CENTRE
DE RECHERCHES
MATHÉMATIQUES

Annual Report

2005
2006

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National
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Centre de recherches mathématiques
Université de Montréal
C.P. 6128, succ. Centre-ville
Montréal, QC H3C 3J7
Canada

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Presenting the Annual Report 2005 – 2006

A Year That Set a New Standard for Canadian Mathematics

The year 2005 – 2006 at the CRM was one of the deepest, most exciting years in the life of the mathematical institutes. Under the scientific direction of Andrew Granville (Montréal), Chantal David (Concordia) and Henri Darmon (McGill), the CRM thematic programme on "Analysis in Number Theory" was a splendid year, a wonderful moment of creativity, collaborations and discoveries. The three CRM Aisenstadt Chair holders, contacted early in 2004 by the organizers, gave splendid lectures and stayed on site at the CRM for several months: M. Bhargava (Princeton), who was a plenary speaker at the 2006 ICM, K. Soundararajan (Stanford), and Terence Tao (UCLA), who was awarded the Fields medal at the 2006 ICM.

What makes the CRM so innovative and stimulating is the involvement at all levels of its scientists, whose work naturally attracts top level mathematicians from around the world. While it is relatively easy for a given institute to invite a Fields medalist or a Nobel Prize winner for a one-day lecture, it is much more difficult and interesting to invite them and work with them for several months before they get the Fields Medal, hoping that they will receive the highest honours. This happened last year with all three of the young CRM Aisenstadt Chair holders. During the year, more than forty researchers from around the world and many postdoctoral fellows stayed for extended periods of time at the CRM. Hundreds of invited speakers came to the CRM for the thematic programme, including Tim Gowers (Cambridge, Fields Medalist), Jean Bourgain (Institute for Advanced Study, Fields Medalist), and Barry Mazur (Harvard).

The CRM is unique because it is much more than a "conference centre": it is both a place where fascinating and world-class developments take place, and an institute where ten large laboratories are based. From Number Theory and Geometry – Topology to Brain Imaging and Quantum Informatics, with strong groups in Statistics and Applied Mathematics, the CRM's vitality relies, ultimately, on these laboratories.

The CRM is currently setting up two new laboratories, one in Quantum Informatics, called INTRIQ (INstitut TRansdisciplinaire en Informatique Quantique), and a second one that will take shape soon. We have also worked intensively on our new web site, with 80,000 dynamic pages updated daily and 7,500 hand-written pages, in both French and English. This website is the result of years of effort to give a complete and easily accessible view of everything that is of interest to mathematicians and mathematical scientists. It is fed by the "CRM Monster," one of the largest databases in mathematics in the world. Go to `www.crm.umontreal.ca` and select the language of your choice (the choice is quite limited, but still, you have a choice!).

The CRM was the first Canadian institute to seek funds from the NSF, NATO, and the Clay Institute simultaneously, and to receive a generous response: all of our applications have been supported with even more enthusiasm than we expected — it is interesting to note that the only NATO Advanced Study Institute in the world, in any scientific field, to be funded year after year, is the CRM's "Séminaire de mathématiques supérieures," jointly sponsored by the Université de Montréal's Department of Mathematics and Statistics. In 2007, we will innovate in another way by organizing an event that will be held at Stanford University in June 2007, the first international large conference to bring together most mathematicians developing various aspects of the "ultimate theory" of Symplectic Field Theory. At the moment of writing, we have just received the confirmation from the NSF that it would grant us the full amount requested.

Other new international agreements have been signed this year by the CRM, notably with INRIA and INSERM (both in France), and with Latin America and with Central Europe (DIMATIA). Negotiations are under way with the CNRS to create three or four GDRI (Groupe de Recherche International) that would launch, for the first time, a complete array of projects jointly funded by Europe and North America in most fields of mathematics. Finally, the CRM is now preparing a scientific mission to establish long term links and projects between Canada and most of the top scientific centres in India. This mission, prepared with the Québec government and several research vice-principals, will take place in a few weeks (November 2006). Since mathematics is one of the three main disciplines targeted in this mission, and India will host the next ICM 2010 (after a very tight competition

with Montréal), it is natural to establish links with both pure and applied mathematical centres.

This year, in collaboration with its educational partner, the Institut des sciences mathématiques (ISM), the CRM launched the Accromaαth project. The Accromaαth texts are produced and revised by the most outstanding Canadian editorial team, comprising André Ross (editor-in-chief), France Caron, Louis Charbonneau, Jocelyn Dagenais, Jean-Marie De Koninck, André Deschênes, Christian Genest, Frédéric Gourdeau, Bernard Hodgson and Christiane Rousseau. The members of the editorial team are involved in the teaching of mathematics at the high school, college or university level, and several of them have gained recognition for their contributions to the popularization of mathematics. For instance, Bernard Hodgson (Université Laval) is secretary-general of the International Commission on Mathematical Instruction, based in Geneva; this is one of the highest international positions in the field of mathematical instruction.

Frédéric Gourdeau (Université Laval) has received the 2006 CMS Excellence in Teaching Award in recognition of his sustained and distinguished contributions to teaching at the undergraduate level. Jean-Marie De Koninck (Université Laval) received the same award in 2004. Christiane Rousseau (Université de Montréal) was until recently president of the Canadian Mathematical Society and Christian Genest (Université Laval) is president-elect of the Statistical Society of Canada. The Accromaαth journal has aroused so much interest in the mathematical community that it has become a focal point for Canadian mathematics. Requests for subscriptions are coming not only from Ontario and New Brunswick, but from every corner of the French-speaking world, for instance France and Belgium and (soon) Africa.

Also this year, the CRM lauched the new programme "CRM Public Lectures" in order to reach out to a general audience, high school and college teachers and their students. Because of their quality and breadth, these lectures are having an impact on many groups, even groups of academics in biology, medicine, philosophy, physics and computer science. Lecturers such as Jean-Marie De Koninck (chosen as "Scientist of the Year" by Radio-Canada), Ivar Ekeland (director of PIMS and former president of the Université de Paris-Dauphine) and Bart de Smit, from the University of Leyden (who gave a lecture in November 2006), are attracting 300 hundred persons from all walks of life for each lecture.

The lectures rotate between the large Québec universities, and could very well take place outside the universities in large halls located in Montréal, Québec, Sherbrooke or Ottawa. The goal of the CRM (already reached to a large extent) is to contribute to the visibility and impact of the universities and its researchers, anywhere and at any time. We want to stimulate the intellectual life of this country, so that it becomes an integral part of our environment; we want to present to Québeckers and Canadians the scientific and cultural issues of the twenty-first century, and leave our ivory towers while preserving the peace of mind that researchers need to work and make discoveries.

One of the best indicators of the vitality of mathematical research in Canada is the competition for the André-Aisenstadt Prize, awarded each year by the CRM Scientific Advisory Panel to a young Canadian mathematician working in Pure Mathematics, Applied Mathematics or Statistics. In 2006, the competition was extremely tight, so we had to award the Prize to two mathematicians: Iosif Polterovich (Université de Montréal) and Tai-Peng Tsai (University of British Columbia). The other CRM prizes in 2006 were awarded to Jeffrey Rosenthal (Statistics, University of Toronto) in collaboration with the Statistical Society of Canada, to John Harnad (Mathematical Physics, Concordia University and CRM) in collaboration with the Canadian Association of Physicists, and to Nicole Tomczak-Jaegermann (Mathematics, University of Alberta) in collaboration with the Fields Institute and PIMS.

I would like to thank the organizers of the 2005 – 2006 thematic programme at the CRM, especially Andrew Granville, Chantal David and Henri Darmon (but there are so many other names), as well as the CRM staff, for their commitment and dedication. I would also like to thank the vice-principals (research) of the seven large universities involved in the CRM enterprise; their support is absolutely essential. And, above all, I would like to emphasize that the CRM is here to serve the international community of mathematical scientists in all possible ways. The directors of the three Canadian Institutes have been working in close collaboration on many national and international issues, such as the applications for the ICM and the ICIAM, the Second Canada – France Conference

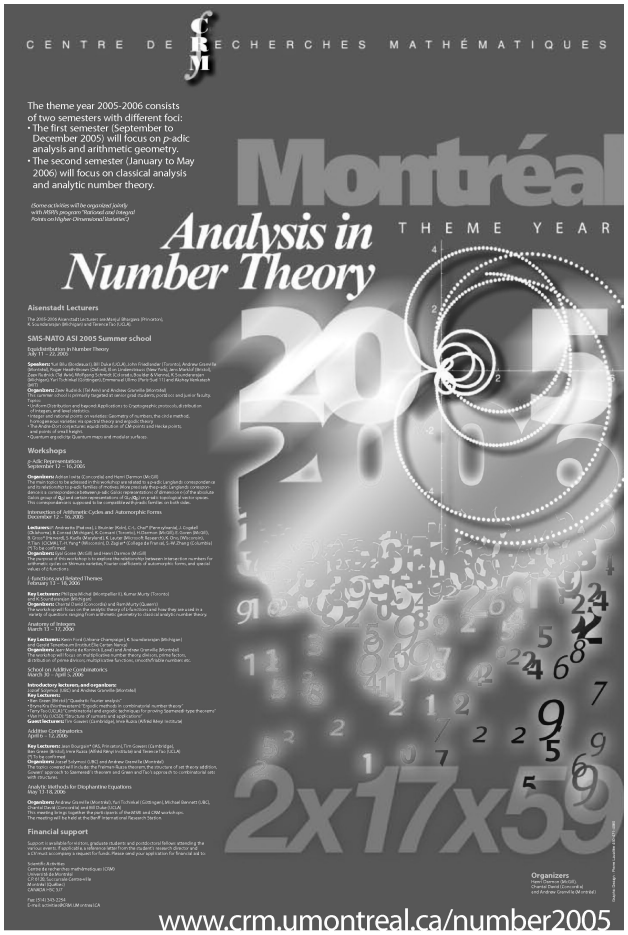
(with Octav Cornea and Nassif Ghoussoub as scientific directors), and the support extended to the three mathematical and statistical societies, to AARMS and to the NPCDS programme in statistics. This year as always, it has been a pleasure to exchange views and combine our efforts, thanks in great part to the Liaison Committee led by Richard Kane.

François Lalonde
Director

Thematic Program

THE core of each year's scientific program at the CRM is its thematic program. The Scientific Advisory Committee chose for 2005 – 2006 the theme *Analysis in Number Theory*, because of the spectacular developments taking place in that field and their impact on the international scientific community. The thematic program included six workshops, several seminars and conferences, three Aisenstadt Chair lecture series (by Manjul Bhargava, K. Soundararajan, and Terence Tao, respectively), a NATO Advanced Study Institute, a CRM – Clay School, long term visits by fifty researchers and some postdoctoral fellowships. In coordination with Montréal universities, the CRM offered two courses in order to help graduate students participate in the activities. *The reports are presented in the language in which they were submitted*.

Thematic Year 2005 – 2006: Analysis in Number Theory



Organizers: Henri Darmon (McGill), Chantal David (Concordia), Andrew Granville (Montréal)

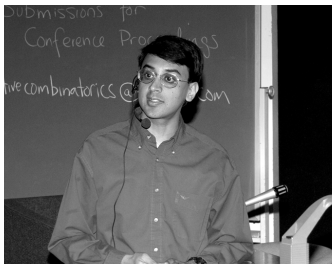
The thematic year on Analysis in Number Theory consisted of two semesters with different foci, both exploring the fruitful interactions between analysis and number theory. The first semester focused on *p*-adic analysis and arithmetic geometry, and the second semester on classical analysis and analytic number theory. In both semesters, several workshops, schools and focus periods have concentrated on the new and exciting developments of the recent years that have emerged from the interplay between analysis and number theory. Here are some of the leading themes of the year: the emerging theory of *p*-adic families of modular forms and the *p*-adic Langlands correspondence in high degrees; the new developments in the classical theory of L-functions (non-vanishing L-functions, subconvexity and applications); the recent spectacular advances in additive combinatorics and harmonic analysis, and their applications to number theory. Some of the activities of the theme year have been organized jointly with the program *Rational and Integral Points on Higher-Dimensional Varieties* held at MSRI from January to May 2006.

Aisenstadt Chairholders in 2005 – 2006: M. Bhargava, K. Soundararajan, and T. Tao

The André-Aisenstadt chairs for the Thematic Year *Analysis in Number Theory* were three exceptional young mathematicians working in different areas of number theory, that have been influenced and developed by their scientific achievements: Manjul Bhargava (Princeton University), K. Soundararajan (Stanford University) and Terence Tao (UCLA). The organizers are specially proud that they managed to convince the three André-Aisenstadt chairs to stay in residence at the CRM for extended periods, from one week to several months. The quality of the many lectures given by the three André-Aisenstadt chairs, and the inspiration provided by their presence, were two of the reasons for the great success of the special year.

Manjul Bhargava

Manjul Bhargava has made phenomenal contributions to number theory, most notably by his discovery of higher order composition laws. This is the topic of his Ph.D. thesis, written under the direction of Professor Andrew Wiles of Princeton University and published as a series of papers in the *Annals of Mathematics*. Bhargava introduced entirely new and unexpected ideas that led to his discovery of composition laws for forms of degree greater than 2, generalising the construction of Gauss for binary quadratic forms. Bhargava then applied these composition laws to solve a new case of one of the fundamental questions of number theory, that of the asymptotic enumeration of number fields of a given degree d. The question is trivial for $d = 1$, and Gauss himself solved the case $d = 2$ in 1801. Davenport and Heilbronn solved the case $d = 3$ in 1971. Bhargava has now solved the $d = 4$ and $d = 5$ cases, which previously had resisted all attempts.



Bhargava also applied his work to make significant progress on the problem of finding the average size of ideal class groups and on the related conjectures of Cohen and Lenstra. Bhargava's contributions have created a whole new area of research in a classical topic that has seen very little activity since the time of Gauss. Manjul Bhargava has also made exceptional contributions to the theory of representations of positive integers by sums of squares, giving a short and direct proof of the "15-Theorem" of Conway and Schneeberger, and proving, in collaboration with Jonathan Hanke, the "290-Theorem" conjectured by Conway.

Manjul Bhargava received his Ph.D. from Princeton University under the advisorship of Andrew Wiles in 2001. After brief visiting positions at the Institute for Advanced Study and Harvard University, he joined the faculty of Princeton University as Professor of Mathematics in 2003, the youngest of that rank at Princeton. Bhargava has received numerous awards and honors, including the 2005 SASTRA Ramanujan Prize (jointly with K. Soundararajan), the AMS Blumenthal Award for the Advancement of Pure Mathematics (2005), the 2005 Clay Research Award, a Packard Foundation Fellowship in Science and Engineering (2004) and the MAA Merten M. Hasse Prize for Exposition (2003). He was also the first Clay Mathematics Institute's five-year Research Fellow (2000 – 2005).

K. Soundararajan

K. Soundararajan has made brilliant contributions to several areas in analytic number theory, which include multiplicative number theory, the Riemann zeta function and Dirichlet L-functions, the analytic theory of automorphic forms and the Katz – Sarnak theory of symmetric groups associated with families of L-functions (random matrix theory). As an undergraduate at the University of Michigan, Soundararajan already made important contributions: first, in joint work with R. Balasubramanian, he proved a famous conjecture of Ron Graham in combinatorial number theory; secondly, he obtained some fundamental results on the distribution of the zeros of the Riemann zeta function. In his Ph.D. thesis, written under the direction of Professor Peter Sarnak of Princeton University, K. Soundararajan proved that more than seven-eighths of quadratic Dirichlet L-functions have no zeros at the critical point $s = \frac{1}{2}$, thereby providing strong evidence for a conjecture of Chowla. This spectacular result was published in the Annals of Mathematics.

The work of Soundararajan is prolific and characterized by its ingenuity and remarkable technical strength. Here are some of his many remarkable works: his work with Brian Conrey proving that a positive proportion of Dirichlet L-functions have no zeros on the real axis within the critical strip; his work with Ken Ono on Ramanujan's ternary quadratic form; and his collaboration with Andrew Granville, resulting in many major works on multiplicative functions, character sums, extreme values of L-functions, and so on.

K. Soundararajan became a Professor at Stanford University in 2006, and was previously Professor at the University of Michigan at Ann Arbor. He has received numerous awards and honors for his remarkable research contributions, including the 2005 SASTRA Ramanujan Prize (awarded for the first time) for his outstanding contributions in areas of mathematics influenced by Ramanu-

jan, and the 2003 Salem Prize, awarded every year to a young mathematician judged to have done outstanding work in the field of interest of Raphaël Salem, primarily the theory of Fourier Series. He was also the first recipient of the AIM Five-Year Fellowship in 1998.

Terence Tao

Terence Tao just received the Fields Medal at the ICM in Madrid in August 2006, for his contributions to partial differential equations, combinatorics, harmonic analysis and additive number theory. He is a supreme problem-solver whose spectacular work has had an impact across several mathematical areas. At 31 years of age, Tao has written over 80 research papers, with over 30 collaborators, and his interests range over a wide spectrum of mathematics. Because of the wide range of his accomplishments, it is difficult to give a brief summary of Tao's oeuvre. We concentrate here on the work that was related to the 2005 – 2006 CRM Thematic Year.

One of the achievements that were recognised by the Fields Medal is his work with Ben Green on Long Arithmetic Progressions in the Primes, which was announced in 2004, stunning the mathematical community. Finding arithmetic progressions in the primes is an old and classical problem of additive number theory, together with the Twin Prime conjecture and Goldbach's conjecture. Van der Corput proved in 1929 that the primes contain infinitely many arithmetic progressions of length 3, and before the work of Green and Tao, there were only partial results towards arithmetic progressions of length 4. The number theory community was thus stunned when news of the theorem of Green and Tao began to circulate: they had proven that there are infinitely many arithmetic progressions of length k in the primes, for any positive integer k (and not just $k = 4$)! At the heart of the work of Green and Tao is Szemerédi's Theorem (1975), which says that if a subset of the integers has positive density, then it contains infinitely many arithmetic progressions of length k for any k. Of course, the primes do not have positive density, and one cannot apply Szemerédi's theorem directly to them. All the proofs of Szemerédi's theorem rely on the interplay between structure and randomness, which Green and Tao were able to exploit to obtain their spectacular result.

Terence Tao completed his Ph.D. at Princeton University under the direction of Elias Stein in 1996. He then moved to UCLA where he became a Full Professor in 2000. His work, of extraordinary breadth and depth, was recognised by many prizes and awards, in addition to the consecration of the Fields Medal in 2006. Let us mention here the Ostrowski Prize (2007), a MacArthur Fellowship (2007), the SASTRA Ramanujan Prize (2006), the Levi L. Conant Award (2004), a Clay Research Award (2003), the Bocher Memorial Prize (2002), and the Salem Prize (2000).

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 chapter on publications in the present report for a list of these monographs). At the request of Dr. Aisenstadt, the first lecture given by an Aisenstadt chairholder should be accessible to a wide audience. Previous holders of the Aisenstadt Chair are: Marc Kac, Eduardo 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, 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, and Andrew J. Majda.

Activities of the Thematic Year

SMS – NATO ASI 2005 Summer School Equidistribution in Number Theory

July 11 – 22, 2005, Université de Montréal
Financed by NATO, CRM, ISM, and Department of Mathematics and Statistics of Université de Montréal

Organizers: Zeev Rudnick (Tel Aviv), Andrew Granville (Montréal)
Speakers: Stephan De Bièvre (Lille), Bill Duke (UCLA), John Friedlander (Toronto), Andrew Granville (Montréal), Roger Heath-Brown (Oxford), Elon Lindenstrauss (New York), Jens Marklof (Bristol), Zeev Rudnick (Tel Aviv), K. Soundararajan (Stanford), Yuri Tschinkel (Göttingen), Emmanuel Ullmo (Paris-Sud) et Akshay Venkatesh (MIT)
Number of participants: 12 speakers and 75 students

We advertised broadly for the Summer School and the amount of interest generated for it was impressive. We received 150 applications, in particular high numbers of outstanding applications from well-qualified students and young researchers from NATO and partner countries. We selected 75 students and twelve main speakers gave series of lectures. Two one-hour lectures were given by Gergely Harcos (University of Texas at Austin) and Andrei Yafaev (University College, London), respectively. The speakers were encouraged to keep the lectures accessible. This led to an incredible enthusiasm from the students, most of whom hardly missed a lecture during two weeks!

The lectures at the Summer School were carefully orchestrated to lead a well educated student from the basics of the subject to the point at which he (or she) could get some idea of the subjects at a very high level. These disparate topics had never before been brought together under one subject, and it became increasingly clear during the meeting that this was appropriate. Many central, recent advances in the field were discussed here, some for the first time in a professional meeting. The speakers were accessible and the scientific atmosphere during the two weeks was stimulating, intense and enjoyable.

As a whole, this School has certainly contributed to the advancement of the subject by providing an access to the most important, recent developments in the field to a group of well motivated and prepared students. We were delighted by the high level of participation and received extraordinarily positive feedback after the end of the School, in fact far more positive than we would ever have thought possible. Many students enthusiastically worked on the lectures in the evenings and weekend and several lecturers have subsequently been asked whether they were willing to supervise a student or postdoc they had met at the School. Somehow the School gained an atmosphere that the students enjoyed!

The School talks came under the general heading *Equidistribution in Number Theory*. With exciting developments in the understanding of zeta functions through random matrix theory, researchers in classical analytic number theory have begun to think more in terms of distributions than they have for a long time (and in new ways). Also Ratner's theorem in ergodic theory has found an astonishing variety of applications. With the unification of techniques and perspectives in algebraic geometry and in the circle method of analytic number theory, distribution questions are taken more seriously in these subjects than they used to. Recently the most exciting breakthroughs derived from ideas that loosely come together under the heading *Equidistribution in Number Theory*. We decided that this would be a wonderful subject for a summer school, and since many of the key results have been proved by younger people, we invited them to give series of lectures.

In the first week, Granville and Rudnick covered the basics of uniform distribution, De Bièvre the big picture of the basic physics that is related to these topics (in particular to quantum unique ergodicity), and Marklof the basics of ergodic theory on manifolds. Ullmo lectured on the basic picture for distribution of algebraic points on varieties, followed by Rudnick, who proved Lang's result for torsion points, and Granville, who proved Bilu's equidistribution theorem. Heath-Brown gave a stunningly beautiful and accessible introduction to the classical circle method, in a form that fascinated several students. Duke highlighted the beauty of his early work on the equidistribution of CM-points in hyperbolic space, which has inspired so much recent work, and gave some pointers to the new directions. Venkatesh introduced the students to ergodic theory on certain manifolds and the directions he is pursuing.

The second week involved deeper concepts and material but the speakers did their best to remain accessible, none more so than Lindenstrauss,

author of some of the most important breakthroughs on distribution using ergodic theory (for which he has won several major prizes). Lindenstrauss focused on examples to bring clarity to his exposition of his work. Tschinkel gave the big picture of distribution of points on high-dimensional surfaces, and in particular the algebraic geometry involved; he surprised us by presenting many simple examples that still defy understanding. Friedlander gave us an overview of the very important work applying these equidistribution ideas to cryptography, and Granville explained how the recent work of Bourgain and his coauthors implies that the Diffie – Hellman protocol is very secure against statistical attacks. Soundararajan gave a beautiful exposition of the heuristics involved in gaining a fine understanding of the distribution of primes.

Workshop
p-adic Representations

September 12 – 16, 2005, CRM
Sponsored by NSERC, FQRNT, NATO, NSF, and CRM

Organizers: Adrian Iovita (Concordia), Henri Darmon (McGill)
Speakers: Fabrizio Andreatta (Padova), Joël Bellaïche (Columbia), Laurent Berger (IHES), Christophe Breuil (IHES), Frank Calegari (Harvard), Pierre Colmez (Paris 6), Matthew Emerton (Northwestern), Elmar Grosse-Klönne (Münster), Michael Harris (Paris 7), H. Hida (UCLA), Mark Kisin (Chicago), Barry Mazur (Harvard), Abdellah Mokrane (Paris 13), Vytautas Paskunas (Bielefeld), Michael Spiess (Bielefeld), Glenn Stevens (Boston), Matthias Strauch (Münster), Jeremy Teitelbaum (Illinois at Chicago), Eric Urban (Columbia), Marie-France Vignéras (Paris 13), Jean-Pierre Wintenberger (Strasbourg)
Number of participants: 76

The workshop, which attracted many graduate students (about 20) and postdocs, had two major themes: a p-adic Langlands Correspondence and p-adic families of motives. Our idea in organizing this workshop was that these two themes have many common features and they are at a stage of development where they could influence each other if only the researchers were given the opportunity to interact. We hoped to create that opportunity by bringing together researchers from both fields and we have to say that our hopes were amply fulfilled. We think that the workshop marked a decisive step in the evolution of the two themes through the important results reported at the workshop but mostly through the interesting ideas and questions offered here for the first time, and through the large number of collaborations that were started at the workshop. In saying so we are almost quoting Barry Mazur whose colloquium talk summarized and ended the workshop.

The theory of a p-adic Local Langlands Correspondence had its beginnings in 2000 with the work of C. Breuil. Given a prime integer $p > 0$, an integer $n > 0$ and a finite extension L of $\mathbb{Q}_p$, his idea was to construct a correspondence satisfying functorial properties between n-dimensional p-adic representations of the group $\mathrm{Gal}(\overline{\mathbb{Q}}_p/L)$ and unitary representations of the group $\mathrm{GL}_n(L)$ on p-adic Banach spaces.

Most of the results have been obtained for the case $L = \mathbb{Q}_p$. In this case and for $n = 1$, the correspondence was easily achieved. For $n = 2$ the correspondence was first established by Breuil for crystalline representations. If V is a 2-dimensional crystalline representation of $\mathrm{Gal}(\overline{\mathbb{Q}}_p/\mathbb{Q}_p)$, let us denote by W the Weil-representation attached to $D_{\mathrm{cris}}(V)$. Then, if W^{cll} is the $\mathrm{GL}_2(\mathbb{Q}_p)$ representation attached to W by the classical Local Langlands Correspondence and if $a \leq b$ are the Hodge numbers of V, there is a unique invariant norm on the $\mathrm{GL}_2(\mathbb{Q}_p)$-representation $U(V) := \mathrm{Sym}^{b-a}(\mathbb{Q}_p^2) \otimes_{\mathbb{Q}_p} W^{\mathrm{cll}}$. Let $B(V)$ denote the completion of $U(V)$ with respect to this norm. Then up to twist by a power of the determinant, $B(V)$ is the Banach-space representation attached to V.

A similar strategy (taking into account the use of $\mathcal{L}$-invariants) was proposed for semi-stable representations of $\mathrm{Gal}(\overline{\mathbb{Q}}_p/\mathbb{Q}_p)$, a strategy that works modulo the conjecture that the p-adic Banach spaces thus obtained are non-trivial. This conjecture was proved by Colmez using (Φ, Γ)-modules. Moreover Colmez announced in his talk at the workshop results on a general p-adic Local Langlands Correspondence for $n = 2$ and $L = \mathbb{Q}_p$.

The talks of M. Strauch, V. Paskunas, M.-F. Vignéras and J. Teitelbaum were connected with generalizations to either $n > 2$ or $[L : \mathbb{Q}_p] > 1$. M. Emerton's talk reported on a possible theory of a global p-adic Langlands Correspondence and M. Kisin announced a proof of certain cases of the Fontaine – Mazur conjecture, his proof using results on the p-adic Local Langlands Correspondence.

The second theme of the conference, the theme of p-adic variation of motives, started in the 70s with articles of J.-P. Serre, N. Katz, and H. Hida and continued in the 90s with the work of B. Mazur, F. Gouvea, and R. Coleman. They realized, conjectured and finally proved that the various congruences modulo powers of a prime $p > 0$ between elliptic modular eigenforms are manifestations of the fact that modular eigenforms of finite slope come to this world in p-adic analytic families parameterized by the weight. In fact these families can be explained by the existence of a geometric object, "the eigencurve," which is a locally finite cover of the weight space and whose points should be thought of as overconvergent eigenforms of finite slope.

There were very interesting talks on this theme at the workshop: F. Calegari reported on work on a construction of an "eigencurve" for modular forms over an imaginary quadratic field, and G. Stevens on a new, cohomological construction of the p-adic families of elliptic eigencurves. E. Urban's talk referred to trace formulas for p-adic analytic families of modular forms for very general reductive groups, J. Bellaïche reported on results related to the local geometry of the eigenvarities attached to unitary groups, and A. Mokrane sketched a program to define p-adic families and "eigenvarieties" for modular eigenforms on symplectic groups using crystalline-cohomological methods. Finally H. Hida talked about his work on Λ-adic Barsotti – Tate groups.

The talk of F. Andreatta on a new theory of relative (Φ, Γ)-modules, that of M. Spiess on Drinfel'd – Stuhler varieties and that of J.-P. Wintenberger on the proof of cases of Serre's conjecture were quite interesting, although not directly related to the two main themes of the workshop. In order to help the young participants follow the talks, we asked Christophe Breuil and Matthew Emerton to give expository talks on the main ideas involved in the two themes.

We organizers think that the workshop was of an exceptionally high level and that, as mentioned at the beginning of this report, it marked a crucial moment in the development of the two themes. In fact, now, almost eight months after the event, we see that many of the ideas presented at the workshop have been followed up, a number of the conjectures presented there have been proved and new and very exciting results in the two fields have been announced. At the AIM conference on p-adic Representations (Palo Alto, February 2006), M. Emerton stated in his talk that the workshop on p-adic Representations in Montréal in September 2005 marked a new way of understanding both the p-adic Langlands Correspondence and the p-adic variation of motives and especially the relationship between the two.

Workshop
Gathering on Stark's conjectures
November 1 – 3, 2005, CRM

Organizers: Pierre Charollois (Montréal), Henri Darmon (McGill), Samit Dasgupta (Harvard), Eyal Goren (McGill)
Speakers: Hugo Chapdelaine (McGill), Pierre Charollois (Montréal), Henri Darmon (McGill), Samit Dasgupta (Harvard), David Dummit (Vermont), Caleb Emmons (California at San Diego), Stefan Erickson (Colorado College), Eyal Goren (McGill), Andrew Granville (Montréal), Jonathan Sands (Vermont), Harold Stark (California at San Diego), Mak Trifkovic (McGill), Daniel Vallières (McGill)
Number of participants: 25

Cet atelier a été originellement conçu comme une occasion de faire le point, en profitant des forces locales déjà présentes à Montréal à l'occasion de l'année spéciale en théorie des nombres, sur les conjectures fondamentales formulées par Harold Stark à la fin des années 1970. Ces conjectures prédisent l'algébricité de certaines valeurs spéciales de fonctions L. Elles sont sans doute intimement reliées au 12ième problème de Hilbert (ou rêve de jeunesse de Kronecker), qui consiste, selon le modèle des corps cyclotomiques, à engendrer explicitement des extensions abéliennes spécifiques d'un corps de nombres par des moyens analytiques. Cette thématique de recherche est déjà bien présente dans la région de Montréal, et les organisateurs souhaitaient en tirer profit pour faire présenter de manière informelle les progrès récents.

En réalité, il s'est avéré qu'un auditoire plus large participerait à cet atelier. C'est ainsi que nous avons eu le plaisir de rassembler dans les locaux du CRM un auditoire de plus de vingt personnes, incluant notamment le professeur H. Stark lui-même. L'exposé introductif, donné par David Dummit, a rappelé le cadre exact de la conjecture de Stark classique et de ses multiples généralisations. Il a ainsi permis de manière très efficace de situer le contexte des travaux plus spécialisés exposés par la suite. Stefan Erickson et Caleb Emmons ont alors pu exposer les extensions des conjectures de Stark qu'ils ont formulées dans leurs thèses.

Jonathan Sands a expliqué comment, dans le cas des extensions multiquadratiques, les outils développés pour résoudre la conjecture de Stark permettent de répondre à des questions analogues en K-théorie. Eyal Goren et son étudiant ont détaillé les constructions explicites de nombres algébriques qu'ils obtiennent dans le cas quartique CM, ainsi que les obstructions à ce que ces nombres soient des unités algébriques. L'atelier a abordé les méthodes modulaires, introduites par Henri Darmon, qui conduisent à une nouvelle approche des conjectures de Stark, les rapprochant de la question de la construction de points de Heegner sur les courbes elliptiques. Ces méthodes conduisent à une meilleure compréhension des fonctions analytiques requises par le 12e problème de Hilbert. Une avancée spectaculaire a été annoncée par Samit Dasgupta, qui laisse espérer une plus vaste généralisation n'utilisant pas la modularité. L'atelier s'est conclu par un exposé très vivant donné par Harold Stark.

Workshop
Intersection of Arithmetic Cycles and Automorphic Forms

December 12 – 16, 2005, CRM
Sponsored by NSERC, FQRNT, NATO, NSF and CRM

Organizers: Eyal Goren (McGill), Henri Darmon (McGill)
Speakers: Kathrin Bringmann (Wisconsin-Madison), Jan Bruinier (Köln), José Ignacio Burgos Gil (Barcelona), James Cogdell (Ohio State), Brian Conrad (Michigan), Katia Consani (Johns Hopkins), Henri Darmon (McGill), Samit Dasgupta (Harvard), Jens Funke (New Mexico State), Jayce Getz (Wisconsin), David Helm (Harvard), Benjamin Howard (Boston College), Paul Jenkins (UCLA), Bruno Klingler (Chicago), Jürg Kramer (Humboldt), Steve Kudla (Maryland), Ulf Kühn (Humboldt), Kristin Lauter (Microsoft Research), Ron Livne (Hebrew University), A. Raghuram (Oklahoma State), Jeremy Rouse (Wisconsin-Madison), Shou-Wu Zhang (Columbia)
Number of participants: 65

The participants came from Canada, the U.S., Germany, Spain, France, Japan and Australia. Among the participants were also graduate students and postdoctoral fellows. The skeleton of the workshop consisted of 5 lecture series. One lecture series was given by Jan Bruinier, who discussed arithmetic intersection theory on Hilbert modular surfaces and values of functions at CM points. His lectures explained the essential use of Borcherds Theory and Arakelov Theory in obtaining the results. Another lecture series was given by Brian Conrad, who explained the local intersection numbers calculations in the work of Gross and Zagier. His lectures provided a solid and conceptual foundation to such calculations and one expects that a similar approach will be indispensable in higher-dimensional cases that are yet to be studied.

Steve Kudla explained some of his research, spanning almost a decade, focusing on joint work with Michael Rapoport and Tonghai Yang that relates a particular generating series of zero cycles on an arithmetic surface and (derivatives of) an Eisenstein series (this is a sample case of the "Kudla program"). His lectures stressed again Arakelov Theory and Borcherds Theory techniques. The fourth lecture series was given by Shou-Wu Zhang, who discussed two topics. The first topic was investigated by Johan de Jong and himself and concerns sub-Shimura varieties of the moduli space of curves; the second was a survey, and discussion, of some recent results connecting period integrals and values of (derivatives of) L-functions.

The last lecture series was given by José Ignacio Burgos Gil, Jürg Kramer and Ulf Kühn, who described their joint project of extending Arakelov Theory (part of this project is in collaboration with Bruinier). The extension that is proposed is such that one can apply it to define sub-Shimura varieties of the moduli space of principally polarized abelian varieties. One could also use the proposed extension to prove finiteness results for these varieties. Such an application is inspired by Faltings' proof of the Shafarevitch conjecture. In addition to these lecture series that comprised 13 lectures, there were 14 additional talks and a colloquium talk. The additional talks covered a spectrum of topics related to the theme of the workshop. Concluding the workshop was a colloquium talk by James Cogdell, who spoke on L-functions, modularity and functoriality.

As organizers we felt that the workshop was of an exceptionally high level. Clearly some of the talks indicated the directions where intensive and influential research will take place in the coming years. The importance of Borcherds' work and Arakelov Theory was stressed throughout the workshop and provided new inspiration. The atmosphere was very friendly, cooperative and stimulating; many people were engaged in discussions during the breaks and after the lectures, and certain new

collaborations have emerged. Especially valuable was the exchange of ideas between three groups: those of arithmetic geometry, Arakelov Theory and automorphic forms, respectively.

Workshop
L-functions and Related Themes
February 13 – 17, 2006, CRM

Organizers: Chantal David (Concordia), Ram Murty (Queen's)
Speakers: Valentin Blomer (Toronto), Brian Conrey (AIM), Dorian Goldfeld (Columbia), Andrew Granville (Montréal), Gergely Harcos (Texas at Austin), Henryk Iwaniec (Rutgers), Emmanuel Kowalski (Bordeaux), Yu-Ru Liu (Waterloo), Stéphane Louboutin (Institut de Mathématiques de Luminy), Philippe Michel (Montpellier), Djordje Milicevic (Princeton), Kumar Murty (Toronto), Yiannis Petridis (CUNY), Guillaume Ricotta (Montréal), Mike Rubinstein (Waterloo), Nina Snaith (Bristol), K. Soundararajan (Stanford), Mark Watkins (Bristol)
Number of participants: 83

This workshop focused on the recent developments in the study of L-functions, and its main themes were: vanishing of L-functions, zero-free regions, size of L-functions, and moments. Many new and exciting results on those topics have been obtained in the last few years, and there are very tantalizing questions that are just at the limit of the current techniques. The skeleton of the workshop was three series of lectures by K. Soundararajan (one of the André-Aisenstadt chairs), Philippe Michel and Kumar Murty. The lectures of Soundararajan were actually Aisenstadt chair lectures (see the preceding section on the Aisenstadt chair holders). All three lectures were masterfully delivered and sounded like a concerto! It was remarkable that Soundararajan was able to present the main ideas of those techniques very explicitly in simple cases, and then to apply them in more complicated cases. His lectures were very inspiring for all participants.

The leading thread of the lectures of Philippe Michel was three classical problems of equidistribution of integral points on spheres solved by Linnik and his school in the 1960s. This choice allowed him to present, in a manner suitable for non-experts in the field, very recent techniques used to tackle new equidistribution problems about special points on homogeneous varieties under the action of an algebraic group. The experts in the field were also well served by his lectures. The recent techniques rely primarily on powerful tools from harmonic analysis, such as Langlands functoriality and approximations towards the Ramanujan – Peterson – Selberg conjecture, and on tools from ergodic theory, such as Ratner's theorem on the classification of invariant ergodic measures under the action of a unipotent subgroup. Finally, the timing of the lectures allowed Philippe Michel to relate those equidistribution problems to classical problems of analytic number theory, such as subconvexity of L-functions and non-vanishing of L-functions at the critical point.

The lectures of Kumar Murty discussed the general space of L-functions and various ways of metrizing this space. They also touched upon the new theme of limits of L-functions and the Chebotarev density theorem for infinite extensions. On the first day, Henryk Iwaniec, who has now been for decades one of the leaders in the field of L-functions and automorphic forms, gave a magnificent and inspiring talk on his recent work with John Friedlander, in which they gave a new proof of Linnik's theorem on the least prime in an arithmetic progression by using sieve methods only.

One of the remarkable features of the workshop was the very impressive talks given by junior mathematicians working in the field of L-functions (some of them still completing their Ph.D.). Valentin Blomer and Gergely Harcos gave a two-part lecture on their new results on subconvexity bounds for general L-functions of $GL(2)$; this entailed a massive amount of work and improved the previous results. Guillaume Ricotta presented his work on the non-vanishing of cubic twists of L-functions of elliptic curves, in a very lively and impressive talk. The work of Djordje Milicevic is concerned with a new and recent application of the mollification technique to large values of automorphic forms. A similar idea was also used by Soundararajan and presented in his series of lectures; it involves optimizing two quadratic forms, making one large with respect to the other. Finally, Yu-Ru Liu, who is emerging as one of the new experts on the circle method, presented her recent work on Waring's problem over function fields.

There was also a series of lectures on the mysterious connections between L-functions and random matrix theory, which have been an important source of inspiration for some recent work on L-functions. This was the topic of the lectures of Nina Snaith, Mike Rubinstein and Mark Watkins. A crucial notion that has emerged from random matrix theory over the last decade is that L-functions should be studied in families,

a notion which is also at the heart of the work of Katz and Sarnak. This notion appeared very beautifully in the work presented by Emmanuel Kowalski, who showed that over function fields, one can get upper bounds going beyond Goldfeld's conjecture in that context, in agreement with a conjecture of Conrey, Keating, Rubinstein and Snaith about the vanishing of functions over number fields for this family of functions.

In his lecture, Dorian Goldfeld presented the material of his forthcoming book on automorphic forms and L-functions on $\mathrm{GL}(n, \mathbb{R})$, giving a rigorous but elementary exposition of the subject. There is a lot of interest for such an explicit treatment of the subject. Yiannis Petridis presented some results on the distribution of primitive conjugacy classes of cofinite subgroups of $\mathrm{SL}(2, \mathbb{R})$.

Finally, the workshop ended on a very entertaining and slightly controversial talk by Andrew Granville, about work in progress with Mark Watkins on the rank of elliptic curves in families of quadratic twists. One of the conjectures presented to the audience was that for any non-CM elliptic curve defined over the rationals, there are at most finitely many square-free integers d such that the quadratic twist E_d has rank larger than 10! This talk inspired a lively discussion between the participants, a perfect finale for a very successful week. The organizers hope that the participants went back home with new questions, answers and directions for their research!

Workshop
Anatomy of Integers
March 13 – 17, 2006, CRM

Organizers: Jean-Marie De Koninck (Laval), Andrew Granville (Montréal)
Speakers: Antal Balog (Rényi Institute), William Banks (Missouri), Valentin Blomer (Toronto), Régis de la Bretèche (Paris-Sud), Jan Cannizzo (Stevens Institute), Ernest S. Croot (Georgia Tech), Cécile Dartyge (Nancy 1), Kevin Ford (Illinois at Urbana-Champaign), John Friedlander (Toronto), Gagan Garg (Indian Institute of Science), Dan Goldston (San Jose State), Andrew Granville (Montréal), Harald Andres Helfgott (Montréal), Rizwan Khan (Michigan), Sergei Konyagin (Moscow State), Youness Lamzouri (Montréal), Yu-Ru Liu (Waterloo), Florian Luca (UNAM), Greg Martin (UBC), Ariane Masuda (Carleton), Elie Mosaki (Lyon 1), Jean-Louis Nicolas (Lyon 1), Paul Pollack (Princeton), Carl Pomerance (Dartmouth), K. Soundararajan (Stanford), Cameron L. Stewart (Waterloo), Trevor Wooley (Michigan), Jie Wu (Nancy 1)
Number of participants: 77

The workshop *Anatomy of Integers* gathered about 70 participants from many different countries around the world. There has never really been a meeting dedicated to these questions before; even though this subject includes some of the most important questions in analytic number theory, they have always been seen as part of other topics. Many of the participants seemed to really enjoy the focus of the conference. There are two major "schools" in this area, one in North America, the other centered in France. The two schools have rarely come together, and on this occasion we saw many of the leading young French researchers in North America and there were some positive interactions.

Two of the biggest breakthroughs in this area in the last few years are described below. 1. The proof of Goldston, Pintz and Yildirim that there are "small" gaps between primes infinitely often (this uses classical sieve theory). Goldston gave a three-hour lecture series at the workshop entitled *Small Prime Gaps*: *From the Riemann Zeta Function and Pair Correlation to the Circle Method*, in which he gave a broad perspective on such questions and indeed his own failed attempts over the last fifteen years! It was a masterful account of many related ideas and the development of thought in the subject. 2. There are many famous questions on the distribution of divisors of integers, a subject that long intrigued Paul Erdős.

The question of how often an integer has a pair of divisors a and b with $a < b < 2a$ has not been well understood until the recent publication of a highly insightful paper by Kevin Ford. Professor Ford gave a three lecture series on his work, in which he resolves several conjectures of Erdős, and indeed his work makes it necessary to rewrite what are the main questions to be studied in this area. Most intriguing perhaps is how Ford converts the problem into questions about random walks and answers questions very similar to some of those that appear in recent developments of percolation theory.

Aisenstadt lecturer Soundararajan gave two lectures on some of his exciting recent results. In the first lecture he spoke on his improvement (with Granville) of the Polya – Vinogradov inequality, and in the second, on his work with Lagarias on smooth solutions to $a + b = c$. This result was improved (during the meeting) by

Soundararajan, working with Konyagin. Konyagin was also inspired to improve a long standing result on finding as many solutions as possible to $a + b = c$ in S-units, giving examples of sets S with more than $\exp(|S|^{2-\sqrt{2}})$ solutions (Evertse's upper bound is $\exp(c|S|)$).

Other principal lecturers included Carl Pomerance, who gave a beautiful historical survey on the anatomy of Euler's function and its friends; Harald Helfgott, who spoke on his spectacular recent work on bounding the number of primes p for which $f(p)$ is a kth power; Ernie Croot, who spoke on his joint work with Granville and Tetali to give very good bounds on the running time of the "matrix part" of the quadratic sieve factoring algorithm, and to understand the anatomy of the integers that make up the square in that part of the algorithm. Jean-Louis Nicolas gave a lovely survey entitled *Parity of the values of the partition function and anatomy of integers*, and Jie Wu a survey entitled *Moyennes de certaines fonctions arithmétiques sur les entiers friables* (which described mostly joint work with Tenenbaum). Finally, Régis de la Bretèche gave a beautiful survey on his important work with Tenenbaum (*A Turan – Kubilius inequality for friable integers, with applications*).

There were also some outstanding shorter talks including a talk on smooth twins by Antal Balog, a talk on sums of smooth squares by Valentin Blomer, and a talk on smooth numbers and the circle method by Trevor Wooley. John Friedlander outlined his work on a polynomial divisor problem with Iwaniec. Cam Stewart presented his surprisingly strong theorems on pure powers in short intervals. Cécile Dartyge outlined her research with Tenenbaum in a talk entitled *Congruences for the sum of digits of polynomial values*. Greg Martin presented his results and conjectures on smooth values of polynomials.

Two fantastic new results were discussed: Yu-Ru Liu made quite a stir by proving the Erdős – Pomerance's conjecture for the Carlitz module, and Sergei Konyagin discussed his breathrough on covering congruences in *Sieving by large moduli* (obtained in collaboration with Filaseta, Ford, Pomerance and Gang Yu). There were several talks by graduate students, two of the most exciting being given by Paul Pollack and Ariane Masuda. They were both intrigued by Chris Hall's very simple proof that there are infinitely many pairs of irreducible polynomials $\{f, f+1\}$ in any given finite field. Pollack generalized this to prove a "weak prime k-tuples conjecture in finite fields," and Masuda to find "consecutive smooth polynomials over a finite field."

School
CRM – Clay School on Additive Combinatorics

March 30 – April 5, 2006, CRM
Sponsored by the Clay Foundation, CRM, NSERC, NSF, FQRNT and DIMATIA (Czech Republic)

Organizers: Jozsef Solymosi (UBC), Andrew Granville (Montréal), David Ellwood (Clay)
Introductory lecturers: Jozsef Solymosi (UBC), Andrew Granville (Montréal)
Key lecturers: Ben Green (Bristol), Bryna Kra (Northwestern), Terence Tao (UCLA), Van H. Vu (Rutgers)
Guest lecturers: Antal Balog (Rényi Institute), Gregory Freiman (Tel Aviv), Imre Ruzsa (Rényi Institute), Endre Szemerédi (Rutgers & Rényi Institute)
Number of participants: 118

The school started with two introductory mini-courses to prepare the students for the main lecture series, given by Andrew Granville and Jozsef Solymosi. Jozsef Solymosi gave an introduction to Hungarian style combinatorial geometry, and in particular the connection with Roth's theorem and related results. Andrew Granville developed a historical view of combinatorial number theory, then gave complete proofs of the Freiman – Ruzsa structure theorem, and of Roth's theorem in the spirit of Gowers.

The mini-courses were followed by the lecture courses, that occupied the bulk of the week. In his lecture series *Quadratic Fourier analysis*, Ben Green explained beautifully the essential ideas that go into the new multi-dimensional Fourier analysis by expounding on the simplest new case, quadratic Fourier analysis. The key idea is to break functions up into a part that reflects structure and a part that reflects random behaviour, something that can now be done very efficiently. Bryna Kra gave the audience insights into ergodic methods in combinatorial number theory. Starting with a detailed explanation of Furstenberg's key ideas for proving Szemerédi's theorem, she showed how research in ergodic theory is developing today (as in her work with Host), and especially how it is affecting the development of methods in combinatorial enumeration and in modern harmonic analysis.

Terence Tao has been fascinated by the three existing proofs of Szemerédi's theorem: a proof

by combinatorial graph theory (Szemerédi), one by ergodic theory (Furstenberg) and one by Fourier analysis (Gowers); and by various new proofs and combinations and developments of the above. In *Combinatorial and ergodic techniques for proving Szemerédi-type theorems*, Tao pulled together these various strands and explained beautifully the analogies between the different approaches. Most lovely was his development of an analytic analogy to the Ruzsa – Szemerédi triangle removal lemma. Van Vu, in *Structure of sumsets and applications*, gave details of the proof of his result with Szemerédi on the existence of long arithmetic progressions in sumsets; they recently obtained the best possible results, conjectured by Erdős.

The four principal lecturers were absolutely terrific. Each had given tremendous thought to his or her talks, and all are excellent lecturers. On Saturday, Antal Balog gave a "special guest lecture" on the Balog – Szemerédi – Gowers theorem, providing a complete proof. On several afternoons we had a discussion session at the end of the day, which provided the students with the opportunity to ask questions about the points they had not understood. On Monday evening Terry Tao gave his Aisenstadt Lecture, *Long arithmetic progressions in the primes*, to a packed room.

On the final day, the three senior mathematicians who did the most to create this field were invited to give presentations. The students found this a very exciting event to wrap up the school and, indeed, these "celebrities" were given an ovation before and after their lectures! Imre Ruzsa gave a beautiful presentation of consequences of Plunnecke's theorem, as well as his recent thoughts on non-abelian analogues. Endre Szemerédi gave a proof of Roth's theorem he first developed twenty-five years ago but never published. Finally, Gregory Freiman gave a lecture entitled *Inverse additive number theory*: *results and problems*. The school ended up with a panel discussion involving all of the speakers, and speculation as to what is the best possible form of Roth's theorem.

The overall atmosphere at the meeting was superb, because of the remarkable quality of the lecturing and the lecturers' desire to be available to the students.

Workshop
Additive Combinatorics

April 6 – 12, 2006, CRM
Sponsored by the Clay Foundation, CRM, NSERC, NSF and DIMATIA (Czech Republic)

Organizers: Jozsef Solymosi (UBC), Andrew Granville (Montréal)
Plenary lecturers: Jean Bourgain (IAS), Mei-Chu Chang (UC Riverside), Timothy Gowers (Cambridge), Harald Helfgott (Montréal), Ben Green (Bristol), Imre Ruzsa (Rényi Institute), Terence Tao (UCLA), Tamar Ziegler (IAS)
Speakers: Daniel Berend (Ben Gurion), Manjul Bhargava (Princeton), Gautami Bhowmik (Lille 1), Javier Cilleruelo (Universidad Autónoma de Madrid), David Conlon (Cambridge), Ernie Croot (Georgia Tech), Jean-Marc Deshouillers (Bordeaux), György Elekes (Eötvős Loránd), Christian Elsholtz (Royal Holloway, University of London), Jacob Fox (MIT), Nikos Frantzikinakis (Memphis), Alexey Glibichuk (Moscow State), Ron Graham (UC san Diego), Laurent Habsieger (Lyon 1), Alex Iosevich (Missouri), Koichi Kawada (Iwate), Sergei Konyagin (Moscow State), Bryna Kra (Northwestern), Michael Lacey (Georgia Tech), Vsevolod Lev (Haifa at Oranim), Akos Magyar (Georgia), Ram Murty (Queen's), Melvyn Nathanson (CUNY Lehman College), Jaroslav Nešetřil (Charles, Prague), Gyan Prakash (Harish-Chandra Institute), Vidhu Prasad (UMass Lowell), Maria Roginskaya (Chalmers University of Technology), Tom Sanders (Cambridge), Ilya Shkredov (Moscow State), Yonutz Stanchescu (The Open University of Israel), Balázs Szegedy (Toronto), Sanju Velani (York, England), Trevor Wooley (Michigan)
Number of participants: 145

The Workshop on Additive Combinatorics was attended by 145 participants from about 30 countries. The meeting was a high profile event with many of the world's leading analysts participating, including Jean Bourgain, Tim Gowers, Terence Tao, Ben Green and Sergei Konyagin. This reflected the great interest in the meeting, the third ever in the subject. The plenary lecturers were Terence Tao, Harald Helfgott, Jean Bourgain, Mei-Chu Chang, Tamar Ziegler, Ben Green, Timothy Gowers and Imre Ruzsa. Terence Tao gave a talk entitled *An infinitary approach to (hyper)graph regularity and removal*, in which he explained how he uses the constructions of ergodic theory to avoid complicated estimates yet obtains explicit results.

Harald Helfgott discussed his surprising breakthrough on growth and generation in $SL_2(\mathbb{Z}/p\mathbb{Z})$. In *Sum-product and expanders*, Jean Bourgain discussed his work with Gamburd and Sarnak extending Helfgott's result to other groups, and then some stunning consequences of this work, particularly with reference to certain sieve questions. Jean Bourgain gave a second plenary talk, *More applications of the sum-product theorem and the quantum cat map*, in which he solves a well-known question of Kurlberg and Rudnick. Then Mei-Chu Chang gave more details of her work with Bourgain in a talk entitled *Sum-product theorems, exponential sum bounds and applications*, describing results that are having an enormous impact on analytic number theory.

Tamar Ziegler proved a wonderful old conjecture of Erdős by ergodic theory methods in *Configurations in sets of positive upper density in* $\mathbb{R}^m$. One of the key difficulties in Gowers' norms is understanding the structures on which they take large values. At this stage of development of the subject, it seems vital to give a more accessible description that can be useful for Fourier analysts, and this was the focus of Bryna Kra in *Gowers norms in ergodic theory and additive combinatorics*. In *Linear equations in primes*, Ben Green discussed his latest work with Terence Tao, where they try to generalize their methods as much as possible in the direction of the prime k-tuples conjecture. In particular they outlined plans to show that for any admissible set of k linear forms, no two of which are linearly dependent over the integers, there are infinitely many integer values for the variables such that the forms all simultaneously take on prime values.

One key issue in understanding Szemerédi's theorem completely is to understand circumstances in which one has significantly fewer arithmetic progressions of length 4 than expected, in spite of the fact that all of the Fourier coefficients are small. Timothy Gowers described his new elegant construction in *A uniform set with few progressions of length* 4. Gowers norms have proved very fruitful in the hands of the analysts and they affect the more classical methods of analytic number theory in very interesting ways. Trevor Wooley and Antal Balog have been developing variants of the circle method after the work of Gowers (this is the title of their talk!), and explained how one can now do much better in the key Diophantine questions in the circle method. The final plenary talk, by Imre Ruzsa, entitled $2A$ *and* $3A$, gave details of his new fundamental results on sumsets, particularly in the non-abelian setting, for bounds on the size of $A + B + C$.

There were many other exciting talks, which we cannot all mention here. For instance, Sergei Konyagin gave new results on the additive properties of product sets in fields of prime order. After his lecture, Harald Helfgott made a few observations that allowed Konyagin to prove the remaining major conjectures in this area! György Elekes discussed his recent work with Ruzsa (*On the structure of sets with many 'medium-size' arithmetic progressions*). After the lecture, Andrew Granville pointed out that this should easily lead to a general structure theorem for almost all arithmetic progressions inside a set. One of the most extraordinary talks was by Balázs Szegedy, who, in joint work with László Lovász, has been developing a theory of "graph limits," allowing them to prove many of the deep theorems of Szemerédi, Ruzsa and others by passing to limits and applying topological techniques to such graph sets. This work comes close to some the ideas of Tao.

There were also several lectures on Ramsey theory, which is an important and related subject. We heard Ron Graham speak on some of his favorite Ramsey theory problems and Jaroslav Nešetřil give a broad survey on Ramsey classes of finite structure. A graduate student, David Conlon, has made an enormous advance reported in *New upper bounds for Ramsey numbers*, the biggest increase in the bounds since the 1930s! An undergraduate student, Jacob Fox, described his many beautiful contributions to infinite Ramsey theory in *Partition regularity of linear equations*, in which many answers depend on which axioms of arithmetic one assumes!

Workshop
Analytic Methods for Diophantine Equations

May 13 – 18, 2006, Banff International Research Station
Organized jointly with MSRI

Organizers: Andrew Granville (Montréal), Yuri Tschinkel (Göttingen), Michael Bennett (UBC), Chantal David (Concordia), Bill Duke (UCLA)
Speakers: Arthur Baragar (Nevada), Valentin Blomer (Toronto), Régis de la Bretèche (Paris-Sud), Tim Browning (Bristol), Jean-Louis Colliott-Thélène (Paris-Sud), Pietro Corvaja (Udine), Ulrich Derenthal (Göttingen), Noam Elkies (Harvard), Jordan Ellenberg (Wisconsin-Madison), Andrew Granville (Montréal), Roger

Heath-Brown (Oxford), Harald Helfgott (Montréal), Noriko Hirata-Kohno (Nihon), Patrick Ingram (UBC), Michael Joyce (Tulane), Hershy Kisilevsky (Concordia), Aaron Levin (Brown), Preda Mihailescu (Göttingen), Per Salberger (Chalmers University of Technology), Alexei Skorobogatov (Imperial College), Ramin Takloo-Bighash (Princeton), Jeff Thunder (Northern Illinois), Yuri Tschinkel (Göttingen), Ronald von Luijk (UC Berkeley), Trevor Wooley (Michigan)
Number of participants: 39

Some of the oldest questions in mathematics stem from the desire to find integer solutions to equations. From the equation in Pythagoras' theorem to Fermat's last theorem, Waring's problem, the *abc*-conjecture and Manin's conjecture, professional and amateur mathematicians alike are thrilled in trying to prove that there are no solutions, or to determine solutions, or to count solutions. With such a venerable topic it is not surprising that there are many competing approaches to such questions, some whose time has already come, some that are very hot methods right now, and some whose time is yet to come. At this meeting at BIRS there were participants from many of the different schools of thought in this fascinating subject; it was an interesting opportunity for them to come together and find common ground.

During the last academic year two of the world's major research institutes, the CRM and the Mathematical Sciences Research Institute (MSRI) in Berkeley, have hosted semester long programs on different aspects of these questions. It was decided to get together at the end of the academic year for a joint meeting, to discuss issues that arose at the thematic programs of both institutes. Thus the participants were primarily people who had attended one special year or the other, though perhaps a third were other researchers who are expert in Diophantine equations.

Perhaps the most consistent theme of this meeting was the topic of counting points on higher dimensional varieties, particularly Manin's conjecture. We heard a highly motivating survey by Yuri Tschinkel, exciting new research from a geometric perspective by Per Salberger, from a perspective of automorphic forms by Ramin Takloo-Bighash and from a perspective closer to Diophantine approximations by Jeff Thunder. There were exciting and controversial new perspectives on Manin's conjecture on $K3$ surfaces from Arthur Baragar and Ronald von Luijk. To understand Manin's conjecture on del Pezzo surfaces we heard an explanation of a basic example by Michael Joyce and saw a representation theoretic approach to universal torsors by Alexei Skorobogatov, and a direct approach to these torsors by Ulrich Derenthal.

Among new results was one announced by Régis de la Bretèche who showed that a specific height zeta function (for a toric cubic surface) cannot be analytically continued to the whole complex plane (it has a natural boundary), so that the "Riemann Hypothesis" is not even a sensible question in general. To count points on higher dimensional varieties one can also proceed by the classical circle method. Roger Heath-Brown told us about his recent major breakthrough for counting points on cubic hypersurfaces (reducing the number of variables in Davenport's famous result). The extension to quartic varieties was discussed by Tim Browning. Trevor Wooley explained his idea to prove that the local-global principle works almost always and discussed what he has shown to date.

Noam Elkies showed how root numbers in families of elliptic curves, in combination with heuristics, could be used to predict surprising behavior regarding uniform boundedness of ranks of elliptic curves over number fields, and to contradict a well-known conjecture on the topology of rational points. Andrew Granville explained his new conjectures on the distribution of rational and integral points on curves and specifically how they have an impact in a provocative way on the question of the ranks of elliptic curves. Aaron Levin developed techniques of Vojta to bound the number of rational points on curves of genus 1 over fields of bounded degree; and Jordan Ellenberg gave impressive new upper bounds, from his work with Akshay Venkatesh, on the heights of points of curves of genus 1, breaking through what had seemed to be a difficult barrier from the work of Heath-Brown.

There were also several talks on related questions. Noriko Hirata-Kohno improved Evertse's theorem by giving good bounds on the total number of solutions of certain Fermat-type Diophantine equations. Preda Mihailescu showed that techniques in the theory of cyclotomic fields could be used to bound the solutions of certain Ljunggren – Nagell type equations. Valentin Blomer improved the error term in the known approximations for representations by ternary quadratic forms using his recent work on convexity-breaking. Pietro Corvaja explained how to show that there are large prime fac-

tors of any Markov pair and Patrick Ingram showed that multiples of integral points on elliptic curves cannot themselves be integral, except in certain obvious cases.

Jean-Louis Colliott-Thélène presented an extension of the Brauer – Manin obstruction to integral points (instead of rational points), and showed how it explained recent results on integral quadratic forms. Hershy Kisilevsky showed how points on cubic twists give rise to points on certain $K3$ surfaces; combining this with work of the Dokshitzers one discovers surprising families of surfaces which must contain rational points. Finally Harald Helfgott conjectured that the only extreme examples in the large sieve are the images of points from a finite set of curves, and indicated how he proved this in two dimensions (with Akshay Venkatesh).

All participants seemed to have greatly enjoyed the meeting. It was an interesting "coming together" of different approaches to important questions, and most speakers tried to be accessible, so a lot was learned. Several new collaborations were formed during the meeting; some results were even proved while in Banff.

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.

Here follows a list of thematic activities organized by CRM since 1987:

2004 – 2005 The Mathematics of Stochastic and Multiscale Modeling
2003 – 2004 Geometric and Spectral Analysis
2002 – 2003 Math 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 (Focal 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

Short Program on Random Matrices, Random Processes and Integrable Systems

June 20 – July 8, 2005, CRM
Organized by CIRGET and the Mathematical Physics Laboratory

Organizers: John Harnad (Concordia), Jacques Hurtubise (McGill)
Lecture series speakers: Mark Adler (Brandeis), Pavel Bleher (IUPU Indianapolis), Bertrand Eynard (CEA, Saclay), Alexander Its (IUPU Indianapolis), Ken McLaughlin (Arizona), Craig Tracy (UC Davis), Pierre van Moerbeke (Louvain & Brandeis), Harold Widom (UC Santa Cruz)
Workshop speakers: Marco Bertola (Concordia), Brian Conrey (American Institute of Mathematics), Percy Deift (Courant), Philippe di Francesco (CEA, Saclay), Sam Howison (Oxford), Vladimir Kazakov (ENS, Paris), Dmitri Korotkin (Concordia), Arno Kuijlaars (Leuven), Andrei Okounkov (Princeton), Alexander Orlov (Oceanology Institute, Moscow), Alexander Soshnikov (UC Davis), Nina Smith (Bristol), Anton Zabrodin (ITEP, Moscow), Ofer Zeitouni (Minnesota & Technion), Paul Zinn-Justin (Paris-Sud), Jean-Bernard Zuber (CEA, Saclay)
Number of participants: 71

This program tried to emphasize the remarkable connections between two domains that a priori seem unrelated: random matrices (together with associated random processes) and integrable systems. The relations between random matrix models and the theory of classical integrable systems have long been studied. These appear mainly in the deformation theory, when parameters characterizing the measures or the domain of localization of the eigenvalues are varied. The resulting differential equations determining the partition function and correlation functions are, remarkably, of the same type as certain equations appearing in the theory of integrable systems. They may be analyzed effectively through methods based upon the Riemann – Hilbert problem of analytic function theory and by approaches related to the study of nonlinear asymptotics in the large N limit. Associated to studies of matrix models are certain stochastic processes, the "Dyson processes," and their continuum limits, which are related to the spectra of random matrix ensembles, and may also be studied by related methods.

Besides the well-known physical applications of random matrix theory, such as the Wigner – Dyson statistical approach to the distribution of high-lying resonances of large nuclei, and the more recent applications to string theory and two-dimensional quantum gravity, there exist further new applications under current study, such as the computation of correlation functions in supersymmetric Yang – Mills theory, and the regularization of the Laplacian growth problem of two-dimensional fluid dynamics. Correlation functions between eigenvalues of random matrices also have close similarities to those in integrable quantum spin systems and many-body models. There are further remarkable connections to a variety of probabilistic problems such as random words, tilings and partitions, as well as to the statistical distribution of zeros of L-functions.

The program provided an opportunity for productive interactions, bringing together top experts and younger researchers beginning work in this area The schedule consisted of two parts. There were eight extended lecture series on related topics, each of one week's duration, having a survey and pedagogical character and aimed primarily at younger researchers entering the field. The afternoon sessions were of "workshop" character, with one-hour talks presented on current work in the field, and contributed talks on topics closely related to the theme of the program. Roughly half the participants were either young researchers, postdoctoral fellows or advanced graduate students, and most of these received partial financing to help cover their travel and/or accommodation expenses.

The main topics covered were the following: spectral theory of random matrices; determinantal ensembles; integral operators in random matrix theory; Dyson processes and Airy, Bessel, sine and Laguerre processes; matrix Riemann-

Hilbert methods and applications to large N asymptotics; differential equations for gap distributions and transition probabilities; relations to integrable systems and isomonodromic deformations; growth processes and applications to fluid dynamics and crystal growth; applications to random tilings, random words and random partitions; applications to L-functions; applications to multivariate statistics. The lecture series part of this program will be published in the Springer *CRM Series in Mathematical Physics*, and the workshop proceedings will be published as a refereed Special Issue of the *Journal of Physics A*: *Mathematical and General* (Volume 39, Number 14, July 2006).

Probability and Mathematical Physics — A Conference in Honor of Stanislav Molchanov's 65th Birthday

June 27 – July 1, 2005, CRM
Organized by the Mathematical Analysis Laboratory

Organizers: Don Dawson (Carleton & McGill), Vojkan Jaksic (McGill), Boris Vainberg (UNC Charlotte)
Speakers: Leonid Bogachev (Leeds), Rene Carmona (Princeton), K. Chen (UNC Charlotte), Gregory Derfel (Ben Gurion), Alexander Figotin (UC Irvine), Mark Freidlin (Maryland), Jürgen Gärtner (Berlin), François Germinet (Cergy-Pontoise), Y. Godin (UNC Charlotte), Ilya Goldsheid (London), Alexander Gordon (Rochester), Rostislav Grigorchuk (Texas A&M), J. Holt (UNC Charlotte), Dirk Hundertmark (Illinois at Urbana-Champaign), Kostya Khanin (Heriot-Watt), Werner Kirsch (Ruhr), Alex Kiselev (Wisconsin-Madison), Abel Klein (UC Irvine), Frédéric Klopp (Paris 13), Wolfgang König (Leipzig), Leonid Koralov (Princeton), Peter Kuchment (Texas A&M), Ari Laptev (Royal Institute of Technology, Stockholm), Yoram Last (Hebrew), N. Minami (Japan), Peter Müller (Göttingen), P. Poulin (McGill), Joan Quinn (Queens College, North Carolina), Alejandro Ramirez (Pontificia Universidad Católica de Chile), Barry Simon (Caltech), Alexander Soshnikov (UC Davis), Thomas Spencer (IAS), Mihai Stoiciu (Caltech)
Number of participants: 47

This conference was in honor of Stanislav Molchanov (North Carolina at Charlotte), a leading probabilist and mathematical physicist who turned 65 in 2005. The topics discussed at the conference were closely related to the research interests (past and present) of Stas Molchanov and covered vast areas of pure and applied mathematics. The conference opened, on Monday morning, with talks by Barry Simon and his graduate student M. Stoiciu on closely related matters concerning the structure of zeros of orthogonal polynomials. In particular, M. Stoiciu talked about the orthogonal polynomial analog of Molchanov's celebrated result on Poissonian statistics of eigenvalues. Two long-term collaborators of Stas, W. Gärtner and W. König, then gave talks on the parabolic Anderson model. In the afternoon, A. Klein and F. Germinet reported on new and truly spectacular results in the spectral theory of random Schrödinger operators, while Y. Last gave a beautiful review of the structural properties of Anderson type Hamiltonians. The final talk was by A. Soshnikov, whose career began in Moscow under Molchanov's supervision.

On the second day, spectral theory, group theory and combinatorics were discussed in the morning (A. Laptev, P. Kuchment, R. Grigorchuk, N. Minami), while the afternoon was devoted to financial (R. Carmona) and applied mathematics (A. Kiselev, M. Freidlin), as well as probabilistic interacting particle systems (A. Ramirez). The talks of Wednesday morning were focused on statistical mechanics (A. Figotin, B. Vainberg, L. Koralov), and the last talk (G. Derfel) dealt with the asymptotics of the Poincaré functions. On Thursday morning, I. Goldsheid reported on spectacular new results concerning Liapunov exponents, S. Warzel presented a new proof of the celebrated result of Klein on extended states for the Anderson model on the Bethe lattice, and K. Khanin dealt with random walks in a quasi-stationary random potential. The first two talks in the afternoon were "random": Y. Godin discussed the random string and L. Bogachev, a former student of Molchanov, the random exponentials. In the afternoon, P. Müller reported on new results concerning spectral asymptotics of Laplacians on bond-percolation graphs. In the final talk, A. Gordon, another former student of Molchanov, discussed the Cantor spectrum for almost periodic one-dimensional Schrödinger operators.

On the morning of the last day, F. Klopp talked about the exponential sums related to the Kronig – Penney model in a constant electric field, while D. Hundertmark discussed bounds on the spectral shift functions. W. Kirsch then gave a very intriguing talk entitled *The draft constitution of the EU, the Electoral College and spin systems*. Finally, J. Quinn, a close collaborator of Stas, dis-

cussed random generators and various tests for randomness with roots in quantum mechanics. The afternoon talks were given by graduate students (K. Chen, J. Holt and P. Poulin). The proceedings of the conference will be published in the CRM/AMS Proceedings and Lecture Notes.

Strings05

July 11 – 16, 2005, University of Toronto

Sponsors: Fields Institute, Perimeter Institute, Pacific Institute of Theoretical Physics, CRM, Canadian Institute for Advanced Research, Canadian Institute for Theoretical Astrophysics, Institute of Particle Physics, PIMS
Organizers: Alex Buchel (Perimeter & Western Ontario), Jaume Gomis (Perimeter), Kentaro Hori (Toronto), Robert Myers (Perimeter & Waterloo), Amanda Peet (Toronto)
Speakers: Nima Arkani-Hamed (Harvard), Vijay Balasubramanian (Pennsylania), Melanie Becker (Maryland), Niklas Beisert (Princeton), Iosif Bena (UCLA), Dick Bond (CITA & Toronto), Raphael Bousso (UC Berkeley), Freddy Cachazo (Perimeter), Atish Dabholkar (Tata Institute), Frederik Denef (Rutgers), Robbert Dijkgraaf (Amsterdam), Michael Dine (Santa Cruz Institute for Particle Physics), Michael Douglas (IHES and Rutgers), Henriette Elvang (UC Santa Barbara), Sergey Frolov (Max-Planck-Institut fur Gravitationsphysik & Albert-Einstein-Institut), Amihay Hanany (MIT), Petr Horava (UC Berkeley & LBNL), Gary Horowitz (UC Santa Barbara), Anton Kapustin (Caltech), Shamit Kachru (SLAC, Stanford), Renata Kallosh (Stanford), Per Kraus (UCLA), Martin Kruczenski (Brandeis), Hong Liu (MIT), Oleg Lunin (IAS), Juan Maldacena (IAS), Dario Martelli (CERN), Hirosi Ooguri (Caltech), Joseph Polchinski (UC Santa Barbara), Fernando Quevedo (Cambridge), Albert de Roeck (CERN), Vyacheslav Rychkov (ITFA, Amsterdam), Nathan Seiberg (IAS), Ashoke Sen (Harish-Chandra Institute), Steve Shenker (Stanford), Eva Silverstein (SLAC, Stanford), Andrei Starinets (Perimeter), Andrew Strominger (Harvard), Shigeki Sugimoto (Yukawa Institute for Theoretical Physics, Kyoto), Lennie Susskind (Stanford), Tadashi Takayanagi (Harvard), Alessandro Tomasiello (ITP, Stanford), Henry Tye (Cornell), Angel Uranga (Universidad Autónoma de Madrid), Erik Verlinde (ITFA, Amsterdam), Bernard de Wit (Institute for Theoretical Physics and Spinoza Institute, Utrecht), Edward Witten (IAS), Shing-Tung Yau (Harvard), Barton Zwiebach (MIT)
Number of participants: 419

The Strings 2005 conference was held as the culmination of the activities organized for the theme year, *The Geometry of String Theory*, which is being hosted jointly by the Fields Institute and the Perimeter Institute (in Waterloo). The "Strings" conferences are the premiere international conference series in the field of string theory. Every year, it brings together leading researchers from around the world to discuss the latest developments in string theory. Strings05 brought roughly 440 researchers to the first such conference to be held in Canada. The meeting took place in the Medical Sciences building at the University of Toronto from July 11 to 16, 2005.

As is traditional with the "Strings" meetings, the bulk of the conference was devoted to invited talks highlighting recent progress in the field and charting out new directions. A sampling of topics includes: new developments in the microscopic description of black hole entropy, understanding physics on the string theory landscape, a possible holographic description of the quark-gluon plasma, and supersymmetry breaking in type IIB flux compactifications. The range of speakers was very broad, extending from established luminaries, such as Renata Kallosh, Ashoke Sen and Ed Witten, to new upcoming postdocs and graduate students The latter would include: Henriette Elvang, who is just finishing her PhD at UCSB; Vyacheslav Rychkov, in his first postdoc at Amsterdam; and Andrei Starinets, a postdoc at Perimeter.

The organizers experimented with several innovations, which gave the conference a unique Canadian flavour. Four of the morning sessions began with hour-long review talks, including: *Topological string theory* by Hirosi Ooguri (Caltech); *Constructions and distributions of string vacua* by Frederik Denef (Rutgers); *Applying integrability in AdS and CFT* by Niklas Beisert (Princeton); *Recent progress in perturbative gauge theories* by Freddy Cachazo (Perimeter). These early morning reviews were skillfully presented, providing a streamlined, incisive summary of the exciting developments achieved in these subjects over the past couple of years.

Another innovation was to finish three of the days with a talk from one of the "affiliated" areas; that is, other subject areas which are of direct interest to string theory or areas with which string theory hopes to make contact. Dick Bond began the week with a review of the status of experimental cosmology and the prospects for measuring the fundamental cosmological pa-

rameters that string theory will have to predict. On Tuesday, Nima Arkani-Hamed gave us his vision of how particle theory will advance in the next decade with the advent of new data from the Large Hadron Collider (LHC) at the CERN laboratory in Geneva. Hopefully these experiments will reveal Nature's choice for the physics at the so-called "electroweak scale." Finally on Friday, Albert de Roeck, a CERN experimentalist, gave his perspective on the challenges and opportunities that lie ahead at the LHC.

Our conference marked the tenth anniversary of the now famous Strings 1995 conference, held at the University of Southern California, which marked the beginning of what is now commonly known as the "Second Superstring Revolution." This anniversary was an opportunity to reflect back on the unanswered questions from the previous decade, and to discuss the future prospects for connections between string theory and the next set of exciting experiments. The forum was a panel discussion entitled *The Next Superstring Revolution*, masterfully led by Steve Shenker. The panel was composed of eight leading figures in the field: Raphael Bousso, Shamit Kachru, Ashoke Sen, Juan Maldacena, Andrew Strominger, Joseph Polchinski, Eva Silverstein and Nathan Seiberg.

A poster session was introduced to make the meeting more inclusive and to allow as many interested participants as possible to present their research. As a result, over 50 posters were set up during the week describing a wide variety of topics, from *D-term Cosmic Strings from* $N = 2$ *Supergravity* to *Duality between Open Gromov–Witten Invariants and Beilinson–Drinfeld Chiral Algebra*. These were all viewed by a large number of participants. The conference ended on a high note. First the technical session was closed by Shing-Tung Yau with a seminar on *Superstring theory with torsion* and an invitation to come to Beijing for Strings06.

The final session consisted of two public lectures by international superstars in string theory, on Saturday afternoon. First, Robbert Dijkgraaf spoke on *Strings, black holes, and the end of space and time*. This was followed by Lennie Susskind with *Cosmic landscape: string theory and the illusion of intelligent design*. These masterful lecturers led the capacity audience of over 500 on two engaging tours of mind-bending concepts like warped space-time, black holes, strings, the big bang and the ultimate fate of the universe. Undoubtedly, Strings05 provided an immense boost to the international profile of string theory research in Canada. The talks and activities of the conference are recorded at the Strings05 website: `www.fields.utoronto.ca/programs/scientific/04-05/string-theory/strings2005`. The organizing committee would like to thank Alison Conway, Fields' Program Director, for her calm guidance and continued efforts over the past year to ensure the great success of the meeting.

Mini-workshop on Computational Aspects of Dynamical Systems

July 15, 2005, Concordia
Organized by the Applied Mathematics Laboratory

Organizer: Sebius Doedel (Concordia)
Speakers: Michael Henderson (IBM T.J. Watson Research Center), Tony Humphries (McGill), Bernd Krauskopf (Bristol), Hinke Osinga (Bristol), Randy Paffenroth (Caltech)
Number of participants: 15

A "mini-workshop" on Computational Aspects of Dynamical Systems was held on July 15, 2005, in the new Engineering and Visual Arts Building of Concordia University. This workshop was attended by members of the Applied Mathematics Laboratory of the CRM and by graduate students from the Montréal universities. It was similar in scope and format to the one held in 2004, and a third workshop is planned for the summer of 2006. The purpose of the workshop was to exchange ideas on computational problems in the numerical study of dynamical systems that arise in important practical applications. Another focus was the development and use of visualization techniques that help understand the complex data that arise from such advanced numerical computations.

The speakers were: Bernd Krauskopf, who presented new results on bifurcations of mutually delay-coupled lasers; Tony Humphries, who described computational and analytic challenges in the analysis of travelling waves in lattice differential equations near propagation failure; Hinke Osinga, who demonstrated how boundary value techniques allow the computation of one-dimensional manifolds of Poincaré maps in slow-fast systems (where standard techniques fail); Michael Henderson, who presented a novel topological approach to computing multidimensional manifolds in dynamical systems, such as hyperbolic closed invariant manifolds, and, potentially, inertial manifolds; and Randy Paffenroth, who presented new, high-order methods in computational electromagnetism, which have

been implemented on a large-scale parallel computer at Caltech.

5th International Conference on Words

September 13 – 17, 2005, LaCIM (UQÀM)

Sponsors: CRM, Ministère de l'Éducation, du Loisir et du Sport du Québec, Faculté des Sciences de l'UQÀM, PIMS, VSIS ConfTool, Chaire de recherche du Canada en algègre, combinatoire et informatique mathématique, Café Rico (Montréal)
Organizers: Srecko Brlek (UQÀM), Cédric Chauve (Simon Fraser & UQÀM), Annie Lacasse (UQÀM), André Lauzon (UQÀM), Geneviève Paquin (UQÀM)
Speakers: Boris Adamczewski (CNRS), Petr Ambroz (Czech Technical University), Peter Balazi (Czech Technical University), Aleksandrs Belovs (Latvia), Valérie Berthé (LIRMM & Montpellier), Jean-Pierre Borel (Limoges), Arturo Carpi (Perugia), Julien Cassaigne (CNRS), Maxime Crochemore (Marne-la-Vallée), Sébastien Simon Ferenczi (CNRS), Thomas Fernique (Montpellier 2), Wit Forys (Jagiellonian), Christiane Frougny (Paris 8), Amy Glen (Adelaide), Vesa Halava (Turku), Stepan Holub (Charles, Prague), Lucian Ilie (Western Ontario), Damien Jamet (Montpellier), Paolo Massazza (Insubria), Michel Mendès France (Bordeaux 1), Jean-Christophe Novelli (Marne-la-Vallée), Pascal Ochem (Bordeaux 1), Maddalena Poneti (Firenze), Antonio Restivo (Palermo), Gwénaël Richomme (Picardie), Kalle Saari (Turku), Bruce Sagan (Michigan State), