicine;
- to maximize interactions between the students, the senior participants, and the main speakers by reserving up to half of the time for student presentations;
- to encourage the participation of non-academic (private or public sector) research or other organizations.

The participants were treated to stimulating and informative lectures by Paul-Louis George, who gave lectures on *Development, Analysis and Application of Finite Element Methods for Partial Differential Equations*, Yousef Saad, who gave lectures on *Iterative Methods for Sparse Matrix Problems*, and Jaap van der Vegt, who gave lectures on *Space-Time Discontinuous Galerkin Methods for Compressible Flows*. An important element of the Computing Days is the opportunity given to junior researchers to present their work to their peers. The prize for best student presentation went to David Titley-Peloquin (McGill) and five other (secondary) prizes were awarded to Abderrahman El Maliki (GIREF, Université Laval), Nam Nguyen (Université Laval), Mélanie McKay (University of Ottawa), Jamal Hussain Al Smail (University of Ottawa), and Waad Subber (Carleton University).

Scientific Meeting

Copula Models: Theory and Applications

May 2, 2008, Université Laval

Organized by the Statistics Laboratory

Organizer: Louis-Paul Rivest (Laval)

Speakers: Vali Asimit (Toronto), Belkacem Abdous (Laval), Christian Genest (Laval), Harry

Joe (UBC), Lajmi Lakhal Chaïeb (Laval), Étienne Marceau (Laval), Fouad Marri (Laval), Mahmed Mesfioui (UQTR), François Perron (Montréal), Jean-François Plante (Toronto), Jean-François Quessy (UQTR)

Number of participants: 45

Les copules sont des outils de modélisation très populaires pour rendre compte de la dépendance entre différentes composantes d'un modèle stochastique. Christian Genest et Harry Joe furent les conférenciers principaux lors de cette rencontre. Les chercheurs du Québec et du Canada sont des chefs de file dans le développe-

ment de la méthodologie statistique basée sur les copules, et les onze présentations de cet atelier ont été pour eux l'occasion d'échanger sur ce thème et de mettre en commun leurs travaux les plus récents. En particulier, l'atelier a permis aux chercheurs de présenter des avancées récentes dans la construction de copules pour des vecteurs aléatoires de dimension arbitraire et dans l'utilisation des copules pour les données discrètes. Un volet de l'atelier porta sur l'utilisation des copules en sciences actuarielles et en finance.

Colloquium Series

The CRM, together with the Institut des sciences mathématiques du Québec (the Québec universities graduate mathematics consortium), runs two Montréal colloquium series, one in mathematics and the other in statistics (the latter jointly with GERAD, an operations research centre located in the André-Aisenstadt building). During the academic year, these series offer survey talks on topics of current interest by distinguished mathematicians and statisticians.

CRM – ISM Mathematics Colloquium

In 2007 – 2008, the colloquium coordinators were Jacques Hurtubise (McGill) and Alexander Shnirelman (Concordia).

September 14, 2007

William Goldman (Maryland)

Geometry and dynamics of surface group

October 5, 2007

Octav Cornea (Montréal)

Geometric and numerical rigidity for Lagrangian submanifolds

October 12, 2007

Tim Phillips (Cardiff)

A lattice Boltzmann model for single-phase and multi-phase fluid flows

October 26, 2007

Boris Khesin (Toronto)

Pseudo-Riemannian geodesics and billiards

November 2, 2007

Akshay Venkatesh (New York)

The geometry of numbers, old and new

November 9, 2007

Étienne Ghys (École Normale Supérieure de Lyon)

Les noeuds modulaires

November 16, 2007

Charles Radin (Texas at Austin)

Unexpected properties of dense packings of spheres

November 16, 2007

John Tate (Texas at Austin)

Symmetries of the field of algebraic numbers

November 23, 2007

Ben Green (Cambridge)

Nilsequences in additive combinatorics

November 30, 2007

Pavel Bleher (Indiana & Purdue Indianapolis)

Exact solution of the six-vertex model of statistical physics

December 14, 2007

Michael Shub (Toronto)

Smale's 17th Problem

January 4, 2008

Michael Jakobson (Maryland)

Attractors and invariant measures in low-dimensional dynamical systems

January 11, 2008

Gérard Letac (Paul Sabatier)

L'invariance de Thomae de $3F_2$ par le groupe symétrique S_5 et les produits de matrices $(2,2)$ aléatoires

January 18, 2008

Ivar Ekeland (UBC and PIMS)

From Elie Cartan to Gérard Debreu: some applications of exterior differential calculus to economic theory

January 25, 2008

Christiane Rousseau (Montréal)

The conformal equivalence problem and bisection problem for germs of curvilinear angles

February 1, 2008

Victor Kac (MIT)

*Quantization and chiralization***February 15, 2008**

Michael F. Singer (North Carolina State)

*Differential groups and differential relations***February 22, 2008**

Fernando Rodriguez Villegas (Texas at Austin)

*Combinatorics as geometry***February 29, 2008**

John Harnad (Concordia and CRM)

*What is a tau function?***March 7, 2008**

Michael Berry (Bristol)

*Tsunami asymptotics***March 14, 2008**

Stephen Vavasis (Waterloo)

*Greedy algorithms and complexity for nonnegative matrix factorization***April 4, 2008**

Vladimir Maz'ya (Ohio State, Liverpool, and Linköping)

*Unsolved mysteries of solutions to PDEs near the boundary***April 11, 2008**

Steve Zelditch (Johns Hopkins)

*Nodal lines of eigenfunctions, geodesics and complex analysis***April 18, 2008**

Rafe Mazzeo (Stanford)

*Flexibility of singular Einstein metrics***April 25, 2008**

Burkhard Wilking (Münster)

*New Ricci flow invariant curvature conditions and applications***CRM – ISM – GERAD Statistics Colloquium**

In 2007–2008, the coordinator of the CRM-ISM-GERAD Statistics Colloquium was Christian Léger, from the Université de Montréal. The other members of the organizing team were Brenda MacGibbon (UQÀM), Alejandro Murua (Université de Montréal), Arusharka Sen (Concordia), and Russell Steele (McGill University).

September 21, 2007

David Stephens (McGill)

*Computation and inference for stochastic volatility models driven by Levy processes***October 5, 2007**

Alexandre Leblanc (Manitoba)

*Chung-Smirnov property for Bernstein estimators of distribution functions***October 12, 2007**

Bertrand Clarke (UBC)

*Models, model lists, model spaces, and predictive optimality***October 19, 2007**

Jim Berger (SAMSI and Duke)

*Bayesian adjustment for multiplicity***October 26, 2007**

Rebecca Nugent (Carnegie Mellon)

*Visualizing clusters with a density-based similarity measure***November 2, 2007**

Aristidis K. Nikoloulopoulos (Laval)

*Finite normal mixture copulas for multivariate discrete data modelling***November 9, 2007**

Christian Genest (Laval)

*Abraham de Moivre: génie en exil***November 16, 2007**

Ciprian Crainiceanu (Johns Hopkins)

*Multilevel functional principal component analysis***November 23, 2007**

Moulinath Banerjee (Michigan, Ann Arbor)

*Multistage procedures for change point estimation***November 30, 2007**

Mathias Drton (Chicago)

*Likelihood ratio tests and singularities***December 7, 2007**

Mary Lesperance (Victoria)

*Testing for Benford's Law and possible fraud detection***February 8, 2008**

Chris Paciorek (Harvard School of Public Health)

*Mapping ancient forests: Bayesian inference for spatio-temporal trends in forest composition using the fossil pollen proxy record***February 15, 2008**

Jason D. Nielsen (Carleton)

*Adaptive functional models for the analysis of recurrent event panel data***February 22, 2008**

Ayesha Ali (Guelph)

Equivalence class searches across directed acyclic graphs with and without latent variables

February 29, 2008

Matthew Stephens (Chicago)

Bayesian imputation-based association mapping

March 7, 2008

Radu Craiu (Toronto)

Learn from thy neighbour: parallel-chain adaptive MCMC

March 14, 2008

J. Steve Marron (North Carolina at Chapel Hill)

Object oriented data analysis

March 28, 2008

Stephan Morgenthaler (Ecole Polytechnique Fédérale de Lausanne)

Modéliser la forme d'une distribution

April 4, 2008

Jenny Bryan (UBC)

Statistical methods for high-throughput reverse genetic studies

April 11, 2008

Yves Atchade (Michigan at Ann Arbor)

Bayesian computation for statistical models with intractable normalizing constants

April 18, 2008

Mary Sara McPeck (Chicago)

Genetic association studies with known and unknown population structure

Multidisciplinary and Industrial Program

The main vehicles for the CRM's efforts in this area are the research networks to which it belongs, principally MITACS, a national network focusing on the mathematics of information technology and complex systems, and the National Program on Complex Data Structures (NPCDS). *The reports are presented in the language in which they were submitted.*

Activities of the Multidisciplinary and Industrial Program

MIP 2007

Workshop on Mixed Integer Programming

July 30 – August 2, 2007, CRM

Sponsored by CRM, GERAD, IBM, ILOG, and Dash Optimization

Program Committee: Oktay Günlük (IBM), Matthias Köppe (Magdeburg), Andrew Miller (Wisconsin Madison), Jean-Philippe Richard (Purdue)

Local Committee: Odile Marcotte (CRM and UQAM) and Jacques Desrosiers (HEC Montréal and GERAD)

Speakers: Shabbir Ahmed (Georgia Institute of Technology), Egon Balas (Carnegie Mellon), Daniel Bienstock (Columbia), Ismael de Farias (Buffalo), Jacques Desrosiers (HEC Montréal), Volker Kaibel (Magdeburg), Eva K. Lee (Georgia Institute of Technology), Yanjun Li (Purdue), Jeff Linderoth (Wisconsin Madison), Andrea Lodi (Bologna), Quentin Louveaux (Louvain), François Margot (Carnegie Mellon), George Nemhauser (Georgia Institute of Technology), Gábor Pataki (North Carolina at Chapel Hill), Suvrajeet Sen (Arizona), Cole Smith (Florida), François Soumis (École Polytechnique de Montréal), Mohit Tawarmalani (Purdue), Annegret Wagler (Magdeburg), Laurence Wolsey (Louvain)

Number of participants: 120

Mixed integer programming is the study of optimization problems in which some variables must take integer values while others may take fractional or real values. Mixed integer programs arise, among other fields, in portfolio selection, transport planning, design of telecommunications networks, and design of cancer treatments. Recent years have seen great progress in cutting planes and other techniques for solving mixed integer programs; as a result, a group of researchers working in this area decided to organize, on a regular basis, workshops on mixed integer programming. The first three workshops took place in New York (2003), Minneapolis (2005), and Miami (2006). The program committee for MIP 2007 chose Montréal as a venue, and the workshop was attended by many members of the Montréal operations research community. For the most part, these members

belong to GERAD or CIRRELT, two research centres with which the CRM has close links.

The workshop featured talks pertaining to several applications. For instance, François Soumis spoke about mathematical programming problems arising in transportation planning, Daniel Bienstock about discrete models in robust portfolio optimization, Annegret Wagler about the network reconstruction problem (an important one in biology and theoretical medicine), and Eva K. Lee about optimization strategies for optimal cancer treatment design. In the latter talk, Dr. Lee mentioned the challenges faced by applied mathematicians trying to optimize medical treatments: medical technology changes (and improves) so rapidly that the mathematicians must constantly devise new algorithms to meet the challenges! George Nemhauser's talk dealt with another important model, arising from a strategic planning problem with start-time dependent costs.

As mentioned above, cutting planes play a crucial role in solving mixed integer programs, and the workshop featured eight talks on this topic (by de Farias, Louveaux, Li, Tawarmalani, Linderoth, Margot, Lodi, and Smith, respectively). On the theoretical side, the workshop included a talk by Egon Balas ("Projecting systems of linear inequalities in binary variables"), a talk by Shabbir Ahmed on probabilistically constrained linear programming, and a talk by Gábor Pataki on the parallel approximation problem. Laurence Wolsey spoke on the application of mixing sets to lot-sizing problems, Jacques Desrosiers on set covering and set partitioning applications, and Suvrajeet Sen on models in stochastic mixed integer programming.

The topic of symmetry breaking was addressed by Volker Kaibel, who described a procedure (called *orbitopal fixing*) that improves the performance of branch-and-cut codes without explicitly adding inequalities to the model. This topic is extremely important in integer and mixed integer programming, since many natural formulations of combinatorial problems exhibit symmetries. Important work in this area was also carried out by François Margot, one of the workshop speakers. To conclude, let us mention that MIP2007 included a well-

attended poster session, featuring posters of a very high quality. Some of the presentations and posters are available on the workshop web site (www.crm.umontreal.ca/MIP2007).

First Montreal Industrial Problem Solving Workshop

August 20–24, 2007, CRM

Organized jointly by CRM, GERAD, ncm₂ (Network for Computing and Mathematical Modeling), CIRANO, MITACS and CIRRELT
Financed by MITACS and ncm₂

Organizing committee: Jean-Marc Rousseau (CIRANO and ncm₂, chair), Alan Bernardi (Bell University Laboratories), Anne Bourlioux (Montréal), Myriam Bouroche (Bell University Laboratories), Michel Gendreau (Montréal), Alexandra Haedrich (MITACS), Pierre Hansen (HEC Montréal), François Lalonde (Montréal), Roland Malhamé (École Polytechnique de Montréal), Odile Marcotte (GERAD and UQÀM)

Participating researchers: Paul Armand (Limoges), Anne Bourlioux (Montréal), Mark Coates (McGill), Jean-François Cordeau (HEC Montréal), Nando De Freitas (UBC), Michel Gendreau (Montréal), Bernard Gendron (Montréal), Stéphane Krau (GERAD and École Polytechnique de Montréal), Bernard F. Lamond (Laval), Frédéric Lesage (École Polytechnique de Montréal), Jean-Marc Lina (École de Technologie Supérieure), Odile Marcotte (GERAD and UQÀM), Dominique Orban (École Polytechnique de Montréal), Mary Pugh (Toronto), Jean-Marc Rousseau (CIRANO and ncm₂), Louis-Martin Rousseau (École Polytechnique de Montréal)

Industrial representatives: Vincent Béchard (Différence S.E.N.C.), Frédéric Leblond (ART-Advanced Research Technologies Inc.), Marc Miousset (Théus Technologies Inc.), John O'Hara (Kruger Products), Marcel Paul Raymond (Hydro-Québec), Réjean Robitaille (Fédération des producteurs de lait du Québec), Marie-Odette St-Hilaire (Lockheed Martin Canada), Vincent Zalzal (Matrox Electronic Systems)

Number of participants: 16 researchers, 8 industrial representatives and 42 students and postdoctoral fellows

In August the CRM organized for the first time an industrial problem solving workshop, according to a model conceived by Professor John Ockendon from the University of Oxford. The two other Canadian mathematical institutes (PIMS and Fields) had already organized such

workshops, but the CRM had never done so. The main goal of these workshops is to foster collaborations between industry and universities. Researchers and students (especially in applied mathematics) are always eager to solve “real-world” problems and to meet persons who tackle such problems in industry. The problem solving workshops provide many benefits to the industrial partners as well. They enhance their company visibility and enable them to forge long-term links with universities, to collaborate with Canadian or foreign experts in mathematical modelling, and to develop innovating solutions for difficult problems.

The planning and program of an industrial problem solving workshop are quite different from those of a standard workshop. In order to prepare the workshop, one has to find concrete industrial problems, proposed by companies in need of mathematical expertise. One must then recruit researchers who are experts in the relevant areas of mathematics and students who wish to participate in the workshop. Each problem is assigned to a team consisting of researchers, students and industry representatives. On the first morning of the workshop, all participants gather to listen to the presentations of all the problems. The teams then work independently from one another. On Wednesday afternoon, the participants meet again to attend the mid-week summary, consisting of the progress reports of the teams. The team work resumes until Friday, when the teams present their solutions.

The First Montreal Problem Solving Workshop unfolded along the preceding lines, but we would like to mention two features that set it apart (to some extent). The first feature is that the workshop was bilingual. Three of the teams worked in French and the other ones in English. This feature was obviously a complicating factor in the workshop planning! The second feature is that the problems on which the participants worked came from diverse fields and required varied mathematical techniques for their solution. These fields include medicine, computer vision, strategic business planning, transportation, data fusion, and industrial process modelling. The majority of participating students came from Montréal universities, but the workshop was also attended by students from Université Laval, the University of Alberta, the University of British Columbia, and five Ontario universities (McMaster, Ottawa, Toronto, Waterloo, and the University of Ontario Institute of Technology).

The genial atmosphere of the workshop and the interactions between the participants ensured the success of the workshop. Between August 20 and August 24, one could observe the students working hard in the laboratories or lounges of the André-Aisenstadt building... On Thursday night, after the traditional pizza dinner, almost all the participants worked until midnight to complete their presentations. To a great extent, the success of the workshop is also due to the industrial partners, and the organizers are extremely grateful to the following partners for providing the problems: ART, Stellate, Matrox, Kruger, Fédération des producteurs de lait du Québec, Lockheed Martin, Alcan, and Hydro-Québec. They are also grateful to MITACS for its generous financial support, and to the Québec MITACS representative, Alexandra Haedrich, for her unfailing help. The proceedings of the workshop are now available on the workshop web site (www.crm.umontreal.ca/probindustriels/index_e.shtml).

2nd French-Speaking Conference on Software Architectures and 14th International Colloquium on Object-Oriented Languages and Models
March 3–7, 2008, CRM

Organizers: Yamine Ait Ameer (LISI-ENSMA, Poitiers), Simon Denier (Montréal), Yann-Gaël Guéhéneuc (École Polytechnique de Montréal), Houari Sahraoui (Montréal), Julie Vachon (Montréal)

Invited speakers: Frédéric Boniol (IRIT-ENSEEIH, France), Lionel Briand (Simula Research Laboratory and University of Oslo), Bran Selic (Malina Software Corp.)

Number of participants: 51

La semaine du 3 au 7 mars 2008, pendant laquelle se tinrent ces deux colloques, fut une semaine scientifique bien remplie, si on considère les trois exposés des conférenciers invités, les dix sessions techniques, le panel sur le sujet délicat de la validation en génie logiciel et l'atelier pour les doctorants. À l'occasion de cet atelier, le professeur Guy Lapalme fit une courte mais néanmoins éloquente présentation sur la direction des projets de thèse.

Les activités de la journée du mercredi 5 mars étaient communes aux deux colloques, et comportèrent trois sessions techniques (sur l'adaptation à l'exécution, la représentation des connaissances et la gestion intégrée des documents, respectivement). Le mardi 4 mars, la Conférence francophone sur les architectures logicielles comporta des sessions techniques sur

les architectures à base d'agents, les architectures orientées « services » et les langages de description d'architectures et de modèles. Les jeudi 6 mars et vendredi 7 mars, le Colloque international sur les langages et modèles à objets comporta des sessions techniques sur la rétro-ingénierie, l'ingénierie des modèles et les langages de modélisation.

Les deux colloques ont permis aux chercheurs francophones travaillant dans le domaine du génie logiciel de nouer des liens avec d'autres collègues d'Europe ou d'Amérique du Nord, et de se retrouver dans une ambiance chaleureuse afin de poursuivre ou d'amorcer des collaborations de recherche.

First CRM – INRIA – MITACS Meeting

May 5–9, 2008, CRM

Sponsored by CRM, the Institut National de Recherche en Informatique et Automatique (INRIA), and MITACS

Organizers: Michel Delfour (Montréal, président), Yves Bourgault (Ottawa), Fahima Nekka (Montréal), Marc Thiriet (INRIA and CNRS)

Speakers: Christian Barillot (VISAGES, INRIA Rennes and IRISA), Youssef Belhamadia (Alberta), Yves Bourgault (Ottawa), Jacques Bélair (Montréal), Dominique Chapelle (MACS, INRIA Paris), Jean Clairambault (BANG, INRIA Paris), Maureen Clerc (ODYSSEE, INRIA Sophia Antipolis), Michel Delfour (Montréal), Dirk Drasdo (INRIA Paris and Universität Leipzig), François Fages (CONTRAINTES, INRIA Paris), Paul Farand (Sherbrooke), Marie-Isabelle Farnas (UQAC), André Fortin (Laval), Michel Fortin (Laval), André Garon (École Polytechnique de Montréal), Céline Grandmont (REO, INRIA Paris), Frédéric Lesage (École Polytechnique de Montréal), Jean-Marc Lina (École de Technologie Supérieure), Fahima Nekka (Montréal), Robert G. Owens (Montréal), Jiří Patera (Montréal), Gérard Plante (Sherbrooke), Maxime Sermesant (ASCLEPIOS, INRIA Sophia Antipolis), Tony W. H. Sheu (National Taiwan University), Michel Sorine (SISYPHE, INRIA Paris), Raymond J. Spiteri (Saskatchewan), Peter Swain (McGill), Marc Thiriet (INRIA Paris and CNRS), Irène Vignon-Clémentel (REO, INRIA Paris), Jean-Paul Zolésio (OPALE, INRIA Sophia Antipolis)

Student speakers: Matteo Astorino (REO, INRIA Paris), Annabelle Ballesta (BANG, INRIA Paris and Université Paris-Sud), Mathieu Dehaes (École Polytechnique de Montréal), Matthew Doyle (Ottawa), Alexandra Franchitti (REO, INRIA Paris and Université Pierre et

Marie Curie), Jiří Hrivnák (CRM), Noura Morcos (REO, INRIA Paris and Université Pierre et Marie Curie), Olivier Rousseau (Ottawa), Matthieu Voorons (CRM), Najib Zemzemi (REO, INRIA Paris)

Number of participants: 50

This year, the Montréal Scientific Computing Days (cf. the previous section of this annual report) were juxtaposed with the First CRM–INRIA–MITACS meeting and Michel Delfour was chair of the organizing committee. INRIA is the French national institute for research in computer science and control. Its activities include research on biological, cognitive, communicating, numerical, and symbolic systems. The First CRM–INRIA–MITACS Meeting lasted five days and was a wonderful opportunity for scientific exchange and interaction between researchers affiliated to the CRM or to INRIA. Indeed, the CRM and INRIA have a long-standing cooperative relationship going back to an agreement signed between Maurice L'Abbé (then vice-rector for research at the Université de Montréal), Lucien Le Cam (director of the CRM), and Jacques-Louis Lions of the Institut de Recherche en Informatique et Automatique (IRIA – initial name of INRIA). The cooperation of the CRM with INRIA was expanded in 2005 by the exchange and cooperation agreement with the Quebec government (FQRNT), as part of its educational and industrial strategies. This first meeting helped strengthen the cooperative relationship between CRM and INRIA and it is hoped that it will be followed by further meetings. In an effort to make the event more attractive to students and postdoctoral fellows, a special conference rate was available for junior research personnel.

The meeting was structured around seven main themes:

- biological systems, cell, and tissues,
- brain imaging and function,
- composite media, multiscale modelling, optimal shape, and design,
- heart,
- implantable medical devices and drug delivery,
- physiological flows, and
- respiratory system.

One of the strengths of the meeting was that it facilitated and even created good interactions among the various participating groups (a rare opportunity even for colleagues from Canada or Quebec!). The participants praised the high scientific quality of the meeting (“Beyond my expectations in terms of academic quality”, “Great

in the aspects of scientific computing and the hemodynamics”, etc.). Here is a survey of the topics covered by the lecturers.

F. Fages spoke on formal cell biology using the BIOCHAM software and emphasized the following points: (1) rule-based modelling of biochemical reaction systems; (2) temporal logic formalization of biological properties; and (3) search algorithms for kinetic parameter values. M. Thiriet illustrated a possible BIOCHAM use by an example originating in blood flows, the so-called mechanotransduction. C. Grandmont spoke on the multiscale modelling of the respiratory tract, focusing on thoracic airways from the trachea (generation 0) to terminal alveolar ducts (generation 23 using the Weibel model). Y. Bourgault carried out simulations of aerosol convection in airways by using a compressible fluid solver (hence avoiding assumptions such as the assumption that the density is constant along fluid particle trajectories, and the assumption that there is no heat transfer). A. Garon and M.-I. Farinas presented the work carried out on a patient-specific model of steady flow in the carotid artery network, in the context of the implantation of a small ventricular assist pump (VAD). T.W.H. Sheu spoke on flow simulations using a tri-quadratic streamline upwind Petrov-Galerkin (SUPG) finite element model of hemodynamics.

J. Bélair presented a model of erythropoiesis with age structure and variable life span. J. Clairambault works with B. Perthame on the mathematical modelling of cell proliferation and its control, focusing on nanoprocesses within the cell to improve drug efficiency by taking into account the circadian cycle. I. Vignon-Clémentel's talk focused on fluid-solid interaction in a porous media, applied to heart perfusion. D. Chapelle presented a framework for CardioSense3D focusing on the modelling of the electromechanical coupling of the heart. M. Sermesant and his colleagues developed fast software for model-based diagnosis and therapy planning of heart diseases. R. Spiteri presented his work on the simulation of the heart electrical activity within the framework of a virtual heart. N. Zemzemi presented simulations of electrocardiograms. A. Franchitti studies with Y. Maday the optimization aspects of pacemaker treatment. Y. Belhamadia proposed a numerical bidomain model of electrical waves in the heart.

M. Sorine proposed a new kind of signal processing to assess arterial blood pressure. The analysis rests on a scattering-based method (SBSA) that targets pressure pulses with soli-

tons. M. Astorino presented his work on fluid-structure interaction and its application to heart valves. M. Doyle spoke on his investigation, using the Adina software, of blood flow coupled with a myocardium being deformed. N. Morcos described her work with Y. Maday on the reduced basis method for blood flow simulations in porous tissues (microcirculation). D. Drasdo spoke on models of multicellular tissues, especially tumor growth and liver regeneration; this work was carried on in collaboration with Leipzig University researchers. The topic of G. Plante's lecture was pharmacokinetics, with a focus on drug delivery in the interstitial fluid compartment that must be crossed for drugs to reach cells. F. Nekka spoke on the pharmacological variability induced by patients' irregular drug intake. P. Farand talked on substitution tissues and prostheses for the cardiovascular system. A. Ballesta presented his work with J. Clairambault on pharmacokinetics and dynamics of anticancer drugs in the cell; they have developed a model for anticancerous drugs.

C. Barillot presented data on neuroinformatics in the context of diseases of the central nervous system; the purpose of this work is to develop computer-aided medicine and surgery tools. O. Rousseau presented his work on an interactive contour algorithm and its application to heart segmentation. M. Clerc spoke on magneto-electroencephalography (MEG) signals to explore brain activity. J. Patera presented his work on Fourier-like transforms of digital data included in bounded lattices of any dimension, symmetry, and density. The technique he presented can be applied to interpolate motions between two frames. J. Hrivnák spoke on two-dimensional (anti)symmetric multivariate exponential functions and the corresponding Fourier transforms (this work was conducted with J. Patera). M. Voorons, a member of J. Patera's team, spoke on image interpolation based on Lie group theory and an algorithm for block decomposition of images.

F. Lesage's talk dealt with optical imaging of the spinal cord. M. Dehaes presented his work with F. Lesage on the stimulation of the brain cortex by visual excitations. In this work he finds inverted curves that have a vascular origin. J.-M. Lina spoke on the processing of optical imaging signals. R. Owens talked on blood rheology and presented a non-homogeneous constitutive model. A. Fortin focused his talk on viscoelastic fluid flow and free surface problems that require unsteady, anisotropic, adaptive remeshing. M. Fortin presented a numerical procedure

to process the frictional contact in solid mechanics. J.-P. Zolésio spoke on the hidden regularity by extractor for Neuman problems after pointing out analogies (under certain circumstances) between Maxwell's equations, elasticity, and wave equations, using an adequate formulation and boundary conditions in incompressible media. M. Delfour presented new equations for the stent dose, under pulsative flow conditions, when one has to design coated stents to prevent restenosis.

CRM-Fields-MITACS Workshop on Lie Groups, Group Transforms, and Image Processing

May 16, 2008, Fields Institute

Sponsored by CRM, MITACS, and the Fields Institute

Organizers: Frédéric Lesage (École Polytechnique de Montréal), Jiří Patera (Montréal), Hongmei Zhu (York)

Speakers: Jiří Hrivnák (Montréal), Frédéric Lesage (École Polytechnique de Montréal), Maryna Nesterenko (Montréal), Jiří Patera (Montréal), Matthieu Voorons (Montréal), Yuesong Yan (York), Hongmei Zhu (York)

Number of participants: 16

The report on this activity appeared in the Fields Institute Annual Report for 2008. This one-day workshop attracted a spectrum of participants, from graduate students and postdocs, to young and senior faculty in various fields, providing a friendly and stimulating environment for exchanging the latest findings and fostering collaboration between researchers from different academic institutions. Featured at the workshop were one $2\frac{1}{2}$ -hour minicourse and five one-hour lectures, which summarized the recent development of group transforms based on the orbit functions of compact Lie groups.

