CENTRE
DE RECHERCHES
MATHÉMATIQUES

Annual Report

2008
2009

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Presenting the Annual Report 2008 – 2009

It is a pleasure to present a brief overview of the CRM annual report for 2008 – 2009. Most of the activities described were planned under the directorship of François Lalonde and carried out while Anne Bourlioux and Christiane Rousseau were serving as acting directors. I would like to take the opportunity here to express the thanks of the CRM community for their outstanding and inspiring leadership. Christiane Rousseau led the CRM for almost a year and oversaw the scientific planning of our thematic programming into the year 2011. I would also like to express my thanks to Odile Marcotte who ably edited this report.

The thematic program, as always the core of the year's scientific activities, consisted of a mammoth year in Probabilistic Methods in Mathematical Physics. It was one of the most ambitious CRM thematic programs ever held, the first of altogether ten workshops being held in June 2008 and the last in June 2009. It was also carefully correlated with the CRM – PIMS Joint Program on Challenges and Perspectives in Probability, which took place in May – September 2009 (straddling two fiscal years, 2008 – 2009 and 2009 – 2010). A highly detailed and informative account of the year by John Harnad can be found in the Fall 2009 issue of *Le Bulletin du CRM*. In particular the four Aisenstadt Chair Lecture Series (by Svante Janson, Wendelin Werner, Andrei Okounkov, and Craig Tracy, respectively) were of truly exceptional caliber; both Werner and Okounkov were awarded the Fields Medal in 2006.

The CRM's general program of workshops and symposia dealt with vast and highly diverse areas of mathematics, statistics, and physics. Included were four large yearly international conferences, one of which was held in conjunction with the SMS Summer School on Symmetries and Integrability of Difference Equations. I would like to mention specifically the Celebration of Raoul Bott's Legacy in Mathematics, which honoured a giant of 20th century mathematics, and a strong friend of Canadian mathematics.

The multidisciplinary program is the CRM's main vehicle to organize activities with partners in the applied mathematical sciences and in industry and government. Among the highlights this year were the Eighth Canadian Summer School on Quantum Information, the SIAM Conference on the Life Sciences, and, continuing a tradition started a year earlier, the Second Montreal Industrial Problem Solving Workshop.

In its outreach program, the CRM series of "Grandes Conférences" continued to great acclaim. Within that program distinguished mathematicians give lectures of the highest scientific level, but accessible to a general public. They continued to be a very successful means for the CRM to stay connected with the wider community. In 2008 – 2009 Jacques Laskar (Observatoire de Paris) and Yvan Saint-Aubin and Gilles Brassard (both from the Université de Montréal) gave lectures attended and appreciated by hundreds of mathematicians, teachers, students, and interested members of the public.

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 latter being jointly organized with GERAD).

The CRM awards four mathematical prizes each year, one on its own and three in partnership with other institutions. In 2008 – 2009 the CRM – Fields – PIMS Prize was awarded to Martin Barlow (University of British Columbia), the André-Aisenstadt Prize to Valentin Blomer (University of Toronto), the CAP – CRM Prize to Hong Guo (McGill University), and the CRM – SSC Prize to Hugh Chipman (Acadia University).

As part of its unique structure the CRM acts as an umbrella organization for a number of specialized research laboratories, ten in 2008 – 2009 (including the Groupe interdisciplinaire de recherche en éléments finis, based at Université Laval in Québec City). 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.

Finally, on behalf of the CRM community, I would like to thank the institutions that have sponsored and continue to sponsor the activities of the CRM, and in particular the granting agencies NSERC and FQRNT, the MITACS network, the National Research Foundation, and the Clay Mathematics Institute.

Peter Russell

Thematic Program

The core of each year's scientific program at the CRM is its thematic program. In 2008 – 2009 the CRM organized a Thematic Year on *Probabilistic Methods in Mathematical Physics*, one of the most ambitious CRM thematic programs ever held, the first workshop beginning on June 2, 2008, and the last one ending on June 13, 2009. Preparatory courses for this thematic year were already in progress as of January 2008. It was also carefully correlated with the CRM – PIMS Joint Thematic Program on *Challenges and Perspectives in Probability*, which took place in the period May – September 2009.

The CRM is very grateful to the National Science Foundation (NSF) for providing generous financial support to the young American mathematicians who attended the activities of the thematic program in 2008 – 2009. The CRM is also grateful to the Clay Mathematics Institute, to NSERC, and to FQRNT for their support.

Thematic Programs of the Year 2008 – 2009 *Probabilistic Methods in Mathematical Physics* and *Challenges and Perspectives in Probability*

Randomness is present in nearly all physical measurements, and is an essential feature in the description of any physical system in which there is uncertainty in initial conditions or so many degrees of freedom that a meaningful microscopic description is only possible in terms of averaged quantities. Moreover, the probabilistic interpretation of measurement lies at the very root of the quantum description of nature. A probabilistic characterization of states, both in classical and quantum statistical mechanics, in or out of equilibrium, forms a central part of contemporary theoretical physics, from microscopic to galactic scales. It is especially important in the domain of condensed matter theory. The phases of matter, critical phenomena, localization phenomena, magnetization, conductivity, heat capacity, disordered systems, radiation and absorption, and even the very basis of quantum field theory all involve concepts derived from probability theory.

The idea of a thematic program in Mathematical Physics was originally proposed in September 2005 by John Harnad, as CRM Mathematical Physics Laboratory Director. This evolved, after careful outside consultation by then CRM Director François Lalonde, solicitation of proposals, input from a variety of sources, and joint discussions, into the Thematic Program on Probabilistic Methods in Mathematical Physics. Actual planning of the program began in early May 2006, with the selection of the Program Coordinators: Pavel Bleher (Indiana University – Purdue University Indianapolis), John Harnad (CRM & Concordia University) and Steve Zelditch (Johns Hopkins University). The full scientific committee of eleven members was assembled by the end of June 2006, at which time John Harnad assumed the role of Chairman of the Scientific Committee. Discussions also began in June regarding the detailed content of the thematic year, the topics of workshops, and the potential organizers; coordination discussions with the organizers of the CRM – PIMS Joint Program (Gordon Slade and David Brydges) also took place in the same period.

The Program Coordinators were assisted in the overall planning by the other members of the International Scientific Committee. This consisted of four Canadians (John Harnad, Pavel Winternitz and Yvan Saint-Aubin, both from CRM and the Université de Montréal, and David Brydges, from PIMS and the University of British Columbia), four researchers from the United States (Craig Tracy, from the University of California, Davis, Pavel Bleher, Charles Newman, from the Courant Institute, NYU, and Steve Zelditch), and three researchers from Europe (Jean-Bernard Zuber, from the Université Pierre et Marie Curie, Alice Guionnet, from the École normale supérieure de Lyon, and Herbert Spohn, from the Technische Universität München). Coordination with the CRM – PIMS Joint Thematic Program on Challenges and Perspectives in Probability was the responsibility of Yvan Saint-Aubin and David Brydges, who were on the scientific committees of both programs.

The purpose of the Program on Probabilistic Methods in Mathematical Physics was to represent the state of the art in several currently very active areas of research within this broad domain, emphasizing the interactions between them. Besides providing a vehicle for communicating the most significant new research results in these areas, the principal objectives included: (1) giving an opportunity for cross-fertilization between the different specialties represented; (2) stimulating new ideas through such cross-fertilization; and (3) providing an environment in which young researchers might learn about and be encouraged to contribute to the exciting new developments in these domains. The program consisted of: ten research workshops between

June 2008 and June 2009, each lasting one week, grouped so as to maximize constructive interactions between them; three Aisenstadt Chair lecture series coordinated with the workshops; twenty-three visits by long-term visitors staying at the CRM for durations of between two and ten weeks; several preparatory lecture courses for advanced graduate students and young researchers on topics related to the workshops; and five postdoctoral research fellowships for young mathematicians based at the CRM, working within the Mathematical Physics group during the year (June 2008 – June 2009).

Three Special Preparatory Courses were offered at the CRM in 2008 as part of the CRM 2008 – 2009 Thematic Program. The first, entitled *Introduction to Tau Functions and their Applications*, was given by John Harnad and lasted throughout the semester (from January to May 2008), with two further lectures given by Marco Bertola (Concordia University). The second, entitled *Modèles statistiques en deux dimensions, théorie des champs conformes, et équation de Schramm-Loewner*, was given by Yvan Saint-Aubin twice weekly from January to April 2008. The third course, entitled *Random Matrices and Exactly Solvable Models of Statistical Mechanics*, was given by Pavel Bleher, one of the Coordinators of the Thematic Year (August 12 – 14 and September 8 – 25, 2008).

Aisenstadt Chairholders in 2008 – 2009: Svante Janson, Wendelin Werner, Andreï Okounkov, and Craig Tracy

The Aisenstadt Chairholder for the CRM – PIMS Joint Thematic Program on *Challenges and Perspectives in Probability* was Svante Janson (Uppsala University). The Aisenstadt Chairholders for the Thematic Year on *Probabilistic Methods in Mathematical Physics* were Wendelin Werner (Université Paris-Sud 11), Andreï Okounkov (Princeton University), and Craig Tracy (University of California, Davis).

Svante Janson

Admitted to Uppsala University at the age of thirteen, Svante Janson received his BA at the age of fourteen and his doctoral degree in functional analysis on his 22nd birthday in 1977. This was followed by a second doctoral degree in probability theory in 1984, all at Uppsala University, where he was appointed professor in 1985. He had a bicephalous career, making a mark in functional analysis starting with his influential 1981 paper *Minimal and Maximal methods of Interpolation* in the *Journal of Functional Analysis*, and moving into probability theory and its applications in combinatorics, random structures, and algorithms during the last three decades. He was awarded several prizes, including the prestigious Göran Gustafsson Prize in 1992.

He has written over 200 papers and four books. Probability theorists know his books *Poisson Approximation* (with Andrew D. Barbour and Lars Holst, 1992), and *Random Graphs* (with Tomasz Luczak and Andrzej Rucinski, 2000) very well. In the field of random graphs, which was created in 1959 by Erdős and Rényi, many consider Janson's 126-page paper *The Birth of the Giant Component* (1993, with Knuth, Luczak, and Pittel) one of the finest ever written. It gives a precise description of the nature of the phase transition in random graphs when the edge probabilities are about $1/n$. Janson is also known for his analyses and ingenious proof methods of many newer random graph models that are being created to explain social, web, computer, and other networks.

On October 17, 2008, at the CRM, Professor Janson gave a lecture geared towards a general audience and entitled *Random Graphs: New Models and the Internet.* In that lecture, he explained that the classical graph models are often too homogeneous to be good approximations, in particular of web graphs. This observation has been a source of inspiration for random graph theorists and led to the introduction of new random graph models in order to mimic the Internet or similar graphs. Professor Janson also gave three technical lectures (on October 20, 21, and 23, respectively), in which he discussed several different models of random graphs. The emphasis of these lectures was on the existence of a giant component, the vertex degree distribution, and the susceptibility (mean size of the component containing a random vertex). We refer the reader to the Spring 2009 issue of *Le Bulletin du CRM* for a detailed description of Professor Janson's lectures.

Wendelin Werner

Wendelin Werner is an expert in probability theory. He obtained his doctorate in 1993 under the supervision of Jean-François Le Gall. He has been a professor in the Laboratoire de mathématiques of the Université Paris-Sud 11, in Orsay, since 1997, and at the École normale supérieure since 2005. With his collaborators Greg Lawler and Oded Schramm, he has

shown that the probability of two mutually avoiding planar random walks decreases as $n^{-5/8}$ (where n is the walks' length) and has determined the Hausdorff dimension ($= \frac{4}{3}$) of the exterior boundary of planar Brownian motion. Werner's work on the Stochastic Loewner Equation and sets of conformal loops have already had a deep impact on the mathematical description of critical phenomena in two dimensions. Werner was awarded the Prize of the European Mathematical Society in 2000, the Fermat Prize in 2001, the Loève Prize in 2005, and the Pólya Prize in 2006. In 2006 he became the first probabilist to be awarded the Fields medal.

On August 1st, 2008, Wendelin Werner gave a lecture geared towards a general audience and entitled *Transitions de phase et invariance conforme en mécanique statistique bidimensionnelle*. He also gave two more technical lectures (on August 12 and August 13, respectively), on the (a)symmetry or random interfaces. In his three lectures Professor Werner addressed the following issues and problems (among others): phase transitions, critical phenomena, the universality hypothesis, the conformal invariance hypothesis, and the Stochastic Loewner Equation. Professor Werner's lectures were closely related to the topics of the Workshop on Stochastic Loewner Evolution and Scaling Limits (see p. 12). We refer the reader to the Fall 2008 issue of *Le Bulletin du CRM* for a detailed description of Professor Werner's lectures.

Andreï Okounkov

Andreï Okounkov was born in Moscow in 1969 and is now a professor at Princeton University. He was awarded the Prize of the European Mathematical Society in 2004 and the Fields Medal in 2006. When Okounkov was awarded the latter at the 2006 International Congress of Mathematicians in Madrid, Giovanni Felder said: "Andreï Okounkov's initial area of research was group representation theory, with particular emphasis on combinatorial and asymptotic aspects. He used this subject as a starting point to obtain spectacular results in many different areas of mathematics and mathematical physics, from complex and real algebraic geometry to statistical mechanics, dynamical systems, probability theory and topological string theory. The research of Okounkov has its roots in very basic notions such as partitions, which form a recurrent theme in his work... at its core (is) the idea that partitions and other notions of representation theory should be considered as random objects with respect to natural probability measures. This idea was further developed by Okounkov, who showed that, together with insights from geometry and ideas of high energy physics, it can be applied to the most diverse areas of mathematics."

Professor Okounkov gave four Aisenstadt Chair lectures on the *Algebra and Geometry of Random Surfaces*, on September 9, 11, 12, and 15, respectively. He also gave two lectures on the *Noncommutative Geometry of Planar Dimers* within the framework of the Workshop on Random Tilings, Random Partitions and Stochastic Growth Processes (see below). We refer the reader to the Fall 2008 issue of *Le Bulletin du CRM* for a detailed description of Professor Okounkov's lectures.

Craig Tracy

Craig Tracy was Professor at Dartmouth College before joining the University of California, Davis in 1984. He is currently Distinguished Professor of Mathematics at the University of California, Davis. In his joint work with Wu, McCoy, and Barouch, he discovered an important connection between exactly solvable statistical models, like the Ising model, and classical integrable systems, in particular the Painlevé transcendants. In more recent years, in collaboration with Harold Widom, he obtained many crucial results on the theory of Fredholm and Toeplitz determinants, and random matrix theory. They introduced a new class of distributions, now called the Tracy – Widom distributions, governing the eigenvalues at the edge of the spectrum in the large N limit. These turned out to be "universal" in the sense that they also underlie the statistics of the longest increasing subsequence problem, several tiling problems, and various growth models. In 2002 he shared the George Pólya Prize with his longtime collaborator Harold Widom, and in 2007 he shared the AMS – SIAM Norbert Wiener Prize with the same collaborator. He is a member of the American Academy of Arts and Sciences.

The third Aisenstadt Chair lecture series relating to the Thematic Program on Probabilistic Methods in Mathematical Physics was given in March 2009 by Professor Tracy. Professor Tracy was also present at the Workshop on Random Matrices (see below), an area in which he has been a pioneering contributor. His Aisenstadt Chair Lectures were on the general theme *The Asymmetric Simple Exclusion Process and Integrable Models in Statistical Physics*. The titles and dates of his three lectures are: *The Asymmetric Simple Exclusion Process*: *Integrable Structure and Limit Theorems*. I (March 3, 2009); *The Asymmetric Simple Exclusion Process*: *Integrable Structure and Limit Theorems*. II (March 5, 2009); *Integrable Models in Statis-*

tical Physics and Associated Universality Conjectures (March 6, 2009).

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 Publications 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 Zarantonello, 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, Sir 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, Richard Stanley, John J. Tyson, John Rinzel, Gerhard Huisken, and Jean-Christophe Yoccoz.

Workshops of the Thematic Year on Probabilistic Methods in Mathematical Physics

Mathematical Aspects of Quantum Chaos

June 2 – 6, 2008, CRM

Organizers:
Nalini Anantharaman (École Polytechnique), Stéphane Nonnenmacher (CEA/Saclay), Zeev Rudnick (Tel Aviv), Steve Zelditch (Johns Hopkins)
Speakers:
Arnd Bäcker (TU Dresden), Alex Barnett (Dartmouth), Gregory Berkolaiko (Texas A&M), Eugène Bogomolny (Paris-Sud 11), Jens Bolte (Royal Holloway), Peter A. Braun (Duisburg-Essen), Shimon Brooks (Princeton), Hans Christianson (MIT), Mirko Degli Esposti (Bologna), Frédéric Faure (Joseph Fourier), Boris Gutkin (Duisburg-Essen), Hamid Hezari (Johns Hopkins), Dmitry Jakobson (McGill), Jonathan Keating (Bristol), Dubi Kelmer (Chicago), Pär Kurlberg (KTH), Dan Mangoubi (Montréal), Sebastian Müller (Bristol), Iosif Polterovich (Montréal), Roman Schubert (Bristol), Lior Silberman (UBC), Alexander Strohmaier (Loughborough), Gregor Tanner (Nottingham), John A. Toth (McGill), Igor Wigman (KTH), Maciej Zworski (UC Berkeley)
Number of participants: 48

The twenty-six speakers represented the broad orientations that are current in the domain of Quantum Chaos: the problem of unique quantum ergodicity; quantum graphs; spectral statistics and connections with random matrices; resonances and diffusion; zeros of eigenfunctions; weakly chaotic systems; arithmetic aspects; and numerical aspects. The speakers approached the subject from various points of view; some were more mathematical and others more physical. These differing points of view often gave rise to animated discussions at the end of the sessions. New questions were formulated by the "physicists" to be considered by the "mathematicians," and vice versa. The participants made good use of the pauses between the sessions to engage in discussions. The numerous young participants especially benefited from these discussions and debates. There were also six poster presentations in the coffee room during the course of the workshop. The interested reader can find a more detailed account of this workshop in the Fall 2008 issue of *Le Bulletin du CRM*.

Integrable Quantum Systems and Solvable Statistical Mechanical Models

June 30 – July 5, 2008, CRM

Organizers:
Alexander Its (IUPUI), Michio Jimbo (Tokyo), Jean-Michel Maillet (ÉNS Lyon), Bruno Nachtergaele (UC Davis)
Speakers:
Ian K. Affleck (UBC), Boyka Aneva (INRNE), Vladimir Bazhanov (ANU), Pavel M. Bleher (IUPUI), Jean-Sébastien Caux (Amsterdam), Alexandre Faribault (Amsterdam), Frank Göhmann (Wuppertal), John Harnad (Concordia), Matthew B. Hastings (Los Alamos), Michio Jimbo, Nikolai Kitanine (Cergy-Pontoise), Vladimir E. Korepin (Stony Brook), Christian Korff (Glasgow), Karol Kozlowski (ÉNS Lyon),

Jean-Michel Maillet, Pierre Mathieu (Laval), Barry McCoy (Stony Brook), Francesco Mezzadri (Bristol), Bruno Nachtergaele, William Orrick (Indiana), Yvan Saint-Aubin (Montréal), Lea F. dos Santos (Yeshiva), Jun'ichi Shiraishi (Tokyo), Robert Sims (Arizona), Fedor Smirnov (UPMC), Shannon Lee Starr (Rochester), Véronique Terras (ÉNS Lyon; CNRS), Jörg Teschner (Deutsches Elektronen-Synchroton), Pavel Winternitz (Montréal), Paul Zinn-Justin (Paris-Sud 11)

Number of participants: 68

During the last few years, various new developments have taken place in the field of quantum integrable systems. One of the major issues that stands out is the exact description of correlation functions. Important progress has been made in the long distance asymptotics for correlation functions in integrable spin chains. Understanding the short distance structure has advanced, and exact formulas have been derived for dynamical and finite temperature cases. Progress on correlation functions and form factors has resulted in direct applications to condensed matter systems. In integrable quantum field theory, important work has been carried out for the vacuum expectation values of local fields and in the theory of Q-operators and its relation to ODEs and classical integrable systems. Aside from these "traditional" topics, the emerging role of integrable systems in various other fields has been revealed, often in a quite unexpected manner. The relevant topics range over such diverse areas as quantum entanglement, combinatorics, integrable stochastic processes and growth models.

Altogether, twenty-three one-hour invited lectures were given. There were also four contributed talks (each lasting 30 minutes) and a poster session. The topics of the lectures ranged over various aspects of integrable spin chains and field theory models, such as correlation functions, time dynamics, entanglement entropy, ordering of energy levels, loop models and combinatorics, quantum geometry and sinh-Gordon field theory. The highlight of the workshop was a report on the long-awaited derivation of the long distance asymptotics of the spin-spin correlation functions of the XXZ model. This is a major breakthrough in this field of mathematics and attracted a great deal of attention from the audience. The atmosphere of the workshop was very friendly and interactive and the high-quality talks stimulated lively discussions among the participants.

Stochastic Loewner Evolution and Scaling Limits

August 4 – 9, 2008, CRM

Organizers:
John Cardy (Oxford), Charles Newman (Courant Inst.), Wendelin Werner (Paris-Sud 11)

Speakers:
Thomas Alberts (Toronto), Robert Bauer (UIUC), Vincent Beffara (ÉNS Lyon), Denis Bernard (ÉNS), Ilia Binder (Toronto), Federico Camia (VU Amsterdam), John Cardy, Benjamin Doyon (Durham), Julien Dubedat (Chicago), Bertrand Duplantier (CEA/Saclay), Clément Hongler (Genève), Nam-Gyu Kang (Caltech), Tom Kennedy (Arizona), Kalle Kytölä (Paris-Sud 11), Gregory Lawler (Chicago), Yves Le Jan (UPMC), Nikolai Makarov (Caltech), Pierre Mathieu (Laval), Alexi Morin-Duchesne (Montréal), Pierre Nolin (ÉNS), Yvan Saint-Aubin (Montréal), Oded Schramm (Microsoft Research), Scott Sheffield (Courant Inst.), Jacob Simmons (Oxford), Stanislav Smirnov (Genève), David B. Wilson (Microsoft Research), Dapeng Zhan (Yale)

Number of participants: 57

In recent years, the most interesting developments in the theory of two-dimensional critical phenomena have emerged from a new field that might be called Conformal Probability Theory, which complements the extensive work on Conformal Field Theory that started in the physics community in the 1970s. Substantial progress has been made in understanding the random fractal geometry of such two-dimensional systems as critical percolation and critical Ising models, and their relation with such classic probabilistic objects as the frontier of two-dimensional Brownian motion. Among the topics covered in this workshop were: SLE and its Extensions, Critical and Near-Critical Scaling Limits, Gaussian Free Field, Coulomb Gas Methods, Relation to Conformal Field Theory and Quantum Gravity.

Everyone present felt that this was one of the best workshops ever to have taken place on the exciting topic of SLE and scaling limits, with an excellent mixture of mathematicians, mathematical physicists and theoretical physicists. One of the most valuable participants in the meeting, Oded Schramm (the inventor of the Schramm Loewner Evolution), gave two excellent talks and was very pleased with the workshop. Tragically, he died in an accident about three weeks later, while hiking on a mountain ridge, not far from his home in Washington State. This was a great loss for mathematics and it is with great regret that we note that our SLE workshop may have been the last international meeting he attended.

Laplacian Growth and Related Topics

August 18 – 23, 2008, CRM

Organizers:
Nikolai Makarov (Caltech), Paul Wiegmann (Chicago)
Speakers:
Artem Abanov (Texas A&M), Oded Agam (HUJI), Yacin Ameur (KTH), Ferenc Balogh (Concordia), Dmitry Belyaev (Princeton), Marco Bertola (Concordia), Darren Crowdy (Imperial College London), Ilya Gruzberg (Chicago), Bjorn Gustafsson (KTH), John Harnad (Concordia), Haakan Hedenmalm (KTH), Dmitry Khavinson (South Florida), Dmitry Korotkin (Concordia), Gregory Lawler (Chicago), Seung-Yeop Lee (Montréal), Lionel Levine (MIT), Igor Loutsenko (SISSA), Irina Markina (Bergen), Kenneth McLaughlin (Arizona), Mark Mineev-Weinstein (Los Alamos), Alexander Orlov (Shirshov Inst.), Yuval Peres (UC Berkeley), Aleix Prats-Ferrer (Montréal), Mihai Putinar (UCSB), Steffen Rohde (Washington), Edward B. Saff (Vanderbilt), Yvan Saint-Aubin (Montréal), Mikhail Sodin (Tel Aviv), Kanhehisa Takasaki (Kyoto), Takashi Takebe (Ochanomizu), Răzvan Teodorescu (Los Alamos), Alexander Vasiliev (Bergen), Anton Zabrodin (ITEP), Michel Zinsmeister (Orléans)
Number of participants: 53

The workshop was devoted to mathematical aspects of Laplacian growth. A broad class of non-equilibrium growth processes have a common law: the normal velocity of the growing boundary of a region is proportional to the gradient of a harmonic field on the exterior. This type of growth (called Laplacian growth) is unstable for nearly all initial configurations. Instabilities develop into fractal singular patterns. Similar instabilities occur in the hydrodynamics of immiscible fluids. The workshop attracted specialists from many areas of theoretical and applied mathematics and physics: complex analysis and approximation theory, random matrices, probability theory and SLEs, conformal field theory, integrable systems, fluid dynamics and condensed matter. The lectures covered a spectacular variety of topics, techniques, and approaches. There were many discussions and interdisciplinary interactions during the conference. There was also a strong degree of overlap, both in terms of interests and participants, between this workshop and subsequent workshops (on Random Matrices and Random Growth Processes, respectively).

The scientific level of the talks was uniformly outstanding. Here are some major developments. Perez and Levine reported on their work concerning internal DLA and some other related probabilistic and dynamical models. They established rigorous connections with the problems of Laplacian growth, and immediately after the talk, Gustafsson and other experts in Laplacian growth recognized familiar structures and suggested important complementary results. Ameur and Hedenmalm, and Balogh and Harnad, have made substantial progress in the study of eigenvalues of random normal matrices. They provided mathematical proofs for several fundamental facts first discovered at the physical level by Wiegmann and Zabrodin. Belyaev, Rohde and Zinsmeister talked about various growth models such as random snowflakes and a version of the Hastings – Levitov model. They collectively presented new mathematical techniques that might turn out to be effective in the analysis of DLA-type growth.

New aspects and several unexpected applications of Laplacian growth were discussed in the talks of Khavinson, Lawler, Putinar and Sodin. Zabrodin, Takebe and Tasaki presented their new results related to the connection between Laplacian growth and integrable dispersionless hierarchies. Teodorescu, Agam, and Mineev discussed new applications of Laplacian growth in hydrodynamics. Especially noticeable are weak solutions and shocks in viscous Hele – Shaw flow and Rayleigh – Taylor instabilities on the boundary of evaporating thin films on a wet surface. Several important open questions and specific conjectures were formulated during the workshop, in particular, concerning general one-component plasma ensembles and zeros of orthogonal polynomials. This workshop was one of the most representative and interesting events in Laplacian growth in recent years. There are already several plans to organize follow-up meetings.

Random Matrices, Related Topics and Applications

August 25 – 30, 2008, CRM

Organizers:
Estelle Basor (AIM), Marco Bertola (Concordia), Bertrand Eynard (CEA/Saclay), Alexander Its (IUPUI), Ken McLaughlin (Arizona)
Speakers:
Mark Adler (Brandeis), Gernot Akemann (Brunel), Alexei Borodin (Caltech), Robert Buckingham (Michigan), Leonid Chekhov (Steklov Inst.), Yang Chen (Imperial College London), Tom Claeys (KU Leuven), Percy Deift (Courant Inst.), Jeffery DiFranco (Seattle), Maurice Duits (KU Leuven), Ioana Dumitriu (Washington), Torsten Ehrhardt (UC Santa Cruz), Nicholas M. Ercolani (Arizona), Alice Guionnet (ÉNS Lyon), Mourad Ismail (Central Florida), Kurt Johansson (KTH), Igor V. Krasovsky (Brunel),

Arno Kuijlaars (KU Leuven), Seung-Yeop Lee (Montréal), Peter Miller (Michigan), Man Yue Mo (Bristol), Alexander Orlov (Shirshov Inst.), Aleix Prats-Ferrer (Montréal), Brian Rider (CU-Boulder), Nina Snaith (Bristol), Kim Splittorff (Copenhagen), Răzvan Teodorescu (Los Alamos), Pierre van Moerbeke (UC Louvain), Harold Widom (UC Santa Cruz), Roderick S.C. Wong (CityU Hong Kong), Jean-Bernard Zuber (UPMC)

Number of participants: 88

This workshop focused on recent advances in the asymptotic spectral theory of random matrices, connections with (multi-)orthogonal polynomials, Riemann – Hilbert and d-bar methods, relations to random surface growth, beta ensembles, coupled chains of random matrices, computational methods, combinatorics and moduli space theory of Riemann surfaces, algebraic geometry, theory of isomonodromic deformations, number theory, Brownian motion, Airy and Pearcey processes, critical behaviour in non-intersecting path ensembles, gap probabilities, linear statistics, higher-order analogs of Tracy – Widom distributions, simple exclusion processes, outpost colonization, entanglement, graphical enumeration, Fisher – Hartwig asymptotics, fermionic representation of partition functions and correlators, and applications to diverse fields (zeros and moments of L-functions, growth processes, black holes, and QCD).

The topics covered included: asymptotic spectral theory of random matrices (Akemann, Ehrhardt, Teodorescu, Lee, Duits); non invariant matrix models (Johannson, Bender); (multi)critical universality classes (Claeys, Lee); random matrix theory and high-energy physics (Akemann, Splittorf); asymptotics of determinants (Deift, Krasovsky); total integrals and statistical lattice applications (DiFranco, Buckingham, Mo); connection with (multi-)orthogonal polynomials (Wong, Duits, Chen); combinatorics (Ercolani); number theory (Snaith); numerical analysis (Dumitriu); Dyson processes (Adler, van Moerbeke, Kuijlaars); random surfaces (Borodin); discrete and continuous random processes (Widom, Adler, van Moerbeke, Kuijlaars); topological expansions (Chekhov, Prats-Ferrer). Thirty-seven talks were scheduled; accommodating all the speakers while maintaining a reasonable schedule was quite a challenge, leaving one afternoon only for spontaneous interaction. Reactions of the participants, speakers and non-speakers, were extremely positive; several participants remarked on the uniformly high level of the lectures.

To contribute to the cross-fertilization of ideas and foster exchanges among participants, the workshop was preceded by the Workshop on Laplacian Growth and Related Topics and followed by the Workshop on Random Tilings, Random Partitions and Stochastic Growth Processes, as well as the series of lectures by Fields medallist A. Okounkov. Several participants chose to extend their stay to include all three of these events, or at least two.

Random Tilings, Random Partitions and Stochastic Growth Processes

September 1 – 5, 2008, CRM

Organizers:
Jinho Baik (Michigan), Alexei Borodin (Caltech), Bernard Nienhuis (Amsterdam), Nicolai Reshetikhin (UC Berkeley), Herbert Spohn (TU München).

Speakers:
Gérard Ben Arous (Courant Inst.), Cédric Boutillier (UPMC), Mihai Ciucu (Georgia Tech), Filippo Colomo (INFN), Nicolas Destainville (Paul Sabatier), Patrick Ferrari (Weierstraß-Institut), Jason Fulman (Southern California), Vadim Gorin (MGU), Kurt Johansson (KTH), Christian Krattenthaler (Wien), Jeffrey Kuan (Caltech), Sevak Mkrtchyan (UC Berkeley), Taro Nagao (Nagoya), Eric Nordenstam (KTH), Andreï Okounkov (Princeton), Grigori Olshanski (IITP), Aleksandr Orlov (Shirshov Inst.), Eric M. Rains (Caltech), Nicolai Reshetikhin, Tomohiro Sasamoto (Chiba), Senya Shlosman (CPT), Evgeny Strahov (HUJI), Mirjana Vuletic (Caltech)

Number of participants: 50

Tiling problems have a long tradition in combinatorics and in statistical mechanics. One of the central problems is to understand the statistical structure of the patterns obtained when tiling a large domain randomly. As noticed by N. Elkies and J. Propp a decade ago, random tilings of a large planar domain may exhibit phase segregation; the density of tiles has a smooth (non-constant) variation in some regions of the domain while in a so-called frozen region the density of tiles is constant. In the corresponding surface picture, the frozen region corresponds to a facet of constant slope, while its complement corresponds to a rounded surface.

In a very influential paper of 1986, M. Kardar, G. Parisi and Y. C. Zhang introduced growth processes of random deposition type without surface diffusion. A particular and much studied one-dimensional model is the corner growth model with discrete time updating, which is isomorphic to the interface in the dimer tiling of the Aztec diamond. The stochastic growth of the line separating the frozen

from the non-frozen region is induced by the random shuffling algorithm, which from a tiling of a domain of linear size N generates a corresponding tiling of a domain of linear size $N+1$ with the correct statistical weight.

During the last decade there has been enormous progress in elucidating the picture and this workshop gave an opportunity to present both an overview and a detailed account of many of these developments. One of these developments is the fact that for the random tiling of a domain in the triangular lattice by rhombi (dimer models on the hexagonal lattice), the limit shapes are algebraic curves (R. Kenyon, A. Okounkov). In the non-frozen region the fluctuations in such models have the statistics of a massless Gaussian free field (R. Kenyon). With the exception of singular points the borderline separating the frozen and non-frozen regions is governed by the Airy process (M. Prähofer, H. Spohn, A. Okounkov, N. Reshetikhin). At singular points the fluctuations are described by the Pearcy process and similar determinantal processes (A. Okounkov, N. Reshetikhin).

As noted by K. Johansson these stochastic processes are closely related to the asymptotics of discrete orthogonal polynomials. There has been an increased understanding of the deep connection (noted first by Johansson) between tilings of particular domains and one-dimensional KPZ growth. This discovery triggered an explosion of related results, in particular the central role of extended determinantal processes, of Dyson's Brownian motion and of low-rank perturbations of random matrices. New results confirmed the expectation that the structure of fluctuations holds for a much wider class of models. Tiling problems are also closely related to the theory of random partitions and representation theory. This is particularly evident for tilings of domains on a triangular lattice by rhombi, developed and presented in the contributions of A. Borodin, A. Okounkov and G. Olshanski. The contents of this workshop were closely related to those of the two preceding ones and to the fascinating series of lectures by Aisenstadt Chair Andreï Okounkov (September 1 – 16, 2008).

Quantum Many-Body Systems; Bose – Einstein Condensation

September 29 – October 4, 2008, CRM

Organizers:
I. Michael Sigal (Toronto), Jan Philip Solovej (Copenhagen), Jakob Yngvason (Wien), Valentin Zagrebnov (CPT)

Speakers:
Stefan Adams (Warwick), Yaniv Almog (Louisiana State), Jean-Bernard Bru (Wien), Yvan Castin (ÉNS), Michele Correggi (SNS), Teunis C. Dorlas (IAS), László Erdős (München), Soeren Fournais (Aarhus), Christian Hainzl (Alabama at Birmingham), Dieter Jaksch (Oxford), Robert L. Jerrard (Toronto), Eduard-Wilhelm Kirr (UIUC), Elliott H. Lieb (Princeton), Vieri Mastropietro (Tor Vergata), Bruno Nachtergaele (UC Davis), Manfred Salmhofer (Leipzig), Benjamin Schlein (Cambridge), Robert Seiringer (Princeton), Jan Philip Solovej (Copenhagen), András Sütő (RISSP), Hiroshi Tamura (Kanazawa), Daniel Ueltschi (Warwick), Jun Yin (Harvard)
Number of participants: 55

The physics of ultracold quantum gases and Bose – Einstein condensation is currently a very active field of both experimental and theoretical research worldwide. Unveiling the fascinating properties of such quantum many-body systems by rigorous mathematical analysis is an important and difficult challenge for mathematical physics. Considerable progress has been made in recent years, involving a variety of mathematical techniques such as spectral theory of partial differential operators with a large number of variables, nonlinear partial differential equations, random walks on lattices and functional integration. Several of the most basic questions are still unanswered, however, and there is much to be learned. The workshop brought together experts with different backgrounds to review the current status of mathematical results in the field and to discuss new developments (where a mathematical approach is fruitful).

The topics covered included ultracold atoms and Bose gases in low dimensions, variational methods, determinants bounds, applications to fermionic many-body systems, lattice models, spin chains, soft matter at high densities, probabilistic approaches to many-body systems, relations to random point fields, relations to random permutations, vortices in Bose – Einstein condensates, the derivation of the Gross – Pitaevskii equation, correlations in Bose – Einstein condensates and applications to superconductors.

Random Functions, Random Surfaces and Interfaces

January 4 – 9, 2009, Hôtel Saint-Gabriel (Sainte-Adèle, Québec)

Organizers:
Dick Bond (Toronto), Michael R. Douglas (Stony Brook), Scott Sheffield (Courant Inst.), Senya Shlosman (CPT), Steve Zelditch (Johns Hopkins)

Speakers:
Robert Adler (Technion), Ben Baugher (Johns Hopkins), Pavel M. Bleher (IUPUI), Dick Bond, Jean-Dominique Deuschel (TU Berlin), Michael R. Douglas (Stony Brook), Bertrand Duplantier (CEA/Saclay), Tadahisa Funaki (Tokyo), Yan V. Fyodorov (Nottingham), Richard Kenyon (Brown), Konstantin Khanin (Toronto), Semyon Klevtsov (ULB), Lev Kofman (Toronto), Manjunath Krishnapur (Toronto), Jason Miller (Stanford), Sergei Nechaev (Paris-Sud 11), Dmitri Pogosyan (Alberta), Sergei F. Shandarin (Kansas), Scott Sheffield, Senya Shlosman, Mikhail Sodin (Tel Aviv), Rien van de Weygaert (Groningen), Igor Wigman (KTH), Steve Zelditch
Number of participants: 28

The workshop was interdisciplinary, with participants ranging from researchers in astrophysics to string theory to statistical mechanics to probability and geometry. It was mainly devoted to random fields such as Gaussian random fields. Motivated by such physical models as (i) the large scale matter distribution in the universe or (ii) landscape statistics in string theory or (iii) the random wave model in quantum chaos or (iv) limit shapes of phase interfaces in statistical mechanics, the workshop largely focused on the zeros or critical points of random fields.

Examples of random functions or random surfaces arising in nature include: the surface of the sea in heavy weather, the cosmic microwave radiation background, the electric field intensity of a laser speckle pattern, and random noise in signals. The initial matter distribution of the universe was modelled as a Gaussian random function by Ya. B. Zeldovich in the 1970s. Random surfaces also play a central role in string theory and M-theory. They are also used to model the early universe in current string theory and quantum gravity. In another direction they arise as interfaces in statistical mechanics. For mathematicians, a focal point was the recent work of Duplantier-Sheffield giving a rigorous definition of Polyakov's Liouville field theory and a proof of the so-called KPZ formula. (Liouville theory is a theory of random metrics on a Riemann surface.)

The astrophysicists spoke largely about the distribution of "matter" in the universe. The evolution in time of the matter distribution is often modelled as the evolution of Gaussian random initial data under the Euler-Poisson equation. The distribution seems to remain roughly Gaussian for a few hundred thousand years, but eventually gravitational attraction causes matter to clump in non-Gaussian filamentary structures. Astrophysicists D. Bond, D. Pogosyan, R. van de Weygaert and S. F. Shandarin presented theoretical results, numerical simulations, and data on the distribution of matter. Pogosyan presented a mathematically convincing picture whereby the ridges or filaments were concentrated along the directions where the gradient of the random field is an eigenvector of its Hessian. M. R. Douglas gave a survey of questions and results pertaining to the landscape problem in string theory and in chaotic inflation, which raises a number of problems he has studied with his collaborators S. Ashok, F. Denef, B. Shiffman, and S. Zelditch.

The talks by Richard Kenyon, Pavel Bleher, and Senya Shlosman dealt with random surfaces arising in certain exactly solvable models. K. Khanin discussed problems related to directed polymers in quasi-stationary random potentials. Such potentials correspond to disordered systems interacting with a chaotic external field. Sergei Nechaev computed the asymptotic distribution of scaled height in various $(1+1)$-dimensional anisotropic ballistic deposition models. Finally there were several talks on the more "geometric" aspects of smooth random surfaces, such as those defined by random holomorphic polynomials or power series in several variables or by real Gaussian random fields on Riemannian manifolds. The interested reader can find a detailed account of this workshop in the Spring 2009 issue of *Le Bulletin du CRM*.

Interacting Stochastic Particle Systems

May 18 – 23, 2009, CRM

Organizers:
Kostya Khanin (Toronto), Joel Lebowitz (Rutgers), Jeremy Quastel (Toronto), Timo Seppäläinen (Wisconsin – Madison)
Speakers:
Kenneth Alexander (Southern California), Gideon Amir (Toronto), Amine Asselah (UPEC), Márton Balázs (BUTE), Cédric Bernardin (ÉNS Lyon), Lorenzo Bertini (La Sapienza), Eric Cator (TU Delft), Ivan Corwin (Courant Inst.), Antonius Dieker (Georgia Tech), János Engländer (UCSB), Davide Gabrielli (Aquila), Alessandro Giuliani (Roma Tre), Ilie Grigorescu (Miami), Stefan Grosskinsky (Warwick), Mohar Guha (Michigan), Dmitry Ioffe (Technion), Min Kang (NC State), Kay Kirkpatrick (MIT), Tobias Kuna (Reading), Claudio Landim (IMPA), Stefano Olla (Paris-Dauphine), Aleksandr Orlov (Shirshov Inst.), Jonathon Peterson (Wisconsin – Madison), Alejandro F. Ramírez (PUC), Leonardo Rolla (ÉNS), Sunder Sethuraman (Iowa State), Bálint Tóth (BUTE),

Benedek Valkó (Wisconsin – Madison), Vladislav Vysotsky (Delaware)

Number of participants: 46

Statistical mechanics provides the formalism of Gibbsian ensembles for computing properties of equilibrium systems from a knowledge of the microscopic interactions between the constituent particles. Our understanding of nonequilibrium situations is less satisfactory. In the field of interacting stochastic particle systems nonequilibrium questions are studied in simplified models that are amenable to mathematically rigorous analysis. This workshop brought together researchers from the field of interacting stochastic particle systems and related areas to survey recent successes and to map out promising directions.

Among these are the universality classes of fluctuations in one-dimensional driven interacting particle systems. In addition to exact limit distributions found in special models, the correct order of fluctuations has been identified for a general class of asymmetric exclusion processes. Another area of recent progress is the large deviation behavior of nonequilibrium stationary states in systems in contact with a reservoir. Interesting new constructions have been presented, such as multilayer systems that represent the stationary distributions of systems with several species of particles; direct connections between queueing models, random walks, and combinatorial methods have been developed.

The talks presented at the workshop covered many of the most active and important current research directions, such as: polymer models; fluctuations, second-class particles, and large deviations for exclusion processes, and related last-passage models; condensation in zero range processes; queuing networks; nonequilibrium thermodynamics; and connections with integrable systems. The balance between scheduled talks and time for free discussions allowed for a good deal of interaction between the participants, many of whom made new acquaintances and had fruitful exchanges that are likely to lead to future collaborations.

Disordered Systems: Spin Glasses

June 8 – 13, 2009, CRM

Organizers:

Gérard Ben Arous (Courant Inst.), Erwin Bolthausen (Zürich), Marc Mézard (Paris-Sud 11), Daniel Stein (Courant Inst.)

Speakers:

Louis-Pierre Arguin (Courant Inst.), Gérard Ben Arous, Éric Brunet (ÉNS), Jiří Černý (ETH Zürich), Pierluigi Contucci (Bologna), Amir Dembo (Stanford), Silvio Franz (Paris-Sud 11), Yan V. Fyodorov (Nottingham), Véronique Gayrard (Provence; CNRS), Cristian Giardina (TU Eindhoven), Francesco Guerra (La Sapienza), Alexander Hartmann (Oldenburg), Kay Kirkpatrick (MIT), Nicola Kistler (Bonn), Jonathan Machta (UMass Amherst), Vincenzo Marinari (La Sapienza), Andrea Montanari (Stanford), Michael A. Moore (Manchester), Dmitry Panchenko (Texas A&M), Jeremy Quastel (Toronto), Mariya V. Shcherbyna (ILTPE), Fabio Lucio Toninelli (ÉNS Lyon), Peter A. Young (UC Santa Cruz)

Number of participants: 42

The workshop brought together a few dozens of the leading international researchers in the theory of spin glasses and related systems. It was unusual in that it included scientists approaching the problem from three different perspectives: theoretical physics (in particular, the use of field theoretical techniques), numerical simulation and analysis, and rigorous mathematics. At their best the three approaches complement and reinforce one another, and each can provide insights for new directions in the other ones. This feedback was very much a part of the workshop, and a significant component of its success.

Each day included talks on a variety of subjects, not only on spin glasses themselves but also topics related to spin glasses: structural glasses, jamming, random matrices, graph theory, branching random walks, and other topics. There were also long breaks between the talks, however, to allow for discussion and interaction. During these periods in particular some new collaborations began and new directions were discussed. A gratifying and positive feature of the workshop was that it served not only to bring information on the latest results to a large and representative sample of the spin glass/disordered systems community, but it also led to animated discussions and interactions among people whose approaches are fundamentally different. Such discussions and collaborations could provide new seeds for substantial progress in the field over the next few years. In particular, although the mathematical proof of the ultrametricity of Gibbs measures of some disordered systems is still missing, the workshop has shown that the framework for understanding the mathematical structure of Parisi's replica symmetry breaking might no longer be out of reach, and that substantial progress might be achieved in the not too distant future.

Workshops of the CRM – PIMS Joint Thematic Program on Challenges and Perspectives in Probability

The reader will find here reports on the workshops that took place at the CRM. We refer the reader to the site http://www.pims.math.ca/scientific/thematic-programs/challenges-and-perspectives-probability for more information on the Joint Thematic Program.

Combinatorics, Randomization, Algorithms, and Probability

May 4 – 8, 2009, CRM

Organizers:
Luigi Addario-Berry (Montréal), Luc Devroye (McGill), Bruce Reed (McGill)
Speakers:
Dimitris Achlioptas (UC Santa Cruz), Nathanaël Berestycki (Cambridge), Nicolas Broutin (INRIA Rocquencourt), Omar Fawzi (McGill), Pablo Augusto Ferrari (Buenos Aires), Kevin Ford (UIUC), Nikolaos Fountoulakis (MPI Informatik), Alan Frieze (Carnegie Mellon), Christina Goldschmidt (Oxford), Simon Griffiths (Montréal), Ravindran Kannan (Microsoft Research India), Peter Keevash (Queen Mary), Jean-François Le Gall (Paris-Sud 11), Imre Leader (Cambridge), Po-Shen Loh (Princeton), Gábor Lugosi (ICREA & Pompeu Fabra), Jean-François Marckert (Bordeaux 1), Michael Molloy (Toronto), Andrea Montanari (Stanford), Ralph Neininger (Frankfurt am Main), Lea Popovic (Concordia), Tibor Szabó (McGill), Van H. Vu (Rutgers), Johan Wästlund (Chalmers), Peter Winkler (Dartmouth)
Number of participants: 50

Nearly every speaker gave the audience more open problems than solved ones, which is an indication that the field of probabilistic combinatorics is healthy and developing! While no Fields medallists attended the workshop, they were there in spirit. Jean-François Le Gall, ex-supervisor of Wendelin Werner, introduced the constructions necessary to define the continuous limit of random planar maps. This is a far-reaching extension of the continuous limits for random trees found over a decade ago by Aldous and others, and this extension was also dealt with in presentations by Christina Goldschmidt and Jean-François Marckert. The second virtual Fields medal presentation was by Van H. Vu, who surveyed the major recent results on random matrix theory, most of which were obtained by himself and Terence Tao (Fields medallist and professor at the University of California, Los Angeles).

By far the most frequently mentioned object was $G(n,p)$, or Erdős – Rényi graph. Benny Sudakov (University of California, Los Angeles) gave a crystal-clear view of resilience parameters of random graphs, which are related to the number of edges to be added or removed from a random graph in order to obtain or destroy a certain property. Another fruitful new avenue of research is the research on so-called Achlioptas processes, in which, contrary to standard random graphs, edges are added one by one, and at each step an edge must be selected from k randomly selected edges. The purpose is either to delay a certain graph property as long as possible, or to achieve it as soon as possible. Po-Shen Loh presented a worked-out example. Other aspects of random graphs were covered by Gábor Lugosi (longest minimum-weight path), Alan Frieze, Tibor Szabó and Nikolaos Fountoulakis. N. Fountoulakis spoke about the broadcasting process, in which an individual tells a rumour to two random neighhbours, who tell it to two random neighbours, and so forth, until everyone has heard it.

The organizers had scheduled one morning dedicated to the important and useful topic of concentration inequalities and related techniques. Ravi Kannan presented some new inequalities. Devdatt Dubhashi (from the University of Gothenburg) could not attend because the Canadian Embassy in Sweden failed to grant him a visa on time. Computer scientists are stumped by the computational difficulty of k-SAT for k at least equal to 3. It is a prototype of the "hard" problems. Others include the so-called constraint satisfaction problems. Thus it is important to understand why these problems are hard. Dimitris Achlioptas explained that in a strong sense, randomly generated instances of these problems have lots of isolated solutions (or near-solutions); i.e., the solution set is not a blob, but resembles a set of stars in the sky.

New Directions in Random Spatial Processes

May 11 – 15, 2009, CRM

Organizers:
Omer Angel (UBC), Alexander Holroyd (UBC), Antal Járai (Bath)
Speakers:
Maria Deijfen (Stockholm), Pablo Augusto Ferrari (Buenos Aires), Nina Gantert (Münster), Christina

Goldschmidt (Oxford), Janko Gravner (UC Davis), Geoffrey Grimmett (Cambridge), Lionel Levine (MIT), James Martin (Oxford), Franz Merkl (München), Charles M. Newman (Courant Inst.), Robin Pemantle (Pennsylvania), James Propp (UMass Lowell), Frank Redig (Leiden), Leonardo Rolla (ÉNS), Dan Romik (HUJI), Adam Timar (Bonn), Cristina Toninelli (UPMC; CNRS), Bálint Tóth (BUTE), Bálint Virág (Toronto), Johan Wästlund (Chalmers), David B. Wilson (Microsoft Research), Peter Winkler (Dartmouth)

Number of participants: 41

The goal of the workshop was to bring together researchers from all over the world, in order to foster collaboration in spatial stochastic models and expose graduate students and postdocs to emerging topics. The workshop was generally agreed to be very successful in all of these objectives. Twenty-two lectures were held on a wide range of exciting and eclectic topics, with the speakers giving special emphasis to surprising new developments and accessible directions for further research. Most talks had an audience of between 40 and 50 people, with up to 60 attendees for some lectures. A portion of the funding was used to support young researchers who participated in the meeting. Ten postdocs and graduate students came specifically for this meeting, and others were present for a longer period of time, since the meeting was part of a series of three workshops in probability and related fields.

Many collaborations were either started or continued during the meeting. Here are some of the projects that have already led to preprints or are at an advanced stage:

- M. R. Hilario, O. Louidor, C. M. Newman, L. T. Rolla, S. Sheffield, V. Sidoravicius: *Fixation for Distributed Clustering Processes* (arXiv:0906.3154);
- A. A. Járai, F. Redig, E. Saada: *Zero dissipation limit in the Abelian sandpile model* (arXiv:0906.3128);
- L. Addario-Berry, N. Broutin, C. Goldschmidt: *Critical random graphs: limiting constructions and distributional properties* (arXiv:0908.3629);
- L. Addario-Berry, S. Griffiths, R. Kang: *Invasion percolation on the Poisson-weighted infinite tree* (arXiv:0912.0335);
- O. Angel, A. E. Holroyd, J. B. Martin, J. Propp: *Discrete low-discrepancy sequences* (arXiv:0910.1077);
- O. Angel, A. E. Holroyd: *Rotor walks on general trees*;
- A. E. Holroyd, J. B. Martin, J. Wästlund: *Percolation games*;
- A. E. Holroyd, G. Grimmett: *Surfaces and embedding*;
- O. Angel, J. B. Martin: *Queues and PASEP*.

We now describe some of the most notable talks. Robin Pemantle spoke on an important new developing area at the intersection of probability and number theory, focusing particularly on probabilistic analysis of factorization algorithms. Lionel Levine spoke on surprising new results involving explosion versus stabilization in the celebrated Abelian sandpile, one of the most mysterious cellular automaton models. Dan Romik's talk contained beautiful new (and old) results concerning enumeration and shapes of alternating sign matrices. Peter Winkler described a stunning recent piece of work on branched polymers, revealing truly remarkable structure and regularities in this model. Cristina Toninelli gave an example of a bootstrap-percolation model with a discontinuous phase transition (a wonderful and completely unexpected phenomenon!).

Johan Wästlund presented a remarkable new approach for the analysis of combinatorial optimization problems (such as minimal weight matchings and spanning trees) involving two-player games. This very appealing method already solves several problems for which no previous answer was known; it also simplifies greatly the analysis in other problems. Geoffrey Grimmett spoke on many fascinating open problems, and some recent progress, concerning clairvoyant demons, dependent percolation, and random embedding. Bálint Virág presented a new approach for questions in group theory, via random walks, which has enabled one to settle several open questions in group theory by probabilistic methods. In summary, the workshop was successful in achieving the goals of showcasing important emerging topics in spatial models, and facilitating collaborations.

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 2008 Dynamical Systems and Evolution Equations

June – December 2007 Applied Dynamical Systems
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

Theory CANADA 4 Conference

June 4 – 7, 2008, CRM
sponsored by CRM, INTRIQ, the Winnipeg Institute for Theoretical Physics, the Canadian Association of Physicists, the Theoretical Physics Institute (University of Alberta), the Perimeter Institute for Theoretical Physics, and the Institute of Particle Physics

Organizers:
Rainer Dick (Saskatchewan), Richard MacKenzie (Montréal), Manu Paranjape (Montréal)
Sessions organizers:
Arundhati Dasgupta (New Brunswick), Joseph Emerson (Waterloo), Richard MacKenzie
Speakers:
Neil Barnaby (Toronto), Stephen Bartlett (Sydney), Marco Bertola (Concordia), Gaetano Bertoldi (Toronto), Robin Blume-Kohout (Perimeter), Latham Boyle (Toronto), Johan Brannlund (Dalhousie), Saurya Das (Lethbridge), Keshav Dasgupta (McGill), Claudia de Rham (Perimeter), Andrew DeBenedictis (Simon Fraser), Olivier Doré (Toronto), Ariel Edery (Bishop's), Jay Gambetta (Waterloo), Patrick Hayden (McGill), Niky Kamran (McGill), Joanna Karczmarek (UBC), Justin Khoury (Perimeter), Robert Mann (Waterloo), Fotini Markopoulou (Perimeter), Pierre Mathieu (Laval), Robert McNees (Perimeter), André Allan Méthot (Waterloo), Catherine Meusburger (Perimeter), Ue-Lin Pen (Toronto), Frans Pretorius (Princeton), Moshe Rozali (UBC), Barry Sanders (Calgary), Omid Saremi (McGill), Sanjeev Seahra (New Brunswick), Marcus Silva (Waterloo), Rafael D. Sorkin (Syracuse), Vardarajan Suneeta (Alberta), Mark Van Raamsdonk (UBC), Masahide Yamaguchi (Stanford & Aoyama Gakuin)
Number of participants: 60

Every year since 2005 the Theory CANADA Conference has been held in conjunction with the Canadian Association of Physicists (CAP) Congress. This year the CAP Congress took place at Université Laval on June 8 – 11. By design the scope of Theory CANADA is broad, so as to promote interaction between theoretical physicists in different research fields. This year the conference consisted of five thematic sessions: quantum information, relativity and gravitation, mathematical physics, cosmology, and strings and quantum gravity. Each session consisted of two thirty-minute talks and five twenty-minute talks. About 25 non-speaking participants also attended the conference, giving a total of about 60 participants, the overwhelming majority of whom are currently working at Canadian institutions.

The conference began with a reception for registration and informal discussion among the participants. Ample time was provided during the sessions for discussion among the participants. Highlights of the conference included presentations by top researchers such as Patrick Hayden (quantum information), Frans Pretorius (relativity and gravitation), and Pierre Mathieu (mathematical physics). Although many positive comments were made on both the scientific content and the smooth running of the conference, its success will ultimately be judged by the enthusiasm with which the next Theory CANADA conference will be greeted; preliminary evidence is extremely encouraging. Theory CANADA 4 will be documented in proceedings to be published as a special issue of the *Canadian Journal of Physics*.

A Celebration of Raoul Bott's Legacy in Mathematics

June 9 – 13, 2008, CRM
sponsored by CRM, the Clay Mathematics Institute, and the National Science Foundation (NSF)

Organizer:
P. Robert Kotiuga (Boston)
Scientific Advisory Committee:
Sir Michael Atiyah (Edinburgh), Octavian Cornea (Montréal), David Ellwood (Clay Inst.), Jacques Hurtubise (McGill), François Lalonde (Montréal), David Mumford (Brown), Graeme Segal (Oxford), Stephen Smale (TTI Chicago), James Stasheff (Pennsylvania), Edward Witten (IAS)
Speakers:
Sir Michael Atiyah, Paul Baum (Penn State), James Bernhard (Puget Sound), Ralph Cohen (Stanford), Octavian Cornea, Marco Gualtieri (Toronto), James Heitsch (UIC & Northwestern), Nancy Hingston

(New Jersey), Morris W. Hirsch (UC Berkeley), John Hubbard (Cornell), Lisa Jeffrey (Toronto), Nitya Kitchloo (UCSD), Joseph Kohn (Princeton), P. Robert Kotiuga, Peter D. Lax (NYU), John Morgan (Columbia), Stephen Smale, András Szenes (Genève), Constantin Teleman (Edinburgh), Susan Tolman (UIUC), Loring Tu (Tufts), Cumrun Vafa (Harvard), Jonathan Weitsman (UC Santa Cruz), Edward Witten

Panelists:

Sir Michael Atiyah, Paul Baum, Nancy Hingston, Jacques Hurtubise, Nitya Kitchloo, James Stasheff, Susan Tolman, Loring Tu

Banquet speakers:

Sir Michael Atiyah, Candace Bott (Clay Inst.), Stephen Smale

Number of participants: 53

This conference was a forward-looking mathematical conference that was not organized around a mathematical topic, but a mathematical personality. Most of the speakers were either students or coauthors of Raoul Bott, or mathematicians who feel that their work clearly reflects the influence that Bott had on them. Minimal effort was expended on a systematic covering of the topics included in Bott's collected works, published over a decade ago. Rather, Bott's colleagues from six consecutive decades were given a free hand to rework and understand past work in terms of current developments. The abstracts posted on the website summarize the mathematical aspects of the conference and document its spirit. The only talk not concerned exclusively with mathematics was given by Jim Lambek, who reminisced about the days Raoul Bott spent as an engineering student at McGill University in the 1940s. Numerous other anecdotes about Bott were given in the first panel session entitled *Raoul Bott as teacher, mentor, and colleague*, and in the banquet speeches.

In addition to being a profound and influential researcher, it is well known that Bott was a wonderful lecturer. Although this has been documented in many places, the conference has produced some posthumous testimony of this! At the end of the second panel session, entitled *Examining Raoul Bott's Legacy in Mathematics*, the conference organizer emphasized that the conference was not organized around a mathematical topic but a mathematician, and asked the younger attendees what they thought of the concept. A student who identified himself as a graduate student working in an unrelated field made what was considered a remarkable comment: he said that he learned more at the conference on Bott's legacy than he did at mathematics conferences in his area of expertise, because speakers at this conference seemed to make an extraordinary effort to communicate their ideas in the simplest and most visual terms possible. What was more remarkable was that the "instant consensus" in the room was that this was a manifestation of all the speakers being influenced by Bott's lecturing style and his insistence on understanding deep mathematical concepts in the simplest terms possible.

Another unique aspect of the conference was the visual memory of Bott: from the "picture gallery" on the website, to pictures of him from six distinct decades on the conference poster, to the screening of Vanessa Scott's film: *A Peek Into the Book*. The unique combination of forward-looking mathematics and intimate connection to the Bott family would not have been possible without the efforts of Bott's daughter, Candace Bott, who spoke at the banquet, introduced her niece's film, and was indispensable in helping with all the visual aspects of the conference. The interested reader may find more information on the background for the conference and its rationale, as well as abstracts and titles of talks, on the conference website (http://crm.math.ca/Bott08/). Currently extended conference proceedings are in the planning stage.

Colloquium on noncommutative algebra

June 9 – 14, 2008, Sherbrooke

sponsored by Bishop's University, the Université de Sherbrooke, CRM, and FQRNT

Organizers:

Ibrahim Assem (Sherbrooke), Thomas Brüstle (Sherbrooke & Bishop's), Claude Cibils (Montpellier 2), Maria Julia Redondo (UN del Sur), Andrea Solotar (Buenos Aires)

Tutorial speakers:

Dieter Happel (TU Chemnitz), Max Karoubi (Paris Diderot), Christian Kassel (CNRS & Louis Pasteur), Andrzej Skowroński (Nicolaus Copernicus)

Other speakers:

Alejandro Ádem (UBC), Roland Berger (Saint-Étienne), Diane Castonguay (UFG), Claudia Chaio (UN Mar del Plata), Flávio Ulhoa Coelho (São Paulo), José Antonio de la Peña (UNAM), Otto Kerner (Düsseldorf), Mark Kleiner (Syracuse), Justyna Kosakowska (Nicolaus Copernicus), Daniel Labardini-Fragoso (Northeastern), Marcelo Lanzilotta Mernies (de la República), Patrick Le Meur (ÉNS Cachan), Shiping Liu (Sherbrooke), Piotr Malicki (Nicolaus Copernicus), Alex Martsinkovsky (Northeastern), Octavio Mendoza Hernandez (UNAM), Selene Sanchez-Flores (Mont-

pellier 2), Manuel Saorín (Murcia), Ralf Schiffler (UMass Amherst), David Smith (Bishop's), Mariano Suárez-Alvarez (Buenos Aires), Hugh Thomas (New Brunswick), Gordana Todorov (Northeastern), Sonia Elisabet Trepode (UN Mar del Plata), Andrei Zelevinsky (Northeastern)

Number of participants: 65

Ce colloque s'inscrit dans le cadre d'une longue série de colloques d'algèbre non commutative rassemblant des mathématiciens français, sud-américains et québécois. Ils ont lieu d'habitude en France ou en Amérique du Sud, mais en 2008, le colloque se tint pour la première fois en Amérique du Nord. L'Université de Sherbrooke et l'Université Bishop's en furent les hôtes. Le colloque attira 65 participants (dont 24 étudiants ou stagiaires postdoctoraux), c'est-à-dire plus de participants que la moyenne pour les colloques de la série. S'il est malheureusement vrai que les prix des billets d'avion ont dissuadé plusieurs chercheurs français ou sud-américains d'y assister, leur absence a été compensée par un nombre supérieur de chercheurs nord-américains.

L'objectif de ces rencontres est de réunir un groupe varié d'experts ayant divers points de vue sur l'étude de problèmes d'algèbre non commutative ; ces points de vue utilisent tous l'algèbre homologique comme outil essentiel. Les organisateurs ont adopté la même formule que pour les précédentes rencontres de la série. Elle a comporté 4 minicours, dans des domaines variés de l'algèbre non commutative, à savoir la K-théorie (Karoubi), la théorie d'Auslander-Reiten dans une catégorie dérivée (Happel), les identités polynomiales en géométrie non commutative (Kassel) et enfin la classification des algèbres auto-injectives (Skowroński).

Parmi les exposés (de 45 ou de 30 minutes), deux lignes de force se sont imposées : l'étude des relations entre algèbre non commutative et topologie, d'une part, et celle des algèbres amassées, d'autre part. La première, qui est à la base de la K-théorie, a été illustrée de diverses façons dans les exposés d'Ádem, Castonguay, Le Meur et de la Peña. Quant aux algèbres amassées (« cluster algebras »), qui ont acquis une importance exceptionnelle en un court laps de temps, les participants ont eu la chance d'entendre sur ce sujet le très bel exposé d'Andrei Zelevinski, un des fondateurs de la théorie (avec S. Fomin), et plusieurs autres exposés (donnés par Kerner, Labardini, Schiffler et Smith).

Les autres exposés ont montré la variété des sujets d'intérêt actuel en algèbre non commutative. La théorie d'Auslander-Reiten, abordée par Happel dans son minicours, a été l'objet des exposés de Chaio, Coelho, Liu et Trepode. L'étude des algèbres de Koszul et de Calabi-Yau était le sujet des conférences de Berger et de Martsinkovsky. Des progrès intéressants sur la fameuse conjecture de la dimension finitiste de Bass ont été présentés par Mendoza et Lanzilotta. La structure multiplicative des anneaux de cohomologie de Hochschild a été abordée par Suárez-Alvarez (qui a annoncé la preuve d'une conjecture de Bustamante) et par Sanchez-Flores, qui s'est plutôt intéressée à la structure d'algèbre de Lie de ces anneaux. Des algèbres de Lie apparaissant en théorie de représentations des algèbres ont aussi fait l'objet de l'exposé de Kosakowska. Si on ajoute l'étude des t-structures dans des catégories dérivées (Saorín), celle des groupes de Coxeter au moyen de modules postprojectifs (Kleiner), celle des groupes d'Artin de type fini au moyen de suites exceptionnelles (Thomas) et celle des dégénérescences dans les catégories de modules (Malicki), on aura un panorama complet de la rencontre.

L'ambiance de travail fut détendue et amicale tout au long de la rencontre. Le niveau des échanges fut particulièrement élevé, avec de nombreuses questions fécondes permettant de préciser des points et parfois ouvrant de nouvelles pistes de réflexion. La plupart des participants se connaissaient depuis longtemps et avaient l'habitude de travailler ensemble. Parmi les retombées, la plus immédiate concerne les étudiants (québécois, américains, français et argentins). Tous en effet nous ont dit à quel point les minicours et les exposés avaient été formateurs pour eux. Ils ont aussi relevé le fait que ce colloque leur a permis de faire la connaissance de chercheurs étrangers dont ils étudient les travaux et qu'ils n'avaient pas eu l'occasion de rencontrer auparavant ; ils ont pu avoir avec ces chercheurs des échanges exceptionnellement cordiaux et fructueux. Quoique rien n'ait été décidé à ce sujet, nous espérons que cette rencontre aboutira à des échanges d'étudiants et de stagiaires postdoctoraux. Sur le plan scientifique, le colloque a permis aux participants de se tenir au courant des résultats obtenus par leurs collègues et de raffermir les liens entre chercheurs européens, sud-américains et nord-américains. Plusieurs participants ont profité de cette rencontre pour faire avancer leurs propres travaux de recherche (dans certains cas de façon substantielle).

SMS 2008 Summer School Symmetries and Integrability of Difference Equations

June 9 – 20, 2008, Université de Montréal
(Department of Mathematics and Statistics)
sponsored by CRM, ISM, Université de Montréal, and the NSF

Scientific Directors:
Pavel Winternitz (Montréal), Vladimir Dorodnitsyn (Keldysh Inst.)
Organizing Committee:
Vladimir Dorodnitsyn, Véronique Hussin (Montréal), François Lalonde (Montréal), Decio Levi (Roma Tre), Peter J. Olver (Minnesota), Pavel Winternitz
Speakers:
Alexei Borodin (Caltech), Vladimir Dorodnitsyn, Basile Grammaticos (UPMC & Paris-Sud 11), Jarmo Hietarinta (Turku), Mourad Ismail (Central Florida), Alexander R. Its (IUPUI), Decio Levi, Sergey P. Novikov (MGU & Maryland), Peter J. Olver, Jiří Patera (Montréal), Yuri B. Suris (TU München), Pavel Winternitz
Number of participants: 48

The field of symmetries and integrability of difference equations is very dynamic and great progress has been made in it over the last 15 years. The key methods that have been developed in this area are based either on the inverse spectral approach or on the application of geometric and group theoretical techniques. The topics covered were the following: isomonodromy transformations of linear difference equations and the Painlevé hierarchy (Alexei Borodin); symmetry preserving discretization of ordinary and partial differential equations (Vladimir Dorodnitsyn); discrete Painlevé equations (Basile Grammaticos); definitions and predictions of integrability for difference equations (Jarmo Hietarinta); orthogonal polynomials and integrable systems (Mourad Ismail); discrete Painlevé equations and random matrices (Alexander Its); generalized Lie symmetries of difference equations (Decio Levi); complete integrability of discrete nonlinear systems (Sergey P. Novikov); moving frames in applications (Peter Olver); Lie group transforms in the interpolation of digital data (Jiří Patera); discrete differential geometry (Yuri Suris); and Lie point symmetries of difference equations (Pavel Winternitz).

This summer school was correlated with the CRM Thematic Year on Probabilistic Methods in Mathematical Physics (see the section Thematic Program) and the international conference SIDE8 (on the same topic as the summer school). Many of the participants and some of the lecturers participated in both events. The SMS lectures thus served as a good preparation for the students attending SIDE8; they were able to learn about the most recent developments in the field.

SIDE8 International Conference Symmetries and Integrability of Difference Equations

June 22 – 28, 2008, Hôtel Mont-Gabriel, Sainte-Adèle (Québec)
sponsored by CRM, the NSF, and the Mathematical Physics Laboratory

Organizers:
Pavel Winternitz (Montréal, Chair), John Harnad (Concordia), Véronique Hussin (Montréal), Decio Levi (Roma Tre), Peter J. Olver (Minnesota), Luc Vinet (Montréal)
Speakers:
Primitivo Belen Acosta-Humanez (UPC), Boyka Aneva (INRNE), Dmytro Arinkin (UNC-Chapel Hill), Natig Atakishiyev (UNAM), Mariusz Białecki (IGFPAS), Andrei Bogatyrev (IMN), Oleg Bogoyavlenskij (Queen's), Alexei Borodin (Caltech), Vladimir Dorodnitsyn (Keldysh Inst.), Anton Dzhamay (Northern Colorado), Michael Gekhtman (Notre Dame), Valentina Golubeva (VINITI), F. Alberto Grünbaum (UC Berkeley), Rodney Halburd (UC London), John Harnad, Michael Hay (Sydney), Willy Hereman (Colorado School of Mines), Rafael Hernández Heredero (UPM), Jarmo Hietarinta (Turku), Peter E. Hydon (Surrey), Nalini Joshi (Sydney), Kenji Kajiwara (Kyushu), Boris Konopelchenko (Salento), Christian Korff (Glasgow), Stéphane Lafortune (Charleston), Jorge Enrique Lopez-Sendino (Valladolid), Alexander Mikhailov (Leeds), Oleksii Mokhonko (Taras Shevchenko), Atsushi Nagai (Nihon), Maciej Nieszporski (Warsaw), Frank W. Nijhoff (Leeds), Masatoshi Noumi (Kobe), Vladimir Novikov (Loughborough), Yasuhiro Ohta (Kobe), Vassilios Papageorgiou (Patras), James Pettigrew (New South Wales), Barbara Prinari (Salento), Mizan Rahman (Carleton), Eric M. Rains (Caltech), Alfred Ramani (École Polytechnique), Raphaël Rebelo (Montréal), Omar Rojas (La Trobe), Wolfgang Karl Schief (TU Berlin), Christian Scimiterna (Roma Tre), Yang Shi (Sydney), Paul Spicer (Sydney), Yuri B. Suris (TU München), Anastasios Tongas (Crete), Sébastien Tremblay (UQTR), Walter Van Assche (KU Leuven), Alexander P. Veselov (Loughborough), Claude Viallet (CNRS & UPMC), Thomas Wolf (Brock), Yunbo Zeng (Tsinghua), Alexei Zhedanov (Donetsk IPE)
Number of participants: 72

SIDE8 was the eighth in a series of biennial conferences devoted to symmetries and integrability of difference equations and related topics: ordinary and partial difference equations, analytic difference

equations, orthogonal polynomials and special functions, symmetries and reductions, difference geometry, integrable discrete systems on graphs, integrable dynamical mappings, discrete Painlevé equations, singularity confinement, algebraic entropy, complexity and growth of multivalued mappings, representations of affine Weyl groups, quantum mappings and quantum field theory on the space-time lattice. The organizers of SIDE 8 are listed above and the SIDE Steering Committee included Frank Nijhoff (Chairman), Alexander Bobenko, Basile Grammaticos, Jarmo Hietarinta, Nalini Joshi, Decio Levi, Vassilis Papageorgiou, Junkichi Satsuma, Yuri Suris, Claude Viallet, and Pavel Winternitz.

The 56 talks of SIDE8 were divided into 8 sessions, corresponding to the following topics (with session organizers indicated within parentheses): geometry of discrete and continuous Painlevé equations (Masatoshi Noumi, Yasuhiro Ohta); discrete integrable systems and isomonodromy transformations (Alexei Borodin); Yang – Baxter map (Alexander P. Veselov); algebraic aspects of discrete equations (Alexander Mikhailov, Frank Nijhoff); singularity confinement, algebraic entropy, and Nevanlinna theory (Basile Grammaticos, Alfred Ramani); discrete differential geometry (Alexander Bobenko, Yuri Suris); special functions as solutions of difference and Q-difference equations (Mourad Ismail, Walter Van Assche); continuous symmetries of discrete equations, theory and computational application (Decio Levi, Pavel Winternitz). The original results presented at SIDE8 gave rise to a special issue of the *Journal of Physics* A: *Mathematical and Theoretical* (J. Phys. A: Math. Theor. 42 (2009)).

Eighth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing

July 6 – 11, 2008, HEC Montréal
sponsored by CRM, GERAD, MITACS, and the NSF

Organizer:
Pierre L'Écuyer (Montréal)
Program Committee:
Pierre L'Écuyer (président), Ronald Cools (KU Leuven), Henri Faure (CNRS & Paul Cézanne), Luc Devroye (McGill), Paul Glasserman (Columbia), Peter W. Glynn (Stanford), Stefan Heinrich (TU Kaiserslautern), Fred J. Hickernell (IIT), Aneta Karaivanova (IPP), Alexander Keller (mental images GmbH), Adam Kolkiewicz (Waterloo), Frances Y. Kuo (New South Wales), Christian Lécot (Savoie), Jun S. Liu (Harvard), Peter Mathé (Weierstraß-Institut), Makoto Matsumoto (Hiroshima), Thomas Müller-Gronbach (Magdeburg), Harald Niederreiter (National University of Singapore), Gilles Pagès (UPMC), Art B. Owen (Stanford), Klaus Ritter (TU Darmstadt), Karl Sabelfeld (Weierstraß-Institut), Wolfgang Ch. Schmid (Salzburg), Ian H. Sloan (New South Wales), Jerome Spanier (Claremont), Bruno Tuffin (INRIA Rennes), Henryk Woźniakowski (Columbia)
Invited Plenary Speakers:
Josef Dick (New South Wales), Arnaud Doucet (UBC), Daan Frenkel (Cambridge), Paul Glasserman (Columbia), Christiane Lemieux (Waterloo), Jun S. Liu, Klaus Ritter, Jeffrey S. Rosenthal (Toronto), Wolfgang Ch. Schmid, Andrew Stuart (Warwick)
Tutorial Speakers:
Alexander Keller, Art B. Owen, Jeremy Staum (Northwestern)
Number of participants: 188

The MCQMC Conference is a biennial meeting devoted to the study of Monte Carlo (MC) and quasi-Monte Carlo (QMC) methods, the relationships between the two classes of methods, and their effective application in different areas. The conference attracts between 150 and 200 participants and is the world's primary event on the two classes of methods. Its aim is to provide a forum where both the leading researchers and the users can exchange on the latest theoretical developments and important applications of these methods. In a nutshell, MC methods study complex systems by simulations fed by computer-generated random numbers. QMC methods replace these random numbers by more evenly distributed (and carefully selected) numbers to improve their effectiveness. A large variety of special techniques are developed and used to make these methods more effective in terms of speed and accuracy. The conference focuses primarily on the mathematical study of these techniques, their implementation and adaptation for concrete applications, and their empirical assessment.

The MCQMC Conference series was initiated by Harald Niederreiter, who deserves our warmest thanks for his far-reaching vision and dedication; Professor Niederreiter cochaired all of the past editions, which took place in Las Vegas (1994), Salzburg (1996), Claremont (1998), Hong Kong (2000), Singapore (2002), Juan-Les-Pins (2004), and Ulm (2006). The Steering Committee of the MCQMC Conference series includes the following members: Stefan Heinrich, Fred J. Hickernell, Alexander Keller, Frances Y. Kuo, Pierre L'Écuyer, Wolfgang Ch. Schmid, and Art B. Owen. In 2008 the conference took place in Montréal and its themes included the following: MC and QMC algorithms; Randomized QMC generation of pseudo-random numbers; Random variates and ran-

dom processes; Low-discrepancy point sets and sequences; Digital nets; Lattice rules; Variance reduction methods; Rare-event simulation; Optimization via MC/QMC; Tractability/complexity analysis of multivariate integration problems; MC/QMC methods for stochastic differential equations, partial differential equations; Markov chain Monte Carlo; Particle methods; MC/QMC methods in physics, chemistry, biology, economy, finance, statistics, management, medical science, computer graphics, etc.

The MCQMC 2008 Conference featured 10 plenary invited lectures, 3 tutorials (each lasting three hours), and 147 accepted contributed talks (of which about ten were cancelled for various reasons). The conference was outstanding both from the scientific and organizational points of view, and all the comments made by the participants were positive. The proceedings of MCQMC 2008 will be published by Springer, in a book entitled *Monte Carlo and Quasi-Monte Carlo Methods* 2008 and edited by Pierre L'Écuyer and Art B. Owen. The organizers wish to extend their warmest thanks to the staff of CRM and GERAD, especially Francine Benoît, Carole Dufour, Marilyne Lavoie, Louis Pelletier, and Suzette Paradis.

Québec – Maine Conference on Number Theory

October 4 – 5, 2008, Université Laval
sponsored by CICMA

Organizers:
Claude Levesque (Laval), Hugo Chapdelaine (Laval), Jean-Marie De Koninck (Laval)
Speakers:
Jennifer Beineke (WNEC), David Bradley (Maine), Abraham Broer (Montréal), Hugo Chapdelaine, John Cullinan (Bard), Henri Darmon (McGill), Chantal David (Concordia), Nicolas Doyon (Laval), Karl Dilcher (Dalhousie), Andrew Granville (Montréal), Adrian Iovita (Concordia), Ernst Kani (Queen's), Omar Kihel (Brock), Hershy Kisilevsky (Concordia), Mitsuo Kobayashi (Dartmouth), John Labute (McGill), Youness Lamzouri (Montréal), Florian Luca (UNAM Morelia), Trueman MacHenry (York), Bao Châu Ngô (IAS), Carl Pomerance (Dartmouth), Damien Roy (Ottawa), Romyar Sharifi (McMaster), Mark Sheingorn (CUNY), Lloyd Simons (St. Michael's College), Cam Stewart (Waterloo), Alain Togbé (Purdue North Central), Enrique Trevino (Dartmouth), John Voight (Vermont), Gary Walsh (Ottawa)
Number of participants: 45

Ce congrès Québec-Maine, qui alterne entre le Maine et le Québec, en était à sa dixième édition. Il portait sur la théorie des nombres sous toutes ses formes avec un accent sur la géométrie arithmétique et les équations diophantiennes. Le congrès de 2008 était dédié aux 80 ans du professeur Paulo Ribenboim. Andrew Granville rappela, diapositives à l'appui, les grandes étapes de la vie de ce mathématicien toujours actif.

Scientic Meeting of the CRM Statistics Laboratory
MCMC: Theory and Applications

October 17, 2008, Université de Sherbrooke

Organizers:
David A. Stephens (McGill), Éric Marchand (Sherbrooke), Louis-Paul Rivest (Laval)
Speakers:
Mylène Bédard (Montréal), Arnaud Doucet (UBC), Alan Gelfand (Duke), Raphael Gottardo (IRCM), Éric Jacquier (HEC Montréal), Geneviève Lefebvre (UQÀM)
Number of participants: 58

Le 17 octobre 2008 eut lieu une rencontre scientifique du Laboratoire de statistique consacrée aux méthodes de Monte-Carlo par chaînes de Markov (MCMC). Arnaud Doucet donna une conférence sur les progrès récents dans ce domaine et Mylène Bédard aborda les aspects théoriques des méthodes MCMC. Geneviève Lefebvre fit un exposé sur une identité d'échantillonnage de chemins permettant de calculer la divergence de Kullback-Leibler et la J-divergence. Éric Jacquier aborda les applications au domaine financier des méthodes MCMC. Raphael Gottardo fit un exposé sur des applications de la modélisation bayésienne et des méthodes MCMC à la génomique. Pour conclure la journée, Alan Gelfand donna une conférence sur des méthodes de réduction de la dimension pour analyser des ensembles de données spatiales de grande taille.

Workshop on Arithmetic and Hyperbolic Geometry

November 8 – 9, 2008, Université du Québec à Montréal
sponsored by CIRGET and the Fields Institute

Organizers:
John Bland (Toronto), Andrew Granville (Montréal), Steven Shin-Yi Lu (UQÀM), Peter Russell (McGill), Noriko Yui (Queen's)
Speakers:
John Bland, Andrew Granville, Steven Shin-Yi Lu, Peter Russell, Noriko Yui
Number of participants: 50

This weekend workshop in Montreal was linked to the Fall 2008 thematic program at the Fields Institute on arithmetic geometry, hyperbolic geometry, and related topics. Its aim was to explore the possible connections of various recent advances in these fields. It was very well attended with over 50 participants, of whom about 20 came from the thematic program. Here are the titles of the lectures given during the workshop:

• *Construction of rational curves in Fano manifolds without using positive characteristic* (Yum-Tong Siu);
• *Chow weights, Hilbert weights and their application in Nevanlinna theory* (Min Ru);
• *Horizontal sections of connections and transcendence* (Carlo Gasbarri);
• *Unicity, Kobayashi hyperbolicity, rational points and examples* (Junjiro Noguchi);
• *Heights of conics and the spectrum of the Laplacian* (Henri Gillet);
• *Upper bound for* $\gcd(a^n-1, b^n-1)$; *Arithmetic and geometric applications* (Pietro Corvaja);
• *A Diophantine "tautological conjecture"* (Paul Vojta);
• *Self rational maps of K3 surfaces* (Xi Chen);
• *Degeneracy of holomorphic maps via orbifolds* (Erwan Rousseau);
• *Symmetric differentials on algebraic surfaces* (Bruno de Oliveira).

Conference on Hilbert Spaces of Analytic Functions

December 8 – 12, 2008, CRM
sponsored by the Mathematical Analysis Laboratory

Organizers:
Javad Mashreghi (Laval), Kristian Seip (NTNU), Thomas J. Ransford (Laval)

Speakers:
Evgueni Abakoumov (Marne-la-Vallée), Jim Agler (UCSD), Joseph A. Ball (Virginia Tech), Ferenc Balogh (Concordia), Laurent Baratchart (INRIA Sophia Antipolis & Méditerranée), André Boivin (Western Ontario), Alexander Borichev (Provence), Abdellatif Bourhim (Laval), Nicolas Chevrot (Laval), Joseph A. Cima (UNC-Chapel Hill), Constantin Costara (Ovidius), Galia Dafni (Concordia), Fatma Zohra Demmad-Abdessameud (Blida), Ronald G. Douglas (Texas A&M), Omar El-Fallah (Mohammed V-Agdal), Tatyana Foth (Western Ontario), Richard Fournier (Montréal & Dawson), Emmanuel Fricain (Lyon 1), Paul M. Gauthier (Montréal), Kohur Gowrisankaran (McGill), Andreas Hartmann (Bordeaux 1), Dmitry Khavinson (South Florida), Daniela Kraus (Würzburg), Yurii Lyubarskii (NTNU), Jordi Marzo (NTNU), Joules Nahas (UCSB), Joaquim Ortega-Cerdà (Barcelona), Vladimir Peller (Michigan State), Mihai Putinar (UCSB), Thomas J. Ransford, Richard Rochberg (WUSTL), William T. Ross (Richmond), Stephan Ruscheweyh (Würzburg), Marius Serban (Montréal), Mahmood Shabankhah (Laval), Hasi Wulan (Shantou), Nicolas Young (Leeds), Hong Yue (Concordia)

Number of participants: 62

Hilbert spaces of analytic functions are currently a very active field of complex analysis. The Hardy space is the most senior member of this family. Its relatives, such as the Bergman space, the Dirichlet space, the de Branges – Rovnyak spaces, and various spaces of entire functions, have been studied in detail by prominent mathematicians since the beginning of the last century. There are, however, many open problems, old and new, that attract a wide spectrum of mathematicians. In this meeting we gathered together a blend of researchers with a common interest in spaces of analytic functions, but seen from many different angles. About fifteen students and postdocs also attended the conference; about half of them gave talks.

The following is a representative sample of the topics discussed at the workshop: completeness of translates in weighted spaces; analytic continuation in backward-shift-invariant subspaces; multivariable extensions of de Branges – Rovnyak spaces; Bernstein-type inequalities in de Branges – Rovnyak spaces; interpolation and sampling in Fock spaces; pointwise estimates for the Bergman kernel of the weighted Fock space; multiplication operators on the Bergman space; compactness criteria for composition operators on BMOA; approximation of and by the Riemann zeta function; curvature and maximal Blaschke products; trigonometric and Hausdorff moments; Poincaré variational problem in potential theory; singularities of solutions to the Dirichlet problem and complex lightning bolts; Hankel forms on the Dirichlet space; cyclicity in the Dirichlet space; the positivstellensatz in Weyl's algebra; operator Hölder functions; power-boundedness on function spaces; function theory on the tetrablock; and uniqueness sets for Nevanlinna – Pick interpolation in two variables.

Scientific Meeting of the CRM Statistics Laboratory
New Investigators Meeting

April 4, 2009, CRM

Organizer:
Geneviève Lefebvre (UQÀM)

Speakers:
Juli Atherton (McGill), Lilia Leticia Ramirez Ramirez (Waterloo), Lajmi Lakhal Chaieb (Laval), Taoufik Bouezmarni (Montréal), Azadeh Moghtaderi (Queen's)
Number of participants: 24

Cette rencontre pour jeunes chercheurs comporta cinq exposés, qui eurent lieu le matin. L'après-midi, une table ronde présidée par Yulia Gel (University of Waterloo) fut suivie d'une discussion de groupe présidée par Juli Atherton (Université McGill) et d'une discussion finale présidée par Jason Nielsen (Carleton University). Le thème de la table ronde était l'identification des enjeux importants pour les nouveaux chercheurs. Voici les titres des exposés qui eurent lieu le matin :

• *Utilisation des données SELEX pour modéliser l'affinité de séquences d'ADN au facteur de transcription Bicoid* (Juli Atherton) ;
• *Dynamique des maladies infectieuses dans les réseaux* (Lilia Leticia Ramirez Ramirez) ;
• *Estimation non paramétrique du tau de Kendall pour durées de vie successives* (Lajmi Lakhal Chaieb) ;
• *Estimation non paramétrique par noyau Beta pour les séries chronologiques à longue mémoire* (Taoufik Bouezmarni) ;
• *Un nouvel estimateur du spectre évolutionnaire Wold-Cramer* (Azadeh Moghtaderi).

The Bellairs Workshop in Number Theory Borcherds products and their applications to arithmetic geometry

May 3 – 10, 2009, Bellairs Research Institute
sponsored by CICMA

Organizer:
Eyal Z. Goren (McGill)
Speakers:
Jan Bruinier (TU Darmstadt), Henri Darmon (McGill), Ehud DeShalit (HUJI), Gerard Freixas i Montplet (CICMA postdoctoral fellow), Steve Kudla (Toronto), Shouwu Zhang (Columbia)
Number of participants: 33

The workshop was dedicated to Borcherds' theory concerning a singular theta lift from weakly holomorphic elliptic modular forms to automorphic forms on orthogonal groups that are forms of $\mathrm{SO}(2,n)$, and its applications and generalizations. Jan Bruinier gave a series of five lectures on this topic. These lectures took place in the mornings and were supplemented by lectures from attending experts, which took place in the evenings. The goal of the workshop was to provide an access point to the field; the participants were expected to have a background similar to that of advanced graduate students. Here are the titles of the lectures by Jan Bruinier: Orthogonal groups and modular forms, Theta liftings of holomorphic and weakly holomorphic modular forms, Borcherds products and automorphic Green functions, CM values and Faltings heights, Harmonic weak Maass forms and the Gross – Zagier formula. Steve Kudla spoke on the Weil representation and the Siegel – Weil formula, Ehud DeShalit on the half-integral weight modular forms and the Shimura lift, Gerard Freixas i Montplet on local and global heights on curves, Henri Darmon on modular curves and Heegner points, and Shouwu Zhang on the Gross – Zagier formula and some applications.

The 6th Montreal Scientific Computing Days

May 4 – 6, 2009, CRM
organized by the Applied Mathematics Laboratory

Organizers:
Michel Delfour (Montréal), André Fortin (Laval) Thomas Wihler (Bern)
Tutorial Speakers:
Robert Michael Kirby (Utah), Yvon Maday (UPMC), Spencer J. Sherwin (Imperial College London)
Other Speakers:
Mohammad Khalil (Carleton), Hatef Monajemi (Carleton), Waad Subber (Carleton), Jérôme Morin-Drouin (Montréal), Abderrahman El Maliki (Laval), Alexandre Iolov (Ottawa), Myriam Rioux (Ottawa), Olivier Rousseau (Ottawa)
Number of participants: 67

The objectives of the Montreal Scientific Computing Days are: to foster scientific exchanges within the scientific computing community; to provide training to senior undergraduate and graduate students, postdoctoral fellows, and young researchers in the form of three mini-courses 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 of the 6th edition of the Montreal Scientific Computing Days enjoyed dazzling lectures by Yvon Maday on the latest developments in *Approximation of Nonlinear PDE's by Reduced Basis Methods*. These lectures had a tremendous impact not only on mathematicians but also on engi-

neering students from École Polytechnique and Carleton University. The participants were also spoiled by Spencer J. Sherwin and Mike Kirby. Professor Kirby gave two talks, respectively entitled *Computational Methods for Quantifying Uncertainty in Biological Modelling* and *Visualization of High-Order Finite Element Methods*. Professor Sherwin gave three talks on the topic of *Spectral/hp Element Methods: Implementation to Application*. Moreover, Professors Kirby and Sherwin gave a joint tutorial that was much appreciated by the participants.

CanaDAM 2009
2nd Canadian Discrete and Algorithmic Mathematics Conference

May 25 – 28, 2009, CRM
sponsored by CRM, the Fields Institute, PIMS, and MITACS

Program Committee:
Carla Savage (NC State, Chair), Jean-Paul Allouche (Paris-Sud 11), David Avis (McGill), François Bergeron (UQÀM), Rodney Canfield (Georgia), Antoine Deza (McMaster), Chris Godsil (Waterloo), Penny Haxell (Waterloo), Marni Mishna (Simon Fraser), Patric Östergård (TKK), Sang-Il Oum (KAIST), Frank Ruskey (Victoria), József Solymosi (UBC), John Watrous (Waterloo)

Executive Committee:
Daniel Panario (Carleton, Chair), Jason Brown (Dalhousie), Pavol Hell (Simon Fraser), Odile Marcotte (UQÀM & CRM), Ortrud Oellermann (Winnipeg), Bruce Richter (Waterloo)

Local Arrangements Committee:
Gena Hahn (Montréal, Chair), Srečko Brlek (UQÀM), Benoit Larose (Champlain St-Lambert & Concordia), Odile Marcotte, Adrian Vetta (McGill)

Plenary Speakers:
Valérie Berthé (Montpellier 2), Sylvie Corteel (Paris-Sud 11), Jesús De Loera (UC Davis), Dannie Durand (Carnegie Mellon), Shafi Goldwasser (MIT & Weizmann Inst.), Joel Spencer (NYU), Carsten Thomassen (DTU), Qing Xiang (Delaware)

Number of participants: 312

The Canadian Discrete and Algorithmic Mathematics conference (CanaDAM 2009) was held at the CRM on May 25 – 28, 2009. This was the second conference in the new series on discrete mathematics that is held every two years (in the odd years) in Canada. The conference has a format similar to that of the SIAM Conference on Discrete Mathematics (held every two years, in the even years). The first CanaDAM conference was held in Banff in May 2007. The general topics of the conference are the theory and applications of discrete structures and its goal is to highlight the most salient trends in the field, which has close links with such diverse areas as cryptography, computer science, large-scale networks, and biology. The conference brings together researchers from the various disciplines with which discrete and algorithmic mathematics interact.

One of the primary goals of the conference was to encourage the participation of Canadian graduate students and postdoctoral fellows. The three Canadian mathematical institutes (CRM, Fields, PIMS) as well as the MITACS network provided some financial support to encourage graduate students and postdoctoral fellows to attend. In addition to its monetary contribution, the CRM provided a substantial amount of its resources as an in-kind contribution to the running of the meeting. In order to receive financial support, graduate students were encouraged to contribute talks; there was also a problem session (followed by a reception) devoted to the presentation of research problems appropriate for graduate students. These problems are now available on the web page of the conference (http://crm.math.ca/CanaDAM2009/). About 40% of the attendees were graduate students or postdoctoral fellows, which pleased the organizers very much. This solid participation of young researchers could not have happened without the generous support of the sponsors.

A great deal of the credit for the success of the conference goes to the Program Committee of CanaDAM 2009 and the Local Arrangements Committee. The strength of a conference is directly related to its scientific program. The chair of the Program Committee, Carla Savage, and the other Program Committee members put together a magnificent program consisting of 8 plenary lectures, 47 talks in the 9 invited minisymposia, 75 talks in the 15 contributed minisymposia, and about 94 contributed talks. In addition there was a special talk by Jason Brown on the connections between mathematics and music. The lectures by the plenary speakers were outstanding; here are their titles.

- *Discrete Geometry and Word Combinatorics* (Valérie Berthé)
- *Enumeration of Fillings of Young Diagrams* (Sylvie Corteel)
- *Two Geometric Algorithms and Their Many Applications in Discrete Optimization* (Jesús De Loera)
- *Genes as LEGO: What Trees and Graphs Can Tell Us About the Evolution of Modular Proteins* (Dannie Durand)

• *Program Obfuscation and One-Time Programs* (Shafi Goldwasser)
• 78 *Years of Ramsey* $R(3,k)$ (*and Counting*!) (Joel Spencer)
• *Graph Decomposition* (Carsten Thomassen)
• *Modular Ranks and Smith Normal Forms of Some Incidence Matrices* (Qing Xiang)

The dedication of the Local Arrangements Committee, led by Gena Hahn and Odile Marcotte, played a vital role in the success of the conference. This committee worked in close collaboration with the CRM staff (especially Louis Pelletier and Suzette Paradis) and graduate students to ensure the smooth running of the conference. The organizers are grateful to their sponsors (CRM, Fields, PIMS, MITACS) for their generous support of CanaDAM 2009. The strong Canadian and international attendance at CanaDAM 2009 clearly indicates that the CanaDAM conference series is already established as one of the main international conferences on discrete and algorithmic mathematics.

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 2008 – 2009 the colloquium coordinators were Abraham Broer (Université de Montréal) and Alexander Shnirelman (Concordia University).

September 5, 2008
Iku Nakamura (Hokkaido)
Stability and Compactification of the Moduli of Abelian Varieties

September 12, 2008
Andrei Okounkov (Princeton)
The Algebra and Geometry of Random Surfaces

September 19, 2008
Kenneth McLaughlin (Arizona)
Some Classes of Random Hermitian Matrices: $F(\mathrm{Tr}(V(M))$ *Instead of* $\mathrm{Tr}(V(M))$

September 26, 2008
Vladimir Sverak (Minnesota)
PDE Aspects of the Navier-Stokes Equations

October 3, 2008
Elliott Lieb (Princeton)
Some Calculus of Variations Problems in Quantum Mechanics

October 10, 2008
Leonid Bunimovich (Georgia Tech)
Visual Chaos: Dispersing, Defocusing, Absolute Focusing and Astigmatism

October 17, 2008
Svante Janson (Uppsala)
Random Graphs: New Models and the Internet

October 24, 2008
David Ruelle (IHÉS)
Nonequilibrium Statistical Mechanics and Smooth Dynamical Systems

October 31, 2008
Robert Seiringer (Princeton)
Dilute Quantum Gases

November 7, 2008
Jean-Louis Loday (CNRS & Strasbourg)
Combinatorial Hopf Algebras

November 14, 2008
Bernard Shiffman (Johns Hopkins)
Overcrowding and Undercrowding of Random Zeros on Complex Manifolds

November 21, 2008
Claude Bardos (Paris Diderot)
Turbulence from Statistical Theory to Wigner Measure

November 28, 2008
Alexandre Girouard (Cardiff)
Carl Herz Prize recipient (2007 – 2008)
Shape Optimization for Low Eigenvalues of the Laplace Operator

December 5, 2008
Robert Coquereaux (CPT)
Fundamental Interactions and Classical or Quantum Geometries

December 12, 2008
Alexander Turbiner (UNAM)
Solvable Schrödinger Equations and Representation Theory

December 19, 2008
Jie Shen (Purdue)
Spectral-Galerkin Methods for High-Dimensional PDEs

January 23, 2009
Chantal David (Concordia)
Statistics for the Zeroes and Traces of Zeta Functions over Finite Fields

January 30, 2009
Alexei Miasnikov (McGill)
Around Tarski's Problems

February 6, 2009
André D. Bandrauk (Sherbrooke)
Nonlinear High-Dimensional PDE's in High Intensity Laser-Matter Interactions – New Mathematics for a New Science

February 13, 2009
William Byers (Concordia)
Mathematics in the Light of Metaphor and Ambiguity

February 20, 2009
Louigi Addario-Berry (Montréal)
Branching Random Walk and Searching in Trees

March 13, 2009
Sergei Yakovenko (Weizmann Inst. & Fields)
Infinitesimal Hilbert 16th Problem

March 27, 2009
Bjorn Poonen (MIT)
Undecidability in Number Theory

April 3, 2009
Olivier Schiffmann (CNRS & ÉNS)
Problème de Riemann-Hilbert sur la sphère et combinatoire des systèmes de racines

April 17, 2009
Alexandru Buium (New Mexico)
Arithmetic Laplacians

April 24, 2009
Gang Tian (Princeton)
Ricci Flow, Monge – Ampère Equation and Algebraic Spaces

CRM – ISM – GERAD Statistics Colloquium

In 2008 – 2009 the organizing team of the Statistics Colloquium included Geneviève Lefebvre (Université du Québec à Montréal), Alejandro Murua (Université de Montréal), Lea Popovic (Concordia University), and Russell Steele (McGill University).

September 26, 2008
Jon A. Wellner (Washington)
Testing for Sparse Normal Means: Is There a Signal?

October 3, 2008
Ranjan Maitra (Iowa State)
Assessing Significance in Finite Mixture Models

October 10, 2008
Pierre-Jérôme Bergeron (Ottawa)
Studying the Natural History of Diseases through Prevalent Cases: Can One Exploit Untapped Features of Length-Biased Data?

October 24, 2008
Paul McNicholas (Guelph)
Model-Based Clustering of Longitudinal Data

October 31, 2008
Surajit Ray (Boston)
Clustering and Classification of Functional Data

November 7, 2008
Peter McCullagh (Chicago)
Sampling Bias in Logistic Models

November 21, 2008
Duncan Murdoch (Western Ontario)
Two Recursive Simulation Schemes

December 5, 2008
Peter Hoff (Washington)
Hierarchical Eigenmodels for Pooled Covariance Estimation

January 23, 2009
Andreas Kyprianou (Bath)
Refracted Levy Processes

January 30, 2009
Christian Robert (Paris-Dauphine)
Computational Approaches to Bayesian Model Choice

February 6, 2009
Taoufik Bouezmarni (Montréal)
A Nonparametric Test for Conditional Independence using Bernstein Density Copulas

February 13, 2009
Thomas A. Louis (Johns Hopkins)
Trend Tests that Accommodate Genotyping Errors

February 20, 2009
Marina Meila (Washington)
Consensus Ranking under the Exponential Model

February 27, 2009
Sayan Mukherjee (Duke)
Two Representations of Graphical Models

March 13, 2009
Fernando Camacho (Damos Inc., Toronto)
Statistical Analysis for Life Cycle Management of Steam Generators

March 20, 2009
Susan Shortreed (McGill)
Learning in Spectral Clustering

March 27, 2009
Lei Sun (Toronto)
Unifying Stratified and Weighted FDR Methods with Applications to Large-Scale Genetic Studies

April 3, 2009
Mary Lesperance (Victoria)
Testing for Benford's Law and Possible Fraud Detection

April 17, 2009
David Dunson (Duke)
Bayesian Density Regression with Epidemiology Applications

April 24, 2009
Jinko Graham (Simon Fraser)
Graphical Displays to Uncover Gene-Environment Interaction from Data on Case-Parent Trios

May 1st, 2009
Constantine Frangakis (Johns Hopkins)
The Role of Principal Stratification in Instrumental Variables in Case-Control Designs – An Application to Mendelian Randomization

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 Institute on Complex Data Structures (NICDS). *The reports are presented in the language in which they were submitted.*

Activities of the Multidisciplinary and Industrial Program

Workshop on Signal Processing Methods in Brain Imaging

June 4, 2008, Institut universitaire de gériatrie de Montréal
sponsored by MITACS and PhysNum

Organizers:
Mathieu Dehaes (UPMC), Louis Gagnon (Harvard-MIT HST), Frédéric Lesage (Polytechnique Montréal), Jean-Marc Lina (ÉTS)
Speakers:
Jorge Armony (Hôpital Douglas, Montréal), Philippe Ciuciu (NeuroSpin, CEA Saclay), Christophe Grova (McGill), Jean-Marc Lina, Vincent Perlbarg (UPMC), Amir Schmuel (McGill)
Number of participants: 32

This workshop was part of the Second Canada-France Congress, which took place at Université du Québec à Montréal from June 1 to 5, 2008 (see the section General Program). It brought together applied mathematicians and practitioners working on models of physiological processes. The goals of the workshop were

- to explore the mathematics of multimodal imaging,
- to study physiological models and measurements, and
- to study approaches to signal processing in order to understand new imaging modalities.

Each half-day of the workshop consisted of three sessions, and each session featured a 30-minute introductory talk followed by a one-hour advanced lecture. The organizers believe that this format was optimal, given that the participants came from many disciplines. Two related themes were explored: modelling of neuronal activity and metabolism, and new imaging techniques in biomedical engineering.

Given the reactions of the participants and the fact that full participation was maintained throughout the day, the organizers think that their goals were met. Indeed, a consensus emerged that the workshop should be held on a yearly basis. Among the participants were a dozen or so graduate students, as well as a number of new researchers, and they were stimulated and excited by this area. They also derived a great deal of new knowledge from the workshop. The discussions after the talks and throughout the afternoon were lively and involved all the participants, and the organizers were especially pleased with the access that our younger participants had to senior well-known investigators. As well they were delighted that no whiff of argumentative or competitive exchanges was detected during the workshop. Variation in expertise, sophistication, technical level, and so on, was taken as natural and as providing opportunities for support and encouragement.

Highlights of the workshop include

- a presentation of recent work on the metabolic response and its modelling by Amir Schmuel,
- a presentation of an exciting wavelet approach applied to diffuse optical imaging by Jean-Marc Lina,
- an application of multi-modal imaging and inverse problems to the diagnosis and understanding of epilepsy, presented by Christophe Grova,
- a review of protocol design in fMRI imaging and the assumptions underlying this modality, by Jorge Armony, and
- a presentation of recent work on the use of signal processing techniques for identifying the rest state of the brain, by Vincent Perlbarg.

The organizers are very grateful to the CRM, to MITACS, and to MathWorks for their generous support.

The Eighth Canadian Summer School on Quantum Information

June 9 – 16, 2008, Université de Montréal (Department of Computer Science and Operations Research)
sponsored by MITACS, CRM, INTRIQ, Perimeter Institute for Theoretical Physics, McGill University, Université de Montréal, and the Canadian Institute for Advanced Research

Organizers:
Patrick Hayden (McGill, Cochair), Alain Tapp (Montréal, Cochair), Ashton Anderson (McGill), Kamil Bradler (McGill), Paul Chouha (Montréal), Thomas Decker (McGill), Nicolas Dutil (McGill), Frédéric Dupuis (Montréal), Abubakr Muhammad (McGill)
Speakers:
Alexandre Blais (Sherbrooke), Kamil Bradler, Anne

Broadbent (Montréal), Andrew Childs (Waterloo), Claude Crépeau (McGill), Frédéric Dupuis, Ed Farhi (MIT), Daniel Gottesman (Perimeter), Patrick Hayden, Peter Hoyer (Calgary), Barry Sanders (Calgary), Alain Tapp, John Watrous (Waterloo)

Number of participants: 102

The Canadian Quantum Information Summer School has become an annual Canadian tradition and welcomes students from all over the world. The goal of the Eighth instalment was to introduce the participants to quantum algorithms, quantum error correction, quantum information theory, and quantum cryptography. Lectures were also given on implementations, quantum complexity theory, nonlocality, and some recent developments in quantum algorithms, namely quantum walks. The School is designed for graduate students and postdocs in computer science, physics, or mathematics who wish to learn about quantum information science. The students specializing in a specific area of quantum information find that it is an ideal opportunity to broaden their knowledge of the field as a whole.

After an introduction to quantum information given by Alain Tapp, the following topics were covered by the lecturers: Grover's algorithm and its lower bound (Peter Hoyer), factoring (Andrew Childs), error correction and fault tolerance (Daniel Gottesman), nonlocality and communication complexity (Anne Broadbent), information theory (Patrick Hayden), quantum computational complexity (John Watrous), quantum optics implementations (Barry Sanders), superconducting circuits implementations (Alexandre Blais), cryptography (Claude Crépeau), and quantum walks (Ed Farhi). Kamil Bradler and Frédéric Dupuis were in charge of the problem session.

SIAM Conference on the Life Sciences

August 4 – 7, 2008, Hyatt Regency Montreal
sponsored by the National Science Foundation (NSF), Merck & Co., Inc., the National Institute of Biomedical Imaging and Bioengineering (NIBIB), CRM, and the Fields Institute

Organizers:
Steven J. Cox (Rice, Cochair), Jonathan E. Rubin (Pittsburgh, Cochair) Carlos Castillo-Chavez (Arizona State), Lisa J. Fauci (Tulane), Leon Glass (McGill), Joyce R. McLaughlin (Rensselaer), Qing Nie (UC Irvine), Dave Polidori (Johnson & Johnson), Michael C. Reed (Duke)

In 2008, the Society for Industrial and Applied Mathematics held its Conference on Life Sciences in Montreal. The life sciences have become increasingly quantitative as new technologies facilitate collection and analysis of vast amounts of data, ranging from complete genomic sequences of organisms to satellite imagery of forest landscapes on continental scales. As a consequence, mathematics and computational science have become crucial technologies for the study of complex models of biological processes. The SIAM Activity Group on Life Sciences brings together researchers who seek to develop and apply mathematical and computational methods in all areas of the life sciences. The SIAM Conference on the Life Sciences, organized by the activity group, provides a cross-disciplinary forum for catalyzing mathematical research relevant to the life sciences. Its themes are biomechanics, cell signaling, evolutionary dynamics, imaging, neuroscience, regulatory networks, and systems biology.

The CRM and the Fields Institute were the sponsors of the public lecture, given by Professor Stuart Kauffman. Until 2009, S. Kaufmann was Professor of Biological Sciences and Physics and Astronomy, Adjunct Professor of Philosophy, and Director of the Institute for Biocomplexity and Informatics (IBI) at the University of Calgary. He was awarded the Herbert A. Simon Award in 2000 and held a John D. and Catherine T. MacArthur Fellowship from 1987 to 1992. His areas of interest include developmental genetics, theoretical biology, evolution, and the origin of life. At the SIAM Conference on the Life Sciences, he gave a lecture entitled *Reinventing the Sacred*: *Science, Faith and Complexity*. The following is adapted from a report written by Dr. Steve Cox, cochair of the conference.

Professor Kaufman engaged an audience of 250, of which more than 100 were not conference participants, in a serious discussion of the limits of reductionism. The crowd was rapt as he spoke in a slow, deliberate fashion, without slides or notes, for 90 minutes on themes, metaphors and analogies that he has developed in three earlier books as preparation for the following proposal: as reductionism cannot be the whole truth, we cannot "mathematicize" the class of Darwinian pre-adaptations and therefore much about our immediate future remains, and will always remain, a mystery. S. Kaufmann also proposes that since this mystery has historically been a wellspring of creativity, we should agree to call this mystery sacred. His lecture closed with a vibrant question and answer period where audience members struggled to distinguish argument from assertion and skeptics sought to expose the semantic sleight of hand that "must" underlie any proposal "explaining" religion. Advance press for his lecture

appeared in three places in the Saturday, August 2 issue of *The Gazette*. In summary, S. Kaufman's lecture succeeded on every possible front. It attracted a significant audience and sparked a healthy, serious, and ongoing discussion regarding science and religion and the perceived limits of mathematics.

Second Montreal Industrial Problem Solving Workshop

August 18 – 22, 2008, CRM
Organized by CRM, MITACS, GERAD, CIRRELT, Network for Computing and Mathematical Modelling (ncm_2), and CIRANO
Financed by MITACS and ncm_2

Organizing committee:
Jean-Marc Rousseau (CIRANO & ncm_2, Chair), Eric Bosco (MITACS), Michel Gendreau (CIRRELT & Montréal), Bernard Gendron (Montréal), Alexandra Haedrich (ISM), François Lalonde (Montréal), Roland Malhamé (Polytechnique Montréal), Odile Marcotte (UQÀM & CRM), Dominique Orban (Polytechnique Montréal), Louis-Martin Rousseau (Polytechnique Montréal)
Participating researchers:
Charles Audet (Polytechnique Montréal), Fabian Bastin (Montréal), Gilles Caporossi (HEC Montréal), Jean-François Cordeau (HEC Montréal), Jean-Marc Frayret (Polytechnique Montréal), Pierre Hansen (HEC Montréal), Qutaibeh Katatbeh (JUST), Sébastien Lemieux (FORAC, Laval), Odile Marcotte, Sylvain Perron (HEC Montréal), Mason Porter (Oxford), Jean-Yves Potvin (Montréal), Jean-Marc Rousseau, Bala Srinivasan (Polytechnique Montréal)
Industry representatives:
Stéphane Alarie (Hydro-Québec), Étienne Ayotte-Sauvé (CanmetENERGY, Natural Resources Canada), Danielle De Sève (Hydro-Québec), Marc Drouin (Exact Modus Inc.), Charles Fleurent (GIRO), Frédéric Guay (Hydro-Québec), Sébastien Lacroix (Feric, FPInnovations,), Luciana Savulescu (CanmetENERGY, Natural Resources Canada), Patrick St-Louis (GIRO), François Vachon (Hydro-Québec)
Number of participants: 14 researchers, 10 industry representatives, and 22 students and postdoctoral fellows

As part of its multidisciplinary and industrial program, the CRM organizes workshops where academic researchers, industry representatives, students, and postdoctoral fellows model and solve problems brought forward by industrial partners. The second Montreal Industrial Problem Solving Workshop (IPSW) was held on August 18-22, 2008, and its participants worked on five problems proposed by the following organizations: Hydro-Québec, CanmetENERGY, FPInnovations (the Feric division), Exact Modus and the company Les Bois Francs L'Islet-Sud, and GIRO. The organizers are very grateful to the persons who supplied the problems, in particular Dr. Sophie D'Amours, professor at Université Laval and co-director of CIRRELT, Mr. Christian Rouleau, of the FORAC consortium, and Dr. Paul Stuart, who holds the NSERC Environmental Design Chair at the École Polytechnique de Montréal.

The five problems studied during the workshop fell within the broad scope of optimization and operations research, areas well represented at GERAD (http://www.gerad.ca) and CIRRELT (http://www.cirrelt.ca), two centres with which the CRM has enduring collaborations. The goal of the first problem, proposed by Hydro-Québec, was to determine the optimal location of gamma monitoring instruments for measuring the snow pack in Northern Québec. The second problem, proposed by CanmetENERGY, consisted of retrofitting the heat recovery network of a pulp and paper mill in order to minimize energy and water consumption.

The goal of the third problem, proposed by FPInnovations, was to model the planning of operations in a forestry supply chain; the ultimate goal of this project, which has just started, is of course to find good or even optimal solutions for the planning of operations. The fourth problem was proposed by two companies, Exact Modus and Les Bois Francs L'Islet-Sud, and consisted of predicting the distribution of a saw mill production among planks of varying qualities, given the characteristics of the logs used to produce the planks. Finally, the fifth problem was proposed by GIRO and was a variant of the pickup and delivery problem; in this variant, one considers potential hubs and allows some demands to be split into "subdemands" going through hubs.

Although most of the participants came from Montréal and Québec City, the workshop welcomed researchers and students from Oxford, Toronto, Waterloo, and Maryland, as well as French students who were staying in Montréal at the time as part of their work-study projects. The atmosphere of the workshop was very friendly, and as in the first Montréal IPSW, the participants (especially those who were taking part in an IPSW for the first time) found the experience intense and very profitable! The reader may find more details (including the problem descriptions and the workshop proceedings) on the workshop web site (http://www.crm.umontreal.ca/probindustriels2008/index_e.shtml).

CI/CS 2009 Spring Technical Meeting

May 10 – 13, 2009, McGill University
sponsored by the Applied Mathematics Laboratory and CRM

Local organizer:
Anne Bourlioux (Montréal)
Technical program coordinators:
Kevin Thomson (NRC), Vahid Hosseini (NRC)
Invited speakers:
Murray J. Thomson (Toronto), Pierre Q. Gauthier (Rolls-Royce Canada), Andrew J. Higgins (McGill)
Other speakers:
Benjamin Akih Kumgeh (McGill), Jeff Bergthorson (McGill), Madjid Birouk (Manitoba), William Kendal Bushe (UBC), Marc Charest (Toronto), Gaby Ciccarelli (Queen's), Adam Coderre (Carleton), Brian Crosland (NRC), Kyle Daun (Waterloo), Cécile Devaud (Waterloo), Cosmin Dumitrescu (NRC), Ahmad El Sayed (Waterloo), Nicolas Farra (Toronto), David Gardiner (RMCC), Philip Geddis (Toronto), Nima Gharib (Windsor), Sandra Goldthorp (CERL), Jean-Sébastien Grondin (McGill), Clinton Groth (Toronto), Ömer L. Gülder (Toronto), Hongsheng Guo (NRC), Dale Haggith (Windsor), William Hallett (Ottawa), Vahid Hosseini (NRC), Christopher Iyogun (Manitoba), Sandeep Jella (Rolls-Royce Canada), Anne Jesuthasan (McGill), Craig Johansen (Queen's), Matthew Johnson (Carleton), Michael Johnson (Windsor), Vsevolods Kamenskihs (McGill), Ahmet Emre Karatas (Toronto), Se Won Kim (KITECH), Alexander Koch (Waterloo), Larry Kostiuk (Alberta), Carlos Leung (Ottawa), Teresa Leung (Calgary), Oliver Link (NRC), Fengshan Liu (Delaware State), Philip Mach (Ottawa), Brian Maxwell (Ottawa), James McEwen (Carleton), Navid Mehrjoo (McGill), Adrian Milford (Waterloo), Richard Mills (Toronto), Greg Pucher (RMCC), Matei Radulescu (Ottawa), Yi Ren (Waterloo), Mohammad Mahdi Salehi (UBC), Mani Sarathy (Toronto), Syed Imran Shah (Alberta), Greg Smallwood (NRC), Ahmed Sobh (Windsor), Andrzej Sobiesiak (Windsor), Jérôme Thiebaud (Toronto), Kevin Thomson (NRC), Luis A. Torres (Alberta), Tommy Tzanetakis (Toronto), Patrizio Vena (Carleton), James Wallace (Toronto), Graeme Watson (McGill), Beth Weckman (Waterloo), John Wen (Waterloo), Ming Zheng (Windsor)
Number of participants: 84

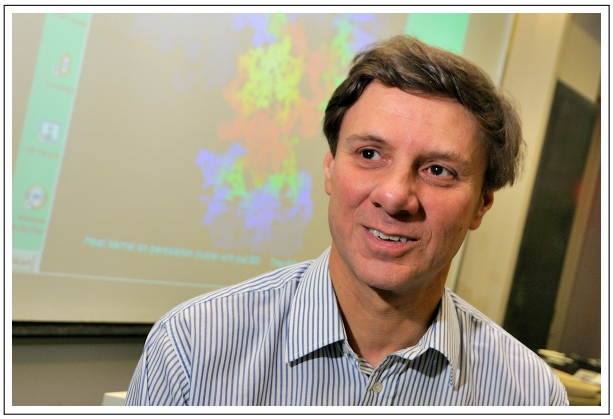
Le Combustion Institute est une société éducative, internationale et sans but lucratif ayant pour but de promouvoir et disséminer la recherche en science de la combustion. Cet institut comporte trente sections nationales. Du 10 au 13 mai 2009 la section canadienne du Combustion Institute tint à Montréal sa réunion technique annuelle, dont l'organisatrice principale était Anne Bourlioux. La réunion eut lieu dans le cadre magnifique du Faculty Club de l'Université McGill, avec l'aide logistique du personnel du CRM, en particulier Guillermo Martinez-Zalce et Suzette Paradis. La réunion attira plus d'une centaine de participants et comporta 3 conférences plénières et 57 présentations orales. Les thèmes abordés couvraient un spectre très large de questions de pointe en combustion, y compris les approches via la modélisation mathématique et la résolution numérique des phénomènes de combustion (à la fois très complexes et très importants en pratique). Un point saillant de cette réunion est l'accent mis sur la présentation de leurs résultats par les étudiants et autres chercheurs débutants ; à la réunion de Montréal une trentaine d'exposés furent donnés par des étudiants.

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 André-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 2009 Awarded to Martin Barlow

Martin Barlow from the University of British Columbia is the recipient of the 2009 CRM – Fields – PIMS Prize. Martin Barlow is a leading figure in probability and the leading international expert in diffusion on fractals and other disordered media. In addition, the impact of his work has been important in such diverse fields as partial differential equations (including major progress on the De Giorgi conjecture), stochastic differential equations, the mathematical finance of electricity pricing, filtration enlargement and branching measure diffusions.



Already in the 1980s, Martin Barlow settled a long-standing open problem of probability theory, by providing necessary and sufficient conditions (the latter with J. Hawkes) for the continuity of local times of Lévy processes. This was the resolution of a thirty-year old problem that had attracted the efforts of Hale Trotter, Ronald Getoor, and Harry Kesten (among others). His conditions have paved the way for the study of the connection between local times and Gaussian processes.

In the 1990s his detailed study of diffusions on a variety of fractals and fractal-like sets opened a new area of study in probability, making him the leading international expert in the behaviour of diffusions on fractals and other disordered media. The study of the diffusion on the Sierpiński carpet, started with Ed Perkins and then Richard Bass in 1986, served as a testing ground for diffusion in highly inhomogeneous media, a domain of interest for the physics community that is now within mathematical reach. Barlow remains at the leading edge of this research with his recent work, giving best possible results for the behaviour of transition probabilities for random walks on super-critical percolation clusters. The pioneering papers on the diffusion on the Sierpiński carpet attracted to the domain experts in Dirichlet forms, diffusions on manifolds, and statistical mechanics. Martin Barlow is currently at the forefront of a program to study the transport properties of a broad class of graphs and manifolds.

Martin Barlow received his undergraduate degree from the University of Cambridge in 1975 and his doctoral degree at the University College of Swansea in Wales in 1978 (with David Williams as supervisor). He held a Royal Society University Research Fellowship at the University of Cambridge from 1985 to 1992. In 1992 he joined the Department of mathematics at the University of British Columbia, where he is currently Professor of Mathematics. He has held a number of visiting professorships at leading universities, including the University of Tokyo, Cornell University, Imperial College London, and the Université de Paris.

Martin Barlow gave an invited lecture at the 1990 ICM in Kyoto and was an invited lecturer at the prestigious Saint-Flour Summer School in 1995. In 2008 he received the Jeffery-Williams Prize of the Canadian Mathematical Society. Other past distinctions include the Rollo Davidson Prize from the University of Cambridge and the Junior Whitehead Prize from the London Mathematical Society. He has been a leader of the international probability community, as a lead organizer of numerous conferences, Associate Editor of all the top probability journals, and Editor-in-Chief of the *Electronic Communications in Probability*. He has been a Fellow of the Institute of Mathematical Statistics since 1995 and of the Royal Society of Canada since 1998. In 2006 he was elected Fellow of the Royal Society (United Kingdom).

More detals on the contributions of Professor Barlow to mathematics may be found in *Le Bulletin du CRM* (Spring 2009).

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), Joel S. Feldman (2007), and Allan Borodin (2008).

André-Aisenstadt Prize 2009 Awarded to Valentin Blomer

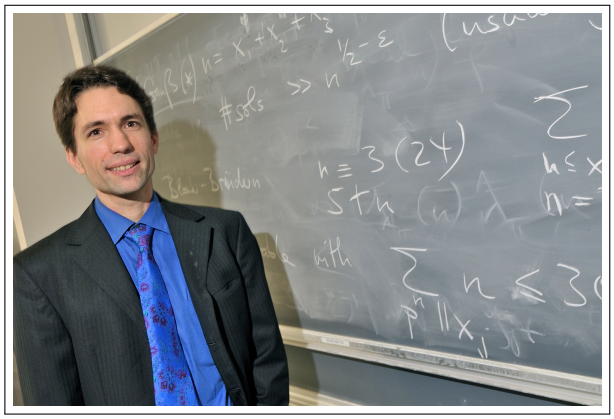
Following his master's degree in 2001, Valentin Blomer burst onto the number theory scene by solving a deep and difficult problem of Paul Erdős, which allowed him to obtain his Ph.D. in 2002 at the University of Stuttgart (under Jörg Brüdern), after just one year! After spending the 2003-2004 year as a postdoctoral fellow at the University of Toronto, he accepted a position as an assistant professor at the University of Göttingen. He has been an assistant professor at the University of Toronto since 2005.

Blomer's solution to Erdős's problem revolved around precise estimates for the number of integers represented by a binary quadratic form and not greater than a given point, where that point is small enough for the coefficients of the form to have a significant impact on the shape of the solution. This type of question goes back to Lagrange and Gauss, and it is not surprising that Blomer's work on this problem had a great impact.

Recently Blomer has focused on the subconvexity problem for automorphic L-functions, obtaining (in papers with Harcos and Michel) the best results known in this central question, in several different aspects. Recently Blomer and Harcos obtained the complete spectral decomposition for the shifted convolution problem, a problem that goes back to Selberg. Blomer has many other fine works in all sorts of different directions. He seems to generate a wealth of ideas, aided by great technical prowess. There is obviously much more to come.

Valentin Blomer's exceptional research has been recognized by several prizes and honors, including the 2005 Heinz Maier-Leibnitz Prize in Germany and a Sloan Research Fellowship (in 2008). Valentin Blomer is also an exceptional pianist, having performed throughout Europe, in Japan, and in Canada, and having even won an international competition in Belgium in 2002.

A detailed description of the contributions of Valentin Blomer may be found in *Le Bulletin du CRM* (Spring 2009).



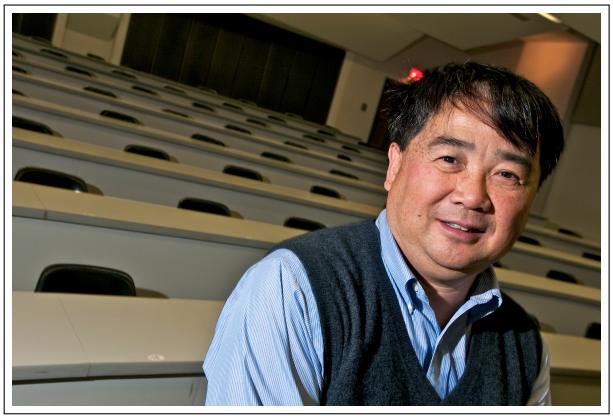
The André-Aisenstadt Prize

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 Scientific Advisory Committee of the CRM. At the time of consideration, candidates must be Canadian citizens 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), Gregory G. Smith (2007), József Solymosi (2008), and Jonathan Taylor (2008).

CAP – CRM Prize 2009 Awarded to Hong Guo

The 2009 CAP – CRM Prize in Theoretical and Mathematical Physics was awarded to Hong Guo, from McGill University, for his pioneering work on the *ab initio* theory of transport in nanoscale systems, including the theory of circuits in which current flows through molecules. Hong Guo has produced many original works covering a wide range of topics in quantum transport theory, non-equilibrium Green's function formalism, electron scattering theory in semiconductor nanostructures, time-dependent and high frequency quantum transport theory, strongly correlated phenomena in quantum dots, new nanoscale quantum device concepts and operation principles, and application of density functional theory atomistic techniques for understanding charge/spin transport. Hong Guo has developed a new theoretical formalism and associated modelling tools that involve a close coupling of quantum physics, non-equilibrium statistical physics, materials physics, and atomistic first principles methods, for investigating nano-electronic devices.



Hong Guo has solved the crucial theoretical problem of quantitative prediction of non-equilibrium quantum transport in atomic/molecular scale devices, by developing an entirely new electronic structure theory that goes beyond the equilibrium closed/isolated or periodic systems conventionally seen in quantum chemistry and solid state physics. Guo's work represents a qualitative advance of quantum transport as well as electronic structure theory; it has become the state-of-the-art in nanoelectronic device theory and is now used by a wide range of researchers, including industrial device researchers. Guo has also contributed extensively to other important issues of quantum transport. Very notable was his work on the solution of the alternating current partition problem using the non-equilibrium Green's function approach. His work has provided very important insight concerning high frequency quantum transport in nanoscale systems, nonlinear quantum capacitance, operational speed of nano-scale devices, and quantum RLC circuits. He has built a unique research program in Canada and his work has a top international reputation; it is of the highest scientific value but has also direct relevance to practical applications.

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 Myers (2005), John Harnad (2006), Joel S. Feldman (2007), and Richard Cleve (2008).

CRM – SSC Prize 2009 Awarded to Hugh Chipman

The Centre de recherches mathématiques and the Statistical Society of Canada were pleased to award the 2009 CRM – SSC Prize to Professor Hugh Chipman, from the Department of Mathematics and Statistics at Acadia University. Professor Chipman has made outstanding contributions to the application of Bayesian statistical inference for data analysis. His work on Bayesian variable selection in experimental design, on a Bayesian paradigm for non-parametric wavelet regression, and on a Bayesian approach to CART (Classification and Regression Tree) modelling is seminal. He has also carried out innovative work in discriminant analysis and clustering and

interdisciplinary research in bioinformatics and machine learning, and trained many graduate students.

Hugh Chipman obtained a B.Sc. in mathematics at Acadia University (in 1990) and an M.Sc. and a Ph.D. in statistics at the University of Waterloo (in 1991 and 1994, respectively). During his doctoral studies he was supervised by C.F.J. Wu et M.S. Hamada. After obtaining his Ph.D. he became assistant professor at the University of Chicago Graduate School of Business. After spending three years in Chicago, he went back to the University of Waterloo, where he stayed during seven years as an assistant professor and then an associate professor. In 2004, Hugh Chipman was awarded a Tier 2 Canada Research Chair in mathematical modelling at Acadia University, where he became a full professor in 2006. In 2002 he was a visiting associate professor at Stanford University.

Professor Chipman has made exceptional contributions to the application of Bayesian statistical inference to data analysis. He has carried out fundamental work on Bayesian variable selection in experimental design, on a Bayesian paradigm for nonparametric wavelet regression, and on a Bayesian approach to CART modelling. In particular, he extended the recursive partitioning in CART (originally a tool for exploring data) in order to turn it into a model; then he developed prior distributions for the space of all CART models and used the MCMC (Markov Chain Monte Carlo) method for computing the posterior distribution. He has also worked on Bayesian treed models, Bayesian additive regression trees, and Bayesian ensemble learning. His papers are widely cited and have a profound impact on the development of computer intensive nonparametric data analysis. In 2006 his work was selected for a full oral presentation at the Neural Information and Processing Systems (NIPS) meeting.

A report on the conference given by Hugh Chipman at the CRM may be found in *Le Bulletin du CRM* (Autumn 2009).

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 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.

Hugh Chipman is the eleventh 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), Richard Cook (2007), and Paul Gustafson (2008).

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 three lectures geared towards a general audience in 2008 – 2009. Two of the lectures took place at the Université de Montréal: a lecture by Professor Jacques Laskar on October 9, 2008, and a lecture by Professor Gilles Brassard, on April 16, 2009. Another lecture was given by Professor Yvan Saint-Aubin at Université Laval on November 28, 2008. The reader will find summaries of these lectures below. Each Grande Conférence attracted hundreds of people of all ages, and was followed by a "vin d'honneur" that enabled the participants to ask questions, reconnect with friends and colleagues, and meet people interested in mathematics and science in general.

In 2008 – 2009, 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 Chaotic Motion of the Solar System – Jacques Laskar (Observatoire de Paris)

by Christiane Rousseau (Université de Montréal)

On October 9, 2008, Jacques Laskar gave the first *Grande Conférence* of the 2008 – 2009 academic year. The audience included groups of college students and other participants with a keen interest in astronomy.

The lecture started with a historical overview of the area and the many proofs of the solar system stability. Jacques Laskar recalled the laws of Kepler and spoke on the "stability proofs" due to Euler and Lagrange. Initially these proofs were found not to agree with the experimental data, but they were eventually replaced by new methods, the perturbative methods (in the case of Euler) and the invariance of the planet major axes (in the case of Lagrange), related to the study of the linearized system. The speaker presented the Chaldeans' historical data, transmitted to us by Ptolemy and which led Halley to conclude that Jupiter was getting closer to the Sun and Saturn further from the Sun. Because Laplace looked at perturbative terms of higher order, he was able to discover the periodic oscillations of the planets major axes (with an approximate period of 800 years); these oscillations provided a perfect fit of the variations that had been observed since antiquity. Jacques Laskar then explained the discovery of chaos by Henri Poincaré and mentioned that chaos could occur in the solar system (in theory, at least). He stressed the fact that in a later text, Poincaré wrote that he did not expect to find chaos in the solar system.

Jacques Laskar then turned to the modern period, where the solar system is simulated on computers. He spoke of the exponential divergence of trajectories and the ensuing problems in numerical simulation: the step must not be too large with respect to the period. The trajectories cannot be controlled after a certain number of steps, because of the cumulative effect of errors. One is thus led to consider the averaged system in fast time and to focus on the slow motions. Since the period is much larger, one can take time steps that are much larger and control the simulations over longer periods. These simulations enable one to look at the variations in the orbit parameters: eccentricity, precession (the rotation axis of the Earth), etc. Jacques Laskar mentioned recent work revealing the remarkable correlation between the Earth axis oscillations and the ice ages, which scientists study by looking at marine sediments.

The results obtained by Jacques Laskar during the 1990s prove the existence of chaos among the solar system internal planets (Mercury, Earth and Venus). Chaos follows from resonances in the orbit parameters of these planets; it entails a weak expansion of the orbit eccentricity for each internal planet, and this expansion in turn enables one to give many different values to the revolution periods of planets. These variations bring the system into a state close to resonance, which speeds up the phenomenon and demonstrates that there exist trajectories where the Mercury orbit crosses that of Venus. When simulating the averaged system over five billion years, one observes that the Mercury and Venus eccentricities exhibit variations allowing for the possibility of col-

lisions. Comparing simulations based on models including general relativity and those based on models not including it, Professor Laskar concluded that the system is much more chaotic without general relativity.

Professor Laskar then explained how to get round the problem of exponential divergence in order to obtain realistic trajectories through simulation. The simulation process first produces sets of trajectories whose initial conditions are close to one another over relatively short periods of time. Then the simulation process produces a new set of trajectories whose initial conditions are close to the final state of the first set. This method amounts to building trajectories piece by piece. In order to find trajectories that can lead to collisions, one chooses trajectories exhibiting the largest possible eccentricity for Mercury. This enables one to prove the existence of trajectories (built piece by piece) leading to collisions. Then a "shadowing lemma" technique can be used to conclude that there exists a real trajectory similar to a trajectory built piece by piece, with initial conditions very close to those of the simulated trajectory. These methods enable scientists to go beyond the study of the averaged system and study the real system, including the position of the planet on its orbit. A large simulation is under way to show that a collision between Mercury and Venus may occur.

Jacques Laskar also spoke on a statistical study of the semi-major axes of internal planets. The distribution of their values is very regular when one makes numerous simulations over very long time periods.

Disorder and Beauty – Yvan Saint-Aubin (Université de Montréal)

by Jean-Marie De Koninck and Claude Levesque (Université Laval)

On November 28, 2008, Professor Yvan Saint-Aubin delivered a *Grande Conférence du CRM* in the Hydro-Québec auditorium of Université Laval. On the poster advertising his conference one could read: "The mathematician who uncovers new patterns or structures will often say that they are beautiful in order to describe his new understanding, because his breakthrough is similar to an aesthetic experience. This point of view is especially startling when the object of study is disorder itself." The lecturer's goal was to "describe topics where mathematicians uncovered structures in situations where only disorder seemed to reign." Yvan Saint-Aubin reached his goal with brilliance and humour, in front of an audience of more than 250 people.

The audience was first introduced to Jackson Pollock, one of the greatest American painters of the twentieth century. His approach is unusual: he seems to be throwing paint randomly on canvas, and although the result looks disordered, his paintings are pleasing to the eye. Why is this so? Richard Taylor, a theoretical physicist and amateur artist (not to be confused with Andrew Wiles' collaborator), argues that Pollock's works (*drippings*) have fractal properties. How can one describe the geometrical objects called "fractals," usually produced by computers?

Professor Saint-Aubin gave the example of the famous *von Koch's Snowflake*, one of the first fractal curves that were described at the beginning of the twentieth century; it was named after the Swedish mathematician Helge von Koch (1870 – 1924). The iterative construction of von Koch's Snowflake (very well illustrated) convinced the audience that it was indeed a closed curve of infinite perimeter whose dimension is greater than one. In order to compute this "fractal dimension," Professor Saint-Aubin evaluated the number of brushstrokes necessary to cover the Snowflake. He was able to show that its dimension is comprised between 1 and 2; actually it equals $\log 4/\log 3 \approx 1.26$.

The same kind of calculation was carried out by Taylor to show that Pollock's works are fractals whose dimension can be estimated. This leads to the hypothesis that the brain is hardwired to appreciate fractal objects. Taylor claims to have been able to identify forgeries (paintings attributed to Pollock) by computing the fractal dimension of these paintings and observing that their dimension was 0! Mathematics can be used to support great art by helping detect forgeries...

In the second part of his lecture Professor Saint-Aubin spoke on disorder at the atomic level, especially the work of the botanist Robert Brown (1773 – 1858) and the scientist Albert Einstein (1879 – 1955). As Brown observed, inert molecules actually move! Their motion is disordered, as illustrated in a short film presented by the lecturer. Einstein proposed to

use this disordered motion in order to compute the Avogadro constant (i.e., the number of atoms in 12 grams of carbon-12). Jean Perrin carried out this experiment and was awarded the Nobel Prize for his groundbreaking experiments on the atomic hypothesis. When the step and the time between two steps become very small (i.e., tend towards zero), Brownian motion looks like a random walk. Professor Saint-Aubin illustrated this model by playing a clip from Madama Butterfly. Not all disorders are the same! Mathematicians were stunned to discover that Brownian motion is almost surely continuous but cannot be differentiated at any point.

Yvan Saint-Aubin also spoke on percolation and used the modelling of a coffee filter as an example. As in the case of Brownian motion, he illustrated his topic with short films, and in particular he localized for his audience the precise point where the grind density is at a "critical level." He explained that conformal transformations are a crucial part of the critical level description and showed pictures displaying conformal and non-conformal transformations. The audience was able to observe the action of a family of conformal transformations allowing the removal of slots from the complex half-plane. If the slot represents an interface between the coffee and the water, the real point where the slot originates is a multiple of Brownian motion.

Professor Saint-Aubin concluded his wonderful lecture by citing Poincaré: "If a new result is significant, it is because it ties together elements that have been known for a long time but seemed unrelated, and thus introduces order in an area that looked disordered" (see *L'avenir des mathématiques* by Henri Poincaré).

Secret Codes Throughout the Ages – Gilles Brassard (Université de Montréal)

by Yvan Saint-Aubin (Université de Montréal)

In his *Grande Conférence du CRM* Gilles Brassard gave the audience a sweeping overview of the history of secret codes. Although geometry and number theory are generally believed to be the only sciences having drawn the attention of several civilizations over two millennia, Brassard's lecture allows one to think that cryptography is on a par with those two sciences. In this report I cannot address all the historical steps to which Gilles Brassard alluded in his lecture, and I will focus on some of them.

Render Unto Caesar...

A person, say, Ms. A, wishes to send a confidential message (also called *plaintext*) to another person, say, Mr. B. To ensure that the message will not be understood if it is intercepted by a third party, Ms. A converts her message into an unintelligible one (also called *ciphertext*) according to rules known to herself and Mr. B. When he receives the ciphertext, Mr. B will use certain rules to decipher the original message. Cryptographers study ciphers (that is, the rules that enable one to convert messages in a secure fashion) and the techniques to break them.

History records several examples of the use of ciphers. According to Suetonius, author of *De vita Caesarum*, Julius Caesar used a cipher based on a shift of the letters. Each of the plaintext letters is replaced by another letter according to the table below. To produce such a table, an integer n is chosen (in the present case n equals 3); then the complete alphabet is written twice on two consecutive rows, the second row being derived by shifting the first one n times to the left. To create the ciphertext, one replaces each letter in the plaintext by looking for this letter in the top row and replacing it by the letter below (in the bottom row). In order for Ms. A and Mr. B to communicate, they need only agree to use this kind of cipher and choose the number n.

...	W	X	Y	Z	A	B	C	D	E	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓	
...	Z	A	B	C	D	E	F	G	H	...

This cipher does not really prevent a serious adversary from understanding the plaintext, but a simple adaptation of the cipher will make the adversary's task much more difficult. If Ms. A chooses a *random* permutation of the 26 letters, for instance JAROC...DGSNL, and shares this secret "key" with Mr. B, then she can convert the plaintext by systematically replacing A by J, B by A, ..., Z by L. Mr. B can then easily decrypt the ciphertext, i.e., recover the plaintext, since he knows the key. This method, known as *monoalphabetic cipher*, is obviously better than Caesar's method, because the adversary wish-

ing to break the cipher may have to try each of $26! > 4 \times 10^{26}$ possible keys (while in the case of Caesar's method, he only has to try each of 26 keys, including the trivial one).

Is this monoalphabetic cipher a secure method, even against a supercomputer? The answer is "no," especially if the ciphertext (and thus the plaintext) is sufficiently long and the language of the plaintext is known. It took several centuries before the polymath Abu Yusuf Ya'qub ibn Ishaq ibn as-Sabbah ibn Oòmran ibn Ismaïl Al-Kindi, author of 290 manuscripts, discovered how to break this cipher by making use of the letter frequencies in the language of the plaintext. In French, for instance, the letter e is the one with the highest frequency, followed by the letters a and s. A first attempt to decipher the message consists of replacing the letter with the highest frequency by e, the letter with the second highest frequency by a, and so on. The letter frequencies in the plaintext may not be exactly the same as in Les Trois Mousquetaires (say), but it is likely that one will be able to decipher the message by taking other information into account, for instance the fact that the French language does not feature many two-letter words (le, la, de, en, un,...).

Fast Forward to the Renaissance...

The main drawback of the monoalphabetic substitution is that a given letter is always replaced by the same letter. As explained above, the use of letter frequencies enables the adversary to decipher the message. Vigenère's cipher gets round this drawback! Blaise de Vigenère (1523 – 1596) was a French diplomat with an interest in cryptology. The cipher we are about to describe bears his name, but it was originally described by Giovan Battista Bellaso in 1553. Vigenère's cipher uses a keyword that is chosen (and kept secret) by A and B. Ms. A and Mr. B also need the so-called "Vigenère's square," in which each row contains all the letters (shifted one time to the left with respect to the preceding row). The rows and columns of Vigenère's square are labelled by the letters, in the usual alphabetical order.

As in Caesar's method, Ms. A will look for a given letter in the top row of the square and replace it by a letter that is at the intersection of the same column and a row determined by the keyword. Assume that the keyword is maths. Then Ms. A will use the row labelled by m to convert the first letter of the plaintext, the row labelled by a to convert the second one, the row labelled by t to convert the third one, and so on. After the five rows m, a, t, h, s have been used, the sixth letter of the plaintext will be converted by using the row m, the seventh by using a, and so on. When using this kind of cipher (called *polyalphabetic*), one does not replace each occurrence of e in the plaintext by the same letter in the ciphertext. Thus it cannot be broken as easily as the monoalphabetic cipher. Indeed, it was not broken until 1854, when Charles Babbage proposed an efficient method for breaking it... 301 years after its invention by Bellaso!

Enigma, Bletchley Park, and the Colossus...

Many other concepts were introduced by Gilles Brassard during his lecture, but I will now skip many centuries to mention the work carried out by British cryptanalysts during the Second World War. The cipher underlying the Enigma machine, used by the Nazi army to encrypt its messages, is too complicated to be described here. It must be said, however, that the success of British cryptanalysts in breaking the majority of enemy messages, while working at Bletchley Park and following in the footsteps of their Polish colleagues, is both a military feat and a great achievement of twentieth-century mathematics. Professor Brassard indicated that this achievement by mathematicians was accompanied by the design and construction of the first programmable electronic computer, the Colossus. The secret surrounding the first computer was so well kept that the ENIAC, built in the United States at the end of the war, was for a long time thought to be the first programmable electronic computer... although it was only the eleventh one (ten Colossi were built!). The technical reports of the time, made public by the British Public Record Office in October 2000, allow us to give the builders of the Colossus their due.

Code Designers and Code Breakers...

Modern cryptology concepts were introduced by Professor Brassard during the short time of his conference, for instance, the notions of asymmetric key and public key. He also described the impact of cryptology on everyday life, but I must now conclude my report. Edgar Allan Poe was a fan of cryptanalysis. He considered this science as a match between two teams, that of scientists who invent new ciphers and that of "adversaries" who break them. Poe and many scientists are convinced that any cipher can be broken by the human mind, given enough time. Gilles Brassard, however, invites us to challenge this belief. Couldn't one use a computer to implement ciphers that no mind or machine would be capable of breaking? If the answer is "yes," then the invention of the

computer by the Code Breakers, while allowing them to win a round, will make them lose the match!

The audience was captivated by Professor Brassard's lecture. Professor Brassard is one of the founders of quantum cryptography, but this important topic was barely mentioned during his lecture. Was this out of modesty? "No, an introduction to this topic would have required too much time," answered the lecturer. We must invite him for another *Grande Conférence du CRM*!

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 International 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 2008 – 2009, the CRM collaborated with or received financial assistance from the following institutions: INSERM (Paris), INRIA, the Banff International Research Station (BIRS), the Universidad de La Habana (Cuba), the Groupe d'études et de recherche en analyse des décisions (GERAD), and the National Institute for Complex Data Structures (NICDS). The CRM has signed an agreement with the Tata Institute of Fundamental Research; the CRM is already collaborating with the Tata Institute, especially its Centre for Applicable Mathematics (located in Bangalore).

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 Institute for Mathematics and its Applications (IMA), École normale supérieure (France), the Isaac Newton Institute, the Institut des Hautes Études Scientifiques (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 International 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. MITACS 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 2008 – 2009, it supported CanaDAM 2009 and the Eighth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing (see the section General Program) and the Workshop on Signal Processing Methods in Brain Imaging, the Eighth Canadian Summer School on Quantum Information, and the Second Montreal Industrial Problem Solving Workshop (see the section Multidisciplinary and Industrial Program). The CRM is grateful to MITACS for its generous financial support in 2008 – 2009.

The National Institute for Complex Data Structures (NICDS)

In 2008-2009, the Canadian statistical community took the initiative and transformed the NPCDS, a national network in statistics created by the statistical community and the three Canadian mathematics institutes, into an institute, the NICDS. The NICDS was created in response to a pressing need to involve statisticians in collaborations with researchers from various disciplines. Its mandate is to enrich and enlarge the national research enterprise through a powerful new model for the statistical sciences. This model has three striking, unique features:

- the creation of interdisciplinary research teams with quantitative leadership;
- the training of the next generation of quantitative researchers to ensure that they will become well versed in the language of multiple disciplines and be prepared to hold leadership positions in long-term scientific collaborations;
- the raising of the national profile of the statistical sciences.

In the context of this model, and supported by a proactive management team, the NICDS elicits research proposals and builds research projects that are national in scope and involve numerous disciplines and partners.

To conclude, let us mention that the National Program on Complex Data Structures ended an extraordinarily successful five years on April 30, 2008. The program established 8 projects, engaged 60 statistical scientists from across Canada, and trained 70 graduate students and postdoctoral fellows. Thirty collaborators worked within NPCDS teams and NPCDS partnered with 20 organizations, including government agencies, research laboratories, industry, research hospitals, and foundations.

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

- *Spatial/Temporal Modelling 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 (UBC),

Wendy Lou (Toronto), Peter Song (Waterloo), Liqun Wang (Manitoba)

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 of Newfoundland, 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 Foundational Methods in Computer Science*
May 30 – June 1, 2008, Dalhousie
Organizers: Dorette Pronk (Dalhousie), Peter Selinger (Dalhousie)

• *Groups of Self-Homotopy Equivalences and Related Topics*
June 29 – July 5, 2008, Dalhousie
Organizers: Keith Johnson (Dalhousie), Renzo Piccinini (Milano-Bicocca)

• *Graded Algebras and Superalgebras*
August 29 – September 2, 2008, Memorial
Organizer: Atlantic Algebra Centre

• *Canadian Hopf Algebras and Noncommutative Geometry Meeting*
September 2 – 5, 2008, New Brunswick
Organizers: Alain Connes (Collège de France), Piotr M. Hajac (Warsaw), Dan Kucerovsky (New Brunswick), Henri Moscovici (Ohio State), Bahram Rangipour (New Brunswick)

• *APICS Meeting: Mathematics Colloquium and Statistics Colloquium*
October 17 – 19, 2008, Moncton
Organizer: Jacques Allard (Moncton)

• *Combinatorial Algebra Meets Algebraic Combinatorics: Sixth Annual Meeting*
January 16 – 18, 2009, Memorial
Organizers: Yuri Bahturin (Memorial), Nantel Bergeron (York), Sara Faridi (Dalhousie), Tony Geramita (Queen's), Mikhail Kotchetov (Memorial)

• *Atlantic General Relativity Meeting*
April 25-26, 2009, New Brunswick
Organizers: Jack Gegenberg (New Brunswick), Viqar Husain (New Brunswick)

• *Workshop on Mathematical Biology*
April 27, 2009, Dalhousie
Organizers: James Watmough (New Brunswick), Sina Adl (Dalhousie)

• *Fifth Annual East Coast Combinatorics Conference*
April 30-May 1, 2009, New Brunswick
Organizer: Tim Alderson (New Brunswick)

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, Université Laval, and Université de Sherbrooke, 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 ten 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. We refer the reader to the section Research Laboratories for descriptions of 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 members can undertake research with colleagues in the CRM's laboratories or participate in the scientific activities of the CRM.

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 Properties of Finite Groups and Finite Dimensional Algebras*
Efim Zelmanov (UCSD), September 19, 2008

- *An Epidemic Treatment Model with Drug Resistance*
Fred Brauer (Wisconsin – Madison & UBC), February 13, 2009

- *Linear Predictability and Biological Invasions*
Mark Lewis (Alberta), March 6, 2009

Network for Computing and Mathematical Modelling (ncm_2)

The CRM is one of the founding members of the Network for Computing and Mathematical Modelling (ncm_2), a network created by several research centres in order to respond to the needs of industry in fields related to computing and mathematical modelling. 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 ncm_2 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 Cooperative 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). The ncm_2 was involved in the organization and financing of the first two Montreal Industrial Problem Solving Workshops.

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 Universitaire 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. In 2008 the annual meeting of the SSC was replaced by a joint meeting with the Société Française de Statistique and the Summer Meeting of the CMS and the annual meeting of CAIMS were replaced by the Second Canada – France Congress.

Joint Meeting of the Statistical Society of Canada and the Société Française de Statistique

May 25 – 29, 2008, Ottawa Congress Centre
sponsored by the French Embassy, Canadian Heritage, Carleton University, CRM, the Fields Institute, ISM, MITACS, PIMS, the SAS Institute, Statistics Canada, and the University of Ottawa

Scientific Program Chairs:
Marc Hallin (ULB), Bruno Rémillard (HEC Montréal)
Local Arrangements Committee:
Pierre Lavallée (Statistics Canada, Chairman),

Hélène Bérard (Statistics Canada), Michel Delecroix (ÉNSAI), Diane Galarneau (Statistics Canada), Carole Jean-Marie (Statistics Canada), Jean-Michel Marin (Montpellier 2), Isabelle Michaud (Statistics Canada), Mike Sirois (Statistics Canada), Paola Versolato (Statistics Canada), Carolyn Zirbser (Statistics Canada)

To commemorate the 400th anniversary of the establishment of the first permanent French settlement in Canada, the Statistical Society of Canada and the Société Française de Statistique decided to hold a Joint Annual Meeting. This daring venture materialized in a meeting of exceptional breadth, whose scientific program reflects the multiple and often complementary concerns of European and North American statisticians. The program included many prestigious lectures, often delivered by award winners. Here is a list of the main lectures.

- The SSC Presidential Invited Address (Paul Embrechts, ETH Zürich).
- The Lucien Le Cam Address (Richard Gill, Leiden).
- The SFdS Presidential Invited Address (Davy Paindaveine, ULB).
- The SSC Gold Medal Award Address (Don McLeish, Waterloo).
- The Special Invited Session of the Survey Methods Section (David Binder, Statistics Canada).
- The Pierre Robillard Award Addresses (Juli Atherton, McGill, and Jingjing Wu, Calgary).
- The *Canadian Journal of Statistics* Award Address (Hwashin Shin, Health Canada).
- The Marie-Jeanne-Laurent-Duhamel Addresses (Gilles Stoltz, CNRS & ÉNS, and Jean-François Quessy, UQTR).
- The Address of the winner of the CRM – SSC Prize (Paul Gustafson, UBC).
- The Isobel Loutit Invited Address on Business and Industrial Statistics (Vijay Nair, Michigan).

Second Canada – France Congress 2008

June 1 – 5, 2008, Université du Québec à Montréal

Congress Partners

CAIMS, CMS, CRM, The Fields Institute, ISM, MITACS, PIMS, Société de mathématiques appliquées et industrielles (SMAI), Société Mathématique de France, Université du Québec à Montréal

Congress Sponsors:

Concordia University, ministère de l'Éducation, du Loisir et du Sport du Québec, University of Ottawa, CIRGET, CICMA

Congress Scientific Directors:

Octav Cornea (Montréal), Nassif Ghoussoub (UBC), François Loeser (ÉNS)

Scientific Committee:

Jean-Pierre Bourguignon (IHÉS), Ivar Ekeland (UBC & PIMS), Étienne Ghys (ÉNS Lyon), Arvind Gupta (Simon Fraser & MITACS), Barbara Keyfitz (Fields & Houston), François Lalonde (CRM & Montréal), William F. Langford (Guelph), Claude Le Bris (ÉNPC), Étienne Pardoux (Provence), Gilles Pisier (Paris Diderot), Christiane Rousseau (Montréal)

Local Organization:

Christiane Rousseau (Montréal), Alexandra Haedrich (ISM & UQÀM), Gertrud Jeewanjee (CMS, ex officio), Jo-Anne Rockwood (MITACS, ex officio)

The Congress was a resounding success, in no small part thanks to the involvement of CRM members, who took part in the organization of the congress itself and its sessions and gave numerous talks. There were 523 Canadians and 196 French mathematicians among the 775 participants. The Congress featured 18 lectures delivered by plenary speakers or award winners, 27 sessions, 7 minisymposia, three workshops, and several networking activities. The Congress was pleased to host Plenary Speakers Yves André (CNRS & École normale supérieure), Olivier Biquard (Université Pierre et Marie Curie), Luc Devroye (McGill University), Andrew Granville (Université de Montréal), Alice Guionnet (CNRS & École normale supérieure de Lyon), Rick Kenyon (Brown), Gérard Laumon (CNRS & Université Paris-Sud 11), Éric Séré (Université Paris-Dauphine), Jean-Pierre Serre (Collège de France), Nicole Tomczak-Jaegermann (University of Alberta), Nizar Touzi (École Polytechnique), and Jianhong Wu (York University).

The Prize Speakers were Alysson M. Costa from Universidade de São Paulo (CAIMS Cecil Graham Doctoral Dissertation Award), Alan George from the University of Waterloo (CAIMS Research Prize), Edward Bierstone from the University of Toronto (CMS Excellence in Teaching Award), Izabella Laba from University of British Columbia (CMS Krieger-Nelson Prize), and Martin Barlow from University of British Columbia (CMS Jeffery-Williams Prize). Yvan Saint-Aubin, from the Université de Montréal, gave the public lecture.

Here is a list of the sessions, along with their organizers.

- *Algebraic Combinatorics*

Organizers: Christophe Hohlweg (UQÀM), Franco Saliola (UQÀM)

- *Algebraic Groups and Related Topics*

Organizers: Philippe Gille (CNRS & ÉNS), Zinovy Reichstein (UBC)

• *Algebraic Topology*
Organizers: Alejandro Ádem (UBC), Bob Oliver (Paris 13)

• *Analytic Number Theory*
Organizers: Philippe Michel (Montpellier 2), Ram Murty (Queen's)

• *Arithmetic Geometry and Number Theory*
Organizers: Gaëtan Chenevier (Paris 13; CNRS), Henri Darmon (McGill)

• *Automorphic Forms*
Organizers: Stephen Kudla (Toronto), Colette Moeglin (IMJ; CNRS)

• *Complex Analysis and Operator Theory*
Organizers: Emmanuel Fricain (Lyon 1), Javad Mashreghi (Laval), Thomas Ransford (Laval)

• *Complex Dynamical Systems*
Organizers: Xavier Buff (Paul Sabatier), Tan Lei (Cergy-Pontoise), Misha Lyubich (Toronto)

• *Financial Mathematics*
Organizer: Tom Salisbury (York)

• *Geometric and Nonlinear Analysis*
Organizers: Pengfei Guan (McGill), Emmanuel Hebey (Cergy-Pontoise)

• *Industrial Fluid Mechanics*
Organizers: Neil Balmforth (UBC), Jean-Frédéric Gerbeau (INRIA Rocquencourt), Bertrand Maury (Paris-Sud 11)

• *Kinetic Methods in Partial Differential Equations*
Organizers: François Castella (Rennes 1), Reinhard Illner (Victoria)

• *Mathematics Education*
Organizers: Michèle Artigue (Paris Diderot), Bernard Hodgson (Laval)

• *Model Theory and Applications to Geometry*
Organizers: Zoé Chatzidakis (CNRS & Paris Diderot), Patrick Speissegger (McMaster)

• *Non-Commutative Geometry and K-Theory for Operator Algebras*
Organizers: Alain Connes (Collège de France & IHÉS), George Elliott (Toronto), Andrew Toms (York)

• *Nonlinear Dynamics in Life Sciences*
Organizers: Jaques Bélair (Montréal), Pascal Chossat (CIRM), Fahima Nekka (Montréal), Jianhong Wu (York)

• *Numerical Analysis for Hyperbolic Systems*
Organizers: Paul Arminjon (Montréal), Marc Laforest (Polytechnique Montréal), Emmanuel Lorin (UOIT)

• *Partial Differential Equations*
Organizers: Henri Berestycki (ÉHÉSS), Robert Jerrard (Toronto)

• *Probability*
Organizers: Martin Barlow (UBC), Jean-François Le Gall (Paris-Sud 11 & ÉNS), Edwin Perkins (UBC), Wendelin Werner (Paris-Sud 11)

• *Scientific Computing*
Organizers: Christine Bernardi (UPMC; CNRS), Anne Bourlioux (Montréal), Brian Wetton (UBC)

• *Set Theory and its Applications*
Organizers: Alain Louveau (UPMC), Stevo Todorcevic (Toronto & Paris-Dauphine)

• *Statistics*
Organizers: Yannick Baraud (Nice Sophia Antipolis), Boris Levit (Queen's)

• *Stochastic Processes in Evolution, Ecology and Genetics*
Organizers: Don Dawson (Carleton), Sylvie Méléard (École Polytechnique & Paris Ouest)

• *Symplectic and Contact Geometry*
Organizers: Emmanuel Giroux (ÉNS Lyon; CNRS), Yael Karshon (Toronto)

• *Topology, Knots and Related Fields*
Organizers: Michel Boileau (Paul Sabatier), Steven Boyer (UQÀM)

• *Variational and Numerical Methods in Geometry, Physics and Chemistry*
Organizers: Lia Bronsard (McMaster), Éric Cancès (ÉNPC), Maria J. Esteban (Paris-Dauphine; CNRS)

• *Women in Mathematics*
Organizers: Maritza Branker (Niagara), Barbara Keyfitz (Fields), Marie-Françoise Roy (Rennes 1)

The Congress also featured 7 minisymposia in applied mathematics, listed below.

• *Asymptotic analysis of localized patterns in PDEs* (CAIMS)
Organizers: David Iron (Dalhousie), Theodore Kolokolnikov (Dalhousie)

• *Canadian Symposium on Fluid Dynamics* (CSFD)
Organizers: John Bowman (Alberta), Lucy Campbell (Carleton), Kai Schneider (Provence), Lennaert van Veen (Concordia)

• *Modelling Fluid-Structure Interaction in Naval Architecture* (CAIMS)
Organizer: Serguei Iakovlev (Dalhousie)

• *Models for transmission of communicable diseases* (CAIMS)
Organizers: Fred Bauer (UBC), Pauline van den Driessche (Victoria)

• *Models of Motion in Biology* (CAIMS)
Organizer: Dan Coombs (UBC)

• *New software for the numerical solution of differential equations* (CAIMS)
Organizers: Paul Muir (Saint Mary's), Ray Spiteri (Saskatchewan)

• *Singular perturbations and the Ginzburg-Landau model* (CAIMS)
Organizers: Stan Alama (McMaster), Lia Bronsard (McMaster)

CMS Winter 2008 Meeting

December 6 – 8, 2008, Marriott Hotel, Ottawa (hosted by Carleton University)
sponsored by Carleton University, CRM, the Fields Institute, MITACS, and PIMS

Scientific Directors:
Matthias Neufang (Carleton), Benjamin Steinberg (Carleton)

The Congress was pleased to host Plenary Speakers David Acheson (University of Oxford), Fan Chung (University of California, San Diego), Gilles Godefroy (Université Pierre et Marie Curie), Sorin Popa (University of California, Los Angeles), Laurent Saloff-Coste (Cornell University), Mark Sapir (Vanderbilt University), and Keith Taylor (Dalhousie University). The Adrien Pouliot Award was awarded to Harley Weston (University of Regina), the Coxeter – James Prize to Ravi Vakil (Stanford University), the David Borwein Distinguished Career Award to Hermann Brunner (Memorial University of Newfoundland), and the Doctoral Prize to Matthew Greenberg (University of Calgary). The G. de B. Robinson Award was awarded to Dmitry Jakobson (McGill University), Nikolai Nadirashvili (CNRS & Université de Provence), and Iosif Polterovich (Université de Montréal), and the Graham Wright Award for Distinguished Service to Bill Sands (University of Calgary). Finally, the participants thanked Graham Wright for services rendered to the CMS over the course of thirty years.

The meeting featured 22 sessions, listed below.

• *Algebraic Combinatorics*
Organizers: François Bergeron (UQÀM), Srečko Brlek (UQÀM), Christophe Hohlweg (UQÀM), Christophe Reutenauer (UQÀM)

• *Algorithmic Mathematics*
Organizers: Prosenjit Bose (Carleton), Evangelos Kranakis (Carleton)

• *Applied Partial Differential Equations*
Organizers: David Amundsen (Carleton), Lucy Campbell (Carleton), Francis Poulin (Waterloo)

• *Banach Spaces*
Organizers: Robb Fry (Thompson Rivers), Srinivasa Swaminathan (Dalhousie)

• *Combinatorics*
Organizers: Daniel Panario (Carleton), Brett Stevens (Carleton)

• *Commutative Algebra and Algebraic Geometry*
Organizers: Sara Faridi (Dalhousie), Anthony V. Geramita (Queen's)

• *Cryptography and Coding Theory*
Organizers: Isabelle Déchène (Ottawa), Ariane Masuda (Ottawa), Monica Nevins (Ottawa)

• *Dynamics of Large Groups and Semigroups*
Organizers: Stefano Ferri (Los Andes), Alica Miller (Louisville), Vladimir Pestov (Ottawa)

• *Geometric Group Theory*
Organizers: Inna Bumagin (Carleton), Denis Serbin (McGill), Benjamin Steinberg (Carleton)

• *History and Philosophy of Mathematics*
Organizers: Tom Archibald (Simon Fraser), Alexander Jones (Toronto)

• *Infinite-Dimensional Lie Theory*
Organizers: Yuly Billig (Carleton), Alistair Savage (Ottawa)

• *Mathematical Aspects of Quantum Information*
Organizer: David Kribs (Guelph)

• *Mathematical Biology*
Organizers: Frithjof Lutscher (Ottawa), Robert Smith (Ottawa)

• *Mathematics Education*
Organizers: Benoit Dionne (Ottawa), John Poland (Carleton)

• *Mathematics and Classical Mechanics*
Organizers: Manuele Santoprete (Wilfrid Laurier), Cristina Stoica (Wilfrid Laurier)

• *Number Theory*
Organizers: Alina C. Cojocaru (UIC), Damien Roy (Ottawa)

• *Numerical Analysis and Computational Mathematics*
Organizer: A. Bass Bagayogo (Saint-Boniface)

• *Operator Algebras*
Organizers: Benoît Collins (Ottawa), Thierry Giordano (Ottawa)

• *Probability*
Organizers: Antal Jarai (Carleton & Bath), Yiqiang Zhao (Carleton)

• *Representation Theory of Algebras*
Organizers: Vlastimil Dlab (Carleton), Ragnar-Olaf Buchweitz (Toronto)

• *Technology Use in Post-Secondary Mathematics Instruction*
Organizers: Chantal Buteau (Brock), Daniel Jarvis (Nipissing), Zsolt Lavicza (Cambridge)

• *Theory and Applications of Functional Differential Equations*
Organizers: Pietro-Luciano Buono (UOIT), Victor LeBlanc (Ottawa)

Canadian Mathematics Education Forum 2009

April 30 – May 3, 2009, Simon Fraser University
organized by CMS and PIMS
sponsored by CMS, PIMS, Simon Fraser University, MITACS, the Fields Institute, the CRM, CAIMS, SSC, Maplesoft, Nelson Education, Pearson, and Wiley

Co-chairs of the Forum Committee
Malgorzata Dubiel (Simon Fraser), Viktor Freiman (Moncton), Peter Taylor (Queen's)

This conference featured a pre-forum, a closing session, three plenary sessions, and three panel discussions. Here is a list of the sessions and discussions.

• *Reconsidering Basic Mathematical Assumptions in Teacher Education* (Rina Zazkis, Simon Fraser)
• *Making School Mathematics Functional: A Stool Needs Three Legs* (Hugh Burkhardt, Shell Center for Mathematical Education, Nottingham)
• *The Vantage Point of Publisher*: *One View of Curriculum Development* (Steven Rasmussen, Key Curriculum Press)
Panel I: *What did I need then*? *What do I need now*?
Chair: Egan Chernoff (Saskatchewan)
Panel II: Presentation and discussion of the Burkhardt plenary
Chair: France Caron (Montréal)
Panel III: Presentation and discussion of the Rasmussen plenary
Chair: Harley Weston (Regina)

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 Institut des sciences mathématiques (ISM).

Institut des sciences mathématiques

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, UQÀM, 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 cegeps 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 cegep 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.

2008-2009 Postdoctoral Fellows

Nadine Badr (Ph.D. 2007, Université Paris-Sud 11) is working in harmonic analysis, functional analysis, and analysis in metric measure spaces with Galia Dafni, Alina Stancu, Dmitry Jakobson, John Toth, and Stephen Drury. In the summer of 2009, she supervised an ISM Undergraduate Summer Scholarship

student. She is now a "maître de conférences" at the Université Claude Bernard Lyon 1.

Bryden Cais (Ph.D. 2007, University of Michigan) is working with Henri Darmon and Eyal Goren in number theory. In the Winter 2009 term, he gave an ISM course entitled *p-adic Hodge Theory*.

Norman Do (Ph.D. 2008, The University of Melbourne) is working with Jacques Hurtubise in geometry and topology, especially on problems related to combinatorics and mathematical physics.

Xander Faber (Ph.D. 2008, Columbia University) is working in arithmetic geometry, dynamic algebraic systems, and tropical geometry. He has published two articles in 2009 and written an article with Andrew Granville (Université de Montréal).

Seung-Yeop Lee (Ph.D. 2007, University of Chicago) is working with Marco Bertola, John Harnad, S. Twareque Ali, and Dmitry Korotkin on the dynamics of two-dimensional fluids. He has written two articles with Marco Bertola (Concordia University).

Dan Mangoubi (Ph.D. 2006, Technion) is working in spectral geometry with Dmitry Jakobson and Iosif Polterovich. During his stay in Montreal, he wrote a paper with Dmitry Jakobson and supervised an ISM Undergraduate Summer Scholarship student. He is now a Senior Lecturer at the Hebrew University in Jerusalem.

Jeehoon Park (Ph.D. 2007, Boston University) is working in algebraic number theory and p-adic modular forms with Henri Darmon.

Igor Wigman (Ph.D. 2006, Tel Aviv University) is doing research in analysis with Dmitry Jakobson and Iosif Polterovich. During his stay in Montreal, he also worked with Granville and Toth and supervised two ISM Undergraduate Summer Scholarship students. He is now a postdoctoral fellow at the KTH (Stockholm).

Benjamin Young (Ph.D. 2008, University of British Columbia) carries out a research program (with Jacques Hurtubise) involving combinatorics, geometry and physics.

ISM Doctoral Fellowships

In 2007 – 2008 the ISM initiated a doctoral fellowships program in order to recruit outstanding Ph.D. students. The doctoral fellowships provide financial support to outstanding, new students to pursue a doctoral program at one of the ISM member universities. Awarded for a two-year period, and renewable for a further two years, the scholarship is worth $20,000 per year. The students filled an application form online and the applications were made available to all the ISM professors. An interuniversity selection committee drew up a short list of candidates (taking the departments' recommendations into account). The 2008 – 2009 scholarship was awarded to Sepideh Farsinezhad, who is doing a Ph.D. in statistics at McGill University.

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.

Ryan Benty (Concordia)
Topic: *The Topology of the Moduli Spaces of Planar Polygons with Fixed Angles*
Duration: 2 months (May – June)
Supervisor: Nadine Badr
Alina Stancu contributed to the financing of this scholarship.

Jean-François Désilets (Montréal)
Topic: *Systèmes intégrables et super-intégrables en mécanique quantique impliquant les particules avec spin* Duration: 3 months
Supervisor: Ismet Yurdusen
Pavel Winternitz contributed to the financing of this scholarship.

Jean-Sébastien Lechasseur (Laval)
Topic: *Notion d'ensemble TF dans des études de fonctions faiblement presque périodiques*
Duration : 4 months (May – August)
Supervisor: Yemon Choi
Thomas Ransford contributed to the financing of this scholarship.

Jonathan L. Moscovici (McGill)
Topic: *Théorie des nœuds*
Duration: 4 months (May – August)
Supervisor: Jeremy Van Horn-Morris
Steven Boyer contributed to the financing of this scholarship.

Guillaume Poliquin (Montréal)
Topic: *Maximization of higher Neumann eigenvalues on disjoint unions of rectangles and disks*
Duration: 4 months (May – August)
Supervisor: Dan Mangoubi
Iosif Polterovich contributed to the financing of this scholarship.

Alan Regis (McGill)
Topic: *Numerical investigation of Laplacian eigenfunctions in planar domains for various boundary conditions*
Duration: 3 months (May – July)
Supervisor: Igor Wigman
Dmitry Jakobson contributed to the financing of this scholarship.

Guillaume Roy-Fortin (Montréal)
Topic: *Shape optimization for Neumann eigenvalues of planar domains*
Duration: 4 months (May – August)
Supervisor: Dan Mangoubi
Iosif Polterovich contributed to the financing of this scholarship.

ISM Graduate Student Conference

The eleventh ISM Graduate Student Conference (*Colloque panquébécois annuel des étudiants*) was held on May 29 – 31, 2009, at Université du Québec à Montréal. About 60 students from Québec, British Columbia, Ontario, and even Taiwan and Algeria attended the conference, which was organized by Jean-Philippe Labbé (Université du Québec à Montréal) and Jonathan Lortie (Université du Québec à Montréal). The plenary lectures were given by Thomas Ransford (Université Laval), Fabrice Larribe (Université du Québec à Montréal), Damien Calaque (Université Claude Bernard Lyon 1) and Nantel Bergeron (York University).

The following students gave talks during the Graduate Student Conference: Valérie Hudon (Concordia University), Waldo Arriagada (Université de Montréal), Alexandre Desfossés Foucault (Université de Montréal), Isabelle Ascah-Coallier (Université de Montréal), François Charette (Université de Montréal), Colin Jauffret (Université de Montréal), Caroline Lambert (Université de Montréal), Laurence Boulanger (Université de Montréal), Rahma Guen (Université Djillali Liabes), Abdelkrim El Basraoui (University of Ottawa), Ratnadha Kolhatkar (University of Ottawa), Jean-Philippe Labbé, Ariane Garon (Université du Québec à Montréal), Sébastien Labbé (Université du Québec à Montréal), Sarah Dufour (Université du Québec à Montréal), Mélina Mailhot (Université du Québec à Trois-Rivières), Benoît Pouliot (Université Laval), Jérôme Fortier (Université Laval), Maxime Fortier Bourque (Université Laval), Malik Younsi (Université Laval), Patrick Letendre (Université Laval), Denis Talbot (Université Laval), Alexis Selezneff (Université Laval), and Sophie Burrill (Simon Fraser University).

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 *Accromαth* magazine aims to draw more young people to the mathematical sciences. *Accromαth*, 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. *Accromαth* 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.

Currently 1500 persons or institutions (mostly teachers from Québec) subscribe to the magazine. In April 2007, *Accromαth* was awarded a bronze medal for its design at the prestigious Summit Creative Awards, where thousands of works from 23 different countries were submitted. In July 2008 the magazine won a Grand Award, the highest distinction, at the Apex Awards. Finally it was also awarded (in June 2009) a prix spécial de la ministre de l'Éducation, du Loisir et du Sport. For more information on *Accromαth*, we refer the reader to the site http://www.accromath.ca/.

Other Joint Initiatives

CMS Mathematics Camps

In order to promote mathematics, the CMS provides extracurricular activities for high school students, especially a National Math Camp and Regional Math Camps. Each year the CMS also offers training camps for the Canadian Team selected for competing at the International Mathematical Olympiad. The CRM sponsors these camps, along with the Fields Institute, PIMS, the Association Mathématique du Québec, PromoScience (NSERC), the host universities, various foundations, and most Canadian provinces (cf. http://www.cms.math.ca/MathCamps/).

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 for high school students and the general public. We refer the reader to the site http://www.smac.ulaval.ca/ for more information.

Mathematical Excursions

In the winter of 2009, Professor Dmitry Jakobson from McGill University launched a new program of introductory lectures on mathematics for cegep students. This program draws its inspiration from the Mathematical Circle, a program of the Moscow universities that was instrumental in training several generations of mathematicians. The program objective is to present various mathematical fields in an accessible and entertaining way. About 25 students from the Montreal area attended the lectures. Here is a sample of the notions introduced in the lectures: juggling, Rubik cube, number theory, complex number, Escher's pictures, graph theory, and combinatorics.

Research Laboratories

Applied Mathematics

Description

The research interests of the laboratory members are quite diverse although there are a number of common threads that make interaction 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 objective of the laboratory is principally to foster and encourage collaboration and scientific interaction 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.

News and highlights

We are very pleased to welcome Eliot Fried (McGill University) as a regular member of the laboratory. Eliot's tertiary education, right through to his Ph.D., was in applied mathematics at the California Institute of Technology. Before joining McGill last September he was full professor in the Department of Mechanical, Aerospace and Structural Engineering at Washington University in St. Louis. His research interests are in continuum mechanics and thermodynamics and this broad area has a number of interesting intersections with current research interests of the other members of the laboratory. As a senior and experienced academic we are sure that his leadership qualities will add greatly to the effective functioning of the laboratory. In 2009, Eliot Fried was made the Tier 1 Canada Research Chair in Interfacial and Defect Mechanics.

Jacques Bélair became president of the Canadian Applied and Industrial Mathematics Society this year, a post that he will hold until 2011. Members of the Society for Industrial and Applied Mathematics (SIAM) approved the SIAM Fellows Program in 2008 to designate as Fellows of the Society certain members who have made outstanding contributions to fields served by SIAM. The laboratory is very pleased to announce that two of its regular members, André Bandrauk and Michel Delfour, were made Fellows of SIAM in May 2009. In October 2009 Cambridge University Press will publish *The Mechanics and Thermodynamics of Continua*, by Morton E. Gurtin, Eliot Fried, and Lallit Anand. AUTO is a software for continuation and bifurcation problems in ordinary differential equations, originally developed by Eusebius Doedel, with subsequent major contributions by several other people. Version 0.6 of AUTO-07p, the successor to both AUTO97 and AUTO2000, was made available on January 13, 2009. Also, at least 43 refereed international journal articles were authored or co-authored by the 14 regular members of the laboratory (source: ISI Web of Knowledge 2008 – 2009).

Michel Delfour gave a plenary talk entitled *The dose under periodic flow conditions for coated stent* at the International Conference on Systems Theory: Modelling, Analysis and Control, which took place on May 25 – 28, 2009, at Fez in Morocco. Peter Bartello was named a Senior Visiting Fellow by the Isaac Newton Institute for Mathematical Sciences (University of Cambridge) during the Fall of 2008. He was also named a Visiting Research Fellow by the Institute for Mathematical Sciences (Imperial College London) for the Spring of 2009. Robert Owens was an "hôte académique" in the Mathematics Institute of Computational Science and Engineering at the École Polytechnique Fédérale de Lausanne during August 2008 and "professeur invité" at the Institut de Mathématiques (Université de Toulouse) from May 11 to June 8, 2009.

Peter Bartello gave an invited talk entitled *The Small-scale transition from QG to something else* at the Tenth Annual CAOS Winter Workshop 2009 (Oceanography at the Observational and Modeling Frontier: Submesoscale Dynamics), which was held at the Courant Institute, NYU on February 20–21, 2009. He also gave an invited talk entitled *Internal*

waves in nearly geostrophic stratified turbulence at the second meeting of the research group Wave-Flow Interactions: A Network in Mathematics, which took place at the International Centre for Mathematical Sciences (Edinburgh, Scotland) on May 25 – 29, 2009.

Students, postdoctoral fellows, visitors

An important aspect of the laboratory's mission is the training of graduate students and postdoctoral researchers. To this end, the annual Scientific Computing Days event (which lasts 3 days) plays a crucial role. The target audience for this meeting is young researchers and the mandate given to the speakers is to present a graduate-level mini-course on a modern topic in scientific computing of their own choice. Lecture notes are made freely available to all participants and time is set aside for the students and postdoctoral fellows to present the results of their own research in a friendly, non-threatening environment. Registration is free and financial support from the laboratory is available for all out-of-town student participants, in order for the meeting to be a service to the wider numerical mathematics community.

The laboratory is keen to help its members' research by giving partial financial support for them to hire postdoctoral fellows. Claude Mangoubi (The Hebrew University of Jerusalem) worked with Robert Owens for the first 6 months of 2009. During the summer Tony Humphries and Eusebius Doedel will be welcoming Renato Calleja to Montreal; he will be working with them for a period of two years. Travel money for the postdoctoral fellows is also available via the laboratory to support their attendance at conferences. Thanks to the careful stewardship of its financial resources over the past few years, the laboratory envisages supporting at least one more postdoctoral fellow in 2009 – 2010.

During the 2008 – 2009 academic year, 9 master's students, 20 Ph.D. students, and 6 postdoctoral fellows were supervised by members of the Applied Mathematics laboratory.

Seminars

The backbone of the laboratory's activities, the weekly seminar, was organised by Xiao-Wen Chang (McGill University) in the 2008 autumn semester and by Lennaert van Veen (Concordia University) in the 2009 winter semester. Both are thanked for their labours in the service of the Montreal applied mathematics community! A number of local speakers agreed to give a seminar: Chris Paige, Lennaert van Veen, David Titley Peloquin, Bart Oldeman, Claude Mangoubi, and Eliot Fried are thanked sincerely. Thanks to job interviews at McGill, the laboratory benefited from having an unusually large number of visiting speakers in 2008 – 2009. These included Dmitry Pelinovsky (McMaster), L. Pamela Cook (Delaware), Geoffrey Hinton (Toronto & CIFAR), Chen Grief (UBC), Francisco-Javier Sayas (Minnesota & Zaragoza), Michael Saunders (Stanford), David A. Steinman (Toronto), Rebecca Tyson (UBC Okanagan), Helmut Kröger (Laval), David Anderson (Wisconsin – Madison), Margaret Beck (Brown), Irina Mitrea (Virginia), Vera Mikyoung Hur (MIT), Laurent Demanet (Stanford), Jin Rebecca Li (INRIA Rocquencourt), Xuemin Tu (UC Berkeley), George Haller (MIT), Gantumur Tsogtgerel (UCSD), Rustum Choksi (Simon Fraser), Chi-Kun Lin (NCTU), Wayne Hayes (UC Irvine), John F. Gibson (Georgia Tech), Thorsten Reiss (Bristol), Nicola Guglielmi (Aquila), Zhilin Li (NC State), Yuan Yuan (Memorial), and Georges Griso (UPMC). A number of the speakers mentioned above stayed for a few days to pursue collaboration with laboratory members, thus bringing further benefit to the research of the members. Professor Jie Shen visited the Department of Mathematics and Statistics of the Université de Montréal during the autumn semester in 2008 and gave a seminar to the laboratory, as well as a colloquium entitled *Spectral – Galerkin Methods for High-Dimensional PDEs* (in December).

Workshops, special sessions, and others

The reader will find a detailed report on the 6th Montreal Scientific Computing Days in the section General Program.

- *The 6th Montreal Scientific Computing Days*

May 4 – 6, 2009, CRM
Organizers: Michel Delfour (Montréal), André Fortin (Laval), Thomas Wihler (Bern)

The reader will find a detailed report on the following activity in the section Multidisciplinary and Industrial Program.

- *CI/CS* 2009 *Spring Technical Meeting*

May 10 – 13, 2009, McGill University
sponsored by the Applied Mathematics Laboratory and CRM
Local organizer: Anne Bourlioux (Montréal)

Michel Delfour was a member of the International Program Committee of the *International Conference on Systems Theory: Modelling, Analysis and Control*, which was held on May 25 – 28, 2009, at Fez in Morocco. He was also co-organizer, with M. Thiriet, of a joint IACM – IUTAM mini-symposium consisting of 3 sessions and entitled *Composite Materials and Multiscale Modeling and Design in Medicine*

and Engineering. This mini-symposium was part of the Joint 8th World Congress on Computational Mechanics and 5th European Congress on Computational Methods in Applied Science and Engineering, which took place in Venice, Italy, from June 30 to July 5, 2008. Robert Owens organized the mini-symposium *Hemorheological Modelling and Simulation* within the framework of the Joint 13th International Congress on Biorheology and 6th International Conference on Clinical Hemorheology, which took place in State College (Pennsylvania) on July 9 – 13, 2008.

From August 26 to December 19, 2008, Peter Bartello was the co-organizer of a four-month program on the nature of high-Reynolds number turbulence that took place at the Newton Institute for Mathematical Sciences, at Cambridge in the United Kingdom (see the site http://www.newton.ac.uk/programmes/HRT/ws.html). This program consisted of 6 workshops, several of which attracted more than 100 participants. Peter Bartello co-organized the whole program as well as two of the workshops. He also organized the workshop "Clouds and Turbulence" at the Imperial College London, from March 23 to 25, 2009. Finally, André Bandrauk organized a session on attosecond science at the *ACS Annual Meeting*, which took place in Salt Lake City in March 2009.

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)
Modelling, 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

Eliot Fried (McGill)
Mechanics and thermodynamics of continuous media

Antony R. Humphries (McGill)
Numerical analysis, differential equations

Sherwin A. Maslowe (McGill)
Asymptotic methods, fluid mechanics

Lennaert van Veen (Concordia)
Application of dynamical systems theory to complex phenomena and high-dimensional chaos

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

Paul F. Tupper (McGill)
Numerical analysis, stochastic processes, statistical mechanics

Thomas P. Wihler (Bern)
Numerical analysis, computational methods for PDEs

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

2008 – 2009 was marked by the arrival of three new members at CICMA: Matilde Lalín, who will be teaching at Université de Montréal, as well as Jayce Getz and Heekyoung Hahn, who will both be at McGill University. Ram Murty was elected to the Indian National Science Academy (INSA) in 2009; INSA is analogous to the National Academy of Sciences (in the United States) and the Royal Society of Canada.

Students, postdoctoral fellows, visitors

In 2008 – 2009 Damien Roy supervised two postdoctoral fellows: Emmanuel Delsinne (September 2008 – June 2010) and Pierre Bel (January 2009 – May 2010). Dmitrij Zelo, who was also supervised by Damien Roy, defended his thesis successfully in January 2009.

In 2008 – 2009 there were 12 postdoctoral fellows in CICMA, among whom Bryden Cais (who obtained his Ph.D. from the University of Michigan), Gerard Freixas (from Université Paris-Sud 11), JeeHoon Park (from Boston University), Arnaud Chadozeau (from Université Bordeaux 1), and Xander Faber (from Columbia University). Also 42 Ph.D. students, 25 master's students, and 5 undergraduate students 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 2008 – 2009, Eyal Goren and Henri Damon were the organizers of the seminar and the latter consisted of 40 lectures. We also mention an activity related to the seminar, a mini-course held at the McGill Research Centre in Bellairs (Barbados). This activity (see below) gathered about fifteen students, three postdoctoral fellows, and three CICMA teachers; it was a great success and also the first instalment of a series that will be repeated every year in May.

Workshops, special sessions, and others

CICMA was involved in the organization of several activities in 2008 – 2009. The reader will find detailed reports on the first two activities below in the section General Program.

- *Québec – Maine Conference on Number Theory*
October 4 – 5, 2008, Université Laval
Organizers: Claude Levesque (Laval), Hugo Chapdelaine (Laval), Jean-Marie De Koninck (Laval)

- The Bellairs Workshop in Number Theory
Borcherds products and their applications to arithmetic geometry
May 3 – 10, 2009, Bellairs Research Institute
Organizer: Eyal Z. Goren (McGill)

- *Summer School in Analytic Number Theory and Diophantine Approximation*
June 30 – July 11, 2008, University of Ottawa
sponsored by the Fields Institute
Organizers: Nathan Ng (Ottawa), Damien Roy (Ottawa)

Regular members of the laboratory

Henri Darmon (McGill) director
Algebraic number theory, geometry, arithmetic, L-functions, Diophantine equations, elliptic curves

Hugo Chapdelaine (Laval)
Algebraic number theory, algebraic geometry

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

Jayce R. Getz (Princeton & IAS)
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

Heekyoung Hahn (Albany)
Eisenstein series, L-functions, trace formula, q-series, theta functions and partitions

Adrian Iovita (Concordia)
Number theory, p-adic cohomology

Olga Kharlampovich (McGill)
Combinatorial group theory 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

Matilde Lalín (Alberta)
Mahler measures, L-functions, zeta functions

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 methods: 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 Université du Québec à Montréal, 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 manifolds; quantization of Hitchin systems and the geometric Langlands program; classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; nonlinear partial differential equations in Riemannian geometry, convex geometry, and general relativity; and Hamiltonian dynamical systems.

News and highlights

Several CIRGET members were honoured this year: Pengfei Guan was named a Fellow of the Royal Society of Canada; Iosif Polterovich, CIRGET's youngest member and a professor at the Université de Montréal, was awarded a Canada Research Chair (Tier II) in Geometry and Spectral Theory; and a conference in honour of Peter Russell is being organized in June 2009 at McGill University. Finally, former doctoral student Alexandre Girouard was awarded the Carl Herz Prize in 2008 for his work on spectral geometry and topological methods in critical point theory.

Students, postdoctoral fellows, 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. In 2008 – 2009, CIRGET members supervised 7 postdoctoral fellows, 13 doctoral students, and 15 master's students. Two of our doctoral students are being co-supervised through the France-Québec exchange program: Eveline Legendre is enrolled at Université du Québec à Montréal and the École Polytechnique, while François Charest has started a doctorate at Université de Montréal and the École normale supérieure de Lyon.

Most of our postdoctoral fellows and students are continuing next year, but those who have completed their stays at CIRGET are moving on to good positions: postdoctoral fellow Jeremy Van Horn-Morris was offered a position at Stanford University; Thierry Daude will start a position in Nantes in January 2010; and graduating doctoral student Liam Watson has accepted an NSERC postdoctoral fellowship, a Hedrick Instructorship at the University of California, Los Angeles, and a research membership at MSRI (Berkeley) for their Spring 2010 thematic program in knot homologies. Doctoral students Dennis The and Mélisande Fortin Boisvert graduated in 2008. Both were awarded NSERC postdoctoral fellowships: D. The is currently working at Texas A&M University and M. Fortin Boisvert is on maternity leave.

CIRGET members greatly benefit from the many international visitors who come to work with them. In addition to the 14 short-term visitors who came over the 2008 – 2009 year, Georges Dloussky (Université de Provence), Michel Vaquié (Université de Toulouse), and Denis-Charles Cisinki (Université Paris 13) all spent one month at CIRGET.

Seminars

In 2008 – 2009 CIRGET invited and partially funded two colloquium speakers for the CRM – ISM Mathematics Colloquium lecture series: Bernard Shiffman (Johns Hopkins University) and Gang Tian (Princeton University).

CIRGET's everyday scientific life 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 22 talks given this year, 14 were given by invited speakers who stayed at the centre for short research visits. CIRGET graduate students from Université du Québec à Montréal, Université de Montréal, and McGill University 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 19 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 a second one by doctoral student Liam Watson on low-dimensional topology with a view towards Heegaard-Floer homology.

Workshops, special sessions, and others

CIRGET organized an international workshop in Montréal this year. The reader will find a detailed report on this workshop in the section General Program.

- *Workshop on Arithmetic and Hyperbolic Geometry*
November 8 – 9, 2008, Université du Québec à Montréal
sponsored by CIRGET and the Fields Institute
Organizers: John Bland (Toronto), Andrew Granville (Montréal), Steven Shin-Yi Lu (UQÀM), Peter Russell (McGill), Noriko Yui (Queen's)

As mentioned above, CIRGET also organized a workshop in honour of Peter Russell. This workshop took place in June 2009 and a report on it will be included in the CRM annual report for 2009-2010.

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)
Microlocal analysis, partial differential equations

GIREF

Description

GIREF is an acronym for "Groupe Interdisciplinaire de Recherche en Éléments Finis," which can be translated into English as "Interdisciplinary Research Group in Finite Element Methods." It is based at Université Laval and headed by Professor André Fortin. The objective of GIREF is to gather researchers and research groups from several universities to support research, development, the training of graduate students and postdoctoral fellows, and industrial collaborations in the field of numerical modelling and simulation. In particular the members of GIREF work in the area of finite elements, finite differences, and finite volumes methods. GIREF is associated with the NSERC Research Chair in High-Performance Scientific Computing, held by Professor André Fortin. The goal of this chair is to study numerical simulations in the field of tires (hyperelastic and viscoelastic materials, rolling of tires, tire wear, rubbing contact, mathematical formulations, adaptive meshing, etc.). Here are some other projects led by GIREF: the development of a state-of-the-art finite elements software (the MEF++ project) to be used by several GIREF members; a numerical modelling project in the wood sciences; a modelling project for flows in a natural environment; and the ACE (*aérosol, cœur et endoprothèse*) project, concerned with numerical modelling in the biomedical field.

News and highlights

The Scientific Computing Research Chair was launched in 2008 – 2009. The development of the finite elements software (MEF++) was greatly accelerated thanks to the usual contributions of the GIREF's research professionals (Éric Chamberland, Cristian Tibirna, Nicolas Tardieu, and Jean Deteix), but also thanks to Michelin's engineers at the Ladoux Laboratory near Clermont-Ferrand (France). The joint development of MEF++ enables us to provide the students with an extremely efficient software with both academic and industrial uses.

Within the framework of a strategic project grant obtained from NSERC in 2006, the collaboration with Mr. Alain Cloutier, Director of the Centre de recherche sur le bois (CRB), continued. This project focuses on the modelling of thermo-hygro-mechanical phenomena for wood-based composite materials. Note that three industrial partners (BOA-FRANC, Uniboard Canada Inc., and FPInnovations) contribute to this project. The goal of the project is to provide industry with a numerical simulation tool.

GIREF's members participate actively in the CLUMEQ network and more specifically in the CLUMEQ site at Université Laval. Under the direc-

tion of Mr. Marc Parizeau, from the Department of Electrical Engineering and Computer Engineering, the purchase of a supercomputer to be installed in the old Van de Graaff accelerator (in the Vachon Pavilion) was planned. With the help of this supercomputer, GIREF's researchers will be able to push back the frontiers of simulations via finite elements in all areas of application.

Note also that GIREF now has new premises in the Alexandre-Vachon Pavilion; the secretary's office, the laboratory, and the offices of professors and research professionals are close to one another. The reader will find additionnal information concerning the GIREF projects on the site http://www.giref.ulaval.ca/projets/.

Students, postdoctoral fellows, visitors

In 2008 – 2009 four postdoctoral fellows, 23 Ph.D. students, 19 master's students and 3 undergraduate students were carrying out research at GIREF. Also 8 students working at GIREF obtained their master's degree and 3 students obtained their Ph.D.

Seminars

In 2008 – 2009 GIREF's seminar included 10 talks, among which talks by Tahar Boulmezaoud (Université de Versailles), Dominique Pelletier, Jérôme Vetel, and André Garon (all three from the École Polytechnique de Montréal), and Michel Delfour (Université de Montréal).

Members of the laboratory

Regular members

André Fortin (Laval) director
Finite elements method, instationary viscous flows, mixing problems

André Garon (Polytechnique Montréal) deputy director
Thermohydraulics, fluid mechanics, finite elements method, hydraulic turbines, mechanics of biofluids: stents and pumps

Youssef Belhamadia (Alberta)
Mathematical modelling and numerical simulation of phase change problems, adaptive meshing for instationary problems in 2 and 3 dimensions, numerical modelling of cryosurgery, numerical modelling of the electromechanical wave in the heart

Pierre Blanchet (Forintek Canada)
Nanotechnology for wood products

Yves Bourgault (Ottawa)
Computational fluid dynamics, numerical methods, finite elements method, mathematical modelling, mechanics of continuous media

Marie-Laure Dano (Laval)
Mechanics and production of composite materials, intelligent mechanical systems

Michel C. Delfour (Montréal)
Control, optimization, design, shells, calculus, biomechanics

Guy Dumas (Laval)
Mechanical engineering, physics of fluids

Marie-Isabelle Farinas (UQÀC)
Modelling, numerical simulation, computational fluid mechanics, design of turbo engines (cardiac pump), optimization

Michel Fortin (Laval)
Numerical analysis of partial differential equations, numerical methods in fluid mechanics, optimization and optimal control for partial differential equations

Yves Fortin (Laval)
Forestry, forest engineering

Guy Gendron (Laval)
Composite materials, optimization and modelling of structures

Robert Guénette (Laval)
Numerical methods in non-Newtonian fluid mechanics, rheological models, Hamiltonian formulation

Jean-François Hétu (NRC)
Numerical modelling of processes

Hassan Manouzi (Laval)
Numerical analysis, applications of mathematics to engineering

Dominique Pelletier (Polytechnique Montréal)
Fluid mechanics and heat transfer, finite elements method, adaptive finite elements methods for compressible and incompressible flows, modelling and simulation of laminar and turbulent viscous flows, modelling and simulation of fluid-structure interactions

Roger Pierre (Laval)
Numerical analysis of partial differential equations

Jean-Loup Robert (Laval)
Numerical models of free surface flows, transport and diffusion models with stochastic components, unified modelling in a saturated and aerated environment

Yves Secretan (INRS-ETE)
Numerical methods for finite elements, mesh generation and adaptation, error estimation, hydrodynamics in 2 dimensions, advection-diffusion phenomena

René Therrien (Laval)
Underground water flows, hydrology, geothermics

José Urquiza (Laval)
Numerical analysis, control of partial differential equations

Associate members

Alain Cloutier (Laval)
Forestry, forest engineering

Claire Deschênes (Laval)
Axial hydraulic turbines

Mohamed Farhloul (Moncton)
Finite elements and finite volumes method, partial differential equations, applications of the mixed finite elements method to fluid mechanics, numerical analysis

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 and highlights

Alain Tapp was elected Director of INTRIQ; his term will start in the summer of 2010.

Students and postdoctoral researchers

INTRIQ members supervised 10 postdoctoral fellows, 52 Ph.D. students, 24 master's students, and 3 undergraduate students in 2008 – 2009.

Workshops, special sessions, and others

David Poulin organized the first biannual INTRIQ workshop, entitled *Quantum Coding Theory for Quantum Information and Quantum Cryptography* (held at Jouvence, Québec, on May 21 – 22, 2009). Guillaume Gervais, Patrick Hayden, and Michael Hilke organized the 2nd biannual INTRIQ workshop, entitled *Physical Implementation of Quantum Information* (held at Val David, Québec, on October 2 – 3, 2009).

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 de Montréal 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), David Poulin (Physics), Michel Pioro-Ladrière (Physics, new member), and André-Marie Tremblay (Physics). At McGill University the INTRIQ members are: David Avis (Computer Science), Aashish Clerk (Physics), Claude Crépeau (Com puter Science), Guillaume Gervais (Physics), Peter Grütter (Physics), Hong Guo (Physics), Patrick Hayden (Computer Science),

Michael Hilke (Physics, INTRIQ Director), Zetian Mi (Electrical Engineering), Prakash Panangaden (Computer Science), 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 Université du Québec à Montréal professors), 5 associate members and 14 collaborating members. It welcomes postdoctoral fellows and its regular members supervise or cosupervise 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

Christophe Hohlweg is now a regular member of LaCIM and a very dynamic one; since his arrival at Université du Québec à Montréal he has recruited many students pursuing graduate studies. Alexandre Blondin Massé and Sébastien Labbé, both supervised by Srečko Brlek, have been awarded NSERC scholarships to carry out their doctoral studies. Each of them also holds a Frontenac scholarship, awarded to outstanding students who are cosupervised by a Québec professor and a French professor.

The Thematic Semester on Recent Advances in Combinatorics (January – June 2007) resulted, among other things, in a book based on the courses given by Jean Berstel and Christophe Reutenauer on word combinatorics. Aaron Lauve and Franco Saliola, both postdoctoral fellows, took the notes. The four authors (J. Berstel, A. Lauve, C. Reutenauer, and F. Saliola) have just published a beautiful text entitled "Combinatorics on Words: Christoffel Words and Repetitions in Words" in the *CRM Monograph Series*.

Students, postdoctoral fellows, visitors

In 2008 – 2009 LaCIM members supervised 8 postdoctoral fellows (including Éric Fusy, Amy Glen, and Li Huilan), 40 Ph.D. students, 34 master's students, and 7 undergraduate students.

Three students who obtained their Ph.D. in 2008 – 2009 have been awarded postdoctoral fellowships: Annie Lacasse (NSERC fellowship), Geneviève Paquin (FQRNT fellowship), and Xavier Provençal (FQRNT fellowship). All three are now pursuing their postdoctoral studies in Montpellier or Chambéry, thus strengthening the cooperation between LaCIM and CNRS laboratories.

In 2008 – 2009 LaCIM hosted several visitors and outstanding researchers in combinatorics: Adriano Garsia (University of California, San Diego) in June 2008, Jean-Louis Loday (Université de Strasbourg; CNRS) in October and November 2008, and Olivier Schiffman (École normale supérieure) in April 2009. Yeong-Nan Yeh, a very dynamic former postdoctoral fellow of LaCIM now working at Academia Sinica, spent two months at LaCIM.

Seminars

The Combinatorics Seminar, held weekly on Friday morning, is attended by the laboratory members, students, and postdoctoral fellows, and sometimes other CRM members. Most lectures are given by visitors. Let us mention Christian Lenard (Albany), Yann Bugeaud (Strasbourg), Bruno Courcelle (LaBRI), Kevin Purbhoo (Waterloo), Bruno Leclerc (ÉHÉSS), Adolfo Rodriguez (LaCIM), Jean-Louis Loday (Strasbourg,; CNRS), Philippe Choquette (York), Mike Zabrocki (York), Angèle Hamel (Wilfrid Laurier), Franco Saliola (Marne-la-Vallée), Aïda Ouangraoua (Simon Fraser), Mark Skandera (Lehigh), Andrew Douglas (City Tech, CUNY), Delaram Kahrobaei (City Tech, CUNY), Linda Chen (Swarthmore), Geneviève Paquin (Savoie), Lauren K. Williams (Harvard), Greg Musiker (MIT), and Luca Ferrari (Firenze). Overall the Seminar featured 30 lectures in 2008 – 2009.

Workshops, special sessions, and others

During the Second Canada – France Meeting, which took place at Université du Québec à Montréal in 2008 (see the section CRM Partnerships), Christophe Hohlweg and Franco Saliola organized a special session on algebraic combinatorics. The session took place on June 2 – 5 and was attended by around 50 participants.

A significant part of the summer was devoted to Sage sessions. Under the leadership of Franco Saliola, who benefited from the technical expertise of Arnaud Bergeron and the help extended by Ph.D. students Alexandre Blondin Massé and Sébastien Labbé, a program library for word combinatorics was developed within the Sage environment. This library was accepted and included in Version 3.2.2 of Sage. Subsequent improvements were also made to this library and are now part of Version 4.1.1.

Gilbert Labelle gave a special lecture entitled "Mes aventures mathématiques avec Pierre Leroux" during the 20th edition of the FPSAC annual conference (June 23 – 27, 2008, Valparaiso, Chile). During the 61th Lotharingian Combinatorics Conference, held on September 21 – 24, 2008, at Curia (Portugal), a special session to honour Pierre Leroux's memory was organized and chaired by Srečko Brlek. Pierre Leroux, who died unexpectedly a few months before this conference, was the founder of LaCIM. The Winter 2008 Meeting of the CMS included a session on algebraic combinatorics organized by François Bergeron, Srečko Brlek, Christophe Hohlweg, and Christophe Reutenauer.

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

Anne Bergeron (UQÀM)
Bioinformatics

Srečko Brlek (UQÀM)
Combinatorics of words, algorithmics

Cedric Chauve (Simon Fraser & 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 Hohlweg (UQÀM)
Algebra, algebraic combinatorics, and convex geometry

Gilbert Labelle (UQÀM)
Enumerative combinatorics, analysis

Vladimir Makarenkov (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
John Mullins has not been a regular member since March 16, 2009.

Christophe Reutenauer (UQÀM)
Algebraic combinatorics, noncommutative algebra, automata theory, coding theory, free algebras

Denis Thérien (McGill)
Complexity theory, logic, combinatorics, probability theory
Denis Thérien has not been a regular member since March 16, 2009.

Timothy R.S. Walsh (UQÀM)
Algorithmics, enumerative combinatorics, graph theory

Associate members

Pierre Lalonde (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 labelled structures and asymmetric structures

Luc Lapointe (Talca)
Algebraic combinatorics, symmetric functions, integrable systems, supersymmetries

Odile Marcotte (UQÀM & 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 (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 (Paris-Sud 11; CNRS)
Enumerative and bijective combinatorics, partitions of integers, and q-series

Adriano Garsia (UCSD)
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 (TÉLUQ)
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 2008 – 2009 the laboratory had 30 regular and 8 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

Iosif Polterovich was awarded a Canada Research Chair in Spectral Geometry. Javad Mashreghi was promoted to the rank of Full Professor. Jérémie Rostand was promoted to the rank of Associate Professor. Christiane Rousseau was Interim Director of CRM from September 2008 to June 2009. Iosif Polterovich and Dmitry Jakobson were awarded the G. de B. Robinson Prize by the Canadian Mathematical Society. Javad Mashreghi, Thomas Ransford, and Kristian Seip organized a conference on Hilbert Spaces of Analytic Functions at CRM, on December 8 – 12, 2008.

Students, postdoctoral fellows, visitors

In 2008 – 2009 laboratory members supervised 11 postdoctoral fellows (the names of supervisors are within parentheses): Sara Derivière (T. Kaczynski); Igor Wigman (I. Polterovich, A. Granville, D. Jakobson, A. Shnirelman, and J. Toth); Zhenbin Yan (J. Toth and D. Jakobson); Xiangjin Xu (J. Toth and D. Jakobson); Denis G. Gaydashev (C. Rousseau and A. Shnirelman); Elena Naidenova (D. Schlomiuk); Dan Mangoubi (D. Jakobson and I. Polterovich); Nadine Badr (G. Dafni and A. Stancu); Nicolas Chevrot (T.J. Ransford); Yemon Choi (F. Gourdeau and T.J. Ransford); Mostafa Nasri (J. Mashreghi).

Altogether, 31 Ph.D. students, 24 master's students, and 8 undergraduate students were supervised or co-supervised by regular or associate members of the laboratory.

Seminars

The members of the Mathematical Analysis laboratory organize several seminars at four main locations. Université Laval hosts an Analysis Seminar, which featured 23 talks in 2008 – 2009, and an Analysis Workshop, which featured 17 talks. Alex Shnirelman (Concordia University) and Dmitry Jakobson (McGill University) organize jointly the McGill/Concordia Analysis Seminar, which featured 31 talks in 2008 – 2009. A Seminar on Dynamical Systems, featuring 2 talks, was also held at Concordia. At the Université de Sherbrooke, Madjid Allili, Virginie Charette, François Dubeau, and Tomasz Kaczynski organize a Seminar in Computational Geometry and Topology that featured 17 talks in 2008 – 2009. The activities of the Groupe de recherche en topologie computationnelle (GRTC) at the Université de Sherbrooke came to an end in March 2009. Tomasz Kaczynski is currently on sabbatical at the Jagiellonian University. The creation of a new laboratory with the same mission as the GRTC, under the leadership of Madjid Allili, is expected soon at Bishop's University. At the Université de Montréal, Paul Gauthier (Université de Montréal) and Richard Fournier (Dawson College) organize an Analysis Seminar that featured 8 talks in 2008 – 2009.

Professor David Ruelle (Institut des Hautes Études Scientifiques) gave a mini-course consisting of 8 lectures at McGill University in September and October 2008. Vojkan Jakšic organized a working seminar on Gaussian random fields (comprising 25 hours) in the Spring of 2009. Sergei Yakovenko, from the Weizmann Institute of Science, gave a colloquium on March 13, 2009, and two informal presentations during his stay in Montréal.

Workshops, special sessions, and others

Vojkan Jakšic organized and taught a 40-hour workshop on "Mathematical aspects of quantum statistical mechanics" at the Université de Cergy-Pontoise in France; in particular the workshop was attended by 6 students from Montréal. The following workshop was organized by members of the Mathematical Analysis laboratory. A detailed report on it is included in the section General Program.

- *Hilbert Spaces of Analytic Functions*

December 8 – 12, 2008, CRM
Organizers: Javad Mashreghi (Laval), Kristian Seip (NTNU), Thomas J. Ransford (Laval)

The following workshops, which were part of the Thematic Year on Probabilistic Methods in Mathematical Physics, were supported in part by the Mathematical Analysis Laboratory and attended by members of the laboratory. Detailed reports on these workshops can be found in the section Thematic Program.

- *Mathematical Aspects of Quantum Chaos*

June 2 – 7, 2008, CRM
Organizers: Nalini Anantharaman (École Polytechnique), Stéphane Nonnenmacher (CEA/Saclay), Zeev Rudnick (Tel Aviv), Steve Zelditch (Johns Hopkins)

- Random Functions, Random Surfaces and Interfaces

January 4 – 9, 2009, Sainte-Adèle (Québec)
Organizers: Dick Bond (Toronto), Michael R. Douglas (Stony Brook), Scott Sheffield (Courant Inst.), Senya Shlosman (CPT; CNRS), Steve Zelditch (Johns Hopkins)

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, 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)
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

Paweł Góra (Concordia)
Ergodic theory, dynamical systems, fractal geometry

Frédéric Gourdeau (Laval)
Banach algebras, cohomology, amenability, functional analysis

Vojkan Jakšic (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 (UC London)
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 differential equations

Thomas J. Ransford (Laval)
Complex and harmonic analysis, functional analysis and theory of operators, spectral analysis, 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, singularities, bifurcations, algebraic curves, primary integral

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

John A. Toth (McGill)
Spectral theory, semi-classical analysis, microlocal analysis, Hamiltonian mechanics

Associate Members

Octavian Cornea (Montréal)
Algebraic topology, dynamical systems

Kohur Gowrisankaran (McGill)
Potential theory

Pengfei Guan (McGill)
Partial differential equations, geometric analysis, several complex variables

John Harnad (Concordia)
Mathematical physics, classical and quantum physics, geometrical methods, integrable systems, group theoretical methods, random matrices, isomonodromic deformations, isospectral flows

Niky Kamran (McGill)
Geometric approach to partial differential equations

Dmitry Korotkin (Concordia)
Integrable systems, isomonodromic deformations, classical and quantum gravity, Frobenius varieties

Nilima Nigam (McGill & Simon Fraser)
Applied analysis, numerical methods in electromagnetism

Samuel Zaidman (Montréal)
Functional analysis and differential equations in abstract spaces, pseudo-differential operators

Mathematical Physics

Description

The mathematical physics group is one of the oldest and most active at the CRM. It consists of 14 regular members, all full-time faculty at five Quebec Universities, and 18 associate members. Around 20 doctoral students and around 20 master's students were working under the supervision of regular members of the Mathematical Physics laboratory in the 2008 – 2009 academic year. The laboratory also includes research associates and postdoctoral fellows. The group hosts many visiting researchers and car-

ries 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 phenomena; 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

In 2008 – 2009 the life of the laboratory revolved around the CRM thematic program, since the theme of the year was "Probabilistic Methods in Mathematical Physics." Members of the Mathematical Physics laboratory also took an active part in the organization of the CRM – PIMS joint thematic program on "Challenges and Perspectives in Probability." We refer the reader to the section Thematic Program for detailed reports on these activities. Vasilisa Shramchenko, professor at the Université de Sherbrooke, became an associate member of the laboratory in 2009.

Students, postdoctoral fellows, visitors

The members of the Mathematical Physics laboratory supervised 14 master's students, 20 Ph.D. students, and 13 postdoctoral fellows in 2008 – 2009. Many researchers visited the CRM and the laboratory during the thematic year; they collaborated with the laboratory members and their students and postdoctoral fellows.

The reader will find below a list of the researchers who visited the laboratory in 2008 – 2009.

- Louis-Pierre Arguin (Courant Inst.): June 7 – 14, 2009.
- Pavel Bleher (IUPUI): August 2 – October 4, 2008.
- Alexei Borodin (Caltech; Clay Institute Emissary): June 9 – 28 and August 25 – September 6, 2008.
- Robert Coquereaux (CPT): November 29 – December 13, 2008.
- Benjamin Doyon (Durham): August 3 – 22, 2008, and August 26 – September 11, 2009.
- Ilya Gruzberg (Chicago): August 3 – September 7, 2008.
- Greg Lawler (Chicago; Clay Institute Emissary): August 1 – 31, 2008.
- Decio Levi (Roma Tre): June 9 – 28, 2008.
- Karl Liechty (IUPUI; Student Long-term Visitor): August 2 – September 25, 2008.
- Igor Loutsenko (SISSA, Trieste): August 19 – 29, 2008.
- Jean-Michel Maillet (Lyon 1): June 23 – July 5, 2008.
- Nicholas Makarov (Caltech): August 3 – 30, 2008.
- Barry McCoy (Stony Brook): June 29 – July 12, 2008.
- Kenneth McLaughlin (Arizona): August 17 – September 6, and September 13 – 28, 2008.
- Jason Newport (UNC-Chapel Hill; Student Long-term Visitor): August 25 – September 28, 2008.
- Stéphane Nonnenmacher (CCEA/Saclay): April 1 – June 10, 2008.
- Andrei Okounkov (Princeton; Aisenstadt Chair): September 1 – 16, 2008.
- Alexandre Orlov (Shirshov Inst.): August 22 – September 20, 2008 and May 17 – June 15, 2009.
- Herbert Spohn (TU München): August 19 – September 9, 2008.
- Răzvan Teodorescu (Los Alamos): August 18 – September 6, 2008.
- Alexander Tovbis (Central Florida): May 21 – 28, 2009.
- Craig Tracy (UC Davis; Aisenstadt Chair): August 26 – 31, 2008, and March 3 – 6, 2009.
- Wendelin Werner (Paris-Sud 11; Aisenstadt Chair): July 31 – August 12, 2008.
- Anton Zabrodin (ITEP): August 17 – 30, 2008.
- Valentin Zagrebnov (CPT): September 21 – October 10, 2008.

Seminars

In 2008 – 2009 the Mathematical Physics Seminar featured 32 talks. Also 8 talks were given within a Working Seminar on Integrable Systems, Random Matrices, and Random Processes.

Workshops, special sessions, and others

Members of the Mathematical Physics laboratory helped organize a summer school and an international conference on symmetries and integrability of difference equations.

- Summer School

SMS 2008
Symmetries and Integrability of Difference Equations
June 9 – 20, 2008, Université de Montréal (Department of Mathematics and Statistics)
sponsored by CRM, ISM, Université de Montréal, and the NSF
Scientific Directors: Pavel Winternitz (Montréal), Vladimir Dorodnitsyn (Keldysh Inst.)
Organizing Committee: Vladimir Dorodnitsyn,

Véronique Hussin (Montréal), François Lalonde (Montréal), Decio Levi (Roma Tre), Peter J. Olver (Minnesota), Pavel Winternitz

• International Conference
Symmetries and Integrability of Difference Equations (SIDE8)
June 22 – 28, 2008, Hôtel Mont-Gabriel, Sainte-Adèle (Québec)
sponsored by CRM, the NSF, and the Mathematical Physics Laboratory
Organizers: Pavel Winternitz (Montréal, Chair), John Harnad (Concordia), Véronique Hussin (Montréal), Decio Levi (Roma Tre), Peter J. Olver (Minnesota), Luc Vinet (Montréal)

For other conferences and workshops organized by laboratory members we refer the reader to the site http://www.crm.umontreal.ca/~physmath/LabPhysMathEn/events_members.html.

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

Jiří 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 (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 Diderot)
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 Jakšic (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, hamiltonian systems

Decio Levi (Roma Tre)
Symmetries of differential and difference equations, integrable nonlinear equations on the lattice 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

Vasilisa Shramchenko (Sherbrooke)
Frobenius manifolds, integrable systems, Riemann – Hilbert problems, isomonodromic deformations of systems of linear differential equations, function theory on Riemann surfaces

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

The PhysNum laboratory was created by physicists (hence its acronym, which means "Physique numérique"). At the present time its members conduct research in medical imaging and pharmacokinetics. The researchers whose field is medical imaging take part in the activities of the Laboratoire International de Neuroimagerie et Modélisation (LINeM), which was created (in 2008) by three institutions: the Institut National de la Santé et de la Recherche Médicale (INSERM, France), the Université Pierre et Marie Curie (Paris), and the Université de Montréal. In particular, PhysNum researchers have ongoing collaborations with researchers from the Centre de recherche de l'Institut universitaire de gériatrie de Montréal (CRIUGM) and from Unité UMR-S 678 (INSERM). The goal of LINeM is to develop the best mathematical models and tools in diverse areas of neuroimaging. Here are the topics studied by LINeM researchers:

- Physiological and biochemical sources of functional brain imaging signals;
- Cerebral activation networks;
- Haemodynamic responses in optical imaging;
- Inverse problems and wavelets;
- Functional neuroanatomy of the spinal cord;
- Intrinsic optical imaging of the spinal cord and the brain and data analysis;
- Quantitative imaging of ageing; and
- Seizure prediction for epileptic patients with implants.

Fahima Nekka and her team conduct research in pharmacometrics, a discipline whose goal is to interpret and describe pharmacological phenomena in a quantitative manner. Pharmacometrics consists of the study of measurement, regression analysis (data fitting), and system reproduction (modelling and simulation), for the estimation, evaluation, understanding, and prediction of pharmaceutical processes in terms of their general trends and variability.

Within this area, Fahima Nekka's group is working on the efficient integration of different drug-related aspects and mechanisms. The group's modelling approach, whether driven by hypotheses or data, aims to increase our understanding and to explain the complex relationship between drugs and living systems. The team is working on the following topics:

- Compliance metrics and ranking;
- Metrics to evaluate the clinical impact of variable drug intake behaviour;
- Pharmacometrics and mechanistic modelling in animal drug use;
- Objective evaluation of a treatment efficacy through the extension of classical breakpoint estimation methods to the case of variable pharmacokinetic profiles;
- Development of physiology-based pharmacokinetic (PBPK) models to predict drug-drug interactions; and
- Development and use of global sensitivity approaches for PBPK models.

Students

In all 13 master's students, 9 Ph.D. students, and 2 postdoctoral fellows were supervised or cosupervised by regular or associate members of PhysNum in 2008 – 2009.

Workshops, special sessions, and others

The workshop below was organized by PhysNum and sponsored by the MITACS network. A detailed report on it is included in the section Multidisciplinary and Industrial Program.

• *Workshop on Signal Processing Methods in Brain Imaging*
June 4, 2008, Institut universitaire de gériatrie de Montréal
sponsored by MITACS and PhysNum
Organizers: Mathieu Dehaes (INSERM), Louis Gagnon (Harvard-MIT HST), Frédéric Lesage (Polytechnique Montréal), Jean-Marc Lina (ÉTS)

Members of the laboratory

Regular members

Jean-Marc Lina (ÉTS) director
Wavelets, statistical modelling and brain imaging, machine learning

Alain Arnéodo (ÉNS Lyon; CNRS)
Fractals and wavelets

Habib Benali (UPMC)
Quantitative analysis in brain imaging, medical imaging and multimodal systems

Line Garnero (UPMC)
Magnetoencephalography
Line Garnero died in July 2009.

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
Keith J. Worsley died in February 2009.

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 (NICDS), 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

This year was marked by the loss of our colleague, Keith Worsley (from McGill University), who died of cancer at the age of 57. Keith was one of the most famous members of the laboratory. He was renowned internationally for his work on the statistical theory of random Gaussian fields and their applications to human brain mapping. Author of more than 150 scientific papers, Keith received numerous distinctions throughout his career. For instance, he was elected Fellow of the Royal Society of Canada in 2003 and Honorary Fellow of the Royal Society of New Zealand in 2008; he was awarded the Gold Medal of the Statistical Society of Canada in 2004. His charm and fine mind will be sorely missed by all members of the laboratory.

This year the laboratory was pleased to welcome two new associate members: Geneviève Lefebvre (Université du Québec à Montréal) and Juli Atherton (McGill University). They were recently hired by their respective universities and will become active members of the laboratory. Let us men-

tion also that five of our members (Mylène Bédard, David Haziza, Aurélie Labbe, Fabrice Larribe, and Lea Popovic) have obtained New Researchers Start-up Grants from FQRNT.

As always, members of the laboratory are influential in the statistical community. They gave invited and plenary talks at many international meetings. For instance, Yoshua Bengio gave the inaugural address at the *Uncertainty in Artifical Intelligence* Conference (Montréal, June 2009); he was also invited at the *DARPA Deep Learning Workshop* held in Virginia in September 2008. Mylène Bédard was invited at the *Optimisation of MCMC Methods* workshop in Warwick (United Kingdom). Martin Bilodeau and Louis-Paul Rivest gave invited talks at workshops held at the Banff International Research Station; the topics of these workshops were respectively *Understanding the New Statistics: Expanding Core Statistical Theory* and *Data Analysis using Computational Topology and Geometric Statistics*.

Christian Genest was invited to the 38th ASTIN Conference (Manchester, United Kingdom, July 2008) and the *Symposium on the Measurement of Low Probability Events* (Philadelphia, April 2008). David Haziza was invited to the *Journées de méthodologie* organized by INSEE (Paris, March 2009) and gave a workshop on the treatment of non-response in Vancouver. Geneviève Lefebvre gave an invited talk to the Population Monte Carlo Working Group within the framework of the *SAMSI Program on Sequential Monte Carlo Methods* (North Carolina). Lea Popovic gave invited lectures at a workshop on random trees (Oberwolfach, Germany, January 2009) and a workshop on probabilistic models in evolution biology (Marseille-Luminy, May 2009).

Laboratory members are very active within the Canadian statistical community. In 2009 Christian Léger was awarded the Distinguished Service Award by the Statistical Society of Canada, on account of his outstanding contribution to the SSC during the last 25 years. Christian Genest is completing his mandate as Past-President of the SSC. Louis-Paul Rivest was appointed director of the Université Laval branch of the Centre interuniversitaire québécois de statistiques sociales (CIQSS); CIQSS is a Research Data Centre belonging to a network created by Statistics Canada. David Stephens and other colleagues from McGill organized a workshop on "Causal Inference in Statistics and the Quantitative Sciences" at the Banff International Research Station (May 3 – 8, 2009). Finally, Louis-Paul Rivest and Thierry Duchesne obtained grants from NICDS in order to organize workshops on the analysis of directional and spatial data at CRM in 2009 – 2010.

Students, postdoctoral fellows, 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. Regular or associate laboratory members supervised or cosupervised 103 master's students, 57 Ph.D. students, and 13 postdoctoral fellows in 2008 – 2009.

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 2008 – 2009 the Statistics Seminar at Université Laval featured 15 lectures and the Statistics Seminar at the Université de Sherbrooke featured about 10 lectures. The list of lectures of the CRM – ISM – GERAD Statistics Colloquium may be found at the end of the section General Program.

Workshops, special sessions, and others

The Statistics laboratory organized two scientific meetings in 2008 – 2009. Detailed reports on these meetings are included in the section General Program. The first of the two meetings took place at the Université de Sherbrooke.

- *MCMC*: *Theory and Applications*

October 17, 2008, Université de Sherbrooke
Organizers: David A. Stephens (McGill), Éric Marchand (Sherbrooke), Louis-Paul Rivest (Laval)

The Statistics laboratory and the Committee on New Investigators of the Statistical Society of Canada organized a (Québec/Ontario) regional meeting on April 4, 2009. The goal of this meeting was to gather assistant professors, postdoctoral fellows, and graduate students for exchanges on the challenges and issues facing young or future researchers in statistics.

- *New Investigators Meeting*

April 4, 2009, CRM
Organizer: Geneviève Lefebvre (UQÀM)
Speakers: Juli Atherton (McGill), Lilia Leticia Ramirez Ramirez (Waterloo), Lajmi Lakhal Chaieb (Laval), Taoufik Bouezmarni (Montréal), Azadeh Moghtaderi (Queen's)

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, change-point 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 Montréal)
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 Montréal)
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)
Change-point 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
Keith J. Worsley died in February 2009.

Associate members

Juli Atherton (McGill)
Biostatistics, optimal Bayesian design, change-point problems, survival analysis, applications to genetics

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

Geneviève Lefebvre (UQÀM)
Bayesian and computational statistics, biostatistics

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 CRM subseries of the *Springer Lecture Notes in Statistics*. An asterisk preceding a publication indicates that its author is an Aisenstadt chairholder.

Recent Titles

The following list of recent titles contains books that appeared in 2008 – 2009 or that will be published soon.

American Mathematical Society
CRM Monograph Series

Marcelo Aguiar & Swapneel Mahajan, *Monoidal Categories, Species and Hopf Algebras* (to appear)

Saugata Ghosh, *Skew-Orthogonal Polynomials and Random Matrix Theory* (to appear).

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

Jean Berstel, Aaron Lauve, Christophe Reutenauer & Franco V. Saliola, *Combinatorics on Words: Christoffel Words and Repetitions in Words*, vol. 27, 2008.

American Mathematical Society
CRM Proceedings & Lecture Notes

P. Robert Kotiuga (ed.), *A Celebration of the Mathematical Legacy of Raoul Bott* (to appear).

David Avis, David Bremner & Antoine Deza (eds.), *Polyhedral Computation*, vol. 48, 2009.

John Harnad & Pavel Winternitz (eds.), *Groups and Symmetries: From Neolithic Scots to John McKay*, vol. 47, 2009.

Springer
CRM Series in Mathematical Physics

John Harnad (ed.), *Random Matrices, Random Processes and Integrable Systems* (to appear).

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 (avec un appendice par 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. Kolyshkin & 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

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.

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 Science 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 Pogosyan & 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.

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CRM Series in Mathematical Physics

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

David Sénéchal, André-Marie Tremblay & Claude Bourbonnais (eds.), *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
Lecture Notes in Statistics (subseries CRM)

Marc Moore (ed.), *Spatial Statistics*: *Methodological Aspects and Applications*, 2001.

S. Ejaz Ahmed & Nancy Reid (eds.), *Empirical Bayes and Likelihood Inference*, 2001.

Les Publications CRM

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.

Armel 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*, 1997.

Faqir Khanna & Luc Vinet (eds.), *Field Theory, Integrable Systems and Symmetries*, 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. Knapp, *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*, 1988.

Lucien Le Cam, *Notes on Asymptotic Methods in Statistical Decision Theory*, 1974.

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*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 Gauthier-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.

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[CRM-3259] M. C. Delfour, *Representations of hypersurfaces and minimal smoothness of the midsurface in the theory of shells*, Control and Cybernetics 37:4 (2008), 879 – 911.

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[CRM-3261] F. Balogh, J. Harnad, *Superharmonic perturbations of a Gaussian potential, equilibrium measures and orthogonal polynomials*, Complex Analysis and Operator Theory, 3:2 (May 2009), 333 – 360.

[CRM-3262] P. Tempesta, *L-series and Hurwitz zeta functions associated with the universal formal group*, Annali della Scuola Normale Superiore di Pisa. Classe di Scienze. Serie V, accepted.

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[CRM-3271] J. Merleau, J.-F. Angers, L. Perreault, A.-C. Favre, *Modelling the average behaviour of a sample of curves with Bayesian regression splines*, December 2008.

[CRM-3272] J. Harnad, A. Y. Orlov, *Convolution symmetries of integrable hierarchies, matrix models and τ-functions*, December 2008.

[CRM-3273] T. Nguyen-Ba, H. Yagoub, R. Vaillancourt, *One-step 9-stage Hermite – Birkhoff – Taylor DAE solver of order 11*, in Scientific Proceedings of Riga Technical University. Series 5. Computer Science, volume 50, Riga; Riga Technical University, 2008.

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[CRM-3279] E. Kengne, R. Vaillancourt, *2D Ginzburg – Landau system of complex modulation for coupled nonlinear transmission lines*, Journal of Infrared, Millimeter and Terahertz Waves, 30:7 (July 2009), 679 – 699.

[CRM-3280] M. Bertola, A. Prats-Ferrer, *Topological expansion for the Cauchy two-matrix model*, March 2009.

[CRM-3281] R. Ashino, T. Nguyen-Ba, R. Vaillancourt, *Decoding low-dimensional linear codes by linear programming*, Canadian Applied Mathematics Quaterly, 16:3 (2008), 241 – 254.

Scientific Personnel

CRM Members in 2008 – 2009

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: Université de Montréal, Concordia University, McGill University, Université du Québec à Montréal, Université Laval, Université de Sherbrooke, and University of Ottawa. Other members are researchers affiliated with the CRM in 2008 – 2009 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

Syed Twareque Ali, Concordia
Jean-François Angers, Montréal
Vestislav Apostolov, UQÀM
Paul Arminjon, Montréal
André D. Bandrauk, Sherbrooke
Line Baribeau, Laval
Peter Bartello, McGill
Robert Bédard, UQÀM
Jacques Bélair, Montréal
Habib Benali, UPMC
Yoshua Bengio, Montréal
François Bergeron, UQÀM
Marco Bertola, Concordia
Yves Bourgault, Ottawa
Anne Bourlioux, Montréal
Steven Boyer, UQÀM
Gilles Brassard, Montréal
Srečko Brlek, UQÀM
Abraham Broer, Montréal
Robert C. Brunet, Montréal
David Bryant, McGill
Cédric Chauve, Simon Fraser
Vašek Chvátal, Concordia
Francis H. Clarke, Lyon 1
Olivier Collin, UQÀM
Octavian Cornea, Montréal
Miklós Csűrös, Montréal
Chris Cummins, Concordia
Galia Dafni, Concordia
Henri Darmon, McGill
Chantal David, Concordia
Jean-Marie De Koninck, Laval
Michel C. Delfour, Montréal
Eusebius J. Doedel, Concordia
Rachida Dssouli, Concordia
Pierre Duchesne, Montréal
Thierry Duchesne, Laval
Nadia El-Mabrouk, Montréal
André Fortin, Laval
Richard Fournier, Dawson
Marlène Frigon, Montréal
André Garon, Polytechnique Montréal
Paul M. Gauthier, Montréal
Christian Genest, Laval
Eyal Z. Goren, McGill
Bernard Goulard, Montréal
Andrew Granville, Montréal
Alfred Michel Grundland, UQTR
Pengfei Guan, McGill
Gena Hahn, Montréal
Richard L. Hall, Concordia
Sylvie Hamel, Montréal
John Harnad, Concordia
Tony R. Humphries, McGill
Jacques Hurtubise, McGill
Véronique Hussin, Montréal
Adrian Iovita, Concordia
Dmitry Jakobson, McGill
Vojkan Jaksic, McGill
André Joyal, UQÀM
Tomasz Kaczynski, Sherbrooke
Niky Kamran, McGill
Olga Kharlampovich, McGill
Hershy Kisilevsky, Concordia
Paul Koosis, McGill
Dmitry Korotkin, Concordia
Gilbert Labelle, UQÀM
John Labute, McGill
François Lalonde, Montréal
Benoît Larose, Champlain St-Lambert & Concordia
Christian Léger, Montréal
Frédéric Lesage, Polytechnique Montréal

Sabin Lessard, Montréal
Jean LeTourneux, Montréal
Claude Levesque, Laval
Jean-Marc Lina, ÉTS
Steven Lu, UQÀM
Brenda MacGibbon, UQÀM
Michael C. Mackey, McGill
Vladimir Makarenkov, UQÀM
Michael Makkai, McGill
Javad Mashreghi, Laval
Sherwin A. Maslowe, McGill
Pierre Mathieu, Laval
John McKay, Concordia
Alexei G. Miasnikov, McGill
M. Ram Murty, Queen's
Fahima Nekka, Montréal
Nilima Nigam, McGill
Robert G. Owens, Montréal
Manu Paranjape, Montréal
Jíři Patera, Montréal
François Perron, Montréal
Iosif Polterovich, Montréal
Lea Popovic, Concordia
James O. Ramsay, McGill
Thomas J. Ransford, Laval
Bruno Rémillard, HEC Montréal
Christophe Reutenauer, UQÀM
Louis-Paul Rivest, Laval
Ivo G. Rosenberg, Montréal
Christiane Rousseau, Montréal
Damien Roy, Ottawa
Roch Roy, Montréal
Peter Russell, McGill
Yvan Saint-Aubin, Montréal
David Sankoff, Ottawa
Dana Schlomiuk, Montréal
Alexander Shnirelman, Concordia
Alina Stancu, Concordia
Ron J. Stern, Concordia
Francisco Thaine, Concordia
John A. Toth, McGill
Paul F. Tupper, Simon Fraser
Lennaert van Veen, Concordia
Luc Vinet, Montréal
Timothy R.S. Walsh, UQÀM
Thomas P. Wihler, Bern
Pavel Winternitz, Montréal
Daniel T. Wise, McGill
Keith J. Worsley, McGill
Xiaowen Zhou, Concordia

Associate Members

Nantel Bergeron, York
Robert Conte, CEA/Saclay
Stéphane Durand, Édouard-Montpetit
Martin J. Gander, Genève
Line Garnero, UPMC
Decio Levi, Roma Tre
Jun Li, Pharsight
Emmanuel Lorin de la Grandmaison, Carleton
Yiannis N. Petridis, UC London
Elisa Shahbazian, Lockheed Martin Canada
Marc Thiriet, INRIA Rocquencourt
Pierre Valin, RDDC Valcartier
Carolyne M. Van Vliet, Miami
Jean-Paul Zolésio, INRIA Sophia Antipolis

Invited Members

Mylène Bédard, Montréal
Louis G. Doray, Montréal
Charles Dugas, Montréal
David Haziza, Montréal
Jorge Jiménez Urroz, UPC
Manuel Morales, Montréal
Alejandro Murua, Montréal
Anatol Odzijewicz, Białystok
Martin Pinsonnault, Western Ontario
Philip Scott, Ottawa
Jie Shen, Purdue
Zora Thomova, SUNYIT
Alexei Zhedanov, Donetsk IPE

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 cofunded 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.

Nadine Badr, Paris-Sud 11
Robert Buckingham, Duke
Bryden Cais, Michigan
Felix Carbonell, La Habana
Arnaud Chadozeau, Bordeaux 1
Emmanuel Delsinne, Caen
Sara Derivière, Rouen
Norman Nam Van Do, Melbourne
Xander Faber, Columbia
Gerard Freixas i Montplet, Paris-Sud 11
Stefan Friedl, Brandeis
Denis G. Gaydashev, UT Austin
Amy Glen, Adelaide
Başak Gürel, UC Santa Cruz
Alexander J. Hariton, Montréal
Jíři Hrivnak, TU Prague
Mohammad Jafari Jozani, Shahid Beheshti
Nathan Conrad Jones, UCLA
Seung-Yeop Lee, Chicago
Jun-Fang Li, Oklahoma
Paweł Lorek, Wrocław
Jason Bryan Lucier, Waterloo
Claude Mangoubi Pigier, HUJI
Dan Mangoubi, Technion
Elena Naidenova, US Moldova
Ismaila Ndiaye, EPFL
Jeehoon Park, Boston
Aleix Prats-Ferrer, Barcelona
Abderrazak Ramadane, Laval
Marie-Odette St-Hilaire, Montréal
Matthieu Voorons, Sherbrooke
Dong Wang, Brandeis
Igor Wigman, Tel Aviv
Xiangjin Xu, Johns Hopkins
Zhenbin Yan, McMaster
Benjamin Young, UBC
Ismet Yurdusen, ODTÜ

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. Most of these activities take place at the CRM itself or on the campus of the Université de Montréal. In the year 2008 – 2009, 626 such participants registered in the thematic program workshops, 775 in activities of the general program (to which one must add 312 registered participants for the 2nd Canadian Discrete and Algorithmic Mathematics Conference), and 264 in activities of the industrial and multidisciplinary program.

Long-term Visitors

The following list includes only the visitors who were in residence for at least four weeks.

Yuri Bilu, Bordeaux 1
Paul Biran, Tel Aviv
Pavel M. Bleher, IUPUI
Alexei Borodin, Caltech
Walter Craig, McMaster
Noureddine Daili, Ferhat Abbas
Vladimir Dorodnitsyn, Keldysh Inst.
Amine El Gradechi, Artois
Isidore Fleischer, independent researcher
Alexandre Girouard, Neuchâtel
Ilya Gruzberg, Chicago
Artemiy Kiselev, Montréal
Gregory Lawler, Chicago
Decio Levi, Roma Tre
Liechty, Karl, IUPUI
Nicolai Makarov, Caltech
Kenneth McLaughlin, Arizona
Stéphane Nonnenmacher, CEA/Saclay
Petr Novotny, TU Prague
Alexander Orlov, Shirshov Inst.
Jie Shen, Purdue
Libor Snobl, TU Prague
Agnieszka Tereszkiewicz, Białystok
Marc Thiriet, INRIA Rocquencourt
Zora Thomova, SUNYIT
Alexander Turbiner, UNAM
Nicolae Vulpe, Inst. de Matematică şi Informatică
Yuan Yuan, Memorial
Eduardo Santillan Zeron, Cinvestav
Yuanli Zhang, independent researcher
Alexei Zhedanov, Donetsk IPE
Jean-Paul Zolésio, INRIA Sophia Antipolis

Short-term Visitors

The following visitors were in residence for less than four weeks.

Omer Angel, UBC
Joan Carles Artés, Alabama at Birmingham
Jinho Baik, Michigan
Márton Balázs, BUTE
Estelle Basor, AIM
Liliane Beaulieu, Vieux-Montréal
Vasile Brînzanescu, Inst. Simion Stoilow

List of Students Having Graduated in 2008 – 2009

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 2008–2009 (note that this information might not be exhaustive). The name of the student is followed by the name of his or her supervisor (or names of his or her supervisors), his or her institution, and his or her program.

Ph.D. Students

Zaky Adam
David Sankoff
University of Ottawa
Mathematics

Gabriel Chênevert
Eyal Z. Goren
McGill University
Mathematics

Mathieu Dehaes
Frédéric Lesage & Michel Delfour
École Polytechnique de Montréal
Biomedical Engineering

Abdoulaye Baniré Diallo
Mathieu Blanchette & Vladimir Makarenkov
Université du Québec à Montréal
Computer Science

Tamara Diaz Chang
Véronique Hussin & Syed Twareque Ali
Université de Montréal
Mathematics (pure mathematics option)

Martin Ducharme
Gilbert Labelle & Pierre Leroux
Université du Québec à Montréal
Mathematics

Remy Magloire Dieudonné Etoua
Christiane Rousseau
Université de Montréal
Mathematics (applied mathematics option)

Catherine Foley
Michael C. Mackey
McGill University
Mathematics

Mélisande Fortin-Boisvert
Niky Kamran
McGill University
Mathematics

Sébastien Gambs
Gilles Brassard & Esma Aïmeur
Université de Montréal
Computer Science

Sardouana Hamadou
John Mullins & Srečko Brlek
École Polytechnique de Montréal
Computer Science

Clément Hyvrier
Lalonde, François
Université de Montréal
Mathematics (pure mathematics option)

Majid Jaberi Douraki
Javad Mashreghi & Thomas J. Ransford
Université Laval
Mathematics

Amel Kaouche
Christophe Reutenauer & Gilbert Labelle
Université du Québec à Montréal
Mathematics

Yulia Klochko
Marco Bertola
Concordia University
Mathematics

Evgenij Kritchevski
Vojkan Jakšić & Dmitry Jakobson
McGill University
Mathematics

Annie Lacasse
Srečko Brlek & Gilbert Labelle
Université du Québec à Montréal
Mathematics

Hugo Larochelle
Yoshua Bengio
Université de Montréal
Computer Science

Sylvain Lavallée
Christophe Reutenauer
Université du Québec à Montréal
Mathematics

Qun Li
Pengfei Guan
McGill University
Mathematics

Baisen Liu
Alain C. Vandal
McGill University
Statistics

Florence Laure Magnifo Kahou
Ivo G. Rosenberg
Université de Montréal
Mathematics (pure mathematics option)

Ian Marquette
Pavel Winternitz
Université de Montréal
Physics

Éric Olivier Paquette
Michel Boyer & Gilles Brassard
Université de Montréal
Computer Science

Geneviève Paquin
Christophe Reutenauer & Srečko Brlek
Université du Québec à Montréal
Mathematics

Juan Manuel Perez-Abarca
Donald A. Dawson
McGill University
Mathematics

Xavier Provençal
Srečko Brlek
Université du Québec à Montréal
Mathematics

William Sacher
Peter Bartello
McGill University
Atmospheric and Oceanic Sciences

Shahab Shahabi
Henri Darmon
McGill University
Mathematics

Alexandru Stanculescu
Michael Makkai & André Joyal
McGill University
Mathematics

Innocent Tamptsé
Paul M. Gauthier
Université de Montréal
Mathematics (pure mathematics option)

Dennis The
Niky Kamran
McGill University
Mathematics

Sidney Trudeau
Ivo Klemes
McGill University
Mathematics

Eugen Ursu
Pierre Duchesne & Louis G. Doray
Université de Montréal
Statistics

Carlos Vinuesa del Río
Javier Cilleruelo & Andrew Granville
Universidad Autónoma de Madrid
Mathematics

Liam Watson
Steven Boyer & André Joyal
Université du Québec à Montréal
Mathematics Ivo

Dmitrij Zelo
Damien Roy
University of Ottawa
Mathematics

Chunfang Zheng
David Sankoff
University of Ottawa
Mathematics

M.Sc. Students

Adil Abkari
Bruno Rémillard
HEC Montréal
Finance

Isabelle Ascah-Coallier
Abraham Broer
Université de Montréal
Mathematics (pure mathematics option)

Maciej Augustyniak
Louis G. Doray
Université de Montréal
Statistics

Jitendra Bajpai
Daniel T. Wise
McGill University
Mathematics

Louis Beaudet
Claude Levesque
Université Laval
Mathematics

Simon Belzile
René Ferland & Steven Shin-Yi Lu
Université du Québec à Montréal
Mathematics

Nicolas Brieu
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

Aurélie Brugallé
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

Bernard Caron
Louis-Paul Rivest
Université Laval
Statistics

Raphaël Clouâtre
Paul M. Gauthier
Université de Montréal
Mathematics (pure mathematics option)

Marc Conti
Robert G. Owens
Université de Montréal
Mathematics

Kevin Davis
Michael C. Mackey
McGill University
Mathematics

Jean-François Delorme
Frédéric Lesage
École Polytechnique de Montréal
Electrical Engineering

Élie Elkhal
Nicolas Papageorgiou & Bruno Rémillard
HEC Montréal
Finance (financial engineering option)

Sylvain Éon
Yvan Saint-Aubin
Université de Montréal
Mathematics (applied mathematics option)

Sara Froehlich
Niky Kamran
McGill University
Mathematics

Louis Gagnon
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

Olga Gordynska
Aurélie Labbe
Université Laval
Statistics

Arthur Goussanou
Louis-Paul Rivest
Université Laval
Statistics

Mark Hagen
Dmitry Jakobson
McGill University
Mathematics

Seyed Ahmad Hosseini Lavasani
Chantal David
Concordia University
Mathematics

Ararat Hurutyunyan
Dmitry Jakobson
McGill University
Mathematics

Maiko Ishii
Syed Twareque Ali
Concordia University
Mathematics

Walid Jbili
Thierry Duchesne
Université Laval
Statistics

Marilyse Julien
Russell Steele
McGill University
Statistics

Sébastien Kerkhoff
Ivo G. Rosenberg
Université de Montréal
Mathematics (pure mathematics option)

Timothy Kusalik
Michael Makkai
McGill University
Mathematics

Sébastien Labbé
Srečko Brlek
Université du Québec à Montréal
Mathematics

Philippe Lahaie
Sabin Lessard
Université de Montréal
Mathematics (applied mathematics option)

David Lasalle Ialongo
Sabin Lessard
Université de Montréal
Mathematics (applied mathematics option)

Pierre-Luc Lavertu
Pierre Mathieu
Université Laval
Physics

Alexandra Lemus Rodriguez
Richard L. Hall
Concordia University
Mathematics

Annie Letarte
François Bergeron & Gilbert Labelle
Université du Québec à Montréal
Mathematics

Jun Li
Yogendra P. Chaubey
Concordia University
Statistics

Marie Luneau
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

Mostafa Mache
Thomas J. Ransford
Université Laval
Mathematics

Davood Malekzadeh
Frédéric Gourdeau & Thomas J. Ransford
Université Laval
Mathematics

Nancy Manzerolle
Thierry Duchesne
Université Laval
Statistics

Hugues Massé
Fabrice Larribe
Université du Québec à Montréal
Mathematics (statistics concentration)

Merlin Mbuembue Njoya
Louis-Paul Rivest
Université Laval
Statistics

Matt McCamus
Christian Léger
Université de Montréal
Statistics

Steven Miscione
Jacques Hurtubise
McGill University
Mathematics

Francis Moreau
Jíři Patera & Hugues Demers
Université de Montréal
Mathematics (applied mathematics option)

Isabel Moreau
Aurélie Labbe
Université Laval
Statistics

Dario Morrone
Masoud Asgharian
McGill University
Statistics

Jérôme Paré
François Bergeron
Université du Québec à Montréal
Mathematics

Mathieu Poissant
Jean-François Angers & Alain Desgagné
Université de Montréal
Statistics

Maggy Pouliot
Thomas J. Ransford & Jérémie Rostand
Université Laval
Mathematics

Nicolas Pradier
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

Ronan Quelever
Frédéric Lesage
École Polytechnique de Montréal
Biomedical Engineering

James Requeima
Daniel T. Wise
McGill University
Mathematics

Adolfo Rodriguez
François Bergeron & Pierre Leroux
Université du Québec à Montréal
Mathematics

Salim Sader
Véronique Hussin
Université de Montréal
Physics

Élodie Samson
Thierry Duchesne
Université Laval
Statistics

Alexandre St-Pierre
Octav Cornea
Université de Montréal
Mathematics (pure mathematics option)

Kim Oanh Tang
Louis G. Doray
Université de Montréal
Mathematics (actuarial science option)

Patrice Tremblay
Jérémie Rostand
Université Laval
Mathematics

Yannic Vargas Lozada
François Bergeron & Christophe Hohlweg
Université du Québec à Montréal
Mathematics

Luc Villandré
Sabin Lessard
Université de Montréal
Statistics

Bocar Amadou Wane
Robert Guénette
Université Laval
Mathematics

Alisha Wissanji
Véronique Hussin
Université de Montréal
Physics

Shu Zhang
Wei Sun
Concordia University
Mathematics

Xiangwen Zhang
Pengfei Guan
McGill University
Mathematics

Foued Zitouni
Richard Fournier
Université de Montréal
Mathematics (pure mathematics option)

Governance and Scientific Guidance

In 2008 – 2009 the structure of the CRM was modified in order to enhance the role of the CRM institutional partners (i.e., universities) in the governance of the centre. The CRM structure consists of a Board of Directors, an Assembly of Members, an International Scientific Advisory Committee, a Local Scientific Committee, an Executive Committee, and a Committee of Directors of Laboratories. In 2008 – 2009, the members of the Local Scientific Committee were Andrew Granville (Université de Montréal), Jacques Hurtubise (McGill University), and Dmitry Jakobson (McGill University). The Executive Committee consists of the CRM Director and the Deputy Directors. For more information, the reader may consult the web site http://crm.math.ca/apropos/CRM_structure_an.shtml.

Board of Directors

The Board of Directors is composed of:

- The Director (ex officio);
- A member of the Executive Committee nominated by the Board for a two-year mandate;
- Two regular members nominated by the Assembly for a three-year mandate, which may be renewed once;
- A Laboratory director, nominated by the Committee of Directors of Laboratories for a two-year mandate, which may be renewed once;
- The Vice-Principal, Research, of each of the main partner universities of CRM, or his representative;
- A Vice-Principal, Research, of one of the other partner universities of CRM, chosen by these universities on a rotating basis for a two-year mandate.

Here are the members of the Board of Directors for 2008 – 2009.

Syed Twareque Ali
Concordia University

Yoshua Bengio
Université de Montréal

Guy Berthiaume, Vice-Rector (Research)
Université du Québec à Montréal

Louise Dandurand, Vice-President (Research)
Concordia University

Michel Delfour
Université de Montréal

Joseph Hubert, Vice-Rector (Research)
Université de Montréal

Véronique Hussin
Université de Montréal

Niky Kamran
McGill University

Javad Mashreghi
Université Laval

Christiane Rousseau
Université de Montréal

Denis Thérien, Vice-Principal (Research)
McGill University

Chantal David (Concordia University), **Andrew Granville** (Université de Montréal), and **Odile Marcotte** (Université du Québec à Montréal), all Deputy Directors of CRM, were invited members.

International Scientific Advisory Committee

The International 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 written or edited 13 books or special volumes.

Jerry Bona is a Professor at the Department of Mathematics, Statistics and Computer Science at 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 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 Real Academia Española since 2002.

Anne Bourlioux is a Professor in the Department of Mathematics and Statistics of the Université de Montréal. She obtained her Ph.D. from Princeton University in 1991, is a member of the Applied Mathematics Laboratory, and was CRM Interim Director from June to August 2008. The main research area of Anne Bourlioux is the numerical modelling of turbulent combustion, and its application to the prediction of NOx formation in internal combustion engines.

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 École normale supérieure de Lyon. She received a Ph.D. from Université Paris-Sud 11 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.

Anthony To-Ming Lau is a Professor in the Department of Mathematics of the University of Alberta and President of the Canadian Mathematical Society. He holds an undergraduate degree from the University of California, Berkeley and a Ph.D. in mathematics from the University of British Columbia. His research is in functional analysis and

harmonic analysis. He is a member of the editorial board of *Scientiae Mathematicae Japonicae*, the *Journal of Nonlinear and Convex Analysis*, and *Fixed Point Theory and Applications*. He was awarded many prizes and honours, among which the Killam Annual Professorship and the Rutherford Award for Excellence in Undergraduate Teaching.

Christiane Rousseau is a Professor in the Department of Mathematics and Statistics of the Université de Montréal. She is a regular member of the Mathematical Analysis Laboratory and was CRM Interim Director from September 2008 to May 2009. She obtained her Ph.D. from the Université de Montréal in 1977 and her research is in dynamical systems. Professor Rousseau was President of the Canadian Mathematical Society from 2002 to 2004, was the coordinator of the Métro 2000 campaign during the World Mathematical Year 2000, and organized the Canadian participation in the Premier congrès de mathématiques Canada-France in Toulouse in 2004. With her colleague Yvan Saint-Aubin, she wrote a textbook entitled *Mathematics and Technology* that won two prizes (the Prize for the best textbook, awarded by the Université de Montréal, and the Adrien-Pouliot Prize of the Association Mathématique du Québec). Professor Rousseau was awarded the 2009 Graham Wright Award for Distinguished Service by the Canadian Mathematical Society.

Catherine Sulem is a Professor in the Department of Mathematics of the University of Toronto. She received a doctorat d'État from the Université Paris 13 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 modelling 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 national du Mérite (2000). His research work concerns the theory of dynamical systems and the Julia and Mandelbrot sets.

Joseph Hubert, Vice-Rector (Research), Université de Montréal, is an ex-officio member of the Advisory Committee. **Chantal David** (Concordia University), **Andrew Granville** (Université de Montréal), and **Odile Marcotte** (Université du Québec à Montréal), all Deputy Directors of CRM, are invited members of the Committee.

CRM Administrative and Support Staff

The Director's Office

Anne Bourlioux
Interim Director
(June 1st, 2008 until August 31, 2008)

Christiane Rousseau
Interim Director
(September 22, 2008 until May 31, 2009)

Chantal David
Deputy Director, Publications and *Le Bulletin du CRM*

Andrew Granville
Deputy Director, CRM Prizes

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

Louise Letendre
Assistant

Computer Services

Daniel Ouimet
Systems Administrator

André Montpetit
Office Systems Manager (half-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, 2009

	NSERC	FQRNT	Université de Montréal	Partner Universities	From Endowment Funds	Partners & Researchers	Other Sources	TOTAL
REVENUE								
Operating and infrastructure grants	1 200 000	605 000	-	-	-	-	-	1 805 000
Université de Montréal grant	-	-	315 000	-	-	-	-	315 000
Université du Québec à Montréal grant	-	-	-	150 000	-	-	-	150 000
Concordia University grant	-	-	-	100 000	-	-	-	100 000
McGill University grant	-	-	-	90 000	-	-	-	90 000
Université Laval grant	-	-	-	66 800	-	-	-	66 800
University of Ottawa grant	-	-	-	30 000	-	-	-	30 000
Université de Sherbrooke grant	-	-	-	9 000	-	-	-	9 000
National Science Foundation (USA) grants	-	-	-	-	-	144 299	-	144 299
MITACS contributions	-	-	-	-	-	22 508	-	22 508
Other grants	-	10 000	28 295	-	-	-	-	38 295
Ministère du Développement économique, Innovation et Exportation (Québec)	-	-	-	-	-	7 295	-	7 295
Contributions of ISM and GERAD (Colloquia series)	-	-	-	-	-	17 464	-	17 464
Other contributions (Conferences and workshops)	-	-	-	-	-	12 015	-	12 015
ISM contribution for joint postdoctoral fellowships	-	-	-	-	-	79 500	-	79 500
Matching fund for postdoctoral fellowships	-	-	-	-	-	149 500	-	149 500
Revenue from Aisenstadt and Bissonnette endowments	-	-	-	-	88 718	-	-	88 718
Registrations	-	-	-	-	-	-	102 047	102 047
Publications' revenue	-	-	-	-	-	-	32 959	32 959
TOTAL REVENUE	**1 200 000**	**615 000**	**343 295**	**445 800**	**88 718**	**432 581**	**135 006**	**3 260 399**

(*Continued on next page*)

	NSERC	FQRNT	Université de Montréal	Partner Universities	From Endowment Funds	Partners & Researchers	Other Sources	TOTAL
EXPENDITURES								
SCIENTIFIC PROGRAM - CENTRE								
Thematic semester: Dynamical systems and evolution equations								
Workshops and schools	7 859	-	-	-	-	(2 372)	-	5 487
Total - Thematic semester: winter-spring 2008	7 859	-	-	-	-	(2 372)	-	5 487
Thematic year on Probabilistic methods in mathematical physics								
Aisenstadt Chairs	5 349	7 685	-	-	4 399	-	-	17 433
Visiting researchers	8 109	-	-	-	-	-	-	8 109
Postdoctoral fellows	74 000	-	-	-	-	-	-	74 000
Workshops and schools	223 226	-	-	-	-	89 153	6 155	318 534
Total - Thematic year 2008-2009	310 684	7 685	-	-	4 399	89 153	6 155	418 076
Joint thematic semester with PIMS: Challenges and perspectives in probability								
Aisenstadt Chair	-	4 368	-	-	767	-	-	5 135
Workshops and schools	85 949	-	-	-	-	-	7 497	93 446
Total - Thematic semester: winter-spring 2009	85 949	4 368	-	-	767	-	7 497	98 581
General program	121 596	15 990	207	-	24 443	83 385	69 813	315 433
Industrial and multidisciplinary program	71 789	(1 294)	-	-	-	23 749	27 040	121 284
Postdoctoral fellows and students	75 750	-	-	30 000	-	229 000	-	334 750
SCIENTIFIC PROGRAM - RESEARCH LABORATORIES								
Course releases	-	-	-	76 500	-	-	-	76 500
Visiting researchers	(87)	14 652	1 405	14 526	-	-	-	30 496
Workshops, seminars and travel	4 329	53 298	6 743	55 378	131	-	2 077	121 957
Postdoctoral fellows	12 000	45 042	18 805	58 976	-	-	-	134 823
Students	-	57 500	20 000	45 918	-	-	-	123 418
Administrative and technical support	-	61 494	-	135 438	-	-	-	196 932
Total - Research laboratories	16 242	231 986	46 954	386 736	131	-	2 077	684 126
Other scientific expenses								
Community college research projects	-	14 847	-	-	-	-	2 200	17 047
Course releases	-	7 500	-	-	10 000	-	-	17 500
Accromath, CRM Bulletin, Annual report and posters	9 530	-	2 881	-	7 500	-	2 088	21 999
Collaboration with Tata Institute	-	-	7 295	-	-	7 295	-	14 589
Joint Math Institutes Open House 2009 / ICM2014 site visit	1 042	-	1 634	-	1 650	2 330	-	6 655
SMAC/AQJM / AMQ	-	8 000	-	-	-	-	-	8 000
Canadian Mathematics Education Forum 2009	4 000	-	-	-	-	-	-	4 000
Total - Other scientific expenses	14 572	30 347	11 810	-	19 150	9 624	4 288	89 792
Personnel (non-academic; excluding research laboratories)	386 406	154 159	169 254	-	-	-	1 266	711 084
Academic management, International advisory committee, networking	365	20 919	80 128	-	311	-	6 281	108 004
Operating and computing costs	26 816	14 935	15 298	-	-	-	1 312	58 361
TOTAL EXPENDITURES	**1 118 029**	**479 095**	**323 651**	**416 736**	**49 201**	**432 539**	**125 729**	**2 944 979**
2008-2009 YEAR-END BALANCE	**81 971**	**135 905**	**19 644**	**29 064**	**39 517**	**42**	**9 277**	**315 420**

Amount avalailable on June 1, 2008	30 317	(105 884)	(52 265)	-	80 406	19 620	145 644	**117 838**
Change in receivables and payables	(62 979)	53 061	27 254	(29 064)	(7 690)	(1 950)	(7 903)	**(29 271)**
2008-2009 Year-end balance	81 971	135 905	19 644	29 064	39 517	42	9 277	**315 420**
Amount available on May 31, 2009	**49 309**	**83 083**	**(5 368)**	**-**	**112 232**	**17 713**	**147 018**	**403 988**

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 (NRC). It became a Natural Sciences and Engineering Research Council (NSERC) national research centre in 1984. It is currently funded by NSERC, by the Government of Québec through the Fonds québécois de la recherche sur la nature et les technologies (FQRNT), by the Université de Montréal, as well as McGill University, Université du Québec à Montréal, Concordia University, University of Ottawa, Université Laval, Université de Sherbrooke 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 André-Aisenstadt Prize given for outstanding work carried out 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 http://crm.math.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 Institute for 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 ten 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 Institut des sciences mathématiques (ISM) including the weekly CRM – ISM colloquia, 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 Board of Directors and the International 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 André-Aisenstadt Prize, and suggest new scientific avenues to explore.