The workshop began with an intensive minicourse given by Jiří Patera, a founder of this research. Dr. Patera introduced the participants to three new families of class functions defined on the maximal torus of a compact simply connected Lie group. Each class of these functions offers a variety of group transforms similar to Fourier and cosine transforms. Group transforms using these functions as bases lead to the discrete analogues of these transforms, called "discrete orbit-function transforms". Dr. Patera also provided a recipe to compute these transforms. Note that the key application of the discrete transforms is that their continuous extensions smoothly interpolate digital data in any dimension and for any lattice with symmetry af-

forded by the structure of the given compact Lie group.

Afternoon lecture series covered a wide range of research, from theoretical and computational research to application aspects of the discrete forms of these transforms. A focal point of these talks was the use of the transforms in digital image processing. Its power was demonstrated through examples in image interpolation, segmentation, edge detection, texture identification, and image compression. Abstracts of the talks are available on the following Fields Institute web page: www.fields.utoronto.ca/programs/scientific/07-08/liegroups/abstracts.html.

Summer School

Systems Biology Dynamics: from Genes to Organisms

May 20–30, 2008, McGill University

Sponsored by MITACS, the DFG Research Center MATHEON, and CRM

Organizers: Michael C. Mackey (McGill) and Peter Swain (McGill)

Speakers: Jacques Bélair (Montréal), Maurice Chacron (McGill), Leon Glass (McGill), Michael Guevara (McGill), Mads Kaern (Ottawa), Michael C. Mackey (McGill), Ted Perkins (McGill), Peter Swain (McGill), Moisés Santillán (Centro de Investigación y de Estudios Avanzados del IPN, Mexico), Alain Vinet (Montréal)

Number of participants: 55

With the current explosion in biological data, from the sequencing of the human genome to the invention of DNA chips, the life sciences have been propelled into the quantitative era. There is a demand in academia, government, and industry for people who speak the languages of both the physical and the biological sciences. The ultimate goal of the new biology, which has been loosely called “Systems Biology”, is to produce a computational model of a biological system that allows accurate, experimentally verifiable prediction at the molecular level.

The Summer School, held under the auspices of The Centre for Nonlinear Dynamics in Physiology and Medicine (McGill University), provided a solid introduction to the fundamental science on which Systems Biology is based; it was also aimed at satisfying the demand for peo-

ple who wish to bridge the gap between the physical and the biological sciences. The School brought together 55 students, postdoctoral fellows, physicians, professors, and industry representatives from 16 countries for a two-week intensive course. The director of the school was Dr. Peter Swain. The instructors were primarily members of the Centre and students associated with the Centre acted as teaching assistants. The mornings consisted of two 1.5 hour lectures and the afternoons of computer laboratory exercises using specifically designed material. The detailed programme and additional information may be found at the following address: www.cnd.mcgill.ca/summer08/program.html.

The first week was devoted to non-linear modelling of physiological dynamics. Following an introductory day, the courses focused on the dynamics of normal and pathological behaviors in both neural and cardiac systems. The second week focused on modelling single cells and particularly their physiology and the genetic networks that create it. Applications included modelling cell replication and stochastic gene expression, inferring model structure from time series data, and synthetic biology, which was taught by Dr. Mads Kaern, a guest lecturer from the University of Ottawa. In addition to the formal academic program, participants had many opportunities to interact informally, through pizza parties at McGill (where attendees presented their research), at a barbecue and a buffet dinner, and at a canoe outing held on the Lachine Canal.

The feedback on the Summer School was extremely positive. Here are the words of one of the students: “This summer school is a great opportunity for me to gain further insights into various aspects of systems biology and learn about interesting applications of mathematical techniques to biological problems. The combination of lectures and laboratories has helped me become familiar with the different topics chosen from various research directions within the broad field of systems biology. Moreover, this summer school has allowed me to meet fellow researchers and participate in stimulating discussions.” In total 13 students were sponsored by MITACS, including 3 students from MATHEON and 2 from INRIA. We are grateful to MITACS for their continued support.

CRM Prizes

THE CRM created and administers, either alone or jointly, four of the eight major national prizes in the mathematical sciences, namely: the CRM–Fields–PIMS Prize, the Prize for Theoretical Physics awarded in collaboration with the Canadian Association of Physicists (CAP), the Prize for young researchers in Statistics awarded jointly with the Statistical Society of Canada (SSC), and the CRM Aisenstadt Prize awarded to rising young Canadian stars, selected by the CRM’s Scientific Advisory Committee. The CRM has invested enormously in time, effort and in its own resources, to propel leading Canadian scientists into the spotlight, giving them international recognition when they most need it.

CRM – Fields – PIMS Prize 2008 awarded to Allan Borodin



The CRM–Fields–PIMS Prize for 2008 was awarded to Professor Allan Borodin, of the University of Toronto, in recognition of his exceptional achievement in mathematical computer science, especially the theory of efficient and “simple” algorithms. Professor Borodin is a world leader in the mathematical foundations of computer science. His influence on theoretical computer science has been enormous, and its scope very broad. Jon Kleinberg, winner of the 2006 Nevanlinna Prize, writes of Borodin that “he is one of the few researchers for whom one can cite examples of impact on nearly every area of theory, and his work is characterized by a profound taste in choice of problems, and deep connections with broader issues in computer science”. Allan Borodin has made fundamental contributions to many areas, including algebraic computations, resource tradeoffs, routing in interconnection networks, parallel algorithms, on-line algorithms, and adversarial queuing theory.

Professor Borodin received his B.A. in Mathematics in 1963 (from Rutgers University), his M.S. in Electrical Engineering and Computer Science in 1966 (from Stevens Institute of Technology), and his Ph.D. in Computer Science in 1969 (from Cornell University). He was a systems programmer at Bell Laboratories in New Jersey from 1963 to 1966, and a Research Fellow at Cornell from 1966 to 1969. Since 1969, he has been a professor in the Department of Computer Science at the University of Toronto, where he

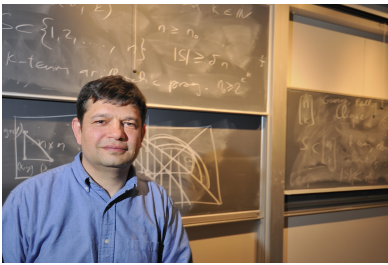
became a full professor in 1977. He was department chair from 1980 to 1985. Professor Borodin has been the editor of many journals, including the SIAM Journal on Computing, *Algorithmica*, the Journal of Computer Algebra, the Journal of Computational Complexity, and the Journal of Applicable Algebra in Engineering, Communication and Computing. He has held positions on, or been active in, dozens of committees and organizations, both inside and outside the University, and has held several visiting professorships internationally. In 1991 Professor Borodin was elected a Fellow of the Royal Society of Canada.

A detailed description of the contributions of Professor Borodin to mathematics and computer science may be found in *Le Bulletin du CRM* (Spring 2008), at the address crm.math.ca/rapports/bulletin/bulletin14-1.pdf.

The CRM – Fields – PIMS Prize

This prize was established in 1994 as the CRM–Fields prize to recognize exceptional research in the mathematical sciences. In 2005, PIMS became an equal partner in the awarding of the prize and its name was changed to the CRM–Fields–PIMS prize. A committee appointed by the three institutes chooses the recipient. The previous recipients of the prize are H.S.M. (Donald) Coxeter (1995), George A. Elliott (1996), James Arthur (1997), Robert V. Moody (1998), Stephen A. Cook (1999), Israel Michael Sigal (2000), William T. Tutte (2001), John B. Friedlander (2002), John McKay (2003), Edwin Perkins (2003), Donald A. Dawson (2004), David Boyd (2005), Nicole Tomczak-Jaegermann (2006), and Joel S. Feldman (2007).

André-Aisenstadt Prize 2008 awarded jointly to József Solymosi and Jonathan Taylor



József Solymosi obtained his doctorate in 2001 at ETH (Swiss Federal Institute of Technology) in Zürich, under

the supervision of Emo Welzl. From 2001 to 2003 he was S.E. Warschawski Assistant Professor in the Department of Mathematics of the University of California, San Diego. He then became a professor in the Department of Mathematics of the University of British Columbia, where he is now Associate Professor. From 2006 to 2008 József Solymosi held a Sloan Research Fellowship, and in 2007-2008, he was a member of the School of Mathematics of the Institute for Advanced Study in Princeton.

József Solymosi's main field of research is additive combinatorics, a new subject bringing together ideas from harmonic analysis, ergodic theory, discrete geometry, combinatorics, graph theory, group theory, probability theory, and number theory. In particular, he has worked on famous questions posed by Paul Erdős, one of the most celebrated mathematicians of the twentieth century: the sum-product problem of Erdős and Szemerédi; problems related to generalizations of Szemerédi's theorem on arbitrary long arithmetic progressions; and questions concerning the number of distinct distances induced by n points in the plane. József Solymosi has also published articles on Ramsey theory, graph theory, and discrete and computational geometry.

The Scientific Advisory Committee of the CRM recognized the beauty, the impact, and the splendid originality of the results obtained by József Solymosi. The committee was struck by the extraordinary efficiency and elegance of his results, at the cutting edge of the new field of additive combinatorics (sometimes called arithmetic combinatorics). The members of the committee appreciated the simplicity and deep insight evident in each of his contributions. A detailed description of these contributions may be found in *Le Bulletin du CRM* (Spring 2008), at the address crm.math.ca/rapports/bulletin/bulletin14-1.pdf.



Jonathan Taylor obtained his Ph.D. at McGill University in 2001, under the supervision of Keith Worsley (from McGill) and Robert Adler (from the Technion in Israel). He has received numerous awards, including the Carl Herz Fellowship from the Institut

des sciences mathématiques (in 2001), the Pierre Robillard Award from the Statistical Society of Canada (in 2002), and the Terman Fellowship at Stanford University (in 2004). He held a Tier 2 Canada Research Chair at the Université de Montréal from 2006 to 2007 and is now a professor in the Department of Statistics at Stanford University.

The Scientific Advisory Committee was impressed by the exceptional breadth of Jonathan Taylor's expertise, which ranges from Gaussian processes and differential geometric methods in statistics to inferential questions in neuroimaging and modelling and analysis of functional and anatomical neuroimaging data. Indeed, Taylor was able to merge tools from the theory of Gaussian processes and differential geometry in order to obtain results on the mean Euler characteristic in random fields indexed by a (not necessarily flat) manifold. The problem he addressed is motivated by neural imaging, and Taylor adopted a novel geometric viewpoint to solve it. As in the case of Solymosi, the Scientific Advisory Committee recognized the impact and originality of Taylor's work.

To conclude, let us mention that Jonathan Taylor also works in other fields of statistics, in particular multiple comparisons and HIV protein sequence analysis. A detailed description of the contributions of Jonathan Taylor may be found in *Le Bulletin du CRM* (Spring 2008), at the address crm.math.ca/rapports/bulletin/bulletin14-1.pdf.

The André-Aisenstadt Prize

Created in 1991, the André-Aisenstadt Mathematics Prize is intended to recognize and reward research achievements in pure and applied mathematics by talented young Canadian mathematicians. This prize consists of a \$3,000 award and a medal. The recipient is chosen by the CRM's advisory committee. At the time of consideration, candidates must be Canadian cit-

izens or permanent residents of Canada, and no more than seven years from their Ph.D.

The previous recipients of the André-Aisenstadt Prize are Niky Kamran (1992), Ian Putnam (1993), Michael Ward (1995), Nigel Higson (1995), Adrian S. Lewis (1996), Lisa Jeffrey (1997), Henri Darmon (1997), Boris

Khesin (1998), John Toth (1999), Changfeng Gui (2000), Eckhard Meinrenken (2001), Jinyi Chen (2002), Alexander Brudnyi (2003), Vinayak Vatsal (2004), Ravi Vakil (2005), Iosif Polterovich (2006), Tai-Peng Tsai (2006), Alexander E. Holroyd (2007), and Gregory G. Smith (2007).

CAP – CRM Prize 2008 awarded to Richard Cleve



In 2008 the CAP–CRM Prize in Theoretical Physics was awarded to Dr. Richard Cleve, from the University of Waterloo,

in recognition of his fundamental contributions to quantum information theory, including the structure of quantum algorithms and the foundations of quantum communication complexity. Professor Richard Cleve is an outstanding computer scientist who has worked at the boundary of physics, mathematics, and computer science. His work has transcended the discipline of computer science and had a broad impact on the physics of quantum information.

Richard Cleve has shown how generic quantum algorithms can be broken down into fundamental physical building blocks, the so-called one-qubit and two-qubit gates. Today most physical implementations of quantum computers use this result. He also created the field of quantum communication complexity, in which one assesses the resources required to perform tasks using quantum systems. He has demonstrated that a quantum walk can provide an exponential algorithmic speedup (with respect to classical algorithms). He has also been involved in the first experimental realization of an order-finding algorithm on a quantum computer, and is one of the most highly cited authors in the field of quantum information.

Besides being one of the top quantum information researchers in the world, Richard Cleve has been instrumental in developing the field of quantum information processing in Canada. He founded the quantum information group at the University of Calgary before moving to the Institute for Quantum Computing at the University of Waterloo. Richard Cleve is the Quantum Information Chair at the Institute for Quantum Computing, an Associate Member of the Perimeter Institute for Theoretical Physics, a founding fellow of the Quantum Information Processing Program at the Canadian Institute for Advanced Research, and Team Leader at QuantumWorks, an NSERC innovation platform bringing together academia, government, and industry to develop quantum information processing in Canada.

The CAP – CRM Prize

The Centre de recherches mathématiques (CRM) and the Canadian Association of Physicists (CAP) created in 1995, on the occasion of the 50th anniversary of the CAP, a joint prize for recognizing exceptional achievements in theoretical and mathematical physics. The prize consists of a \$2,000 award and a medal.

The previous recipients of the prize are Werner Israel (1995), William G. Unruh (1996), Ian Affleck (1997), J. Richard Bond (1998), David J. Rowe (1999), Gordon W. Semenoff (2000), André-Marie Tremblay (2001), Pavel Winternitz (2002), Matthew Choptuik (2003), Jiří Patera (2004), Robert C. Myers (2005), John Har-nad (2006), and Joel S. Feldman (2007)

CRM – SSC Prize 2008 awarded to Dr. Paul Gustafson



In 2008, the CRM–SSC Prize was awarded to Paul Gustafson, from the Department of Statistics of the University of British Columbia. Paul Gustafson is a leading international expert in Bayesian analysis, and his contributions to Bayesian statistical methodology

and its application to epidemiology have had an immense impact in statistics, biostatistics, and public health.

Within 15 years of obtaining his Ph.D., Paul Gustafson has made outstanding contributions to the understanding of Bayesian statistical inference, to the implementation of the Bayesian paradigm in the health sciences, and to the de-

velopment of algorithms for Bayesian inference. His work displays a deep knowledge of the foundation of statistical reasoning and a true ability to make substantial contributions to diverse domains of application. In 2004, Professor Gustafson published a well-received book entitled *Measurement Error and Misclassification in Statistics and Epidemiology: Impacts and Bayesian Adjustments*. It documents the impact of measurement error in explanatory variables and details Bayesian adjustment methods for both continuous and categorical variables. It uses modern Markov Chain Monte Carlo techniques to implement the proposed methodology.

In a provocative 2005 discussion paper in *Statistical Science*, Professor Gustafson questions the conventional wisdom that a Bayesian model with parameters that cannot be identified from the data should be simplified. Surprisingly, he argues that it may be more appropriate to expand the model. Even more astonishingly, he establishes an asymptotic theory for the identifiable parameters in non-identifiable models. Professor Gustafson has also written key papers in several areas of statistics such as survival analysis, the analysis of count data, computational methods, and disease mapping. He has made solid methodological contributions through his collaborative work with epidemiologists, medical researchers, and psychologists.

Paul Gustafson obtained his B.Sc. in Mathematics in 1990 and his M.Sc. in Statistics in 1991 from the University of British Columbia. He completed his Ph.D. in 1994 at Carnegie Mellon University. He is a third generation SSC-CRM Prize recipient, since Larry Wasserman, his adviser, and Robert Tibshirani (Wasserman's adviser), were awarded the prize in 2002 and 2000, respectively. In 1994 Paul Gustafson held a postdoctoral fellowship at the University of British Columbia, where he was appointed As-

sistant Professor in 1995, Associate Professor in 2000, and Full Professor in 2005. In 2001, he was awarded a UBC Killam Faculty Research Fellowship.

Professor Gustafson holds research grants from four major research agencies: NSERC, CIHR, NPCDS, and SSHRC. These grants are a tribute to his research and show the breadth of his scientific activities. In 2007, he was one of the first recipients of the Discovery Accelerator Supplement of NSERC, a special research grant for outstanding researchers who show strong potential to become international leaders in their field. Professor Gustafson has also served on selection committees for CIHR, NSERC, and NPCDS. He has been an Associate Editor for the *Canadian Journal of Statistics (CJS)*, the *Journal of Statistical Planning and Inference*, *Lifetime Data Analysis*, and *Statistics in Medicine*. In 2007 he became Editor-in-Chief of the *CJS*. He has also served as President of the Biostatistics Section of the Statistical Society of Canada.

The CRM – SSC Prize

The SSC, founded in 1977, is dedicated to the promotion of excellence in statistical research and practice. The prestigious CRM – SSC Prize, jointly sponsored by the SSC and the Centre de recherches mathématiques (CRM), is given each year to a Canadian statistician in recognition of outstanding contributions to the discipline during the recipient's first 15 years after earning a doctorate.

Paul Gustafson is the tenth recipient of the CRM – SSC Prize. The previous winners of the award are Christian Genest (1999), Robert J. Tibshirani (2000), Colleen D. Cutler (2001), Larry A. Wasserman (2002), Charmaine B. Dean (2003), Randy Sitter (2004), Jiahua Chen (2005), Jeffrey Rosenthal (2006), and Richard Cook (2007).

The CRM Outreach Program

The CRM is eager to fulfill the public's desire for understanding the latest developments in the mathematical sciences. To this end, the CRM initiated in the spring of 2006 a series of lectures called the "Grandes Conférences du CRM", which feature outstanding lecturers able to convey the beauty and power of mathematical research to a wide audience. Les *Grandes Conférences du CRM* are now well established and there were two lectures geared towards a general audience in 2007-2008. The first lecture was given by Professor Étienne Ghys on November 7, 2007, and a detailed report on it (written by Yvan Saint-Aubin) may be found below. The second lecture was given by Professor Tadashi Tokieda, from the University of Cambridge, on March 18, 2008, and was entitled "Dimension $2\frac{1}{2}$ - Science à partir d'une feuille de papier". A detailed report on Professor Tokieda's lecture, written by Christiane Rousseau, may be found below. Each of the lectures attracted hundreds of people of all ages, and was followed by a "vin d'honneur" that enabled the participants to ask questions to the lecturers, reconnect with friends and colleagues, and meet people interested in mathematics and science in general.

In 2007-2008, the *Grandes Conférences* program was under the stewardship of Christiane Rousseau and Yvan Saint-Aubin, professors at the Département de mathématiques et de statistique of the Université de Montréal.

The butterfly effect Étienne Ghys, CNRS and École normale supérieure de Lyon



How many of us were featured on the front page of a major newspaper before delivering a scientific lecture? Which

North American daily newspapers have included into their front page a report on a mathematical lecture? The members of the Montréal mathematical community were thus startled and overjoyed when they took a look at *Le Devoir* newspaper on November 7, 2007. On its front page the newspaper was highlighting the fact that the butterfly effect fascinates mathematicians, and a fairly long article on the topic was illustrated with a picture of the mathematician Étienne Ghys and a Lorenz attractor fragment.

Why was a Grande Conférence du CRM thus singled out by *Le Devoir*? Mathematicians know very well the contributions of Professor Ghys, in particular his work on the geometrical and topological aspects of dynamical systems. They also know that he is a great communicator, that he delighted the participants of the International Congress of Mathematicians (ICM) in Madrid, and that he is a dedicated popularizer (having delivered first-rate presentations to high school students and general audiences). One wonders, however, how Professor Ghys' talents, well known to mathematicians, were noticed by a journalist working for a daily newspaper... Was this breakthrough caused by the "butterfly effect", an indication that the predic-

tive power of mathematical models is not unlimited? Was it caused by the realization that the general public is interested in science?

Professor Ghys began his presentation by asking whether the flapping wings of a butterfly can cause a hurricane in Texas, or at least alter its path. He introduced the Lorenz attractor and made it concrete by using a video clip displaying a Lorenz water mill. His description of the butterfly effect, however, was not strictly chronological. He related this effect to the study of initial conditions inaugurated by Poincaré and Hadamard, and to the work of the mathematicians who followed Lorenz (Smale, for instance).

Professor Ghys explained the dependency of certain phenomena on initial conditions by discussing some results with a geometric flavour: the geodesics of the surfaces with opposite curvatures (according to Hadamard), and his recent work, presented at the Madrid ICM, on the characterization of the knots formed by the periodic orbits in the Lorenz system. Professor Ghys then gave a more refined characterization of the link between the flapping of the wings and the hurricane, recalling the intuition of Lorenz, who thought that small perturbations do not modify the frequency of phenomena such as hurricanes but may influence the order in which such phenomena occur.

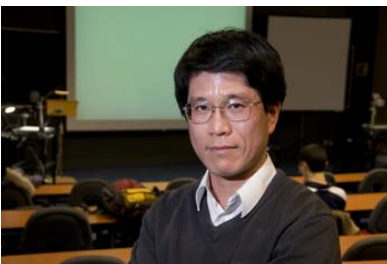
Finally Professor Ghys explained the recent results by W. Tucker confirming the existence of the Lorenz attractor and its robustness (i.e., the fact that any differential equation "close" to the Lorenz equation exhibits similar properties). He concluded his lecture by highlighting two as-

pects of the butterfly effect that seem to contradict one another. This effect illustrates a dependency on initial conditions, since a minor modification may have important consequences for future events. On the other hand, the study of the butterfly effect reveals a lack of dependency on the initial conditions, since the frequency of future events (measured over long periods) does not depend upon them.

The publicity offered by *Le Devoir* was welcome, even if we do not know what prompted the newspaper to feature Étienne Ghys on its

front page! With each new Grande Conférence, the proportion of participants known to the organizers decreases. Our students and colleagues, who attend these lectures faithfully, do not constitute a majority any more, and the general audience present at the Grandes Conférences demonstrates that many non-specialists have a strong interest in science. We are very grateful to our colleague Étienne Ghys, whose lecture undoubtedly persuaded many of the 250 participants to attend other Grandes Conférences. . .

Dimension 2 1/2 — The Science of Paper Sheets Tadashi Tokieda, University of Cambridge



Tadashi Tokieda began his lecture in an amusing fashion by illustrating several characteristics of paper sheets. A sheet

of paper is a two-dimensional object, but it may assume many shapes in 3-dimensional space because of its flexibility; thus one may consider that it has dimension $2\frac{1}{2}$. If a sheet contains a square-shaped hole and one folds the sheet adequately, then a disk with a diameter twice the side of the square can go through this hole. Also a regular pentagon can be built with a strip of paper, by making a knot and flattening the vertices of the knot.

Nowadays the mathematics of paper-folding and origami are being developed and compared to the classical constructions, which use ruler and compass only. The latter constructions enable us to perform the standard operations and extract square roots, but the origami constructions enable us to compute cubic roots as well. Hence there is an origami construction for the angle trisection problem, which cannot be solved by ruler and compass alone. Professor Tokieda illustrated the trisection of an angle during his lecture. Furthermore, any regular polygon can be built by an origami construction, while only certain regular polygons may be constructed by ruler and compass alone. Professor Tokieda showed how to construct a regular polygon with 11 vertices.

Tadashi Tokieda then turned to paper crumpling. Crumpling a sheet results in a graph outlined on the sheet of paper. This graph looks random but actually has many combinatorial and

metric properties. For instance, the number of edges incident upon a vertex is always even, and the alternating sum of the angles incident upon a vertex is always equal to 0. Professor Tokieda then turned to the relation between the topics discussed so far and classical mechanics and variational principles. In Lagrangian mechanics, the trajectories can be identified with the critical points of a functional; these critical points are assumed (wrongly) to be minima in every case. For instance, this assumption is false for a falling piece of paper: a sheet falls by following a zigzag curve and a strip by whirling, and both movements correspond to maxima of the functional.

In the last part of his conference, Professor Tokieda presented one of his contributions to physics. He introduced Poisson's ratio, for which he has proposed a new notation (having the shape of a fish, *poisson* in French!). In the present report, we shall denote the Poisson's ratio by the Greek letter α , even if it lacks an eye. . . The Poisson's ratio of an elastic body is the ratio of its transverse strain to its extension. In the course by Landau and Lifchitz, considered as the Bible of theoretical physics, one can read that α is strictly positive. In the incompressible case, we have $\alpha = \frac{1}{\dim-1}$, yielding $\frac{1}{2}$ in dimension 3, and for elastic bodies in dimension 3, the relation $0 < \alpha < \frac{1}{2}$ holds in general.

Professor Tokieda discovered many objects for which $\alpha < 0$ holds, i.e., objects whose length decreases when they are subjected to a transversal strain! These objects result from origami constructions or are models with hinges, pivots, or slides. Among these is the famous Miura-fold, often used for the transportation of a folded object and its remote unfolding. This technique is used, among other things, for transporting solar panels on satellites, intravascular stents, and

some roadmaps. The Miura-fold appears spontaneously when a paper sheet flares up. Tadashi Tokieda concluded his lecture by posing his conjecture that contrary to what is generally believed ($\alpha > 0$), a “random structure” verifies the relation $\alpha < 0$ with probability 1.

Professor Tokieda’s lecture demonstrated once more that he can entertain and instruct his audience at the same time. We are looking forward to his next lecture in Montreal!

CRM Partnerships

The CRM is strongly committed to its national mission and takes measures to ensure that as many Canadian scientists as possible benefit from its activities and become involved in their planning. For instance, it appoints to its Scientific Advisory Committee eminent Canadian scientists from various parts of the country; it is present in all important forums where the future directions of the Canadian mathematical sciences are discussed; it urges its organizers to ensure that Canadian specialists are included in their activities; it organizes and supports scientific events across the country; it collaborates with Canadian institutes, societies and associations. A specific budget is set aside each year for the participation of Canadian graduate students in its programs. The CRM is the only national institute that operates in the two official languages of Canada and it is highly visible on the international scene. In keeping with its national role, it coordinates its activities with the Fields Institute, PIMS, the Canadian Mathematical Society (CMS), MITACS, the Canadian Applied and Industrial Mathematics Society (CAIMS), the Statistical Society of Canada (SSC), the Canadian Association of Physicists (CAP), as well as with other societies and institutes abroad.

CRM Partners

The Fields Institute (FI) and the Pacific Institute for the Mathematical Sciences (PIMS)

Since the early 1990s two other research institutes have joined the CRM on the Canadian scene: Toronto's Fields Institute (FI) and the Pacific Institute for the Mathematical Sciences (PIMS). As well as coordinating their scientific activities, the three institutes have worked closely on a variety of initiatives, the most important of which is the Mathematics of Information Technology and Complex Systems network (MITACS). The three institutes were also involved in other initiatives, such as the CRM–Fields Prize awarded in recognition of outstanding accomplishments in the mathematical sciences in Canada. It was created in 1994 and in 2006 became the CRM–Fields–PIMS Prize. The administrative responsibility for this prize rotates between the three institutes.

International and National Collaborations

In 2007–2008, the CRM collaborated with or received financial assistance from the following institutions: INSERM (Paris), INRIA, the ALGANT programme, the Banff International Research Station (BIRS), the University of Havana (Cuba), the Groupe d'études et de recherche en analyse des décisions (GERAD), and the Canadian Society for Systems Biology.

In its publishing activities, the CRM is continuing its partnership with the American Mathematical Society (AMS), in particular through its two series of joint publications, the CRM Monograph Series and the CRM Proceedings and Lecture Notes Series. Two CRM series, in statistics and in mathematical physics, are published by Springer. The CRM has exchange agreements with the Fields Institute, PIMS, MSRI, the Insti-

tute for Mathematics and its Applications (IMA), École Normale Supérieure (France), the Isaac Newton Institute, the Institut des Hautes Études Scientifiques (IHÉS, France), and BIRS.

Associations and Professional Societies

The CRM maintains close ties with the different professional societies in the mathematical sciences: CMS, CAIMS, SSC and CAP. The president of the CMS is an ex-officio member of the CRM Scientific Advisory Committee. The CRM has also supported financially certain initiatives of the CMS, such as the mathematical camps. Together with the other institutes, the CRM organizes or sponsors special sessions at the CMS, CAIMS and SSC meetings. The CRM awards a prize each year jointly with the SSC; similarly, it awards a prize each year with the CAP in mathematical and theoretical physics.

The Mathematics of Information Technology and Complex Systems Network (MITACS)

MITACS was conceived by the three Canadian mathematical sciences institutes. They envisioned a pan-Canadian network of projects each using sophisticated mathematical tools for modelling industrial problems in key sectors of the Canadian economy. MITACS was officially launched on February 19, 1999. By March 1999, all 21 initial research projects were under way.

MITACS leads Canada's effort in the generation, application and commercialization of new mathematical tools and methodologies within a world-class research program. The network initiates and fosters linkages with industrial, governmental, and not-for-profit organizations that require mathematical technologies to deal with problems of strategic importance to Canada. MI-

TACS is driving the recruiting, training, and placement of a new generation of personnel with highly mathematical skills that is vital to Canada's future social and economic well-being.

MITACS creates links between academia, industry and the public sector to develop cutting edge mathematical tools vital to a knowledge-based economy. The only Network of Centres of Excellence (NCE) for the mathematical sciences, MITACS currently has around four hundred scientists, one thousand students, and three hundred partner organizations working on its projects. To improve Canada's international competitiveness, MITACS research focuses on five key sectors of the economy:

- biomedical and health;
- environment and natural resources;
- information processing;
- risk and finance;
- communication, networks and security.

MITACS Inc. is a federally incorporated not-for-profit society formed to administer the MITACS Network of Centres of Excellence.

MITACS also gives financial support to some events organized by the CRM and other institutions. For instance, in 2007–2008, it supported, jointly with CRM, six activities within the thematic semester on applied dynamical systems. We refer the reader to the section on the CRM thematic program for more information on these activities. Furthermore, MITACS supported the workshop on Statistical Methods for Modeling Dynamic Systems and The 5th Montreal Scientific Computing Days (see the section on the CRM general program), and the First Montreal Industrial Problem Solving Workshop, the First CRM–INRIA–MITACS Meeting, the CRM–Fields–MITACS Workshop on Lie Groups, Group Transforms, and Image Processing, and finally the summer school on Systems Biology Dynamics: from Genes to Organisms (see the section on the CRM multidisciplinary and industrial program). The CRM is grateful to MITACS for its generous financial support in 2007–2008.

National Program on Complex Data Structures (NPCDS)

The NPCDS is a national network in the statistical sciences, conceived in partnership with the mathematics institutes. The broad goal of the program is to foster nationally coordinated projects with substantial interactions with the large community of scientists involved in the analysis of complex data sets, and to establish a framework for the national networking of re-

search activities in the statistical community. The original proposal targeted the development and application of statistical methods for the analysis of data obtained from complex survey sample designs and longitudinal biological, epidemiological and medical studies. More specific objectives of the program include the development of collaborations between university and extra-university researchers, and the provision of training for graduate students in important scientific areas through these collaborations.

NPCDS Projects

STATISTICAL METHODS FOR COMPLEX SURVEY DATA

Project Leader: Changbao Wu (Waterloo)

CANADIAN CONSORTIUM ON STATISTICAL GENOMICS

Project Leader: Rafal Kustra (Toronto)

DATA MINING WITH COMPLEX DATA STRUCTURES

Project Leaders: Hugh Chipman (Acadia), Antonio Ciampi (McGill), Theodora Kourti (McMaster), Helmut Kröger (Laval)

DESIGN AND ANALYSIS OF COMPUTER EXPERIMENTS FOR COMPLEX SYSTEMS

Project Leader: Derek Bingham (Simon Fraser)

FORESTS, FIRES AND STOCHASTIC MODELING

Project Leaders: John Braun (Western Ontario), Charmaine Dean (Simon Fraser), Dave Martell (Toronto)

SPATIAL/TEMPORAL MODELING OF MARINE ECOLOGICAL SYSTEMS

Project Leaders: Michael Dowd (Dalhousie), Joanna Flemming (Dalhousie), Chris Field (Dalhousie), Rick Routledge (Simon Fraser)

STATISTICAL INNOVATION FOR THE ANALYSIS OF COMPLEX DATA IN MEDICAL AND HEALTH SCIENCE

Project leaders: Richard Cook (Waterloo), Michal Abrahamowicz (McGill), Paul Gustafson (British Columbia), Wendy Lou (Toronto), Peter Song (Waterloo), Liqun Wang (Manitoba)

NPCDS Workshops

WORKSHOP ON APPLICATIONS OF CLIMATE STATISTICS IN AGRICULTURE

June 6–7, 2007, University of Regina

WORKSHOP AT DALHOUSIE ON STATISTICAL METHODS FOR MARINE ECOLOGICAL DATA

June 7–8, 2007, Dalhousie University

FIELDS WORKSHOP ON DISTURBANCES: MODELLING SPREAD IN FORESTS

November 22–23, 2007, University of Western

Ontario
sponsored by NPCDS and the Fields Institute
METHODODOLOGICAL NEEDS AND DESIRES IN
PUBLIC AND POPULATION HEALTH RESEARCH
April 25, 2008, University of British Columbia
sponsored by NPCDS and PIMS

Course

UNDERSTANDING AND MANAGING MISMEAS-
URED VARIABLES IN BIOSTATISTICAL ANALY-
SIS
April 24, 2008, University of British Columbia
sponsored by NPCDS and PIMS

Atlantic Association for Research in the Mathematical Sciences (AARMS)

AARMS was founded in March 1997 at a time when the National Network for Research in the Mathematical Sciences was being discussed and planned. AARMS exists to encourage and advance research in all mathematical sciences, including statistics and computer science, in the Atlantic region. In addition, AARMS acts as a regional voice in discussions of the mathematical sciences on a national level. Since its inception, AARMS has played an important role in the research activities in the Atlantic region, sponsoring or co-sponsoring numerous meetings and workshops. In the summer of 2002, AARMS initiated an annual Summer School for graduate students and promising undergraduates. AARMS is grateful to Canada's three mathematical institutes, the Centre de recherches mathématiques, the Fields Institute, and the Pacific Institute for the Mathematical Sciences, as well as to the member universities, for providing funding for its activities. Its member universities are Acadia University, Cape Breton University, Dalhousie University, Memorial University, Mount Allison University, St. Francis Xavier University, Saint Mary's University, the Université de Moncton, the University of New Brunswick and the University of Prince Edward Island.

AARMS Scientific Activities

WORKSHOP ON NONCOMMUTATIVE GEOME-
TRY
June 11–15, 2007, University of New Brunswick
Organizer: Dan Kucerovsky (New Brunswick)
AARMS/ACENET/MITACS SUMMER TRAIN-
ING WORKSHOP IN HIGH PERFORMANCE COM-
PUTING IN THE MATHEMATICAL SCIENCES
July 9–14, 2007, Acadia
Organizers: Hugh Chipman and Richard Karsten

(Acadia), Ronald Haynes (Memorial), Duane Currie (Acadia)

BLUENOSE NUMERICAL ANALYSIS DAY 2007
July 27, 2007, Saint Mary's University
Organizers: Patrick Keast (Dalhousie), Paul Muir (Saint Mary's), Richard Karsten (Acadia), Ronald Haynes (Memorial)

INTERNATIONAL WORKSHOP ON GROUPS,
RINGS, LIE AND HOPF ALGEBRAS II
August 13–17, 2007, Memorial
Organizer: Yuri Bahturin (Memorial)

4TH WORKSHOP ON COMBINATORIAL AND AL-
GORITHMIC ASPECTS OF NETWORKING
August 14, 2007, Dalhousie
Organizer: Norbert Zeh (Dalhousie)

10TH WORKSHOP ON ALGORITHMS AND DATA
STRUCTURES (WADS 2007)
August 15–17, 2007, Dalhousie
Organizer: Norbert Zeh (Dalhousie)

APICS MEETING: SPECIAL SESSIONS IN MATH-
EMATICS AND STATISTICS
October 12–13, 2007, University of New
Brunswick
Organizers: Colin Ingalls, Rolf Turner, Maureen Tingley (New Brunswick)

DALHOUSIE EULER SYMPOSIUM
October 26–27, 2007, Dalhousie
Organizers: Karl Dilcher, Roman Smirnov, S. Swaminathan (Dalhousie)

RELATIVITY IN CAPE BRETON: A GENERAL
RELATIVITY AND COSMOLOGY WORKSHOP
October 26–28, 2007, Mabou River Inn, Mabou,
Nova Scotia
Organizer: Robert van den Hoogen (St. Francis
Xavier)

JOINT AARMS/CRM WORKSHOP ON RECENT
ADVANCES IN FUNCTIONAL AND DELAY DIF-
FERENTIAL EQUATIONS
November 1–5, 2007, Dalhousie
Organizers: Hermann Brunner (Memorial), An-
thony R. Humphries (McGill), Dmitry Peli-
novsky (McMaster)
Local organizers: Patrick Keast (Dalhousie), Paul
Muir (Saint Mary's)

COMBINATORIAL ALGEBRA MEETS ALGEBRAIC
COMBINATORICS
January 18–20, 2008, Dalhousie
Organizers: Sara Faridi (Dalhousie), John Irving
(Saint Mary's), Hugh Thomas (New Brunswick)
2008 EAST COAST COMBINATORIAL CONFER-
ENCE
May 1–2, 2008, St. Francis Xavier University
Organizer: Stephen Finbow (St. Francis Xavier)

ATLANTIC CONFERENCE ON GENERAL RELATIVITY

May 10, 2008, University of New Brunswick
Organizer: Jack Gegenberg (New Brunswick)

WORKSHOP ON FOUNDATIONAL METHODS IN COMPUTER SCIENCE

May 30 – June 1, 2008, Dalhousie University
Organizers: Dorette Pronk and Peter Selinger (Dalhousie)

Academic Partners

The activities of the CRM rest on a solid basis of cooperation with regional universities, in particular the Montréal universities, and most particularly the Université de Montréal, whose support for the CRM has been unfailing. The Université de Montréal releases five of its faculty members to work at the CRM each year, and the support of these faculty members is an essential asset for the CRM's scientific activities. There is in addition a regular program of teaching releases with the other Montréal universities, bringing the equivalent of another two positions to the CRM each year. On an ad-hoc basis linked to the thematic program, the CRM has also been arranging the release of research personnel from nearby universities such as Laval, Sherbrooke, Queen's and Ottawa. The partnerships of the CRM with the other research institutes in the Montréal area have been very profitable.

With the financial support of the Université de Montréal, McGill University, the Université du Québec à Montréal, Concordia University, and Université Laval, as well as grants from NSERC and the Fonds québécois de recherche sur la nature et les technologies (FQRNT), the CRM finances the activities of its nine laboratories, which collectively represent the most active branches of the mathematical sciences. These laboratories are the perfect illustration of scientific vitality and serve to feed the national and international scientific programs of the CRM. Please refer to the section "Research Laboratories" for reports describing the activities of each of these laboratories.

Association with the University of Ottawa

In 2003, the Department of Mathematics and Statistics of the University of Ottawa became a member of the Centre de recherches mathématiques (CRM). In partnership with the University of Ottawa, the CRM co-finances the CRM–University of Ottawa Distinguished Lecture Series, postdoctoral fellowships, and teaching releases so that University of Ottawa faculty mem-

bers can undertake research with colleagues in the CRM's laboratories or participate in CRM scientific activities.

CRM – University of Ottawa Distinguished Lecture Series

The series features talks by prominent mathematicians from Canada and abroad on topics at the forefront of today's mathematical research.

Asymptotic Geometric Analysis; Geometrization of Probability

Vitali Milman (Tel Aviv), September 21, 2007

Freeness, von Neumann algebras and matricial microstates

Ken Dykema (Texas A & M), November 8, 2007

Network for Computing and Mathematical Modelling (ncm₂)

The CRM is one of the founding members of the Network for Computing and Mathematical Modeling (ncm₂), a network created by several research centres in order to respond to the needs of industry in fields related to computing and mathematical modeling. The research of the network focuses on five major themes: risk management, information processing, imaging and parallel computing, transport and telecommunications, and health and electronic commerce. The ncm₂ was founded by the CRM, the Centre de recherche en calcul appliqué (CERCA), the Center for Interuniversity Research and Analysis of Organizations (CIRANO), the Center for Research on Transportation (CRT), and the Group for Research in Decision Analysis (GERAD). Since then, three new members have joined the network: the Co-operative Centre for Research in Mesometeorology (CCRM), the Centre de Recherche Informatique de Montréal (CRIM), and the Institut National de la Recherche Scientifique-Énergie, Matériaux et Télécommunications (INRS-EMT).

Laboratoires universitaires Bell (LUB)

The CRM is an active participant in Laboratoires universitaires Bell, a joint project between the ncm₂ and Bell. The goal of the LUB is to make innovations in the field of multimedia research and applications (mainly interactive applications aimed at the general public, electronic commerce applications, and new generations of networks), as well as to promote the training of a highly qualified, international calibre workforce in these areas.

Québec Neuroimaging Initiative (RNQ)

In recent years, CRM's PhysNum laboratory has developed a strong collaborative network with various partners in neuroimaging in the Montréal area. This network became an officially recognized network with the founding of the "Regroupement Neuroimagerie Québec" (RNQ), under the umbrella of the Institut Uni-

versitaire de Gériatrie in Montréal. RNQ, with its 70 researchers, has recently purchased some key equipment in neuroimaging thanks to a very large grant (\$11M). One of the strongest alliances of the CRM within that network is its association with the INSERM laboratory for brain imaging at Jussieu – La Salpêtrière (Paris), whose director is Dr. Habib Benali.

Joint Initiatives

The annual meetings of the CMS, SSC and CAIMS, as well as some of their training and promotion activities, are jointly sponsored by the CRM, the Fields Institute, PIMS, and MITACS.

CAIMS Annual Meeting 2007

May 20 – 24, 2007, Banff Centre, Alberta

Chair: Peter Lancaster (Calgary)

CAIMS (Canadian Applied and Industrial Mathematics Society) held its 2007 annual meeting in Banff, Alberta. The meeting featured

- plenary lectures by Karl Hadeler, Phillip Colella, Nicholas Higham, Shui-Nee Chow, and William Symes,
- thematic symposia on mathematical biology, computational PDEs, applied linear algebra, and geophysical inversion theory, and
- contributed symposia on stochastic spatial models of biochemical systems, mathematical modelling and numerical simulation of flow of complex fluids, innovative numerical algorithms for ordinary and partial differential equations, mathematical tumor modelling, pattern formation with mean flow, dynamics of gene-regulatory networks, and numerical linear algebra and its applications.

The CAIMS Annual Meeting received financial support from CRM, the Fields Institute, PIMS, MITACS, Pearson Education, and the Canadian Applied Math Quarterly.

CMS-MITACS Joint Conference

May 31 – June 3, 2007, University of Manitoba

Scientific Directors: Don Dawson (Carleton) and Fereidoun Ghahramani (Manitoba)

In 2007, the CMS Summer Meeting was replaced by a joint conference with MITACS that was very successful. The following researchers gave plenary lectures at the conference: John Baldwin (Illinois, Chicago), Kristin Bennett (Rensselaer Polytechnic Institute), Richard Cleve (Waterloo), Richard Kenyon (UBC), Charles Read (Leeds), Arnold Rosenberg (Massachusetts, Amherst), and Dror Varolin (Stony Brook). The Jeffery-Williams Prize was awarded to Nassif Ghoussoub (UBC), the Krieger-

Nelson Prize to Pauline van den Driessche (Victoria), the CMS Excellence in Teaching Award to Brian Forrest (Waterloo), and the CMS Distinguished Service Award to Graham P. Wright (Ottawa).

The CMS-MITACS Joint Conference received financial support from the University of Manitoba, Simon Fraser University, CRM, the Fields Institute, PIMS, and the Institute for Quantum Computing. Here is a list of the scientific sessions of the joint conference.

ALGEBRAIC VARIETIES WITH GROUP ACTIONS
Organizer: Jaydeep Chipalkatti (Manitoba)

BANACH ALGEBRAS AND ABSTRACT HARMONIC ANALYSIS
Organizer: Yong Zhang (Manitoba)

COMPLEX FUNCTION THEORY
Organizers: Ian Graham (Toronto), Eric Schippers (Manitoba)

COMPUTER ALGEBRA AND COMPUTER ALGEBRA SYSTEMS
Organizer: Michael Monagan (Simon Fraser)

FINITE COMBINATORICS
Organizers: Robert Craigen and David Gundersen (Manitoba)

MATHEMATICAL ALGORITHMS FOR MEDICAL IMAGING
Organizer: Sima Noghianian (Manitoba)

MATHEMATICAL BIOLOGY
Organizers: Gerda de Vries (Alberta), Frithjof Lutscher (Ottawa)

MATHEMATICAL/COMPUTATIONAL FINANCE
Organizer: Ruppa K. Thulasiram (Manitoba)

MATHEMATICAL IMMUNOLOGY
Organizers: Beni Sahai (Caham Provincial Laboratory), Robert Smith (Ottawa)

MATHEMATICAL PHYSICS
Organizers: Richard Froese (UBC), Tom Osborn (Manitoba)

MATHEMATICS EDUCATION

Organizers: Abba Gumel (Manitoba), Randall Pyke (Simon Fraser)

MATHEMATICS OF INFECTIOUS DISEASES

Organizer: Abba Gumel (Manitoba)

MODEL THEORY AND ITS APPLICATIONS

Organizers: Bradd Hart (McMaster), Thomas Kucera (Manitoba), Rahim Moosa (Waterloo)

NETWORK ALGORITHMS

Organizer: Evangelos Kranakis (Carleton)

NONLINEAR METHODS IN COMPUTATIONAL MATHEMATICS

Organizer: Kirill Kopotun (Manitoba)

QUANTUM INFORMATION THEORY

Organizer: Richard Cleve (Waterloo)

REPRESENTATIONS OF FINITE AND ALGEBRAIC GROUPS

Organizers: Gerald Cliff (Alberta), Anna Stokke (Winnipeg)

RESOURCE ALLOCATION OPTIMIZATION

Organizers: Binay Bhattacharya and Abraham Punnen (Simon Fraser)

STATISTICAL LEARNING

Organizer: Yoshua Bengio (Montréal)

Annual Meeting of the Statistical Society of Canada

June 10–13, 2007, Memorial University

Program Committee: John Braun (Chair, Western Ontario); Biostatistics Section, Paul Gustafson (UBC); Business and Industrial Statistics Section, Gemai Chen (Calgary); Survey Methods Section, Milorad Kovacevic (Statistics Canada); Probability Section, Andrei Volodin (Regina)

Chair of the Local Arrangements Committee: Brajendra Sutradhar (Memorial)

The thirty-fifth Annual Meeting of the Statistical Society of Canada brought together researchers in statistics and probability and users from academia, government and industry. The meeting featured three workshops and sixty-one paper sessions (including a contributed poster session). SSC 2007 was sponsored by CRM, the Fields Institute, PIMS, MITACS, AARMS, the Department of Mathematics and Statistics and the Faculty of Science of Memorial University, Minitab, the SAS Institute, Inc., Pearson Education Canada, and Thomson Nelson.

The Presidential Invited Address was given by Norman Breslow (Washington), the Gold Medal Address by Chris Field (Dalhousie), and the CRM-SSC Award Address by Richard Cook (Waterloo). The Pierre-Robillard Award Address

was given by Mylène Bédard (Toronto) and the *Canadian Journal of Statistics* Award Address by Angelo Canty, Anthony Davison, David Hinkley, and Valérie Ventura, authors of the article “Bootstrap diagnostics and remedies”.

The Isobel Loutit Invited Address on Business and Industrial Statistics was given by Bo-vas Abraham (Waterloo), and the Special Invited Address of the Survey Methods Section by Robert Smith, Carolyn Cahill and Michael Bordt (Statistics Canada). The Special Invited Address of the Probability Section was given by Robert Elliott (Calgary), Tak Kuen Siu (Heriot-Watt), and Hailiang Yang (Hong Kong). Finally, the Inaugural Invited Lecture of the National Institute for Complex Data Structures was given by Andrew Lawson and Bo Cai (University of South Carolina).

CMS Winter 2007 Meeting

December 8–10, 2007, The University of Western Ontario

Meeting Director: J.F. Jardine (Western Ontario)

The plenary speakers were Marcelo C. Borba (UNESP-São Paulo State University), Erich Kaltofen (North Carolina), Mikhail Kapranov (Yale), Giovanni Landi (Trieste), Blaine Lawson (SUNY/Stony Brook), Seth Lloyd (MIT), and Otmar Venjakob (Heidelberg). The following prizes were awarded during the meeting: the Adrien Pouliot Award to Richard Nowakowski (Dalhousie), the Coxeter-James Prize to Vinayak Vatsal (British Columbia), the Doctoral Prize to Lap Chi Lau (Chinese University of Hong Kong), and the G. de B. Robinson Award to Ronald van Luijk (Simon Fraser and British Columbia).

The meeting received financial support from CRM, the Fields Institute, PIMS, and The University of Western Ontario. Here is a list of the scientific sessions of the meeting, along with their respective organizers.

ALGEBRAIC COMBINATORICS, REPRESENTATIONS AND GEOMETRY

Organizers: Lex Renner (Western Ontario), Benjamin Steinberg (Carleton)

ALGEBRAIC STACKS

Organizer: Ajneet Dhillon (Western Ontario)

ALGORITHMIC CHALLENGES IN POLYNOMIAL AND LINEAR ALGEBRA

Organizer: Stephen Watt (Western Ontario)

CALCULUS OF VARIATIONS IN PHYSICS, GEOMETRY AND ECONOMICS

Organizers: Robert McCann and Benjamin Stephens (Toronto)

COMBINATORICS AND ITS APPLICATIONS TO MATHEMATICAL PHYSICS

Organizers: Michael Gekhtman (Notre Dame), Michael Shapiro (Michigan State)

COMPLEX ANALYTIC GEOMETRY

Organizers: Tatyana Foth (Western Ontario), Finnur Larusson (Adelaide), Rasul Shafikov (Western Ontario)

ERROR CONTROL CODES, INFORMATION THEORY AND APPLIED CRYPTOGRAPHY

Organizers: Aiden Bruen (Calgary), David Wehlau (Queen's and RMC)

GRAPH THEORY

Organizers: Sebastian Cioaba (UC, San Diego), Stephen Kirkland (Regina), Claude Tardif (RMC)

HISTORY AND PHILOSOPHY OF MATHEMATICS

Organizers: Tom Archibald (Simon Fraser), Deborah Kent (Hillsdale College)

HOMOTOPY THEORY

Organizer: Kristine Bauer (Calgary)

IWASAWA THEORY

Organizers: Manfred Kolster and Romyar Sharifi (McMaster)

MATHEMATICAL APPLICATIONS OF CATEGORY THEORY

Organizers: F. William Lawvere (SUNY Buffalo), Walter Tholen (York)

MATHEMATICAL IMAGINATION

Organizer: George Gadanidis (Western Ontario)

MATHEMATICS OF FINANCE

Organizers: Matt Davison, Rogemar Mamon and Mark Reesor (Western Ontario)

NON-COMMUTATIVE GEOMETRY

Organizer: Masoud Khalkhali (Western Ontario)

NONLINEAR WAVE EQUATIONS AND APPLICATIONS

Organizers: Walter Craig (McMaster), Catherine Sulem (Toronto)

QUANTUM INFORMATION THEORY IN QUANTUM GRAVITY

Organizers: David Kribs (Guelph), Fotini Markopoulou (Perimeter Institute)

Mathematical Education

As part of its mandate to promote and stimulate research in the mathematical sciences, at every level, the CRM provides funding and support for many activities and programs related to mathematical education and the training of researchers. Many of these activities and programs are carried out jointly with the ISM (Institut des sciences mathématiques).

Institut des sciences mathématiques (ISM)

Created in 1991 by the departments of mathematics and statistics of the four Montréal universities, the ISM is a consortium of seven Québec universities (Concordia, Laval, McGill, Université de Montréal, UQAM, UQTR and Université de Sherbrooke), six of which offer a Ph.D. program in mathematics. As an institute to which belong almost all the Québec researchers in the mathematical sciences, the ISM has at its disposal vast material and intellectual resources, and as a result, Montréal and Québec itself have become one of the main centres of training and research in the mathematical sciences in North America. The ISM is funded by the Ministère de l'Éducation, du Loisir et du Sport du Québec and by the seven universities in the consortium.

The reader will find below an overview of the activities and programs of the ISM.

- Coordination and harmonization of graduate programs

The ISM was created to bring together the strengths of its member departments, in order to turn them into a great school of mathematics. Thus the ISM coordinates the graduate studies of the mathematics departments, supports the sharing of expertise among its researchers and facilitates student mobility between the Montréal universities.

- Scholarships and financial support

The ISM helps students and beginning researchers carry out their research activities in several ways, for instance through the ISM Scholarships for Graduate Studies, the Carl Herz Scholarship (financed by the Carl Herz Foundation), the Travel Bursaries, the Undergraduate Summer Scholarships and the CRM–ISM postdoctoral fellowships.

- Scientific activities

Since its creation, the ISM has initiated several activities that are by now an integral part of the Québec scientific scene: the CRM–ISM Mathematics Colloquium, the CRM–ISM–GERAD Statistics Colloquium, the ISM Graduate Student Conference and the ISM Graduate Student Seminar.

- Promotion of the mathematical sciences

The ISM produces the *Accromath* journal and distributes it freely in all the cégeps and secondary schools in Québec. In this way, it contributes to spreading mathematical knowledge among teachers, young students and the general public. Each year, ISM professors give talks attended by thousands of cégep students; these talks present the latest breakthroughs in mathematics and the careers available to mathematics graduates.

As the above list demonstrates, the CRM has several joint activities with the ISM, in particular two colloquia, a joint program of postdoctoral fellowships, and the planning of graduate courses related to the thematic programs of the CRM. Since the summer of 2003, the CRM has also supported the Undergraduate Summer Scholarships program, which allows postdoctoral fellows to supervise undergraduate students doing research.

CRM – ISM Postdoctoral Fellowships

The CRM–ISM postdoctoral fellowships enable promising young researchers to devote themselves to their research work. The ISM organizes a single competition on behalf of the seven universities of the consortium, and it receives a large number of applications, which are then evaluated by the 150 ISM professors. The selection of the fellows is rigorous and only one in forty applicants is awarded a fellowship. The applications are handled electronically in order to streamline the selection process and economize the resources consumed during the selection. The postdoctoral fellows play a crucial role in the Montréal universities: they collaborate with the established researchers, stimulate their work and bring new ideas from other great centres of mathematical research. Also they are a vital link between the professors and the students, especially when they organize on their own study groups on emerging topics.

2007 – 2008 Postdoctoral Fellows

Bryden Cais (Ph.D. 2007, Michigan) works in number theory with Professors Henri Darmon and Eyal Goren. In the fall of 2007, he co-

organized the McGill-Concordia Seminar on Berkovich Spaces.

Félix Carbonell (Ph.D. 2006, La Habana) works on medical imaging with Professor Keith Worsley. He will continue his postdoctoral internship at the Montreal Neurological Institute under the supervision of Alain Dagher and Amir Shmuel.

Stefan Friedl (Ph.D. 2003, Brandeis) works on the topology of 3-dimensional and 4-dimensional manifolds with Professors Olivier Collin and Steven Boyer (UQÀM). During his stay in Montréal he created a working group on low-dimensional topology. Stefan Friedl is now a professor at the University of Warwick in England.

Başak Gürel (Ph.D. 2003, UC at Santa Cruz) works on symplectic topology with Octav Cornea and François Lalonde. In 2007-2008, she co-organized the inter-university seminar in symplectic topology. She has accepted a tenure-track position at Vanderbilt University.

Seung-Yeop Lee (Ph.D. 2007, Chicago) works on the dynamics of two-dimensional fluids with Professors Marco Bertola, S. Twareque Ali and Dmitry Korotkin. He will take an active part in the thematic year on probabilistic methods in mathematical physics, which will take place at the CRM in 2008-2009.

Jecheon Park (Ph.D. 2007, Boston) works on algebraic number theory and p -adic modular forms with Professor Henri Darmon.

Igor Wigman (Ph.D. 2006, Tel Aviv) works in analysis with Professors Dmitry Jakobson and Iosif Polterovich.

Undergraduate Summer Scholarships

In collaboration with the CRM and the ISM professors, the ISM awards summer scholarships to promising undergraduates who want to do research during the summer and plan to study mathematics at the graduate level. These undergraduates are supervised by postdoctoral fellows, who in general are supervising students for the first time. The reader will find below the list of the undergraduate scholars.

Agnès Beaudry (McGill)

Topic: Theory of modular symbols for Hilbert modular forms

Duration: 3 months (June – August)

Supervisor: Jecheon Park

Professor Henri Darmon contributed to the financing of this scholarship.

Rachel Kidd (McGill)

Topic: Nodal sets of solutions to Schrödinger

equations

Duration: 6 weeks (June 1-July 15)

Supervisor: Igor Wigman

Professor Dmitry Jakobson financed half of this scholarship.

Yang Li (McGill)

Topic: Stochastic mathematical programming

Duration: 3 months (May-July)

Supervisor: Christophe Weibel

Professor Bruce Shepherd financed half of this scholarship.

Putra Manggala (McGill)

Topic: Probabilistic methods in discrete mathematics

Duration: 4 months (May-August)

Supervisor: Ross Kang

Professor Bruce Reed financed half of this scholarship.

Rosalie Plantefève (Montréal)

Topic: Introduction et analyse de la théorie des modèles de matrices aléatoires

Duration: 4 months (May-August)

Supervisor: Aleix Prats-Ferrer

Professor Yvan Saint-Aubin partially financed this scholarship.

Louis-Xavier Proulx (Montréal)

Topic: Chaos in the universal area-preserving map

Duration: 2 months (May-June)

Supervisor: Denis Gaidashev

Professor Christiane Rousseau financed half of this scholarship.

Adrian Walton (McGill)

Topic: Metric and topological properties of steady solutions to Euler and Navier-Stokes equations

Duration: one month (July 10-August 10)

Supervisors: Zhenbin Yan and Xiangjin Xu

Professor Dmitry Jakobson financed half of this scholarship.

Katherine Woodward (McGill)

Topic: Explicit computation of p -adic Gross-Stark units for a field Q

Duration: 3 months (June-August)

Supervisor: Jecheon Park

Professor Henri Darmon partially financed this scholarship.

ISM Graduate Student Conference

The tenth ISM Graduate Student Conference (Colloque panquébécois annuel des étudiants) was held from May 30 to June 1, 2008, at the Université de Montréal and UQÀM. It was organized by Radu Cepanu, Clément Hyvrier, and Liam Watson and the plenary lectures were

given by Patrick Ingram (Toronto), Dagan Karp (Berkeley), Luis Paris (Dijon), and Dale Rolfsen (UBC).

The following students gave talks during the Graduate Student Conference: Geneviève Paquin, Amel Kaouche, Gabriel Chênevert, Charles Bergeron, Mahmood Shabankhah, Valérie Hudon, Isabelle Ascah-Coallier, Dominique Guillot, Patrice Rivard, Hugues Lapointe, Ahmad Lavasani, Quentin Rajon, Caroline Lambert, Tayeb Aissiou, Adam Clay, and Othmane Kortbi.

Promotion of the mathematical sciences

Produced by the ISM and financed by the ISM, the CRM, the MITACS network and the Canadian Mathematical Society, the *Accromath* magazine aims to draw more young people to

the mathematical sciences. *Accromath*, whose editor-in-chief is André Ross, instructor of mathematics at the Cégep de Lévis-Lauzon, is available free of charge in all the high schools and cegeps of Québec. *Accromath* is designed by an exceptional team of researchers and instructors with a broad experience in the promotion of mathematics; it provides high school and cegep teachers with stimulating and topical articles on the most recent discoveries and applications, as well as articles on the history of mathematics and its links with the arts.

In January 2008 Marc Tison published an article entitled “Vendre les maths” in the *La Presse* newspaper. In this article he praised the *Accromath* magazine. For more information on *Accromath*, we refer the reader to the site www.accromath.ca.

Other joint initiatives

2007 AMQ Mathematics Camp

June 10–17, 2007, Université de Sherbrooke

In 2007 the Department of mathematics of the Université de Sherbrooke organized the mathematics camp of the Association mathématique du Québec (AMQ). Created in the sixties and drawing its inspiration from the Ross Program in the United States, the AMQ mathematics camp initially welcomed high school students and lasted one month each summer. There was no camp between 1967 and 1980, but starting in 1980, mathematics camps were organized by the Université de Sherbrooke (from 1980 to 1989), UQAC (in 1990), Université Laval (from 1991 to 1993), the Université de Montréal (from 1994 to 1997), UQTR (from 1998 to 2000), UQÀM (from 2001 to 2005), and Bishop’s (in 2006).

In 2007, the camp welcomed 25 participants from 19 different cegeps. The participants are chosen amongst the winners of the mathematics contest organized by the AMQ at the cegep level. The camp tutors are professors and university lecturers, industrial researchers, and graduate and undergraduate university students, who share their enthusiasm for mathematics with these highly talented students.

Sciences et mathématiques en action

The CRM contributes to the “Sciences et mathématiques en action” program, created by Professor Jean-Marie De Koninck from Université Laval in order to popularize mathematics and science in high schools and the general public. We refer the reader to the site www.smac.ulaval.ca for more information.

Research Laboratories

In 2007–2008 the CRM was encompassing nine research laboratories at the heart of the Québec mathematical community. These research groups act as focal points for local scientific activity and participate actively in the scientific programs of the CRM.

Applied Mathematics

Description

The research interests of the laboratory members are quite diverse although there are a number of common threads that make interchange and collaboration both possible and fruitful. Active areas of research represented within the laboratory include, for example, the application of dynamical systems theory to complex phenomena, high-dimensional chaos, and biology. There is an interest in numerical linear algebra and its applications, including the design, analysis, and implementation of effective computer algorithms. Amongst the membership one will also find expertise in numerical simulation, applied dynamical systems, quantum chemistry, turbulence, combustion, biomechanics, numerical methods in fluid mechanics and electromagnetism, hp-finite element methods, molecular dynamics, control, optimization, preconditioners, and large-scale eigenvalue problems. As irrefutable evidence of the excellence of the research conducted by laboratory members we present below some of the prizes, honours, and distinctions awarded to them in recognition of their achievements, as well as information on invitations received to speak at prestigious scientific meetings.

The diversity of research expertise of the laboratory members is regarded by the laboratory as positive and enriching and leads to stimulating common seminars and workshops, for example, as ideas are exchanged and links forged between different people and subject areas. Indeed, the objective of the laboratory is principally to foster and encourage collaboration and scientific interchange between its own members, with other researchers in Montréal, as well as with the numerous visitors and conference and seminar speakers invited to Montréal by members of the laboratory. The weekly applied mathematics seminar is a core laboratory event and an important gathering point for the members, their research personnel, and other interested parties.

The CRM applied mathematics laboratory was very pleased to be able to add two more professors to the membership list in 2007–2008. The arrival of Lennaert van Veen as an assistant professor in applied mathematics at Concordia

University and the wish of Professor Xiao-Wei Chang (Computer Science, McGill) to join the laboratory have raised its membership to 15 full members, in addition to its complement of 4 associate members. Their addition to the laboratory bolsters further its very solid academic reputation. Although warmly congratulating them on their success in securing excellent professorial positions outside Québec and wishing them well for the future, the laboratory will be sorry to lose three very valued members in 2008-2009. Paul Tupper, Nilima Nigam, and Thomas Wihler, all three from the Department of Mathematics and Statistics at McGill University, will be sorely missed.

News and highlights

The outstanding research accomplishments over the last year or so of members of the laboratory have been recognized through the award of a number of prizes and nominations. Last year, André Bandrauk was nominated Fellow by the Humboldt Foundation, allowing him to make three visits, each of four months, to the Free University of Berlin and to the Max Born Institute (in 2007, 2008, and 2009). In March 2008 André was elected a Fellow of the American Physical Society (APS). Tucker Carrington, now holder of a Tier 1 Canada Research Chair at Queen's University, Ontario, was also made a Fellow of the APS (chemical physics division). In March 2008, André Bandrauk was awarded (together with Paul Corkum, Senior Scientist at the National Research Council Steacie Institute) the 2007 John C. Polanyi Award from NSERC, its most prestigious prize (worth \$250,000). André Bandrauk was also awarded an honorary doctorate by the Free University of Berlin in July 2008.

Also in 2007, Nilima Nigam was one of 50 recipients across Canada of an NSERC Discovery Accelerator Supplement, valued at \$40,000 per annum for three years. She and Paul Tupper will be taking up Tier 2 Canada Research Chairs at Simon Fraser University in the summer of 2008. Jacques Bélair will be the president of the Canadian Applied and Industrial Mathematics Society from 2009 onwards. Tucker Carrington was a Visiting Professor at the Université Louis Pasteur in Strasbourg in June and July of 2008. Robert Owens will be an "hôte académique" at

the Institute of Analysis and Scientific Computing (EPFL, Switzerland) during the 2008-2009 academic year.

As testimony to the high profile and standing enjoyed by many of the laboratory's members in their chosen research fields, a very large number (estimated to be easily more than 50 and almost certainly closer to 100) of invitations to give seminars and lecture courses were received by them in 2007–2008. Although we cannot list all the invitations, we mention, for example, the series of 10 Humboldt lectures delivered by André Bandrauk in October and November 2007 on "Attosecond Science - The New Frontier" in Heidelberg, Berlin, Dresden, Marburg, Würzburg, as well as 4 graduate lectures that he delivered in the Freie Universität Berlin. Also noteworthy is the lecture course on computational methods that was delivered by Anne Bourlioux in the 2008 Summer School of the Atlantic Association for Research in the Mathematical Sciences (AARMS) in Fredericton (New Brunswick) from July 13 to August 9, 2008.

Students, postdoctoral fellows, and visitors

Evidence of the strong commitment of the laboratory to the training of research personnel may be seen in the budgetary statement for 2007–2008, and during this time three postdoctoral researchers (Miguel Moyers-Gonzalez, Abderazak Ramadane, and Jason Cooper) were supported financially. The identification and recruitment of high-quality postdoctoral research assistants continues to be a challenge for the laboratory but it will continue to tackle this challenge in the coming months and years; indeed, the recruitment of postdoctoral researchers is a major priority of the laboratory.

In 2007–2008, 12 master's students, 24 Ph.D. students, and 11 postdoctoral fellows were supervised by Laboratory members.

Seminars

The seminar programme has the dual aim of presenting new research ideas to the membership and providing the chance for the speaker's host to enjoy an extended time of research with his or her visitor, since when the latter comes from outside Montréal it is often the case that he or she will stay for at least a couple of days. An even more generous allowance will be made in the 2008–2009 budget to fund the laboratory's visitor/speaker programme in recognition of the positive impact that this has on the vitality of the research of the host members.

The main regular applied mathematics laboratory scientific event is without doubt the weekly seminar. We thank Robert Owens and Paul Tupper for having taken on the organization of this key event in 2007–2008 and look forward with excitement to the program that is being prepared by Xiao-Wen Chang and Lennaert Van Veen for 2008–2009. During the autumn and winter semesters no fewer than 26 seminars were given in most areas of interest to the laboratory, by speakers that included Ilse Ipsen (North Carolina State), Louis Rossi (Delaware), Béatrice Rivière (Pittsburgh), Samuel Isaacson (Utah), Tim Phillips (Cardiff), Jayme de Luca (Universidade Federal de São Carlos, São Paulo, Brazil), Nathalie Lanson (Waterloo), Yves Bourgault (Ottawa), Andrei Draganescu (Maryland), David Bindel (Courant Institute), Brian Moore (Central Florida), Sean Bohun (UOIT), Alex Barnett (Dartmouth), Marc Embree (Rice), Victor LeBlanc (Ottawa), and Michael Haslam (York).

Two applied maths colloquia were delivered during the academic year 2007–2008, by Tim Phillips (Cardiff), who spoke on lattice Boltzmann methods for single and multi-phase flows, and by Steve Vavasis (Waterloo), who spoke on "Greedy algorithms and complexity for non-negative matrix factorizations". In addition to organising those colloquia and the seminar and defraying the associated expenses, the laboratory was also a sponsor of the Computational Sciences and Engineering Seminar at McGill, whose organising committee included laboratory members Peter Bartello, Xiao-Wen Chang, and Thomas Wihler. Around 13 talks were given in this series.

Workshops, special sessions, and others

The laboratory played an important role in the organization and sponsorship of the 2007 CRM thematic semester on applied dynamical systems that took place between June and December 2007. We refer the reader to the section of this report concerning the CRM Thematic Program. Two Aisenstadt chairs (John Tyson and John Rinzel) were partially supported by the laboratory as part of the semester. The two advanced graduate courses delivered during the semester were given respectively by lab members Paul Tupper ("A practical introduction to stochastic differential equations") and Eusebius Doedel ("Numerical analysis of nonlinear equations"). A full article describing the thematic semester and written by Tony Humphries may be found in the Spring 2008 issue of *Le Bulletin du CRM*.

Organizing conferences in industrial applied mathematics is also an important activity for the members of the applied maths laboratory. Odile Marcotte (CRM and UQÀM) and Anne Bourlioux (Montréal) were among the organizers of the First Montréal Industrial Problem Solving Workshop, which took place on August 20–24, 2007. For more details on this workshop, which was supported by the MITACS and ncm₂ networks, we refer the reader to the section on the CRM Multidisciplinary and Industrial Program. In 2008, Nilima Nigam was a member of the scientific committee for the second Fields-MITACS Industrial Problem Solving Workshop (held at the Fields Institute in August 2008). The objective of these workshops (and a similar one organized by the PIMS institute) is to gather industry representatives, academic researchers, graduate students, and postdoctoral fellows to work on concrete problems proposed by industry.

Michel Delfour and Jean-Paul Zolésio organized an invited session on “Static and Moving Geometries as Modeling and/or Control Variables” within the 23rd IFIP TC 7 Conference on System Modeling and Optimization. This conference took place on July 23–27, 2007, in Cracow. Michel Delfour organized two mini-symposia at the 6th International Congress on Industrial and Applied Mathematics in Zürich (July 16–20, 2007); he was also a member of the program committee. Paul Arminjon participated in this congress and Thomas Wihler was a co-organizer, at the same congress, of a two-part mini-symposium on advances in discontinuous Galerkin methods.

The annual Montréal Scientific Computing Days conference serves to teach and undergird the graduate and postgraduate community, both in Montréal and further afield in Québec, Ontario, and abroad. The 2008 Computing Days meeting was longer and more ambitious than ever and was juxtaposed with a highly successful CRM-INRIA-MITACS meeting on the theme of mathematics in medicine. The Computing Days were sponsored by MITACS and by the laboratory. The financial support allowed travel and subsistence bursaries to be made available to attendees coming from outside Montréal. An important element of the Computing Days is the opportunity that is given to junior researchers to present their work to their peers and a prize was awarded for the best presentation. The reader will find a complete report on the Computing Days in the section on the CRM General Program and a complete report on the CRM-INRIA-

MITACS Meeting in the section on the CRM Multidisciplinary and Industrial Program.

- THE 5TH MONTREAL SCIENTIFIC COMPUTING DAYS

April 30–May 2, 2008, CRM

Organized by the Applied Mathematics Laboratory

Sponsored by MITACS

Organizers: Michel Delfour (Montréal), André Fortin (Laval), Thomas P. Wihler (McGill)

- FIRST CRM-INRIA-MITACS MEETING

May 5–9, 2008, CRM

Sponsored by CRM, the Institut National de Recherche en Informatique et Automatique (INRIA), and MITACS

Organizers: Michel Delfour (Montréal, president), Yves Bourgault (Ottawa), Fahima Nekka (Montréal), Marc Thiriet (INRIA and CNRS)

Members of the laboratory

Regular members

ROBERT G. OWENS (Montréal), *Director*
Mechanics, numerical simulation of complex fluids

PAUL ARMINJON (Montréal)
Numerical methods in fluid mechanics

ANDRÉ D. BANDRAUK (Sherbrooke)
Quantum chemistry

PETER BARTELLO (McGill)
Turbulence, CFD

JACQUES BÉLAIR (Montréal)
Dynamical systems in physiology

ANNE BOURLIOUX (Montréal)
Modeling, numerical simulation in turbulent combustion

XIAO-WEN CHANG (McGill)
Numerical linear algebra and applications

MICHEL C. DELFOUR (Montréal)
Control, optimization, design, shells, calculus, biomechanics

EUSEBIUS J. DOEDEL (Concordia)
Numerical analysis, dynamical systems, differential equations, bifurcation theory, scientific software

ANTONY R. HUMPHRIES (McGill)
Numerical analysis, differential equations

SHERWIN A. MASLOWE (McGill)
Asymptotic methods, fluid mechanics

PAUL F. TUPPER (McGill)
Numerical analysis, stochastic processes, statistical mechanics

LENNAERT VAN VEEN (Concordia)
Application of dynamical systems theory to

complex phenomena and high-dimensional chaos

THOMAS P. WIHLER (McGill)

Numerical analysis, computational methods for PDEs

JIAN-JUN XU (McGill)

Asymptotics and numerical analysis, nonlinear PDEs, materials science

Associate members

TUCKER CARRINGTON (Queen's)

Chemical dynamics

MARTIN J. GANDER (Genève)

Domain decomposition, preconditioning

NILIMA NIGAM (McGill)

Applied analysis, numerical methods in electromagnetism

JEAN-PAUL ZOLÉSIO (INRIA Sophia-Antipolis)

Control, optimization

CICMA

Description

This centre comprises researchers working in number theory, group theory and algebraic geometry. Contemporary number theory follows two major courses. On the one hand, there is the theory of special values of L -functions attached to arithmetic objects, originating in the work of Gauss and Dirichlet and leading to the modern conjectures of Deligne, Beilinson and Bloch–Kato. On the other hand, the Langlands program postulates a close link between arithmetic L -functions and automorphic representations. An area where these two currents intersect is the study of elliptic curves. This area is particularly well represented in the Centre, with Darmon, Iovita, and Kisilevsky. CICMA also acquired an expertise in many aspects of analytic number theory when Andrew Granville, one of the leaders in the field, became a member of CICMA. On the group theory side, Kharlampovich and Miasnikov are world-renowned specialists on group varieties and McKay is one of the originators of the moonshine program.

The problems to be studied by the group in the coming years include the construction of rational points on elliptic curves both from the algorithmic and theoretical viewpoints; zeta functions of varieties over finite fields and the algorithmic approach; canonical lifting of elliptic curves and Abelian varieties; cryptography, Abelian varieties, and many aspects of analytic number theory, for instance averages of special values of L -functions, distribution of prime numbers and prime divisors, and problems in additive number theory.

News and highlights

Chantal David was an invited professor at the Université de Nancy for one month, in June 2008. Andrew Granville was awarded the pres-

tigious Chauvenet Prize (2008) of the Mathematical Association of America and was invited to give a plenary talk at the MAA annual meeting in Washington. He also gave a plenary talk at the Canada-France Congress, held at UQAM (Montréal) in June 2008. Adrian Iovita was awarded the Ribenboim Prize of the Canadian Number Theory Association and gave a plenary talk during the CNTA 2008 meeting. Henri Darmon was awarded the Killam Prize by the Canada Council for the Arts and a Discovery Accelerator Supplement by NSERC. Matthew Greenberg, a CICMA student who defended his thesis in 2006, was awarded the 2008 Doctoral Prize of the Canadian Mathematical Society.

Students, postdoctoral fellows, and visitors

In 2007–2008, CICMA hired four new postdoctoral fellows: Bryden Cais (Michigan State), Riad Masri (Texas), JeeHoon Park (Boston), and Arnaud Chadozeau (Lille). The following students defended their thesis in 2007–2008: Gabriel Chênevert (who was supervised by Eyal Goren) and Shahab Shahabi (who was supervised by Henri Darmon). Also, in 2007–2008, 23 master's students, 36 Ph.D students, and 16 postdoctoral fellows were supervised by CICMA members.

Seminars

The Québec–Vermont Number Theory Seminar is the main scientific activity of CICMA, is held every second Thursday for a full day, and is attended by about 30 regular participants from Montréal, Vermont, Québec, and Ottawa. In 2007–2008, Eyal Goren and Henri Darmon were the organizers of the seminar and the latter consisted of 40 lectures. We also mention an activity related to the seminar, a mini-conference on Galois Groups held in Novem-

ber 2007 to mark the 65th anniversary of John Labute. The complete program of the Québec-Vermont Number Theory Seminar may be found at the following address: www.math.mcgill.ca/darmon/qvnts/07-08/qvnts.

Workshops, special sessions, and others

In 2007–2008, CICMA members were involved in the organization of the Maine/Québec Number Theory Conference, which took place at the University of Maine, Orono, on September 29 and 30, 2007. CICMA also organized a conference in honour of John Labute; the reader may find a report on this conference in the section on the CRM general program.

- CONFERENCE IN HONOUR OF JOHN LABUTE
November 15–16, 2007, McGill University and CRM

Sponsored by McGill University and CRM

Organizers: Henri Darmon (McGill) and Eyal Goren (McGill)

Regular members of the laboratory

HENRI DARMON (McGill), *Director*

Algebraic number theory, geometry, arithmetic, L -functions, diophantine equations, elliptic curves

CHRIS CUMMINS (Concordia)

Group theory, modular functions, moonshine

CHANTAL DAVID (Concordia)

Analytic number theory, L -functions

JEAN-MARIE DE KONINCK (Laval)

Analytic number theory: distribution of prime numbers, factorization of numbers, asymptotic behaviour of arithmetic functions, Riemann zeta function

DAVID S. DUMMIT (Vermont)

Algebraic number theory, arithmetic algebraic geometry, computational mathematics

DAVID FORD (Concordia)

Computational number theory, algorithmic number theory

EYAL Z. GOREN (McGill)

Arithmetic geometry, algebraic number theory, moduli spaces of abelian varieties, Hilbert modular forms, p -adic modular forms

ANDREW GRANVILLE (Montréal)

Analytic number theory, arithmetic geometry, combinatorics

ADRIAN IOVITA (Concordia)

Number theory, p -adic cohomology

OLGA KHARLAMPOVICH (McGill)

Combinatorial theory of groups and Lie algebras

HERSHY KISILEVSKY (Concordia)

L -functions, Iwasawa theory, elliptic curves, class field theory

JOHN LABUTE (McGill)

Pro- p -groups, Lie Algebras, Galois Theory

CLAUDE LEVESQUE (Laval)

Algebraic number theory, units, class number, cyclotomic fields

MICHAEL MAKKAI (McGill)

Mathematical logic

JOHN MCKAY (Concordia)

Computational group theory, sporadic groups, computation of Galois groups

ALEXEI G. MIASNIKOV (McGill)

Group theory

M. RAM MURTY (Queen's)

Number theory: Artin's conjecture, elliptic curves, modular forms, automorphic forms, Langlands program, Selberg's conjectures, sieve methods, cryptography

DAMIEN ROY (Ottawa)

Transcendental number theory

PETER RUSSELL (McGill)

Algebraic geometry

FRANCISCO THAINE (Concordia)

Cyclotomic fields, cyclotomy, rational points on curves

CIRGET

Description

Geometry and topology are fundamental disciplines of mathematics whose richness and vitality have been evident throughout human history and reflect their deep link to our experience of the universe. They are a focal point of modern mathematics and in effect several domains of mathematics have recently shown a strong trend towards a geometrization of ideas and meth-

ods: two cases in point are mathematical physics and number theory. During the last twenty-five years, several researchers of international calibre in geometry and topology have been hired by Québec universities. The research centre, based at UQÀM, now comprises eighteen professors together with a large number of postdoctoral fellows and graduate students. The main themes to be pursued in the coming years include the topological classification of 3-dimensional man-

ifolds; quantization of Hitchin systems and the geometric Langlands program; classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; non-linear partial differential equations in Riemannian geometry, convex geometry, and general relativity; and Hamiltonian dynamical systems.

News and highlights

Vestislav Apostolov, Octav Cornea, and Pengfei Guan were actively involved in the CRM thematic semester on Dynamical Systems and Evolution Equations, organizing two workshops (see below). In addition, Cornea was one of the main scientific organizers of the Second Canada-France Congress held at UQÀM, a conference that hosted over 800 mathematicians and was the largest mathematics conference ever held in Canada. CIRGET helped organize and fund three of the scientific sessions.

The computer infrastructure of CIRGET received a great boost this year thanks to an NSERC research tools grant. The Centre was awarded over \$100,000 to revamp its computer laboratory. The equipment should be fully updated by the end of 2008.

Students, postdoctoral fellows, and visitors

Graduate students and postdoctoral fellows are an integral part of CIRGET scientific life, organizing working groups and seminars, mentoring undergraduate students, and occasionally giving specialized courses. All of our finishing postdoctoral fellows and doctoral students have moved on to good positions. Başak Gürel has been hired as a tenure-track professor at Vanderbilt University, Stefan Friedl is now a tenure-track professor at Warwick, Ozgür Ceyhan accepted a position at the Max Planck Institute in Bonn, and Shengda Hu will be working at the University of Waterloo. Our Ph.D. graduates will be moving on to positions in Canada, France, and Great Britain. In 2007–2008, CIRGET members supervised 10 postdoctoral fellows, 17 doctoral students, and 22 master's students. In addition, 7 undergraduate students carried out summer research projects under the supervision of CIRGET members in 2008.

CIRGET members also greatly benefit from the many international visitors who come to work with them. In addition to the approximately 20 short-term visitors who came for visits in 2007–08, Paul Biran from the University of Tel Aviv spent 6 months at CIRGET to work with Octav Cornea.

Seminars

The everyday scientific life of CIRGET revolves around its weekly seminars and working groups where professors, postdoctoral fellows, and students meet on a regular basis. The CIRGET Geometry and Topology Seminar, organized by Vestislav Apostolov, is a general seminar series attended by all CIRGET members. Of the 28 talks given this year, 16 were given by invited speakers who stayed at the centre for short research visits. To complement this general seminar, CIRGET members organized three specialized seminars: the Symplectic Topology Seminar (organized by postdoctoral fellows Başak Gürel, Shengda Hu, and Martin Pinsonnault), the Geometric Group Theory Seminar (organized by Daniel Wise and Olga Kharlampovich), and the Algebraic Geometry Seminar (organized by Steven Lu and Peter Russell). Finally, CIRGET graduate students from UQÀM, Université de Montréal, and McGill continued to participate in the CIRGET Junior Seminar, organized by the doctoral student Liam Watson. This seminar gives graduate students a forum to present their research to their peers. A total of 22 talks were given this year.

CIRGET working groups meet on a regular basis to explore specific topics over a period of several months or more. This year two working groups were organized, one by Vestislav Apostolov on Kählerian Geometry, and another one by the postdoctoral fellow Stefan Friedl on low-dimensional topology with a view towards Heegaard-Floer homology.

Workshops, special sessions, and others

CIRGET members organized three workshops this year at the CRM, two of which were part of the Winter 2008 Thematic Semester on Dynamical Systems and Evolution Equations. The report on the first workshop may be found in the section on the CRM general program, and the reports on the other two in the section on the CRM thematic program.

- NON-LINEAR INTEGRAL TRANSFORMS: FOURIER-MUKAI AND NAHM
August 27–31, 2007, CRM
Organizers: Benoit Charbonneau (Duke), Jacques Hurtubise (McGill), Marcos B. Jardim (Campinas), Eyal Markman (University of Massachusetts Amherst)
- GEOMETRIC EVOLUTION EQUATIONS
April 16–27, 2008
Organizers: Vestislav Apostolov (UQÀM),

Pengfei Guan (McGill), and Alina Stancu (Concordia)

- FLOER THEORY AND SYMPLECTIC DYNAMICS
May 19 – 24, 2008

Organizers: Octav Cornea (Montréal), Leonid Polterovich (Tel Aviv), and Felix Schlenk (Université Libre de Bruxelles)

CIRGET also contributed to the funding and organization of three sessions of the Second Canada-France Congress, held on June 1-6, 2008, at UQÀM.

- GEOMETRIC AND NONLINEAR ANALYSIS
<http://www.cms.math.ca/Events/summer08/abs/gna.html#va>

Organizers: Pengfei Guan (McGill) and Emmanuel Hebey (Cergy)

The session on “Geometric and Nonlinear Analysis” had 13 speakers from France and Canada, more than two thirds of whom represented the top young researchers in geometric analysis from these countries. The talks covered some of the most recent results for nonlinear partial differential equations in connection with a broad range of areas in differential geometry: conformal geometry, G2 geometry, Kähler geometry, Kerr geometry in general relativity, and minimal surfaces.

- SYMPLECTIC AND CONTACT GEOMETRY
<http://www.cms.math.ca/Events/summer08/abs/sct.html#da>

Organizers: Emmanuel Giroux (CNRS-ENS Lyon) and Yael Karshon (Toronto)

The “Symplectic and Contact Geometry” session featured eleven speakers. Of these, six were French or based in France, and five were Canadian or based in Canada. We emphasized recent contributions of young mathematicians; almost all of our speakers were within ten years of their PhD. The talks covered a variety of topics, including new constructions in mirror symmetry, various aspects and variants of Lagrangian Floer homology, generalized pseudo-holomorphic curves, Mather theory in symplectic manifolds, symplectic and contact homology, overtwistedness in high-dimensional contact manifolds, coisotropic intersections, ball-embeddings in symplectic four-manifolds, and Kirwan surjectivity for hyper-Kähler manifolds.

- TOPOLOGY, KNOTS AND RELATED FIELDS
<http://www.cms.math.ca/Events/summer08/abs/top.html#hb>

Organizers: Michel Boileau (Toulouse) and Steven Boyer (UQAM)

This session brought together most of the top young researchers in low-dimensional topology based in France or Canada, as well as a sprin-

gling of more senior mathematicians. There were sixteen talks covering a number of contemporary research topics including (Heegaard) Floer theory, Ricci flow, spectral flow and Casson’s invariant, the representation theory, deformations, and virtual properties of the fundamental groups of 3-manifolds, symmetries, dominations, and embeddings of 3-manifolds, finite type invariants of knots, and braid groups.

Members of the laboratory

Regular members

STEVEN BOYER (UQÀM), *Director*
Topology of manifolds, low-dimensional geometry and topology

VESTISLAV APOSTOLOV (UQÀM)
Complex geometry, Kähler geometry

ABRAHAM BROER (Montréal)
Algebraic transformation groups, invariant theory

VIRGINIE CHARETTE (Sherbrooke)
Discrete group actions on affine varieties, Lorentz manifolds, Riemann surfaces discretization, discrete differential geometry

OLIVIER COLLIN (UQÀM)
Invariants of knots and 3-manifolds arising from global analysis

OCTAVIAN CORNEA (Montréal)
Algebraic topology, dynamical systems

PENGFEI GUAN (McGill)
Partial differential equations, geometric analysis, several complex variables

JACQUES HURTUBISE (McGill)
Algebraic geometry, integrable systems, gauge theory, moduli spaces

ANDRÉ JOYAL (UQÀM)
Algebraic topology, category theory

NIKY KAMRAN (McGill)
Geometric approach to partial differential equations

FRANÇOIS LALONDE (Montréal)
Symplectic topology and geometry, global analysis on manifolds, infinite dimensional transformation groups

STEVEN LU (UQÀM)
Chern number inequalities, semi-stability of tensorial sheaves, log jets, log and hyperbolic geometry, algebraic degeneracy

IOSIF POLTEROVICH (Montréal)
Geometric analysis, spectral theory, functional analysis, differential geometry, partial differential equations

PETER RUSSELL (McGill)

Algebraic geometry

DANIEL T. WISE (McGill)

Geometric group theory, low-dimensional topology

Associate members

SYED TWAREQUE ALI (Concordia)

Coherent states, wavelets, quantization techniques, harmonic analysis, Wigner functions

JOHN HARNAD (Concordia)

Mathematical physics, classical and quantum physics, geometrical methods, integrable systems, group theoretical methods, random matrices, isomonodromic deformations, isospectral flows

JOHN A. TOTH (McGill)

Spectral theory, semi-classical analysis, microlocal analysis, Hamiltonian mechanics

INTRIQ

Description

The central theme of INTRIQ (INstitute for Transdisciplinary Research in Quantum computing) is quantum information. Quantum information is the generalization of the classical notion of information, obtained by including the most fundamental law of physics, i.e., quantum mechanics. Indeed, classical information can be derived from quantum information when decoherence is present. Until now, in most fields related to information, quantum effects have often been neglected. For instance, when information is transmitted through optical fibres, the transmitted information is classical because the number of photons used to transmit this information is so large that quantum effects barely enter the picture and can easily be neglected. However, thanks to the impressive recent advances in the development of optical communication and fibre technologies, it has become possible to send single photons, so that an understanding at the quantum level becomes necessary. In fact, nowadays, commercial devices can be acquired that transmit quantum information (for example, id Quantique and MagiQ). A very similar pattern is starting to emerge in the field of information processing, where the increasing miniaturization of our electronic components will have the consequence that information is not processed by billions of electrons at a time but only a small number. This implies that the quantum nature of devices will become more and more important. The same is true of magnetic memories, which might ultimately be based on single spins. Hence it is no longer unreasonable to think that parts of our information support will soon be of a quantum nature.

News

In April 2008, INTRIQ became a “regroupement stratégique” financed by FQRNT.

Activities

In 2007, Michael Hilke organized a mini-workshop on quantum information at McGill University. David Avis was Co-chair of the Program Committee of The Second International Conference on Quantum, Nano, and Micro Technologies (ICQNM 2008, February 10–15, 2008, in Sainte-Luce, Martinique). Gilles Brassard was Keynote Speaker at ICQNM 2008.

Members of the Laboratory

Quantum information brings together many different fields, including computer science, engineering, and physics, which are all represented in INTRIQ. At the Université de Montréal the INTRIQ members are: Michel Boyer (Computer Science), Gilles Brassard (Computer Science), Richard Mackenzie (Physics), Louis Salvail (Computer Science, new member), and Alain Tapp (Computer Science). At the École Polytechnique the INTRIQ members are: José Manuel Fernandez (Computer Engineering), Nicolas Godbout (Engineering Physics), and Suzanne Lacroix (Engineering Physics). At the Université de Sherbrooke the INTRIQ members are: Alexandre Blais (Physics), Patrick Fournier (Physics), and David Poulin (Physics, new member). At McGill University the INTRIQ members are: David Avis (Computer Science), Aashish Clerk (Physics), Claude Crépeau (Computer Science), Guillaume Gervais (Physics), Peter Grütter (Physics), Hong Guo (Physics), Patrick Hayden (Computer Science), Michael Hilke (Physics, INTRIQ Director), Zetian Mi (Electrical Engineering), and Thomas Szkopek (Electrical Engineering).

LaCIM

Description

LaCIM (French acronym meaning “Combinatorics and Mathematical Computer Science Laboratory”) is home to mathematics and theoretical computer science researchers whose interests comprise discrete mathematics and the mathematical aspects of computer science. LaCIM was founded in 1989 and is associated with the Department of Mathematics, the Department of Computer Science, and the Canada Research Chair in Algebra, Combinatorics and Mathematical Computer Science of the Université du Québec à Montréal. LaCIM includes 15 regular members (of which 9 are UQÀM professors), 5 associate members and 14 collaborating members. It welcomes postdoctoral fellows and its regular members supervise or co-supervise many M.Sc. or Ph.D. students, undergraduate students who do research work during the summer, and some cégep students. Many renowned mathematicians visit LaCIM and collaborate with its members in the following areas: enumerative and bijective combinatorics, theory of species, algebraic combinatorics, combinatorics of finite and infinite words, discrete geometry, theory of languages and automata, Gray codes, bioinformatics and combinatorial optimization.

News and highlights

In 2007–2008, the LaCIM members took an active part in the organization of several conferences and workshops. Srečko Brlek was a member of the Program Committee and the Organizing Committee of Words 2007, which took place at CIRM (Marseille) from September 17 to 21, 2007. Christophe Reutenauer was one of the organizers of “Shuffles, Descent and Representations - A conference in memory of Manfred Schöcker”, which took place from September 10 to 14, 2007, in Nice. François Bergeron was one of the organizers of the workshop on “Applications of Macdonald polynomials”, at the Banff International Research Station (September 9 to 14, 2007). Alain Goupil was one of the organizers of the “Congrès annuel de l'Association mathématique du Québec” (Trois-Rivières, October 12–13, 2007). Robert Bédard was a member of the organizing committee of the VIth Colloquium on Module Theory and Related Topics (UQÀM, February 15, 2008). Pierre Leroux organized, in collaboration with Abdelmalek Abdesselam (University of Virginia), the conference

on “Combinatorial Identities and their Applications in Statistical Mechanics” at the Newton Institute (University of Cambridge, April 7–11, 2008). Finally, Srečko Brlek was a member of the program committee of IWCIA'08 (International Workshop on Combinatorial Image Analysis), which took place in Buffalo from April 7 to 9, 2008.

On March 9, 2008, the laboratory lost its main founder and former director, Pierre Leroux, who worked tirelessly to develop LaCIM and establish its international reputation.

Students, postdoctoral fellows, and visitors

In 2007–2008, the LaCIM members supervised or co-supervised 5 postdoctoral fellows, 33 Ph.D. students, 31 master's students, 12 undergraduate summer interns, and one junior college student. Here is a list of the postdoctoral fellows (with their supervisors within parentheses): Amy Glen (Christophe Reutenauer and Srečko Brlek), Navin Goyal (Denis Thérien), Aaron Lauve (Christophe Reutenauer), Sarah K. Mason (François Bergeron), and Franco Saliola (François Bergeron and Christophe Reutenauer).

Several renowned researchers visited LaCIM in 2007–2008 in order to work with its members. In particular, Adriano Garsia (UCSD) visited LaCIM in June 2007 and Janvier Nzeutchap (Université de Rouen) visited LaCIM from September 13 to 30, 2007. Claudia Malvenuto (Roma 1) worked at LaCIM from January 23 to February 5, 2008. Hugh Thomas (New Brunswick) visited LaCIM in April 2008 and Laurent Vuillon (Université de Chambéry) visited LaCIM from April to June 2008. Claudia Malvenuto worked with Christophe Reutenauer, Hugh Thomas with Christophe Hohlweg and François Bergeron, and Laurent Vuillon with Srečko Brlek. François Descouens (Fields Institute) visited LaCIM in October 2007. Xavier Viennot (LaBRI) was invited by Pierre Leroux and visited LaCIM from February 18 to 22, 2008.

Seminars

The LaCIM Combinatorics Seminar, held weekly on Friday morning, is attended regularly by LaCIM members, graduate students, and postdoctoral fellows. Most of the talks are given by visitors; special mention should be made of the talks by Arthur Reutenauer (École nationale

supérieure des télécommunications de Bretagne), Hugh Thomas (New Brunswick), Muge Taskin (York), Cédric Chauve (Simon Fraser), Xavier Viennot (LaBRI), Angèle Hamel (Wilfrid Laurier), and François Descouens (Fields Institute, Toronto). In 2007–2008, the Combinatorics Seminar featured 27 talks.

Members of the laboratory

Regular members

FRANÇOIS BERGERON (UQÀM), *Director*
Combinatorics, algebra, representations of finite groups

ROBERT BÉDARD (UQÀM)
Representations of finite groups, Lie theory

SRECKO BRLEK (UQÀM)
Combinatorics of words, algorithmics

CEDRIC CHAUVE (Simon Fraser and UQÀM)
Enumerative combinatorics, trees, bioinformatics

ALAIN GOUPIL (UQTR)
Combinatorics, algebra, linear representations of groups, symmetric group

SYLVIE HAMEL (Montréal)
Bioinformatics and algorithms, theory of languages and automata, algebraic combinatorics

CHRISTOPHE HÖHLWEG (UQÀM)
Algebra, algebraic combinatorics, and convex geometry

GILBERT LABELLE (UQÀM)
Enumerative combinatorics, analysis

PIERRE LEROUX (UQÀM) (deceased on March 9, 2008)
Enumerative and algebraic combinatorics

VLADIMIR MAKARENKO (UQÀM)
Computational biology, mathematical classification

MARNI MISHNA (Simon Fraser)
Algorithms and enumerative, analytical, and algebraic combinatorics

JOHN MULLINS (Polytechnique Montréal)
Analysis of cryptographic protocols and e-commerce protocols, formal semantics, secure mobile code specification, operational concurrency models

CHRISTOPHE REUTENAUER (UQÀM)
Algebraic combinatorics, noncommutative algebra, automata theory, coding theory, free algebras

DENIS THÉRIEN (McGill)
Complexity theory, logic, combinatorics, probability theory

TIMOTHY R.S. WALSH (UQÀM)
Algorithmics, enumerative combinatorics, graph theory

Associate members

PIERRE LALONDE (Cégep Maisonneuve)
Enumerative and bijective combinatorics, alternating sign matrices, enumeration of involutions with respect to various parameters, use of pfaffians and determinants in enumeration

CÉDRIC LAMATHE (UQÀM)
Combinatorics of tree-like structures, theory of species, indicator series of partially labeled structures and asymmetric structures

LUC LAPOINTE (Talca)
Algebraic combinatorics, symmetric functions, integrable systems, supersymmetries

ODILE MARCOTTE (UQÀM and CRM)
Combinatorial optimization, integer programming, graph theory

DOMINIC ROCHON (UQTR)
Complex analysis, hypercomplex numbers

Collaborating members

MARCELLO AGUIAR (Texas A&M)
Algebraic combinatorics, non-commutative algebra, Hopf algebras and quantum groups, category theory

LUC BÉLAIR (UQÀM)
Mathematical logic, model theory

NANTEL BERGERON (York)
Applied algebra

PIERRE BOUCHARD (UQÀM)
Commutative algebra, algebraic geometry and combinatorics

MICHEL BOUSQUET (Cégep du Vieux-Montréal)
Enumeration of combinatorial structures, planar maps and cacti, theory of species, Lagrange inversion formulas

YVES CHIRICOTA (UQÀC)
Computer graphics, mathematical methods in computer graphics, combinatorics, computational geometry, symbolic computation

SYLVIE CORTEEL (LRI, Paris-Sud)
Enumerative and bijective combinatorics, partitions of integers and q -series

ADRIANO GARSIA (UC San Diego)
Algebraic combinatorics, symmetric functions, harmonic and co-invariant spaces, quasiharmonic and quasi-invariant functions

ANDRÉ JOYAL (UQÀM)
Algebraic topology, category theory

JACQUES LABELLE (UQÀM)
Combinatorics, topology

LOUISE LAFOREST (UQÀM)
Data structures, combinatorics, asymptotic analysis, quaternary trees

DANIEL LEMIRE (TELUQ)
Database theory, data warehousing, multidimensional databases (OLAP), data mining, time

series, collaborative filtering, information retrieval

SIMON PLOUFFE
Integer sequences, generalized expansions of real numbers

XAVIER G. VIENNOT (Bordeaux 1)
Enumerative, algebraic, and bijective combinatorics, interactions between combinatorics, theoretical informatics, and theoretical physics

Mathematical Analysis

Description

At the same time classical and central to modern mathematics, analysis involves the study of continuous systems, from dynamical systems to solutions of partial differential equations and spectra of operators. In 2007–2008 the Laboratory had 32 regular and 6 associate members working at eight different universities in Québec, the United States, and France. The members of the Laboratory work in the following areas: harmonic analysis, complex analysis and several complex variables, potential theory, functional analysis, Banach algebras, microlocal analysis, analysis on manifolds, nonsmooth analysis, spectral theory, partial differential equations, geometric analysis, ergodic theory and dynamical systems, control theory, mathematical physics, applied mathematics, probability, nonlinear analysis, nonlinear differential equations, topological methods in differential equations, fluid dynamics, and turbulence.

News and highlights

This year, members of the Mathematical Analysis Laboratory co-organized the Thematic Semester in Dynamical Systems and Evolution Equations, as well as sessions of the Second Canada-France Congress 2008.

Students, postdoctoral fellows, and visitors

In 2007–2008, 7 postdoctoral fellows were supervised by Laboratory members: Z. Yan (CRM-ISM fellowship), N. Badr (CRM-ISM fellowship), I. Wigman (CRM-ISM fellowship), N. Chevrot (Laval), Y. Choi (Laval), D. Mangoubi (CRM-ISM fellowship), and D. Gaidashev (CRM, Montréal, and Concordia). Altogether, in 2007–2008, 2 undergraduate students, 32 master's students, and 30 Ph.D. students were supervised or co-supervised by regular or associate members of the laboratory. The laboratory hosted a number

of scientific visitors, including D. Ruelle (visiting Jakobson and Jaksic), R. Schubert, M. Levitin, L. Parnowski, A. Strohmaier, C. Liverani, M. Stillman (visiting D. Schlomiuk), John Hubbard (visiting D. Schlomiuk), N. Dimitrov (visiting D. Schlomiuk).

Seminars

The members of the Mathematical Analysis Laboratory organize several seminars at four main locations. Université Laval hosts an Analysis Seminar, which featured 18 talks in 2007–2008, and an Analysis Workshop, which featured 10 talks. Alex Shnirelman (Concordia) and Dmitry Jakobson (McGill) organize jointly the McGill/Concordia Analysis Seminar, which featured 29 talks in 2007–2008. A Working Seminar on Generic Metrics and PDEs (organized by D. Jakobson) was also held at McGill, and included 16 talks in the Winter and Summer of 2008. At the Université de Montréal, Christiane Rousseau organizes a Seminar in Nonlinear Analysis and Dynamical Systems that featured one talk in 2007–2008. At the Université de Sherbrooke, Madjid Allili, Virginie Charette, François Dubeau, and Tomasz Kaczynski organize a Seminar in Computational Geometry and Topology that featured two talks in 2007–2008, one by Konstantin Mischaikow and one by Afra Zomorodian. At the Université de Montréal, Paul Gauthier organized a Seminar in Analysis featuring two talks: one by Richard Fournier (Dawson College and CRM) and one by Alip Mohammed (York).

Workshops, special sessions, and others

The following activities were organized in 2007–2008 by members of the laboratory as part of the Thematic Semester in Dynamical Systems and Evolution Equations. Detailed reports on these activities may be found in the section on the Thematic Program of the CRM.

- YOUNG MATHEMATICIANS' CONFERENCE
January 18-19, 2008
Organizers: Walter Craig (McMaster), Adrian Nachman (Toronto), Nilima Nigam (McGill), Dmitry Pelinovsky (McMaster), Mary Pugh (Toronto), and Catherine Sulem (Toronto)
- WORKSHOP ON INITIAL CONDITIONS
January 24-25, 2008
Organizers: Walter Craig (McMaster), Pengfei Guan (McGill), and Christiane Rousseau (Montréal)
- SPECTRUM AND DYNAMICS
April 7-11, 2008
Organizers: Dmitry Jakobson (McGill) and Iosif Polterovich (Montréal)
- GEOMETRIC EVOLUTION EQUATIONS
April 16-27, 2008
Organizers: Vestislav Apostolov (UQÀM), Pengfei Guan (McGill), and Alina Stancu (Concordia)
- MINICOURSE ON SINGULARITIES, HAMILTONIAN AND GRADIENT FLOWS
May 5-9, 2008
Organizers: Walter Craig (McMaster), Christiane Rousseau (Montréal), and Alexander Schnirelman (Concordia)
- SINGULARITIES, HAMILTONIAN AND GRADIENT FLOWS
May 12-16, 2008
Organizers: Walter Craig (McMaster), Christiane Rousseau (Montréal), and Alexander Schnirelman (Concordia)

The following sessions were organized by laboratory members for the Second Canada-France Congress 2008.

- COMPLEX ANALYSIS AND OPERATOR THEORY
June 2-4, 2008, UQÀM
Organizers: Emmanuel Fricain (Lyon), Javad Mashreghi (Laval), and Thomas Ransford (Laval)
- GEOMETRIC AND NONLINEAR ANALYSIS
June 2-5, 2008, UQÀM
Organizers: Pengfei Guan (McGill) and Emmanuel Hebey (Cergy)

Members of the laboratory

Regular members

DMITRY JAKOBSON (McGill), *Director*
Pure mathematics, global analysis, spectral geometry, quantum chaos, harmonic analysis, eigenvalues and eigenfunctions

- LINE BARIBEAU (Laval)
Complex and functional analysis, Banach algebras, holomorphic iterations, discrete groups
- ABRAHAM BOYARSKY (Concordia)
Dynamical systems
- FRANCIS H. CLARKE (Lyon 1)
Nonlinear and dynamic analysis, control theory, calculus of variations
- GALIA DAFNI (Concordia)
Harmonic analysis, partial differential equations, several complex variables
- DONALD A. DAWSON (Carleton)
Probability, stochastic processes
- S. W. DRURY (McGill)
Harmonic analysis, matrix theory
- RICHARD DUNCAN (Montréal)
Ergodic theory, martingale theory, probability theory in Banach spaces
- RICHARD FOURNIER (Dawson College)
Complex analysis, function theory
- MARLÈNE FRIGON (Montréal)
Nonlinear analysis, differential equations, fixed point theory, critical point theory, multivalent analysis
- PAUL M. GAUTHIER (Montréal)
Complex analysis, holomorphy, harmonicity, analytic approximation
- PAWEL GORA (Concordia)
Ergodic theory, dynamical systems, fractal geometry
- FRÉDÉRIC GOURDEAU (Laval)
Banach algebras, cohomology, amenability, functional analysis
- KOHUR GOWRISANKARAN (McGill)
Potential theory
- VOJKAN JAKŠIĆ (McGill)
Mathematical physics, quantum statistical mechanics, random Schrödinger operators
- TOMASZ KACZYNSKI (Sherbrooke)
Topological methods, Conley index, applications to dynamical systems
- IVO KLEMES (McGill)
Harmonic analysis, trigonometric series
- ALEXEY KOKOTOV (Concordia)
Spectral geometry of Riemann surfaces, hyperbolic partial differential equations
- PAUL KOOSIS (McGill)
Harmonic analysis
- JAVAD MASHREGHI (Laval)
Complex analysis, harmonic analysis, Hardy spaces

YIANNIS N. PETRIDIS (Lehman College, CUNY)
Automorphic forms and their spectral theory,
analytic number theory, spectral and scattering
theory of manifolds

IOSIF POLTEROVICH (Montréal)
Geometric analysis, spectral theory, functional
analysis, differential geometry, partial differen-
tial equations

THOMAS J. RANSFORD (Laval)
Complex and harmonic analysis, functional
analysis and theory of operators, spectral analy-
sis, potential theory

DOMINIC ROCHON (UQTR)
Complex analysis, hypercomplex numbers

JÉRÉMIE ROSTAND (Laval)
Complex analysis, experimental mathematics

CHRISTIANE ROUSSEAU (Montréal)
Dynamical systems, bifurcations, qualitative
theory, polynomial systems, analytic invariants,
integrable systems

DANA SCHLOMIUK (Montréal)
Global analysis, dynamical systems, singulari-
ties, bifurcations, algebraic curves, primary inte-
gral

ALEXANDER SHNIRELMAN (Concordia)
Applications of geometric analysis to fluids and
“weak” solutions of the Euler and Navier–
Stokes equations

ALINA STANCU (Concordia)
Geometric analysis

RON J. STERN (Concordia)
Functional analysis and theory of operators, lin-

ear and nonlinear systems, non-smooth analysis,
stability, optimal order

JOHN A. TOTH (McGill)
Spectral theory, semi-classical analysis, microlo-
cal analysis, Hamiltonian mechanics

SAMUEL ZAIDMAN (Montréal)
Functional analysis and differential equations in
abstract spaces, pseudo-differential operators

Associate members

OCTAVIAN CORNEA (Montréal)
Algebraic topology, dynamical systems

PENGFEI GUAN (McGill)
Partial differential equations, geometric analy-
sis, several complex variables

JOHN HARNAD (Concordia)
Mathematical physics, classical and quantum
physics, geometrical methods, integrable sys-
tems, group theoretical methods, random ma-
trices, isomonodromic deformations, isospectral
flows

NIKY KAMRAN (McGill)
Geometric approach to partial differential equa-
tions

DMITRY KOROTKIN (Concordia)
Integrable systems, isomonodromic deforma-
tions, classical and quantum gravity, Frobenius
varieties

NILIMA NIGAM (McGill)
Applied analysis, numerical methods in electro-
magnetism

Mathematical Physics

Description

The mathematical physics group is one of the oldest and most active at the CRM. It consists of fourteen regular members, all full-time faculty at five Québec universities, and sixteen associate members. A total of 24 doctoral students and 22 master’s students were working under the supervision of Regular Members of the PhysMath Lab in the 2007–2008 academic year. The laboratory also includes eight research associates and postdoctoral fellows, and laboratory members supervise or co-supervise the thesis work of approximately fifty students. The group hosts many visiting researchers and carries out research in many of the most active areas of mathematical physics: coherent nonlinear systems in fluids, optics, and plasmas; classical and quantum integrable systems; the spectral theory of random matrices; percolation phenom-

ena; conformal field theory; quantum statistical mechanics; spectral and scattering theory of random Schrödinger operators; quasi-crystals; relativity; spectral transform methods; asymptotics of eigenstates; foundational questions in quantization; coherent states; wavelets; supersymmetry; the symmetry analysis of PDE’s and difference equations; representation theory of Lie groups and quantum groups; and the mathematical structure of classical and quantum field theories.

News and highlights

The laboratory welcomed two new Associate Members in 2007–2008: Manu Paranjape (full professor at the Département de physique, Université de Montréal) and Robert Brandenberger (Canada Research Chair in Theoretical Cosmology at the Department of Physics, McGill Uni-

versity.) Jean LeTourneux, who has been a Regular Member of the Lab since its creation, took his retirement in 2007, but remains as an Associate Member of the Lab. Of the sixteen Associate Members, five are “external” members; three are from France, one from Italy, and one from the U.S., and all are close collaborators of Regular Members of the Lab and frequent visitors at the CRM.

Dmitry Korotkin was a long-term visitor at the Max-Planck Institute in Bonn from September to December 2007. Manu Paranjape spent a sabbatical leave in 2007–2008 at the Center for Quantum SpaceTime of Sogang University in Seoul (Korea), and two months at the Institute of Theoretical Physics of the Chinese Academy of Sciences. Pavel Winternitz was on sabbatical leave in 2007–2008 at the Università Roma 3 and Frascati (for seven months) and Universidad Complutense in Madrid (for four months). Michel Grundland spent his sabbatical half-year (from January to July 2008) as visiting research professor at the Doppler Institute of the Czech Technical University (for two months), as well as visiting research professor at the Centre de Mathématiques et de Leurs Applications (CMLA), at the Ecole Normale Supérieure de Cachan.

Alexander Its spent his 2007–2008 sabbatical leave at Brunel University and Imperial College (London) in the United Kingdom, where he conducted research including joint projects with the research groups at the University of Cambridge and the University of Bristol. During this time, he gave several talks at different universities in the United Kingdom (Imperial College, Brunel University, Queen Mary University, University of Bristol) and continental Europe (SISSA at Trieste in Italy, Katholieke Universiteit Leuven in Belgium, Institut Henri Poincaré in Paris); he also taught a short graduate course at the University of Reading and an intensive course for Ph.D. students in the framework of the London Taught Course Centre (LTCC).

Invited talks by laboratory members at international conferences and workshops were too numerous in 2007–2008 to be listed here, but we mention a few of these events: the KITPC Program on String Cosmology at KITPC (Beijing, China, October 23 - November 2, 2007), where Robert Brandenberger gave a series of four lectures on modern cosmology, and the conference entitled “The Very Early Universe 25 Years On” at DAMTP (Cambridge University, December 17 - 20, 2007), where he was an invited plenary speaker. Alexander Its was a plenary speaker at

the Foundations of Computational Mathematics conference, held in Hong Kong on June 16-26, 2008. Associate Member Dmitry Jakobson was awarded the 2008 G. de B. Robinson Prize of the Canadian Mathematical Society, together with N. Nadirashvili and I. Polterovich, for their joint paper “Extremal metric for the first eigenvalue on a Klein bottle”.

Students, postdoctoral fellows, and visitors

Here is a list of the postdoctoral fellows and research associates who were working under the supervision of one or more of the Regular Members of the laboratory in 2007-2008 (the names of the supervisors are given within brackets): Iana Anguelova (M. Bertola, J. Harnad, and C. Cummins); Armen Atoyan (research associate, J. Patera); Mhenni Benghorbal (R. Hall); Patrick Desrosiers (J. Harnad); Mickaël Germain (J. Patera); Alexandre Hariton (M. Grundland); Seung-Yeop Lee (J. Harnad and M. Bertola); Andrew McIntyre (D. Korotkin and M. Bertola); Man Yue Mo (J. Hurtubise and M. Bertola); Maryna Nesterenko (collaborator of Jiri Patera); Aleix Prats Ferrer (J. Harnad and M. Bertola); Gábor Puztai (J. Harnad); and Ismet Yurdusen (collaborator of Michel Grundland, Véronique Hussin, and Pavel Winternitz).

Amongst our recent postdoctoral fellows and students, Man Yue Mo completed a second year of postdoctoral research at the University of Bristol. In 2007-2008, former doctoral student Oksana Yermolayeva held a Marie Curie Research Fellowship and continued her research at the International School for Advanced Studies (SISSA) in Trieste. Former student Vasilisa Schramchenko, after spending the period 2005-2008 at the Max Planck Institute in Bonn (where she held an Alexander Von Humboldt Fellowship) and the Oxford Mathematical Institute (where she held an EPSRC postdoctoral research fellowship and was a Junior Fellow of Worcester College), was awarded a URF at the Université de Sherbrooke, where she is currently Assistant Professor. In 2007-2008, a total of 24 doctoral students and 22 master’s students were working under the supervision of Regular Members of the Mathematical Physics Laboratory.

The following is a list of researchers who visited the laboratory in the period between July 2007 and September 2008; they were either invited as guests of one or more of the laboratory members, or long-term visitors within the 2008-2009 CRM Thematic Year on Probabilistic Methods in Mathematical Physics. Several of these

visitors are external Associate Members and/or collaborators of laboratory members; others organized or participated in the workshops comprising the program of the Thematic Year.

- Viktor Enolskii (Kiev), September–December 2007 (J. Harnad)
- Alexandre Orlov (Moscow), October 24–November 24, 2007 (J. Harnad)
- Pavel Bleher (IUPUI), November 29–December 1, 2007 (J. Harnad)
- Nasser Saad (Prince Edward Island), January–June 2008 (R. Hall)
- Bertrand Eynard (Saclay), February 2008 (J. Harnad and M. Bertola)
- Z. Rabbani (Vali-E-Asr University of Rafsanjan), February–July 2008 (S.T. Ali)
- F. Bagarello (Palermo), April 2008 (S.T. Ali)
- Alexander Its (IUPUI), June 2008 and August 2008 (J. Harnad)

Seminars

The usual weekly Seminar Series in Mathematical Physics took place at the CRM every Tuesday afternoon between September 2007 and May 2008, with active participation by members, visitors, postdoctoral fellows, and students. In 2007–2008 the seminar organizers were Yvan Saint-Aubin (Montréal and CRM) and Michel Grundland (UQTR). Approximately half the talks were given by visiting invited speakers; the rest were given by regular and associate laboratory members, postdoctoral fellows, and laboratory visitors.

In addition, the Working Seminar on Integrable Systems, Random Matrices, and Random Processes continued, taking place again every Thursday afternoon at Concordia, with active participation of many laboratory members, postdoctoral fellows, students, and visitors. In 2007–2008 the seminar organizers were Marco Bertola (Concordia and CRM) and Iana Anguelova (laboratory postdoctoral fellow, CRM and Concordia).

Workshops, special sessions, and others

Several laboratory members were involved in the long-term preparations for the CRM 2008–2009 Thematic Year on Probabilistic Methods in Mathematical Physics, the first half of which took place between June 2008 and October 2008. The second half followed in the period January–June 2009. In particular, the Scientific Committee for this program, consisting of eleven researchers from around the world (four from Canada, four from the United States, and three from Europe), was chaired by John Harnad, and

included laboratory members Pavel Winternitz and Yvan Saint-Aubin. The coordinators of the Thematic Year were John Harnad, Steve Zelditch (Johns Hopkins), and Pavel Bleher (IUPUI). One of the Aisenstadt Chairs for 2008–2009, Craig Tracy, was also on the Scientific Committee, and several laboratory members (Alexander Its, Bertrand Eynard, Marco Bertola, John Harnad) were amongst the principal organizers of the various workshops and other events relating to the Thematic Year.

Other events organized by laboratory members in 2007–2008 included the activities listed below. The reader will find a report on each of the first two activities in the section on the CRM general program, and a report on the third activity in the section on the CRM thematic program.

- SHORT PROGRAM ON MODULI SPACES OF RIEMANN SURFACES AND RELATED TOPICS
June 4–15, 2007, CRM

Sponsored by CIRGET and the Mathematical Physics Laboratory

Organizers: Marco Bertola (Concordia) and Dmitry Korotkin (Concordia)

- WORKSHOP ON NON-LINEAR INTEGRAL TRANSFORMS: FOURIER-MUKAI AND NAHM
August 27–31, 2007, CRM

Organizers: Benoit Charbonneau (Duke), Jacques Hurtubise (McGill), Marcos B. Jardim (Campinas), Eyal Markman (University of Massachusetts Amherst)

- WORKSHOP ON SPECTRUM AND DYNAMICS
April 7–11, 2008

Organizers: Dmitry Jakobson (McGill) and Iosif Polterovich (Montréal)

Also, Robert Brandenberger was the principal organizer of the Cosmology Session at the “Theory Canada 4” Conference, which took place at the CRM on June 4–7, 2008. François Lalonde was a member of the Scientific Advisory Committee of the meeting “A Celebration of Raoul Bott’s Legacy in Mathematics”, an international conference that also took place at the CRM in June 2008.

The Mathematical Physics Laboratory is committed to providing at least two colloquium speakers each year from amongst its scientific visitors or members. In 2007–2008 the colloquium speakers sponsored were Pavel Bleher (IUPUI), who spoke on November 30, 2007, Viktor Kac (MIT), who spoke on February 1st, 2008, and John Harnad (Concordia and CRM), who spoke on February 29, 2008.

Laboratory members also organized events elsewhere between June 2007 and June 2008. Pavel Winternitz was a member of the Inter-

national Organizing Committee of two international conferences: “Symmetries in Physics” (March 27–29, 2008, Dubna, Russia) and “Superintegrable Systems in Classical and Quantum Mechanics” (May 5–9, 2008, Prague). François Lalonde was one of the principal organizers of the conference on “New Perspectives and Challenges in Symplectic Field Theory” that took place at Stanford University on June 25–29, 2007 (see the section on the CRM general program).

Members of the laboratory

Regular members

JOHN HARNAD (Concordia), *Director*

Mathematical physics, classical and quantum physics, geometrical methods, integrable systems, group theoretical methods, random matrices, isomonodromic deformations, isospectral flows

SYED TWAREQUE ALI (Concordia)

Coherent states, wavelets, quantization techniques, harmonic analysis, Wigner functions

MARCO BERTOLA (Concordia)

Axiomatic quantum field theory, invariant theory of discrete groups, random matrices, isomonodromic deformations

ALFRED MICHEL GRUNDLAND (UQTR)

Symmetry of differential equations in physics

RICHARD L. HALL (Concordia)

Spectra of Schrödinger, Klein–Gordon, Dirac and Salpeter operators, many-body problems, relativistic scattering theory, iterative solution to ODEs and boundary-value problems

JACQUES HURTUBISE (McGill)

Algebraic geometry, integrable systems, gauge theory, moduli spaces

VÉRONIQUE HUSSIN (Montréal)

Group theory, Lie algebras and applications in physics, supersymmetries in classical and quantum mechanics

DMITRY KOROTKIN (Concordia)

Integrable systems, isomonodromic deformations, classical and quantum gravity, Frobenius varieties

JEAN LETOURNEUX (Montréal)

Symmetry properties of systems, special functions

PIERRE MATHIEU (Laval)

Conformal field theory, classical and quantum integrable systems, affine Lie algebras

JIRÍ PATERA (Montréal)

Applications of group theory, quasi-crystals, Lie algebras

YVAN SAINT-AUBIN (Montréal)

Conformal field theory, statistical mechanics, 2-dimensional phase transition model

LUC VINET (Montréal)

Symmetry properties of systems, special functions

PAVEL WINTERNITZ (Montréal)

Methods of group theory in physics, nonlinear phenomena, symmetries of difference equations, superintegrability

Associate members

ROBERT BRANDENBERGER (McGill)

Theoretical Cosmology

ROBERT CONTE (CEA Saclay)

Integrable and partially integrable systems, Painlevé analysis, exact solutions, finite difference equations

CHRIS CUMMINS (Concordia)

Group theory, modular functions, moonshine

STÉPHANE DURAND (Cégep Édouard-Montpetit)

Classical and quantum physics, mathematical physics, symmetries, parasupersymmetries, fractional supersymmetries, KdV equations, quantum mechanics, relativity

BERTRAND EYNARD (CEA Saclay)

Matrix models, integrable systems, string theory, relationship between matrix models, integrability and algebraic geometry

JEAN-PIERRE GAZEAU (Paris 7)

Coherent states, wavelets, relativistic quantum frames, symmetry groups for beta-lattices

ALEXANDER ITS (IUPUI)

Soliton theory, integrable systems, special functions, mathematical physics

DMITRY JAKOBSON (McGill)

Pure mathematics, global analysis, spectral geometry, quantum chaos, harmonic analysis, eigenvalues and eigenfunctions

VOJKAN JAKŠIĆ (McGill)

Mathematical physics, quantum statistical mechanics, random Schrödinger operators

NIKY KAMRAN (McGill)

Geometric approach to partial differential equations

FRANÇOIS LALONDE (Montréal)

Symplectic topology and geometry, global analysis on manifolds, infinite dimensional transformation groups

DECIO LEVI (Roma 3)

Symmetries of differential and difference equations, integrable nonlinear equations on the lat-

tice and reductive perturbation theory on the lattice

MANU PARANJAPE (Montréal)

Theoretical particle physics: field theory, solitons, noncommutative geometry, alternative gravity

ALEXANDER SHNIRELMAN (Concordia)

Applications of geometrical analysis to fluids and “weak” solutions of the Euler and Navier–Stokes equations

JOHN A. TOTH (McGill)

Spectral theory, semi-classical analysis, microlocal analysis, Hamiltonian mechanics

CAROLYNE M. VAN VLIET (Miami)

Non-equilibrium statistical mechanics, fluctuations and stochastic processes, quantum transport in condensed matter, electronic behavior in submicron quantum devices

PhysNum

Description

PhysNum is a laboratory dedicated to the study and solution of mathematical problems arising in medicine and pharmacology. We first describe the work of the PhysNum–MIC group, where MIC stands for “Mathématiques de l’Imagerie Cérébrale” (Mathematics of Brain Imaging).

PhysNum is a laboratory dedicated to the study and solution of mathematical problems arising in medicine and pharmacology. We first describe the work of the PhysNum–MIC group, where MIC stands for “Mathématiques de l’Imagerie Cérébrale” (Mathematics of Brain Imaging).

The members of the PhysNum–MIC group specialize in brain imaging methodology and functional neuroimaging, in particular the modelling of cerebral activity, the analysis methodology for optical and bioelectrical signals, the solution of inverse problems that include multimodal data, time-frequency analyses, and the synchrony and specter of singularities of intracranial electroencephalography signals. On the other hand, Frédéric Lesage is developing new imaging modalities for small animals, especially photo-acoustic imaging and intrinsic optical imaging; in his work, he uses recent results from approximation theory (“compressed sensing”) to develop ground-breaking innovations in methodology.

Habib Benali works on the modelling of physiological brain processes and has developed models of interaction between the neuron populations whose activity is detected through functional magnetic resonance imaging (fMRI) or electroencephalography (EEG). His goal is to obtain a better interpretation of the signals produced by these two modalities and, broadly speaking, to understand better the functional connectivity of the brain. Habib Benali’s research thus sheds light on the learning and adaptive processes of the brain, on the postoperative re-

cuperation processes, and the BOLD signal of spinal chord imaging.

All members of the PhysNum–MIC group belong to a research team financed by FQRNT, the Québec government granting agency. The goal of this team is to develop methods of analysis for signals produced by different methodologies (optical imaging, EEG, MEG, and fMRI). The team members use variational calculus techniques and entropy-based methods to solve inverse problems arising in the detection of neuronal activity through several imaging modalities (including optical imaging). Jean-Marc Lina uses techniques based on analytic wavelets to study bioelectrical signals in the brain. The two goals of the team are to study the synchronies and “skeletons” in the time/frequency plane of the signals (optical signals, EEG signals, intracranial signals in the context of epilepsy), and to study the specters of singularities in the preictal phase (i.e., the phase just before a fit of epilepsy). The work of the team relies on the use of “wavelet leaders” within the framework of Daubechies complex wavelets.

The research interests of Fahima Nekka, a professor at the Faculty of Pharmacy of the Université de Montréal, are in pharmacokinetic models and the application of fractal analysis to porous media. One of her projects consists of studying the pharmacokinetic variability induced by drug intake behaviour in animal collective therapy. The non-uniform access to medicated feed, influenced by swine individual feeding behaviour, is a determinant of antibiotic exposure. F. Nekka and her team used reported animal behaviour to propose a feeding behaviour pharmacokinetic model of in-feed chlortetracycline; they were able to delineate the impact of different feeding behaviour components and characterize the induced model variability. This work enabled them to offer a practical tool, in-

corporated into medical practice, for choosing a dosing regimen based on dose and age.

In a second project, F. Nekka and her team are using a random time series approach to formalize the drug intake behaviour of patients and make it an integral part of a general pharmacokinetic model. They showed that the random features of drug intake behaviour, previously treated as “noise”, are in fact an inherent component of the mechanistic model. Thus the variability in compliance adds an additional variation to the regular oscillation curves of the main drug administration routes. F. Nekka and her team have properly characterized this variation; their work will allow an objective medical intervention and can be adapted to different compliance patterns in various pathologies.

Fahima Nekka and her research group are also working on the processing of complex data and the application of complexity analysis to polymers and porous media (which are widely used as vehicles for drug delivery). The design of synthetic polymers has been revolutionized by the recent achievements in high-resolution, broad-mass-range spectrometry. Wave propagation and scattering through porous media and highly ramified materials give rise to (spatial) signals that can be considered as defined on fractal systems. The autocorrelating process is a classical mathematical method widely used in engineering and the applied sciences to reorganize intrinsic similarities hidden in a structure. On the other hand, fractal methods enable one to quantify efficiently complex information based on existing similarities. The inadequacy of traditional methods and the known limitations of popular fractal methods led F. Nekka to combine both approaches in order to create more powerful and less degenerate methods.

Students

In all, 4 undergraduates, 15 master’s students, and 7 Ph.D. students were supervised or co-supervised by regular or associate members of the laboratory in 2007–2008.

Publications of the PhysNum – MIC group (journals)

- Lina, J.-M., Dehaes, M., Matteau-Pelletier, C., and F. Lesage, Complex wavelets applied to diffuse optical spectroscopy for brain activity detection, *Opt. Express*. 2008 Jan 21;16(2):1029-50
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- Jouvet, P., Farges, C., Hatzakis, G., Monir, A., Lesage, F., Dupic, L., Brochard, L., and P. Hubert, Weaning children from mechanical ventilation with a computer-driven system (closed-loop protocol): a pilot study, *Pediatr. Crit. Care Med.* 2007 Sep;8(5):425-32
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- Li, J., and F. Nekka, Is the Classical Autocorrelation Function Appropriate for Complex Signals? The Necessity of the Generalized Autocorrelation Function, *Physica* 2007;A376,147-157

Members of the laboratory

Regular members

JEAN-MARC LINA (ÉTS), *Director*
Wavelets, statistical modelling and brain imaging, machine learning

ALAIN ARNÉODO (CNRS)

Fractals and wavelets

HABIB BENALI (CHU Pitié-Salpêtrière)

Quantitative analysis in brain imaging, medical imaging and multimodal systems

LINE GARNERO (Hôpital de la Salpêtrière)

Magnetoencephalography

BERNARD GOULARD (Montréal)

Brain imaging

FRÉDÉRIC LESAGE (Polytechnique Montréal)

Conformal theory, integrable systems, inverse problems, optical imaging

FAHIMA NEKKA (Montréal)

Fractal analysis, porous systems, wavelets

Associate member

KEITH J. WORSLEY (McGill)

Statistics of brain mapping, geometry of random images in medicine and astrophysics

Statistics

Description

Statistics is central to many endeavours in society. Whether it be through surveys from sampling, clinical trials to study various biomedical treatments or experimental designs in agriculture or industry, statistical methodology can be found everywhere in science. Recently, statistics has undergone a revolution in its techniques and approaches. This revolution has been driven by the need to analyze very large data sets and data with more complex structure, and by the advent of powerful computers. For example, statistical methodology is now addressing problems whose structure is very complex, such as the analysis of brain images or genome data, and new methodology is being developed for large data sets. Data mining is one of the tools used. One of the aims of the Laboratory is to structure the Québec statistical community so that it take part in this revolution at a time when an important renewal of the academic personnel is taking place. This structure allows the Québec community to benefit from a recently created Pan-Canadian program for complex data structures (NPCDS), organized by the three Canadian mathematics institutes. The Laboratory consists of the leaders of the Québec school of statistics, who work on topics such as statistical learning and neural networks, survey sampling, analysis of functional data, statistical analysis of images, dependence structures, Bayesian analysis, analysis of time series and financial data, and resampling methods.

News and highlights

The hiring of new colleagues in statistics as well as the wish of many researchers in probability and statistics to join the laboratory led the members to consider the issue of laboratory size. It was decided to include the new members as associate members; they may become regular members after a probationary period of a few

years. This year, Mylène Bédard (Montréal), José Garrido (Concordia), David Haziza (Montréal), Lajmi Lakhali-Chaïeb (Laval), and Lea Popovic (Concordia) became associate members, while Wei Sun (Concordia) became a regular member. Their various skills (probability, life time analysis, and sampling) complement the expertise of the other laboratory members.

Members of the Statistics Laboratory are still influential in the statistical community. They gave lectures and plenary talks as invited speakers at many international meetings, such as the Meeting of the International Chinese Association of Statisticians in Taipei, Taiwan (Louis-Paul Rivest), the 38th ASTIN congress, in Manchester, England (Christian Genest), the "Primero congreso Canadá-México de Estadística" in Guanajuato, Mexico (Christian Genest and Bruno Rémillard), the "Cinquième Colloque francophone sur les sondages" à Marseille, France (David Haziza and Louis-Paul Rivest), the Joint Statistical Meeting in Denver, Colorado (Christian Genest), and the World Congress in Probability and Statistics, Singapore (Lea Popovic).

Laboratory members are very much involved in the training of students, and the excellence of their work has been recognized by two awards. In 2007, the Pierre Robillard Award for best Ph.D. thesis was given to Juli Atherton, co-supervised by David Wolfson and Alain Vandal. Also, the Marie-Jeanne Laurent-Duhamel Prize was awarded to Jean-François Quessy for his thesis, written under the supervision of Christian Genest and Bruno Rémillard; this prize is given by the Société française de Statistique in order to honour the quality of a thesis written by a young francophone statistician.

Laboratory members are actively taking part in the work of Canadian statistical associations. Christian Genest is president of the Association des statisticiennes et statisticiens du Québec and of the Société statistique du Canada (SSC). Bruno Rémillard (co-chair of the Scientific Program

Committee) and Christian Léger (secretary of the Program Committee of the SSC) were quite involved in the organization of the joint meeting of the Statistical Society of Canada and the Société Française de statistique, which took place in Ottawa in June 2008. The international meeting gathered more than 600 participants, and was an overwhelming success. Thierry Duchesne, as chair of the local arrangements committee, and Christian Léger, as chair of the scientific committee, are already working on the upcoming edition of the 2010 SSC Annual Meeting, which will take place at Université Laval. We also note that some members of the laboratory gave advice to governmental bodies in order to promote an appropriate use of statistics. For instance, Louis-Paul Rivest is a member of the scientific advisory committee on “input data for computing the forest yield” at the Ministère des ressources naturelles du Québec.

Students, postdoctoral fellows and visitors

Laboratory members are very much involved in the training of HQP. Indeed, within their respective departments, statisticians are usually among those who train the largest number of students. Altogether, in 2007–2008, 3 undergraduate students, 104 master’s students, 59 Ph.D. students, and 13 postdoctoral fellows were supervised by laboratory members. During that year, 45 students obtained a master’s degree and 13 a Ph.D. degree under the supervision of a laboratory regular member.

Seminars

On a weekly basis, the scientific life of the laboratory revolves around the CRM–ISM–GERAD Statistics Colloquium in Montréal, the Statistics Seminar at Université Laval in Québec City, and the Statistics Seminar at the Université de Sherbrooke in Sherbrooke. In 2006–2007, the Statistics Seminar at Université Laval featured 20 lectures and the Statistics Seminar at the Université de Sherbrooke featured 11 lectures. The list of lectures of the CRM–ISM–GERAD Statistics Colloquium may be found at the end of the section on the CRM general program.

Workshops, special sessions, and others

In July 2007, James Ramsay and two collaborators organized a workshop on statistical methods for dynamical systems. More than 50 participants from around 20 countries attended this workshop. Two thematic workshops were organized by Louis-Paul Rivest. The first one took place on October 19, 2007, at the Université de

Montréal, and its theme was the use of statistics for the management of natural resources. The second workshop, on the theory and applications of copulas, took place on May 2, 2008, in Québec City. Reports on these workshops and on the Journée de statistique Montréal–Québec may be found in the section of the present report on the CRM general program.

- SCIENTIFIC MEETING

JOURNÉE DE STATISTIQUE MONTRÉAL–QUÉBEC
June 1st, 2007, CRM

Organizers: Christian Léger (Université de Montréal), Alejandro Murua (Université de Montréal), Aurélie Labbe (Université Laval)

- WORKSHOP

STATISTICAL METHODS FOR MODELING DYNAMIC SYSTEMS
July 9–13, 2007, CRM

Sponsored by MITACS and CRM

Organizers: David Campbell (McGill), Giles Hooker (Cornell), James Ramsay (McGill)

- SCIENTIFIC MEETING

USING STATISTICS FOR THE MANAGEMENT OF NATURAL RESOURCES
October 19, 2007, CRM

Organizer: Louis-Paul Rivest (Université Laval)

- SCIENTIFIC MEETING

COPULA MODELS: THEORY AND APPLICATIONS
May 2, 2008, Université Laval

Organizer: Louis-Paul Rivest (Université Laval)

Members of the laboratory

Regular members

LOUIS-PAUL RIVEST (Laval), *Director*

Linear models, robustness, directional data, sampling, applications in finance

BELKACEM ABDOUS (Laval)

Biostatistics, health research methodology, construction and validation of measuring tools in the health sector

JEAN-FRANÇOIS ANGERS (Montréal)

Decision theory, Bayesian statistics, robustness with respect to prior information, function estimation

MASOUD ASGHARIAN (McGill)

Survival analysis, changepoint problems, simulated annealing and its variants, optimization

YOSHUA BENGIO (Montréal)

Statistical learning algorithms, neural networks, nucleus models, probabilistic models, data mining, applications in finance and statistical language modelling

MARTIN BILODEAU (Montréal)

Multivariate analysis, decision theory, asymptotic methods

YOGENDRA P. CHAUBEY (Concordia)

Sampling, linear models, resampling, survival analysis

PIERRE DUCHESNE (Montréal)

Time series, sampling, multivariate analysis

THIERRY DUCHESNE (Laval)

Survival analysis, longitudinal data analysis, missing data, modelling of losses, insurance of catastrophic incidents, nonparametric inference, model selection, warranty

CHARLES DUGAS (Montréal)

Actuarial science, finance, learning algorithms, neural networks, universal approximation, survival analysis

DEBBIE J. DUPUIS (HEC)

Extreme values, robustness

SORANA FRODA (UQÀM)

Nonparametric methods in function estimation, applications of stochastic modelling in biology and medicine

CHRISTIAN GENEST (Laval)

Multidimensional data analysis, dependence measures, nonparametric statistics, decision theory, applications in actuarial science, finance and psychology

NADIA GHAZZALI (Laval)

Multidimensional data analysis, neural networks and genetic algorithms, applications in astrophysics and biostatistics

AURÉLIE LABBE (Laval)

Biostatistics and statistical genetics

FABRICE LARRIBE (UQÀM)

Statistical genetics and biostatistics

CHRISTIAN LÉGER (Montréal)

Resampling methods, adaptive estimation, model selection, robustness, applications in data mining

BRENDA MACGIBBON (UQÀM)

Mathematical statistics, decision theory, biostatistics

ÉRIC MARCHAND (Sherbrooke)

Statistical inference, Bayesian statistics, multivariate analysis and probability

ALEJANDRO MURUA (Montréal)

Data mining, machine learning, object recognition, signal processing, and various applications of statistics and probability to bioinformatics and the social and health sciences

FRANÇOIS PERRON (Montréal)

Decision theory, multidimensional data analysis, Bayesian statistics

JAMES RAMSAY (McGill)

Functional data analysis, smoothing and nonparametric regression, curve registration

BRUNO RÉMILLARD (HEC)

Probability theory, empirical processes, time series, nonlinear filtering, applications in finance

ROCH ROY (Montréal)

Time series analysis, predictive methods, applications in econometrics and epidemiology

ARUSHARKA SEN (Concordia)

Statistical inference of truncated data, nonparametric function estimation

RUSSELL STEELE (McGill)

Bayesian approaches to mixing modelling, multiple imputation

DAVID STEPHENS (McGill)

Bayesian statistics, Markov Chain Monte Carlo and applications to bioinformatics, statistical genetics, and time series analysis

WEI SUN (Concordia)

Nonlinear filtering and its applications, stochastic analysis, statistical inference, stochastic modelling

JONATHAN E. TAYLOR (Montréal)

Gaussian processes, multiple comparisons, neuroimaging, HIV protein sequence analysis

ALAIN C. VANDAL (McGill)

Biostatistics, nonparametric survival estimation and graph theory, imaging, capture-recapture models

DAVID B. WOLFSON (McGill)

Changepoint problems, survival analysis, Bayesian statistics, optimal design, applications in medicine

KEITH J. WORSLEY (McGill)

Statistics of brain mapping, geometry of random images in medicine and astrophysics

Associate members

MYLÈNE BÉDARD (Montréal)

Optimal scaling, Metropolis-Hastings algorithms

JOSÉ GARRIDO (Concordia)

Risk theory, insurance statistics

DAVID HAZIZA (Montréal)

Sampling theory, inference with missing data, robust inference

LAJMI LAKHAL CHAÏEB (Laval)

Multidimensional analysis of survival data, analysis of recurrent events, semi-parametric models and incomplete data

LEA POPOVIC (Concordia)

Probability theory and its applications to evolutionary biology, population genetics, and cell biology

Publications

The CRM publishes monographs, lecture notes, proceedings, software, videos and research reports. It has several collections. The in-house collection “Les Publications CRM” offers titles in both English and French. The CRM also has publishing agreements with the American Mathematical Society (AMS) and Springer. Since 1992, two collections, edited by CRM, have been published and distributed by the AMS. They are the *CRM Monograph Series* and the *CRM Proceedings and Lecture Notes*. Springer publishes the *CRM Series in Mathematical Physics* and the Subseries of the *Springer Lecture Notes in Statistics*. An asterisk preceding an author indicates that this is a monograph from an Aisenstadt Chairholder.

Recent Titles

The following list of recent titles contains books that appeared in 2006–2007 or that will be published soon.

American Mathematical Society CRM Monograph Series

Jean Berstel, Aaron Lauve, Christophe Reutenauer & Franco V. Saliola, *Combinatorics on Words — Christoffel Words and Repetitions in Words* (to appear).

Olga Kharlampovich & Alexei Myasnikov, *Algebraic Geometry for a Free Group* (to appear).

American Mathematical Society CRM Proceedings & Lecture Notes

David Avis, David Bremner & Antoine Deza (eds.), *Polyhedral Computation* (to appear).

John Harnad & Pavel Winternitz (eds.), *Groups and Symmetries: From Neolithic Scots to John McKay* (to appear).

Jean-Marie De Koninck, Andrew Granville & Florian Luca (eds.), *Anatomy of Integers*, vol. 46, 2008.

Panos M. Pardalos & Pierre Hansen (eds.), *Data Mining and Mathematical Programming*, vol. 45, 2008.

Stanley Alama, Lia Bronsard & Peter Sternberg (eds.), *Singularities in PDE and the Calculus of Variations*, vol. 44, 2007.

Springer CRM Series in Mathematical Physics

Marc Thiriet, *Biology and Mechanics of Blood Flows*, 2008.

Previous Titles

American Mathematical Society CRM Monograph Series

Victor Guillemin & Reyer Sjamaar, *Convexity Properties of Hamiltonian Group Actions*, vol. 26, 2005.

*Andrew J. Majda, Rafail V. Abramov & Marcus J. Grote, *Information Theory and Stochastics for Multiscale Nonlinear Systems*, vol. 25, 2005.

Dana Schlomiuk, Andrei A. Bolibrukh, Sergei Yakovenko, Vadim Kaloshin & Alexandru Buium, *On Finiteness in Differential Equations and Diophantine Geometry*, vol. 24, 2005.

Prakash Panangaden & Franck van Breugel (eds.), *Mathematical Techniques for Analyzing Concurrent and Probabilistic Systems*, vol. 23, 2004.

Montserrat Alsina & Pilar Bayer, *Quaternion Orders, Quadratic Forms, and Shimura Curves*, vol. 22, 2004.

Andrei Tyurin, *Quantization, Classical and Quantum Field Theory and Theta Functions*, vol. 21, 2003.

Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Riemann Surfaces of Infinite Genus*, vol. 20, 2003.

*Laurent Lafforgue, *Chirurgie des grassmanniennes*, vol. 19, 2003.

*George Lusztig, *Hecke Algebras with Unequal Parameters*, vol. 18, 2003.

Michael Barr, *Acyclic Models*, vol. 17, 2002.

*Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Fermionic Functional Integrals and the Renormalization Group*, vol. 16, 2002.

Jose I. Burgos, *The Regulators of Beilinson and Borel*, vol. 15, 2002.

Eyal Z. Goren, *Lectures on Hilbert Modular Varieties and Modular Forms*, vol. 14, 2002.

Michael Baake & Robert V. Moody (eds.), *Directions in Mathematical Quasicrystals*, vol. 13, 2000.

Masayoshi Miyanishi, *Open Algebraic Surfaces*, vol. 12, 2001.

Spencer J. Bloch, *Higher Regulators, Algebraic K-Theory, and Zeta Functions of Elliptic Curves*, vol. 11, 2000.

- James D. Lewis, *A Survey of the Hodge Conjecture*, 2e édition, vol. 10, 1999 (with an appendix by B. Brent Gordon).
- *Yves Meyer, *Wavelets, Vibrations and Scaling*, vol. 9, 1997.
- *Ioannis Karatzas, *Lectures on Mathematics of Finance*, vol. 8, 1996.
- John Milton, *Dynamics of Small Neural Populations*, vol. 7, 1996.
- *Eugene B. Dynkin, *An Introduction to Branching Measure-Valued Processes*, vol. 6, 1994.
- Andrew M. Bruckner, *Differentiation of Real Functions*, vol. 5, 1994.
- *David Ruelle, *Dynamical Zeta Functions for Piecewise Monotone Maps of the Interval*, vol. 4, 1994.
- V. Kumar Murty, *Introduction to Abelian Varieties*, vol. 3, 1993.
- Maximilian Ya. Antimirov, Andrei A. Kolyskin & Rémi Vaillancourt, *Applied Integral Transforms*, vol. 2, 1993.
- *Dan V. Voiculescu, Kenneth J. Dykema & Alexandru Nica, *Free Random Variables*, vol. 1, 1992.
- American Mathematical Society
CRM Proceedings & Lecture Notes**
- Andrew Granville, Melvyn B. Nathanson & Jozsef Solymosi (eds.), *Additive Combinatorics*, vol. 43, 2007.
- Donald A. Dawson, Vojkan Jakšić & Boris Vainberg (eds.), *Probability and Mathematical Physics: A Volume in Honor of Stanislav Molchanov*, vol. 42, 2007.
- André Bandrauk, Michel C. Delfour & Claude Le Bris (eds.), *High-Dimensional Partial Differential Equations in Sciences and Engineering*, vol. 41, 2007.
- Vestislav Apostolov, Andrew Dancer, Nigel Hitchin & McKenzie Wang (eds.), *Perspectives in Comparison, Generalized and Special Geometry*, vol. 40, 2006.
- Pavel Winternitz, David Gomez-Ullate, Arieh Iserles, Decio Levi, Peter J. Olver, Reinout Quispel & Piergiulio Tempesta (eds.), *Group Theory and Numerical Analysis*, vol. 39, 2005.
- Jacques Hurtubise & Eyal Markman (eds.), *Algebraic Structures and Moduli Spaces*, vol. 38, 2004.
- Piergiulio Tempesta, Pavel Winternitz, John Harnad, Willard Miller Jr., George Pogoyan & Miguel A. Rodriguez (eds.), *Superintegrability in Classical and Quantum Systems*, vol. 37, 2004.
- Hershy Kisilevsky & Eyal Z. Goren (eds.), *Number Theory*, vol. 36, 2004.
- H. E. A. Eddy Campbell & David L. Wehlau (eds.), *Invariant Theory in All Characteristics*, vol. 35, 2004.
- Pavel Winternitz, John Harnad, C.S. Lam & Jiří Patera (eds.), *Symmetry in Physics*, vol. 34, 2004.
- André D. Bandrauk, Michel C. Delfour & Claude Le Bris (eds.), *Quantum Control: Mathematical and Numerical Challenges*, vol. 33, 2003.
- Vadim B. Kuznetsov (ed.), *The Kowalevski Property*, vol. 32, 2002.
- John Harnad & Alexander R. Its (eds.), *Isomonodromic Deformations and Applications in Physics*, vol. 31, 2002.
- John McKay & Abdellah Sebbar (eds.), *Proceedings on Moonshine and Related Topics*, vol. 30, 2001.
- Alan Coley, Decio Levi, Robert Milson, Colin Rogers & Pavel Winternitz (eds.), *Bäcklund and Darboux Transformations*, vol. 29, 2001.
- John C. Taylor (ed.), *Topics in Probability and Lie Groups: Boundary Theory*, vol. 28, 2001.
- Israel M. Sigal & Catherine Sulem (eds.), *Nonlinear Dynamics and Renormalization Group*, vol. 27, 2001.
- John Harnad, Gert Sabidussi & Pavel Winternitz (eds.), *Integrable Systems: From Classical to Quantum*, vol. 26, 2000.
- Decio Levi & Orlando Ragnisco (eds.), *SIDE III—Symmetry and Integrability of Difference Equations*, vol. 25, 2000.
- B. Brent Gordon, James D. Lewis, Stefan Müller-Stach, Shuji Saito & Noriko Yui (eds.), *The Arithmetic and Geometry of Algebraic Cycles*, vol. 24, 2000.
- Pierre Hansen & Odile Marcotte (eds.), *Graph Colouring and Applications*, vol. 23, 1999.
- Jan Felipe van Diejen & Luc Vinet (eds.), *Algebraic Methods and q -Special Functions*, vol. 22, 1999.
- Michel Fortin (ed.), *Plates and Shells*, vol. 21, 1999.
- Katie Coughlin (ed.), *Semi-Analytic Methods for the Navier–Stokes Equations*, vol. 20, 1999.
- Rajiv Gupta & Kenneth S. Williams (eds.), *Number Theory*, vol. 19, 1999.
- Serge Dubuc & Gilles Deslauriers (eds.), *Spline Functions and the Theory of Wavelets*, vol. 18, 1999.
- Olga Kharlampovich (ed.), *Summer School in Group Theory in Banff*, 1996, vol. 17, 1998.
- Alain Vincent (ed.), *Numerical Methods in Fluid Mechanics*, vol. 16, 1998.
- François Lalonde (ed.), *Geometry, Topology and Dynamics*, vol. 15, 1998.

John Harnad & Alex Kasman (eds.), *The Bispectral Problem*, vol. 14, 1998.

Michel Delfour (ed.), *Boundaries, Interfaces and Transitions*, vol. 13, 1998.

Peter G. Greiner, Victor Ivrii, Luis A. Seco & Catherine Sulem (eds.), *Partial Differential Equations and their Applications*, vol. 12, 1997.

Luc Vinet (ed.), *Advances in Mathematical Sciences: CRM's 25 Years*, vol. 11, 1997.

Donald E. Knuth, *Stable Marriage and Its Relation to Other Combinatorial Problems*, vol. 10, 1996.

Decio Levi, Luc Vinet & Pavel Winternitz (eds.), *Symmetries and Integrability of Difference Equations*, vol. 9, 1995.

Joel S. Feldman, Richard Froese & Lon M. Rosen (eds.), *Mathematical Quantum Theory II: Schrödinger Operator*, vol. 8, 1995.

Joel S. Feldman, Richard Froese & Lon M. Rosen (eds.), *Mathematical Quantum Theory I: Field Theory and Many-Body Theory*, vol. 7, 1994.

Guido Mislin (ed.), *The Hilton Symposium 1993*, vol. 6, 1994.

Donald A. Dawson (ed.), *Measure-Valued Processes, Stochastic Partial Differential Equations and Interacting Systems*, vol. 5, 1994.

Hershy Kisilevsky & M. Ram Murty (eds.), *Elliptic Curves and Related Topics*, vol. 4, 1994.

Andrei L. Smirnov & Rémi Vaillancourt (eds.), *Asymptotic Methods in Mechanics*, vol. 3, 1993.

Philip D. Loewen, *Optimal Control via Nonsmooth Analysis*, vol. 2, 1993.

M. Ram Murty (ed.), *Theta Functions*, vol. 1, 1993.

Springer

CRM Series in Mathematical Physics

David Sénéchal, André-Marie Tremblay & Claude Bourbonnais, *Theoretical Methods for Strongly Correlated Electrons*, 2003.

*Roman Jackiw, *Lectures on Fluid Dynamics*, 2002.

Yvan Saint-Aubin & Luc Vinet (eds.), *Theoretical Physics at the End of the Twentieth Century*, 2001.

Yvan Saint-Aubin & Luc Vinet (eds.), *Algebraic Methods in Physics*, 2000.

Jan Felipe van Diejen & Luc Vinet (eds.), *Calogero–Moser–Sutherland Models*, 1999.

Robert Conte (ed.), *The Painlevé Property*, 1999.

Richard MacKenzie, Manu B. Paranjape & Wojciech J. M. Zakrzewski (eds.), *Solitons*, 1999.

Luc Vinet & Gordon Semenoff (eds.), *Particles and Fields*, 1998.

Springer

CRM Subseries of the Lecture Notes in Statistics

Marc Moore (ed.), *Spatial Statistics: Methodological Aspects and Applications*, 2001.

S. Ejaz Ahmed & Nancy Reid (eds.), *Empirical Bayes and Likelihood Inference*, 2001.

CRM Publications

Laurent Guieu & Claude Roger, *L'Algèbre et le Groupe de Virasoro*, 2007.

Luc Lapointe, Ge Mo-Lin, Yvan Saint-Aubin & Luc Vinet, *Proceedings of the Canada-China Meeting on Theoretical Physics*, 2003.

Armél Mercier, *Fonctions de plusieurs variables : Différentiation*, 2002.

Nadia El-Mabrouk, Thomas Lengauer & David Sankoff (eds.), *Currents in Computational Molecular Biology*, 2001.

James G. Huard & Kenneth S. Williams (eds.), *The Collected Papers of Sarvadaman Chowla*, Volume I 1925-1935; Volume II 1936-1961; Volume III 1962-1986, 2000.

Michael Barr & Charles Wells, *Category Theory for Computing Science*, 1999.

Maximilian Ya. Antimirov, Andrei A. Kolyshkin & Rémi Vaillancourt, *Mathematical Models for Eddy Current Testing*, 1998.

Xavier Fernique, *Fonctions aléatoires gaussiennes, vecteurs aléatoires gaussiens*, Montréal, 1997.

Faqir Khanna & Luc Vinet (eds.), *Field Theory, Integrable Systems and Symmetries*, Montréal, 1997.

Paul Koosis, *Leçons sur le théorème de Beurling et Malliavin*, 1996.

David W. Rand, *Concorder Version Three*, 1996 (software and user guide).

Jacques Gauvin, *Theory of Nonconvex Programming*, 1994.

Decio Levi, Curtis R. Menyuk & Pavel Winternitz (eds.), *Self-Similarity in Stimulated Raman Scattering*, 1994.

Rémi Vaillancourt, *Compléments de mathématiques pour ingénieurs*, 1993.

Robert P. Langlands & Dinakar Ramakrishnan (eds.), *The Zeta Functions of Picard Modular Surfaces*, 1992.

Florin N. Diacu, *Singularities of the N-Body Problem*, 1992.

Jacques Gauvin, *Théorie de la programmation mathématique non convexe*, 1992.

Pierre Ferland, Claude Tricot & Axel van de Walle, *Analyse fractale*, 1992 (software and user guide).

Stéphane Baldo, *Introduction à la topologie des ensembles fractals*, 1991.

Robert Bédard, *Groupes linéaires algébriques*, 1991.

Rudolf Beran & Gilles R. Ducharme, *Asymptotic Theory for Bootstrap Methods in Statistics*, 1991.

James D. Lewis, *A Survey of the Hodge Conjecture*, 1991.

David W. Rand & Tatiana Patera, *Concorder*, 1991 (software and user guide).

David W. Rand & Tatiana Patera, *Le Concordeur*, 1991 (software and user guide).

Véronique Hussin (ed.), *Lie Theory, Differential Equations and Representation Theory*, 1990.

John Harnad & Jerrold E. Marsden (eds.), *Hamiltonian Systems, Transformation Groups and Spectral Transform Methods*, 1990.

M. Ram Murty (ed.), *Automorphic Forms and Analytic Number Theory*, 1990.

Wendy G. McKay, Jiří Patera & David W. Rand, *Tables of Representations of Simple Lie Algebras, Volume I: Exceptional Simple Lie Algebras*, 1990.

Anthony W. Knap, *Representations of Real Reductive Groups*, 1990.

Wendy G. McKay, Jiří Patera & David W. Rand, *SimpLie*, 1990 (software and user guide).

Francis H. Clarke, *Optimization and Nonsmooth Analysis*, Montréal, 1989.

Samuel Zaidman. *Une introduction à la théorie des équations aux dérivées partielles*, 1989.

*Yuri I. Manin, *Quantum Groups and Noncommutative Geometry*, Les Publications CRM, 1988.

Lucien Le Cam, *Notes on Asymptotic Methods in Statistical Decision Theory*, 1974.

Les Presses de l'Université de Montréal Aisenstadt Chair Collection

Laurent Schwartz, *Semimartingales and Their Stochastic Calculus on Manifolds*, 1984.

*Yuval Ne'eman, *Symétries, jauges et variétés de groupe*, 1979.

*R. Tyrrell Rockafellar, *La théorie des sous-gradients et ses applications à l'optimisation, fonctions convexes et non convexes*, 1979.

*Jacques-Louis Lions, *Sur quelques questions d'analyse, de mécanique et de contrôle optimal*, 1976.

*Donald E. Knuth, *Mariages stables et leurs relations avec d'autres problèmes combinatoires*, 1976.

*Robert Hermann, *Physical Aspects of Lie Group Theory*, 1974.

*Mark Kac, *Quelques problèmes mathématiques en physique statistique*, 1974.

*Sybreen de Groot, *La transformation de Weyl et la fonction de Wigner: une forme alternative de la mécanique quantique*, 1974.

Other Collaborations with Publishers

Marc Moore, Sorana Froda & Christian Léger (eds.), *Mathematical Statistics and Applications: Festschrift for Constance van Eeden*, Lecture Notes–Monograph Series, vol. 42, 2003 (a collaboration with the *Institute of Mathematical Statistics*).

Duong H. Phong, Luc Vinet & Shing-Tung Yau (eds.), *Mirror Manifolds and Geometry*, AMS/IP Studies in Advanced Mathematics, vol. 10, 1998 (a collaboration with the AMS and International Press).

Pierre Ferland, Claude Tricot & Axel van de Walle, *Fractal Analysis User's Guide*, 1994 (a collaboration with the AMS).

Hedy Attouch, Jean-Pierre Aubin, Francis Clarke & Ivar Ekeland (eds.), *Analyse non linéaire*, 1989 (a collaboration with Gauthiers-Villars).

Videos

Efim Zelmanov, *Abstract Algebra in the 20th Century*, 1997.

Serge Lang, *Les grands courants*, 1991.

Robert Bédard, *Brouiller les cartes*, 1991.

Serge Lang, *Les équations diophantiennes*, 1991.

Laurent Schwartz, *Le mouvement brownien*, 1990.

Laurent Schwartz, *Une vie de mathématicien*, 1989.

CRM Preprints

[CRM-3240] Lambert, C., Rousseau, C., *The Stokes phenomenon in the confluence of the hypergeometric equation using Riccati equation*, Journal of Differential Equations (submitted).

[CRM-3241] Daili, N., *Analytic densities in number theory. III. Extensions to Epstein's zeta-function*, July 2007.

[CRM-3242] Daili, C., Daili, N., Merikhi, B., *Duality gap and quadratic programming. II Dual*

Bounds of a quadratic programming problem and applications, July 2007.

[CRM-3243] Daili, N., *I-suites régulières et fonctions arithmétiques additives*, July 2007.

[CRM-3244] Delfour, M. C., Dello Sbarba, O., *Linear-quadratic differential games: closed loop saddle points*, SIAM Journal on Control and Optimization, 47:6 (2008), 3138-3166.

[CRM-3245] Gilbert, H., Schlomiuk, N., *Sur les propriétés des fonctions réelles arbitraires de variable réelle: une approche historique*, September 2007.

[CRM-3246] Grundland, A. M., Hariton, A. J., *A supersymmetric version of a Gaussian irrotational compressible fluid flow*, Journal of Physics. A. Mathematical and Theoretical, 40:50 (December 2007), 15113-15129.

[CRM-3248] Grundland, A. M., Hereman, W., Yurdusen, I., *Conformally parametrized surfaces associated with $\mathbb{C}P^{N-1}$ sigma models*, Journal of Physics. A. Mathematical and Theoretical, 41:6 (February 2008), 065204.

[CRM-3249] Roy, R., Saidi, A., *Aggregation and systematic sampling of ARMA processes*, September 2007.

[CRM-3250] Harnad, J., Orlov, A. Y., *Determinant identity for multilevel systems and finite determinantal point processes*, International Mathematics Research Notices. IMRN (submitted).

[CRM-3251] Nguyen-Ba, T., Bozic, V., Kengne, E., Vaillancourt, R., *One-step 4-stage Hermite-Birkhoff-Taylor ODE solver of order 14*, in Scientific Proceedings of Riga Technical University, Series 5, Computer Science (submitted).

[CRM-3252] Vaillancourt, R., Zakharov, V. G., *Interval wavelets adapted to monomial differential operators*, Journal of Wavelet Theory and Applications, 1:1 (2007), 31-63.

[CRM-3253] Nguyen-Ba, T., Sharp, P. W., Yagoub, H., Vaillancourt, R., *Hermite-Birkhoff-Obrechhoff 5-stage 4-step ODE solver of order 15 with quantized stepsize*, Scientific Proceedings of Riga Technical University, Series 5, Computer Science (submitted).

[CRM-3255] Kengne, E., Vaillancourt, R., *Modulational stability of solitary states in a lossy nonlinear electrical line*, September 2007.

[CRM-3256] Schlomiuk, D., Vulpe, N., *Moduli spaces of planar quadratic vector fields with invariant lines of total multiplicity at least four and three distinct infinite singularities*, January 2008.

[CRM-3257] Eynard, B., Prats-Ferrer, A., *Topological expansion of the chain of matrices*, May 2008.

[CRM-3276] Marcotte, O. (ed.), *Premier atelier de résolution de problèmes industriels de Montréal*, 2009.

Scientific Personnel

CRM Members in 2007 – 2008

In contrast with most other mathematics institutes around the world, the CRM can count on the solid foundation of regular, associate and invited members. Each regular member is also a professor at one of the partner institutions: Montréal, Concordia, McGill, UQÀM, Laval, Sherbrooke and the University of Ottawa. Other members are researchers affiliated with the CRM in 2007 – 2008 as part of exchange agreements with neighbouring universities and industry or are long-term visitors from Canadian and foreign institutions. The presence at the CRM of such an active group of researchers has brought many benefits to the Centre. In particular, the CRM's national program is greatly facilitated by having on hand a large reserve of willing organizers, who have even contributed financially to the organization of activities. The largest partnership is with the Université de Montréal, which grants the equivalent of five full-time teaching positions in release time to the CRM. Release agreements with the other Montréal area universities afford the equivalent of two more full-time positions. Facilities are also provided to researchers affiliated with junior colleges. Several members are affiliated to the CRM through industrial agreements.

Regular Members

Ali, Syed Twareque, Concordia University	Darmon, Henri, McGill University
Angers, Jean-François, Université de Montréal	David, Chantal, Concordia University
Apostolov, Vestislav, Université du Québec à Montréal	De Koninck, Jean-Marie, Université Laval
Arminjon, Paul, Université de Montréal	Delfour, Michel C., Université de Montréal
Bandrauk, André D., Université de Sherbrooke	Doedel, Eusebius J., Concordia University
Baribeau, Line, Université Laval	Dssouli, Rachida, Concordia University
Bartello, Peter, McGill University	Duchesne, Pierre, Université de Montréal
Bédard, Robert, Université du Québec à Montréal	Duchesne, Thierry, Université Laval
Bélair, Jacques, Université de Montréal	El-Mabrouk, Nadia, Université de Montréal
Benali, Habib, CHU Pitié Salpêtrière	Fortin, André, Université Laval
Bengio, Yoshua, Université de Montréal	Fournier, Richard, Dawson College
Bergeron, François, Université du Québec à Montréal	Frigon, Marlène, Université de Montréal
Bertola, Marco, Concordia University	Garon, André, École Polytechnique de Montréal
Bourgault, Yves, Université d'Ottawa	Gauthier, Paul M., Université de Montréal
Bourlioux, Anne, Université de Montréal	Genest, Christian, Université Laval
Boyer, Steven, Université du Québec à Montréal	Goren, Eyal Z., McGill University
Brassard, Gilles, Université de Montréal	Goulard, Bernard, Université de Montréal
Brllek, Srecko, Université du Québec à Montréal	Granville, Andrew, Université de Montréal
Broer, Abraham, Université de Montréal	Grundland, Alfred Michel, Université du Québec à Trois-Rivières
Brunet, Robert C., Université de Montréal	Guan, Pengfei, McGill University
Bryant, David, McGill University	Hahn, Gena, Université de Montréal
Chauve, Cédric, Simon Fraser University	Hall, Richard L., Concordia University
Chvátal, Vašek, Concordia University	Hamel, Sylvie, Université de Montréal
Clarke, Francis H., Université de Lyon I	Harnad, John, Concordia University
Collin, Olivier, Université du Québec à Montréal	Humphries, Tony R., McGill University
Cornea, Octavian, Université de Montréal	Hurtubise, Jacques, McGill University
Csűrös, Miklós, Université de Montréal	Hussin, Véronique, Université de Montréal
Cummins, Chris, Concordia University	Iovita, Adrian, Concordia University
Dafni, Galia, Concordia University	Jakobson, Dmitry, McGill University
	Jaksic, Vojkan, McGill University
	Joyal, André, Université du Québec à Montréal
	Kaczynski, Tomasz, Université de Sherbrooke

Kamran, Niky, McGill University
 Kharlampovich, Olga, McGill University
 Kisilevsky, Hershy, Concordia University
 Koosis, Paul, McGill University
 Korotkin, Dmitry, Concordia University
 Labelle, Gilbert, Université du Québec à Montréal
 Labute, John, McGill University
 Lalonde, François, Université de Montréal
 Larose, Benoît, Champlain Regional College and Concordia University
 Léger, Christian, Université de Montréal
 Leroux, Pierre, Université du Québec à Montréal
 Lesage, Frédéric, École Polytechnique de Montréal
 Lessard, Sabin, Université de Montréal
 LeTourneux, Jean, Université de Montréal
 Levesque, Claude, Université Laval
 Lina, Jean-Marc, École de Technologie Supérieure
 Lu, Steven, Université du Québec à Montréal
 MacGibbon, Brenda, Université du Québec à Montréal
 Mackey, Michael C., McGill University
 Makarenkov, Vladimir, Université du Québec à Montréal
 Makkai, Michael, McGill University
 Mashreghi, Javad, Université Laval
 Maslowe, Sherwin A., McGill University
 Mathieu, Pierre, Université Laval
 McKay, John, Concordia University
 Miasnikov, Alexei G., McGill University
 Murty, M. Ram, Queen's University

Associate Members

Beaulieu, Liliane, Collège du Vieux-Montréal
 Bergeron, Nantel, York University
 Conte, Robert, CEA Saclay
 Durand, Stéphane, Collège Édouard-Montpetit
 Gander, Martin J., Université de Genève
 Garnero, Line, CHU Pitié Salpêtrière
 Levi, Decio, Università di Roma Tre
 Li, Jun, Pharsight Corporation

Invited Members

Doray, Louis G., Université de Montréal

Nekka, Fahima, Université de Montréal
 Nigam, Nilima, McGill University
 Owens, Robert G., Université de Montréal
 Paranjape, Manu, Université de Montréal
 Patera, Jiří, Université de Montréal
 Perron, François, Université de Montréal
 Polterovich, Iosif, Université de Montréal
 Ramsay, James O., McGill University
 Ransford, Thomas J., Université Laval
 Rémillard, Bruno, HEC Montréal
 Reutenauer, Christophe, Université du Québec à Montréal
 Rivest, Louis-Paul, Université Laval
 Rosenberg, Ivo G., Université de Montréal
 Rousseau, Christiane, Université de Montréal
 Roy, Damien, Université d'Ottawa
 Roy, Roch, Université de Montréal
 Russell, Peter, McGill University
 Saint-Aubin, Yvan, Université de Montréal
 Sankoff, David, Université de Montréal
 Schlomiuk, Dana, Université de Montréal
 Shnirelman, Alexander, Concordia University
 Stern, Ron J., Concordia University
 Thaine, Francisco, Concordia University
 Toth, John A., McGill University
 Tupper, Paul F., McGill University
 Vinet, Luc, Université de Montréal
 Walsh, Timothy R.S., Université du Québec à Montréal
 Wihler, Thomas P., McGill University
 Winternitz, Pavel, Université de Montréal
 Wise, Daniel T., McGill University
 Worsley, Keith J., McGill University

Lorin de la Grandmaison, Emmanuel, University of Ontario Institute of Technology
 Petridis, Yiannis N., City University of New York
 Shahbazian, Elisa, Lockheed Martin Canada
 Thiriet, Marc, INRIA Rocquencourt
 Valin, Pierre, Valcartier DND
 Van Vliet, Carolyne M., University of Miami
 Zolésio, Jean-Paul, INRIA Sophia-Antipolis

Dugas, Charles, Université de Montréal

Gowrisankaran, Kohur, McGill University
 Haziza, David, Université de Montréal
 Jiménez Urroz, Jorge, Universitat Politècnica de Catalunya
 Morales, Manuel, Université de Montréal

Murua, Alejandro, Université de Montréal
 Parent, Paul-Eugène, University of Ottawa
 Pinsonnault, Martin, University of Western Ontario

Postdoctoral Fellows

Each year the CRM plays host to a great number of postdoctoral fellows. Their funding is provided by the NSERC and FQRNT postdoctoral programs, the NATO international program administered by NSERC, the CRM (usually in collaboration with the ISM), the CRM's research laboratories, and individual research grants from CRM members. The list below includes postdoctoral fellows in residence at the CRM and those co-funded by the CRM. Some of the fellows were in residence at the CRM for only part of the year. The affiliation given is the institution where the doctorate was obtained.

Anguelova, Iana, University of Illinois at Urbana-Champaign
 Bejanov, Boyan, University of Alberta
 Cais, Bryden, University of Michigan, Ann Arbor
 Carbonell, Felix, Universidad de La Habana
 Ceyhan, Ozgur, Université Strasbourg 1
 Chadozeau, Arnaud, Université Bordeaux 1
 Daudé, Thierry, Université Bordeaux 1
 Derivière, Sara, Université de Rouen
 Desrosiers, Patrick, Université Laval
 Friedl, Stefan, Brandeis University
 Gaydashev, Denis G., University of Texas at Austin
 Glen, Amy, University of Adelaide
 Guillotte, Simon, Université de Montréal
 Gürel, Başak, University of California, Santa Cruz
 Hariton, Alexander J., Université de Montréal
 Hrivnák, Jiří, Czech Technical University
 Hu, Shengda, University of Wisconsin Madison
 Jafari Jozani, Mohammad, Shahid Beheshti University
 Jones, Nathan Conrad, University of California, Los Angeles

Lee, Seung-Yeop, University of Chicago
 Letellier, Emmanuel, Université Paris 6
 Li, Jun-Fang, University of Oklahoma
 Lucier, Jason Bryan, University of Waterloo
 Marmora, Adriano, Université Paris 13
 Masri, Riad, University of Texas at Austin
 Moyers-Gonzalez, Miguel Angel, University of British Columbia
 Naidenova, Elena, State University of Moldova
 Ndiaye, Ismaila, Ecole Polytechnique Fédérale de Lausanne
 Nesterenko, Maryna, Académie nationale des sciences d'Ukraine
 Park, Jeehoon, Boston University
 Prats-Ferrer, Aleix, Universitat de Barcelona
 Ramadane, Abderrazak, Université Laval
 Villani, Éric, Université Paris 6
 Voorons, Matthieu, Université de Sherbrooke
 Wigman, Igor, Université de Tel Aviv
 Xu, Xiangjin, Johns Hopkins University
 Yan, Zhenbin, McMaster University
 Yurdusen, Ismet, Middle East Technical University

Long-term Visitors

Each year the CRM hosts a large number of visitors. The majority come to the Centre to participate in scientific activities organized or co-organized by the CRM. In the year 2007–2008, 694 such participants registered in the thematic program workshops, 507 in activities of the general program and 303 in those of the industrial and multidisciplinary program. The CRM also contributed financially to other scientific events, including the Conference on Banach Algebras (see the section on the general program) and the Summer School on "Systems Biology Dynamics: from Genes to Organisms" (see the section on the multidisciplinary and industrial program). The following list only includes visitors who were in residence for at least four weeks.

Adhikari, Sukumar Das, Harish-Chandra
Research Institute
Biran, Paul, Tel Aviv University
Craig, Walter, McMaster University
Daili, Noureddine, Université F. Abbas
Dolgopyat, Dmitry, University of Maryland
Donato, Paul, Université d'Aix-Marseille 1
El Gradechi, Amine, Université d'Artois
Enolskii, Victor, National Academy of Sciences
of Ukraine
Fiz-Pontiveros, Gonzalo, Churchill College
Fleischer, Isidore, Université de Montréal
Haglund, Jim, University of Pennsylvania
Malik, Muslim, Indian Institute of Science,
Bangalore
Monastyrsky, Michael, Institute for Theoretical
and Experimental Physics, Moscow
Ng, Nathan, University of Ottawa
Nonnenmacher, Stéphane, CEA-Saclay
Orlov, Aleksander Yu., Shirshov Institute of
Oceanology

Parnovski, Leonid, University College London
Prasanna, Kartik, University of California, Los
Angeles
Safarov, Yuri, King's College London
Saliola, Franco, Université du Québec à
Montréal
Thiriet, Marc, CNRS and INRIA
van Willigenburg, Stephanie, University of
British Columbia
Vinuesa, Carlos, Universidad Autónoma de
Madrid
Vulpe, Nicolae, Academy of Sciences of
Moldova
Willems, Matthieu, Université de
Cergy-Pontoise
Zhang, Yuanli, Université de Montréal
Zhavrotskyi, Dmytro, Interzvyazok Company
Zhedanov, Alexei, Donetsk Institute for Physics
and Technology
Zograf, Peter, Steklov Mathematical Institute

Short-term Visitors

The following visitors were in residence for less than four weeks.

Anantharaman, Nalini, École Polytechnique
Beaulieu, Liliane, Cégep du Vieux Montréal
Bleher, Pavel M., Indiana University – Purdue
University Indianapolis
Colbois, Bruno, Université de Neuchâtel
Farkas, Hershel M., The Hebrew University of
Jerusalem
Grigoryan, Arthur, Academy of Sciences of
Armenia
Huisken, Gerhard, Universität Tübingen
Itenberg, Ilia, Université Strasbourg 1
Kaloshin, Vadim, University of Maryland
Levitin, Michael, Cardiff University
Mardesic, Pavao, Université de Bourgogne

Montgomery, Richard, University of California,
Santa Cruz
Moody, Robert V., University of Alberta
Petridis, Ioannis, University College London
Pogossian, Edward, Academy of Sciences of
Armenia
Ruscheweyh, Stephan, Universität Würzburg
Schubert, Roman, University of Bristol
Solymosi, József, University of British Columbia
Stolovitch, Laurent, Université Paul Sabatier
Strohmaier, Alexander, Loughborough
University
Vakil, Ravi, Stanford University
Zolésio, Jean-Paul, INRIA

Graduates

List of Students Having Graduated in 2007 – 2008

The CRM members supervise a large number of graduate students. In this section we give information on the students supervised by CRM members who graduated in 2007-2008. The name of the student is followed by his or her supervisor (or supervisors), his or her institution, and his or her program.

Ph.D. Students

- | | |
|---|---|
| Ayoub, Nabil
Gauthier, Paul M.
Université de Montréal
Pure mathematics | Le Roux, Nicolas
Bengio, Yoshua
Université de Montréal
Computer science |
| Beaudoin, David
Duchesne, Thierry & Genest, Christian
Université Laval
Statistics | Leclercq, Rémi
Cornea, Octav
Université de Montréal
Pure mathematics |
| Ben Khalifa, Ouassim
Hussin, Véronique
Université de Montréal
Mathematical physics | Lefebvre, Geneviève
Steele, Russell & Wolfson, David
McGill University
Statistics |
| Broadbent, Anne
Brassard, Gilles & Tapp, Alain
Université de Montréal
Computer science | Lepage, Thomas
Bryant, David & Tupper, Paul
McGill University
Biomathematics |
| Campbell, David
Ramsay, James O.
McGill University
Statistics | Liu, Baisan
Vandal, Alain C.
McGill University
Statistics |
| Carreau, Julie
Bengio, Yoshua
Université de Montréal
Computer science | Perez Abarca, Juan Manuel
Dawson, Donald A.
McGill University
Mathematics |
| Chamandy, Nicholas
Steele, Russell & Worsley, Keith
McGill University
Mathematics | Renaud, Jean-François
Rémillard, Bruno
Université de Montréal
Applied mathematics |
| Chapdelaine, Hugo
Darmon, Henri
McGill University
Mathematics | Roy, Sylvain
Ransford, Thomas J.
Université Laval
Mathematics |
| Dubois, Olivier
Gander, Martin J. & Nigam, Nilima
McGill University
Mathematics | Shahabi, Shahab
Darmon, Henri
McGill University
Mathematics |
| Girouard, Alexandre
Frigon, Marlène & Polterovich, Iosif
Université de Montréal
Pure mathematics | Soulière, Anik
Tokieda, Tadashi & Lalonde, François
Université de Montréal
Applied mathematics |
| Guillotte, Simon
Perron, François & Ramsay, James
Université de Montréal
Statistics | Spyksma, Kyle
Bartello, Peter
McGill University
Mathematics |

St-Hilaire, Marie-Odette
Arminjon, Paul
Université de Montréal
Mathematics

Turner, Elizabeth
Vandal, Alain C.
McGill University
Statistics

M.Sc. Students

Abed, Djamila
Froda, Sorana
Université du Québec à Montréal
Statistics

Alomari, Fida
Sen, Arusharka
Concordia University
Statistics

Apostu, Raluca
Mackey, Michael C.
McGill University
Mathematics

Bajpai, Jitendra
Wise, Daniel T.
McGill University
Mathematics

Bobos-Kristoff, Georgeana
Dafni, Galia
Concordia University
Mathematics

Bolduc, Marie-Josée
Hussin, Véronique
Université de Montréal
Applied mathematics

Bonneau, Dave
De Koninck, J.-M. & Levesque, Claude
Université Laval
Mathematics

Bourdeau-Brien, Michaël
Genest, Christian
Université Laval
Statistics

Brunet, Dominique
Rostand, Jérémie
Université Laval
Mathematics

Chabot-Hallé, Dominique
Duchesne, Pierre
Université de Montréal
Statistics

Yue, Hong
Dafni, Galia
Concordia University
Mathematics

Charette, François
Cornea, Octav
Université de Montréal
Pure mathematics

Chen, Shou Xiang
Duchesne, Pierre
Université de Montréal
Statistics

Chouha, Paul-Robert
Lu, Steven Shin-Yi
Université du Québec à Montréal
Mathematics

Coleman, Kimberley
Vandal, Alain C. & Wolfson, David
McGill University
Statistics

Croteau, Jordie
Angers, Jean-François
Université de Montréal
Statistics

Davis, Kevin
Mackey, Michael C.
McGill University
Applied mathematics

Dello Sbarba, Olivier
Delfour, Michel C.
Université de Montréal
Applied mathematics

Elfouth, Naoual
Froda, Sorana
Université du Québec à Montréal
Statistics

Elswad, Salma
Ali, Syed Twareque & Hall, Richard
Concordia University
Mathematics

Farhat, Yasser
Mashreghi, Javad & Gourdeau, Frédéric
Université Laval
Mathematics

- Ferns, Ryan
 Klemes, Ivo
 McGill University
 Mathematics
- Grand'maison, Jérôme
 Darmon, Henri
 McGill University
 Mathematics
- Gravel, Claude
 Polterovich, Iosif
 Université de Montréal
 Mathematics
- Grégoire, Vincent
 Genest, Christian
 Université Laval
 Statistics
- Guo, Liming
 Chaubey, Yogendra P.
 Concordia University
 Statistics
- Huo, Shu Guo
 Chaubey, Yogendra P.
 Concordia University
 Statistics
- Janzen, David
 Darmon, Henri
 McGill University
 Mathematics
- Jin, Yu
 Sen, Arusharka
 Concordia University
 Statistics
- Julien, Pierre-Olivier
 Rivest, Louis-Paul
 Université Laval
 Statistics
- Karanfil, Kassem
 Mackey, Michael C.
 McGill University
 Applied mathematics
- Kelome, Djvede Armel
 Wolfson, David B.
 McGill University
 Statistics
- Lapierre, Elisabeth
 Polterovich, Iosif
 Université de Montréal
 Mathematics
- Lauer, Joseph
 Wise, Daniel T.
 McGill University
 Mathematics
- Leclaire, Sébastien
 Bourlioux, Anne
 Université de Montréal
 Applied mathematics
- Lemay, Jérôme
 Duchesne, Thierry & Rivest, L.P.
 Université Laval
 Statistics
- Lincourt-Ethier, Marie-Noëlle
 Garon, André
 École Polytechnique de Montréal
 Mechanical engineering
- Loranger, Francis
 Saint-Aubin, Yvan
 Université de Montréal
 Mathematical physics
- Manzagol, Pierre-Antoine
 Bengio, Yoshua
 Université de Montréal
 Computer science
- McCamus, Matt
 Léger, Christian
 Université de Montréal
 Statistics
- McKeown, Jesse
 Guan, Pengfei
 McGill University
 Mathematics
- Memartoluie, Amir
 Sen, Arusharka & Larose, Benoît
 Concordia University
 Statistics
- Minoukadeh, Kimiya
 Garon, André & Delfour, M.
 École Polytechnique
 Applied mathematics
- Muise, Sylvain
 Kisilevsky, Hershy
 Concordia University
 Mathematics
- Navarra, Alessandro
 Nigam, Nilima
 McGill University
 Mathematics
- Panait, Andreea M.
 Darmon, Henri & Crépeau, Claude
 McGill University
 Mathematics
- Paradis-Therrien, Catherine
 Angers, Jean-François
 Université de Montréal
 Statistics

Perrault-Joncas, Dominique
Maslowe, Sherwin A.
McGill University
Applied mathematics

Poulin, Denis
Ransford, Thomas & Gourdeau, Frédéric
Université Laval
Mathematics

Poulin, Jennifer
Duchesne, Pierre
Université de Montréal
Statistics

Qiao, Ming
Dssouli, Rachida
Concordia University
Computer science

Rainone, Timothy
Drury, Stephen W.
McGill University
Mathematics

Ramdenee, Vinal
Dugas, Charles
Université de Montréal
Statistics

Rayan, Steven
Kamran, Niky
McGill University
Mathematics

Rivard, Patrice
Baribeau, Line
Université Laval
Mathematics

Ross, Michelle
Steele, Russell
McGill University
Statistics

Shinohara, Russell
Asgharian, Masoud
McGill University
Statistics

Tarik, Jari
Lu, Steven Shin-Yi
Université du Québec à Montréal
Mathematics

Tekaya, Mohamed Ridha
Rivest, Louis-Paul
Université Laval
Statistics

Ubartas, Cindy
Angers, Jean-François & MacGibbon, B.
Université de Montréal
Statistics

Verge-Rebelo, Raphaël
Winternitz, Pavel
Université de Montréal
Applied mathematics

Wang, Liangliang
Ramsay, James O.
McGill University
Statistics

Governance and Scientific Guidance

Bureau de direction

The Bureau consists of members from the Université de Montréal (eight to eleven members) and from elsewhere (two to five members). The rector of the Université de Montréal and the Dean of the Faculty of Arts and Sciences are represented on the Bureau. The Bureau adopts the policies of the Centre, recommends the nomination and the promotion of researchers and the appointment of regular and associate members, advises the Director on the preparation of the budget and the Université de Montréal on the choice of the Director.

Syed Twareque Ali

Concordia University

Yoshua Bengio

Université de Montréal

Michel Delfour

Université de Montréal

René Durocher, Dean

Faculty of Arts and Sciences, Université de Montréal

Véronique Hussin

Université de Montréal

Niky Kamran

McGill University

François Lalonde

Université de Montréal

Javad Mashreghi

Université Laval

Christiane Rousseau

Université de Montréal

Joseph Hubert, Vice-Principal (Research)

Université de Montréal

Chantal David (Concordia University), **Andrew Granville** (Université de Montréal), **Jean LeTourneux** (Université de Montréal), and **Odile Marcotte** (Université du Québec à Montréal), all Deputy Directors of the CRM, were invited members.

Scientific Advisory Committee

The Scientific Advisory Committee consists of distinguished researchers from Canada and abroad. Its members are either mathematicians or scientists with close ties to the mathematical sciences. The Advisory Committee is kept informed regularly of the activities of the Centre through the Director. The Committee makes recommendations about the general scientific orientations of the CRM and gives advice about proposed scientific activities.



James Berger is the Arts and Sciences Professor of Statistics at the Institute of Statistics and Decision Sciences of Duke University and Director of the Statistical and Applied Mathematical Sciences Institute (SAMSI). He

received a Ph.D. in mathematics from Cornell University in 1974 and is a past recipient of the Guggenheim and Sloan Fellowships. He was elected to the National Academy of Sciences in 2003. His research has primarily been in Bayesian statistics, foundations of statistics, statistical decision theory, simulation, model selection, and various interdisciplinary areas of science and industry. He has supervised 30 Ph.D. dissertations, published over 140 articles and has written or edited 13 books or special volumes.



Jerry Bona is a Professor at the Department of Mathematics, Statistics and Computer Science of The University of Illinois at Chicago. He received a B.Sc. degree from Washington University in St. Louis (1966) and a Ph.D.

from Harvard University (1971). His research experience is vast. His research interests include fluid mechanics, partial differential equations, computational mathematics and the associated numerical analysis, oceanography, coastal engineering, and mathematical economics. He is an Elected Fellow of the American Association for the Advancement of Science and a member of the editorial boards of twenty-five scientific journals and of several academic committees and panels. Jerry Bona is a co-organizer of the Mathematicians and Educational Reform Network.



Jean-Pierre Bourguignon received an engineering degree from the École Polytechnique and a Ph.D. in mathematics. A differential geometer by training, he has also worked on the mathematical aspects of physical theories: Dirac operators and spins, general relativity. His areas of specialty are the geometrical estimation of eigenvalues of Laplace–Beltrami operators, Kählerian geometry, and, more recently, Finslerian geometry. Jean-Pierre Bourguignon is a research leader at the highest echelon of the Centre national de la recherche scientifique (CNRS). He is currently the Director of the Institut des hautes études scientifiques (IHES) at Bures-sur-Yvette and Professor of Mathematics at the École Polytechnique. From 1990 to 1992, he served as President of the Société mathématique de France, and from 1995 to 1998, as President of the European Mathematical Society. He is a member of several scientific advisory committees in Europe. He has been a member of Academia Europaea since 1996 and a foreign associate of the Spanish Royal Academy since 2002.



Jean-Louis Colliot-Thélène is "directeur de recherche" at the Centre national de la recherche scientifique (UMR 8628, Université de Paris-Sud, Orsay). He specializes in algebraic geometry and its links to arithmetic. He obtained a Doctorat d'État (1978) from Paris-Orsay. He is a member of the editorial board of the *Annales scientifiques de l'École Normale Supérieure* (of which he was editor-in-chief until recently), as well as of the boards of the *Journal of Number Theory* and the *Journal of K-Theory*. Jean-Louis Colliot-Thélène was one of the main organizers of the 2005-2006 Thematic Program at MSRI (Berkeley).



Mark Goresky has been a member of the Institute for Advanced Study in Princeton since 1994. He received his B.Sc. from the University of British Columbia in 1971 and a Ph.D. from Brown University in 1976. In 1986, he was elected to the Royal Society of Canada. He was awarded the Jeffery-Williams Prize of the Canadian Mathematical Society in 1996 and the Steele Prize of the American Mathematical Society in 2002

(jointly with R. MacPherson). He was a member of the editorial board of the Canadian Journal of Mathematics from 1997 to 2000 and is currently a member of the editorial board of the Bulletin of the American Mathematical Society. He is a world expert in geometric representation theory.



Alice Guionnet is "directrice de recherche" at the CNRS and teaches at the Ecole Normale Supérieure de Lyon. She received a Ph.D. from Université Paris-Sud in 1995. In 1999 she was awarded the Oberwolfach Prize (for a young European mathematician under 35 years old) and in 2009 she received the Loève Prize in Probability. She was an invited speaker at ICIAM 2003 and ICM 2006. She is a member of the editorial board of *Stochastic Processes and their Applications* and editor-in-chief of the *Annales de l'Institut Henri Poincaré*. Her research interests focus mainly on probability theory in relation to mathematical physics.



A mathematician and physicist by training, **François Lalonde** holds a Doctorat d'État (1985) from the Université de Paris-Sud Orsay in the field of differential topology. His fields of interest include symplectic topology, Hamiltonian dynamics, and the study of infinite-dimensional transformation groups. He has been a member of the Royal Society of Canada since 1997 and held a Killam Research Fellowship in 2000–2002. He holds the Canada Research Chair in Differential Geometry and Topology at the Department of Mathematics and Statistics of the Université de Montréal. He was Plenary speaker at the First Canada-China Congress in 1997, and part of his collaborative work with Dusa McDuff was presented in her plenary address at the ICM 1998 in Berlin. Professor Lalonde was an invited speaker at the ICM 2006 in Madrid.



Thomas Salisbury is President of the Canadian Mathematical Society and a Professor at the Department of Mathematics and Statistics of York University. He was Deputy Director of the Fields Institute until May 2006. He holds degrees from McGill University (B.Sc.) and the University of British Columbia (Ph.D.).

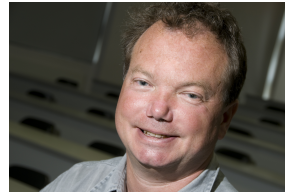
His research is in probability theory and its connections to both finance and mathematical analysis. He has been Editor-in-Chief of the *Canadian Mathematical Bulletin* and Associate Editor of the *Canadian Journal of Statistics*, and is currently on the editorial board of *Potential Analysis*.



Catherine Sulem is a Professor in the Department of Mathematics of the University of Toronto. She received a Doctorat d'État from the Université de Paris-Nord in 1983. She was Keynote Speaker at IMACS2003 (International Association for Mathematics and Computers in Simulation) and an invited speaker at a meeting of the American Mathematical Society in 1999. In 1998, she was awarded the Krieger–Nelson Prize by the Canadian Mathematical Society. Her research interests are in nonlinear partial differential equations arising in physics: nonlinear partial differential equations, nonlinear Schrödinger equations and related systems, the water wave problem, the Boltzmann equation, and computational fluid mechanics. Since 2000, she has been an Associate Editor of the *SIAM Journal of Mathematical Analysis*. From 1999 to 2005, she was an Associate Editor of the *Canadian Journal of Mathematics*.



Mary F. Wheeler holds the Ernest and Virginia Cockrell Chair in Engineering at the University of Texas at Austin where she is also Professor at the Department of Mathematics. In addition, she is Director of the Center for Subsurface Modeling of the Texas Institute for Computational and Applied Mathematics (TICAM) at the same university. She obtained her Ph.D. from Rice University. She is currently an editor of six journals and is Managing Editor of *Computational Geosciences*. In 1998, she was elected to the National Academy of Engineering. Her research interests include parallel computation and numerical solution of partial differential systems with applications to the modeling of subsurface and surface flows.



Jean-Christophe Yoccoz is Professor at the Collège de France where he holds a Chair in Mathematics (Differential Equations and Dynamical Systems). He obtained a Doctorat d'État in 1985. He was awarded the Fields medal in 1994 and is a member of the Académie des sciences (France), a Chevalier de la Légion d'Honneur (1995) and an Officer of the Ordre du Mérite (2000). His research work concerns the theory of dynamical systems and the Julia and Mandelbrot sets.

Joseph Hubert, Vice-Principal (Research), Université de Montréal, is an ex-officio member of the Advisory Committee. **Chantal David** (Concordia University), **Andrew Granville** (Université de Montréal), **Jean LeTourneux** (Université de Montréal), and **Odile Marcotte** (Université du Québec à Montréal), all Deputy Directors of the CRM, are invited members of the Committee.

CRM Administrative and Support Staff

The Director's Office

François Lalonde

Director

Chantal David

Deputy Director, Bulletin du CRM

Andrew Granville

Deputy Director, CRM Prizes

Jean LeTourneux

Deputy Director, Publications

Odile Marcotte

Deputy Director, Annual Report and Coordination with Related Fields

Administration

Vincent Masciotra

Head of Administration

Muriel Pasqualetti

Administrative Assistant

Guillermo Martinez-Zalce

Research Laboratories Administrative Coordinator

Diane Brulé-De Filippis

Assistant

Scientific Activities

Louis Pelletier

Coordinator

Josée Laferrière

Assistant

Sakina Benhima

Project Manager

Josée Simard

Assistant (until August 1, 2007)

Computer Services

Daniel Ouimet

Systems Administrator

André Montpetit

Office Systems Manager (half time)

François Cassinat

Technical Assistant (part time)

Publications

André Montpetit

TeX Expert (half time)

Louise Letendre

Technician

Communications

Suzette Paradis

Communications Officer and Webmaster

**Statement of Revenue and Expenditures
for the Fiscal Year Ending on
May 31, 2008**

	NSERC	NSERC- NPCDS	FQRNT	Université de Montréal	Other Universities	From Endowment Funds	Partners & Researchers	Other Sources	TOTAL
REVENUE									
Operating and infrastructure grants	966 000	57 100	455 000	-	-	-	-	-	1 478 100
Université de Montréal grant	-	-	-	237 500	-	-	-	-	237 500
UQAM grant	-	-	-	-	117 000	-	-	-	117 000
McGill University grant	-	-	-	-	72 000	-	-	-	72 000
Concordia University grant	-	-	-	-	50 000	-	-	-	50 000
Université Laval grant	-	-	-	-	30 000	-	-	-	30 000
University of Ottawa grant	-	-	-	-	30 000	-	-	-	30 000
Université de Sherbrooke grant	-	-	-	-	8 000	-	-	-	8 000
National Science Foundation (USA)	-	-	-	-	-	-	48 500	-	48 500
NATO	-	-	-	-	-	-	71 300	-	71 300
MITACS	-	-	-	-	-	-	85 590	-	85 590
Contributions for colloquia series (ISM et GERAD)	-	-	-	-	-	-	16 866	-	16 866
Other contributions (conferences and workshops)	-	-	-	-	-	-	23 542	-	23 542
ISM contribution for postdoctoral fellows	-	-	-	-	-	-	57 625	-	57 625
Matching contributions for postdoctoral fellows	-	-	-	-	-	-	276 042	-	276 042
Matching contributions for workshops	-	-	-	-	-	-	20 808	-	20 808
Aisenstadt & Bissonnette endowment funds	-	-	-	-	-	52 689	-	-	52 689
Registrations	-	-	-	-	-	-	-	27 996	27 996
Publications	-	-	-	-	-	-	-	18 219	18 219
Other revenue	-	-	-	3 265	-	-	-	55	3 320
TOTAL REVENUE	966 000	57 100	455 000	240 765	307 000	52 689	600 272	46 270	2 725 096

(continued on next page)

	NSERC	NSERC- NPCDS	FQRT	Université de Montréal	Other Universities	From Endowment Funds	Partners & Researchers	Other Sources	TOTAL
EXPENDITURES									
SCIENTIFIC PROGRAM - CENTRE									
Thematic semester Recent developments in combinatorics									
Postdoctoral fellows	12 000	-	-	-	-	-	15 000	-	27 000
Total - Thematic semester Winter-Spring 2007	12 000	-	-	-	-	-	15 000	-	27 000
Thematic semester Applied dynamical systems									
Aisenstadt Chair	25	-	4 699	-	-	260	-	2 654	7 639
Workshops and schools	118 852	-	-	-	-	-	37 000	8 269	164 121
Total - Thematic semester Summer-Fall 2007	118 877	-	4 699	-	-	260	37 000	10 923	171 759
Thematic semester Dynamical systems and evolution equations									
Aisenstadt Chair	14	-	8 937	-	-	1 338	-	-	10 288
Postdoctoral fellows	55 000	-	-	-	-	-	32 875	-	87 875
Workshops and schools	44 474	-	187	-	-	63	41 500	16 377	102 602
Total - Thematic semester Winter-Spring 2008	99 487	-	9 124	-	-	1 401	74 375	16 377	200 765
General program									
Industrial and multidisciplinary program	106 088	13 000	26 525	-	-	22 862	108 107	4 286	280 868
National program on complex data structures (NPCDS)	17 428	-	6 385	1 524	-	3 000	54 965	3 652	86 953
Postdoctoral fellows and students	35 080	42 656	-	-	-	-	-	-	77 737
SCIENTIFIC PROGRAM - RESEARCH LABORATORIES	63 625	-	-	-	34 000	-	285 958	-	383 583
Course releases	-	-	7 500	-	55 600	-	-	-	63 100
Visiting researchers	1 395	-	28 918	-	9 443	-	-	-	39 756
Workshops, seminars, etc.	15 628	-	27 710	5 734	56 717	-	-	822	106 612
Postdoctoral fellows	30 500	-	29 000	19 625	53 154	-	-	-	132 279
Students	31 350	-	31 350	5 325	43 386	-	80 061	-	80 061
Administrative and technical support	-	-	68 000	-	46 468	-	-	-	114 468
Total - Laboratories	47 523	-	192 478	30 684	264 769	-	-	822	536 276
Other scientific expenses									
Community college researchers' projects	-	-	50 219	-	-	-	-	-	50 219
Course releases	-	-	15 600	-	-	10 000	-	-	25 600
Invited researchers	1 058	-	5 546	-	-	-	10 624	-	17 228
SMAC & AQJM	-	-	-	-	-	5 000	-	-	5 000
Accommod, Bulletin, Publicity, Annual Report	12 699	-	-	-	-	7 079	550	1 329	21 656
Total - Other scientific expenses	13 757	-	71 365	-	-	22 079	11 174	1 329	119 702
Personnel (non-academic)									
Academic management, Advisory committee, networking	392 941	-	241 129	161 476	-	-	587	1 710	797 843
Operating and computing expenses	6 747	-	24 643	73 102	-	-	-	6 162	110 654
TOTAL EXPENDITURES	31 378	-	10 170	4 561	-	-	1 242	646	47 998
TOTAL EXPENDITURES	944 933	55 656	586 516	271 348	298 769	49 603	588 409	45 905	2 841 139
YEAR-END BALANCE	21 067	1 444	(131 516)	(30 583)	8 231	3 087	11 863	365	(116 043)
Amount available at June 1, 2007									
Change in receivables and payables	(9 164)	-	89 296	(55 500)	-	83 140	10 723	145 280	263 774
Year-end balance	18 414	(1 444)	(63 663)	33 818	(8 231)	(5 821)	(2 966)	-	(29 893)
Amount available at May 31, 2008	21 067	1 444	(131 516)	(30 583)	8 231	3 087	11 863	365	(116 043)
Amount available at May 31, 2008	30 317	-	(105 884)	(52 265)	-	80 406	19 620	145 644	117 838

Mandate of the CRM

The Centre de recherches mathématiques (CRM) was created in 1969 by the Université de Montréal through a special grant from the National Research Council of Canada. It became an NSERC national research centre in 1984. It is currently funded by NSERC (Natural Sciences and Engineering Research Council), by the Government of Québec through the FQRNT (Fonds québécois de la recherche sur la nature et les technologies), by the Université de Montréal, as well as McGill University, Université du Québec à Montréal, Concordia University, University of Ottawa, Université Laval, and by private donations. The mission of the CRM is to support research in mathematics and closely related disciplines and to provide leadership in the development of the mathematical sciences in Canada.

The CRM carries on its mission and national mandate in several ways:

- it organizes each year a series of scientific events on a specific theme (high-profile lectures, workshops, summer schools, etc.),
- its general program and its multidisciplinary and industrial program provide funding for conferences and special events at the CRM and across the country,
- each year it invites, through the Aisenstadt Chair, one or more distinguished mathematicians, to give advanced courses as part of its thematic program,
- it awards four prizes yearly: the CRM–Fields–PIMS Prize recognizing major contributions to mathematics, the Aisenstadt Prize given for outstanding work done by a young Canadian mathematician, the CAP–CRM Prize for exceptional achievement in theoretical and mathematical physics, and the CRM–SSC Prize for exceptional contributions to statistics in early career,
- it publishes technical reports and about ten books per year (and some of its collections are published jointly with the AMS and with Springer),
- it has an extensive postdoctoral fellowship program, with more than thirty postdoctoral fellows on site, funded in partnership with other organizations and researchers,
- it informs the community of its activities through its newsletter, *Le Bulletin du CRM*, and its web site at crm.umontreal.ca,
- it participates, with the other two Canadian institutes, in groundbreaking national initiatives, for instance the MITACS network (Mathematics of Information Technology and Complex Systems). The institutes sponsor the Annual Meetings of the Mathematical Sciences Societies

(CMS, SSC, CAIMS), the development of the mathematical sciences in the Atlantic provinces through AARMS, and other activities organized outside the three institutes. They also participate in the National Program on Complex Data Structures jointly with the Canadian statistical community.

This national mandate is complemented by, and indeed supported by, a long-standing vocation of promoting research in the mathematical sciences in Québec. For instance,

- the CRM supports research through its nine research laboratories spanning most of the important areas of the mathematical sciences,
- it supports, through partnership agreements, a group of local researchers chosen mainly from departments of mathematics and statistics, but also computer science, physics, economics, engineering, etc.,
- it organizes series of regular seminars and lecture courses on different areas of the mathematical sciences,
- it sponsors joint activities with the ISM (Institut des sciences mathématiques) including the weekly CRM/ISM colloquium, graduate courses offered by distinguished visitors, and a program of postdoctoral fellowships,
- it works actively at developing contacts with industry. Its joint activities with liaison and research centres (CIRANO, CRIM, and MITACS) and research centres doing applied research (CIRRELT, GERAD, INRS–EMT, and INSERM) led to the creation of industrial networks. The most recent ones involved, in 2004–2005, Bombardier Aerospace and the Brain Imaging Unit CRM–IUGM–INSERM.

The CRM fulfils its national mission by involving the largest possible number of Canadian mathematicians in its scientific programs, both as participants and as organizers. It also supports many events taking place outside Montréal and the Province of Québec. It is recognized worldwide as one of the major institutes in the mathematical sciences. The director of the CRM is assisted by two managerial structures: the Bureau de direction and the Scientific Advisory Committee. The Advisory Committee is a group of internationally renowned mathematicians from Canada and abroad, who approve scientific programs and thematic years, choose recipients of the Aisenstadt Prize, and suggest new scientific avenues to explore.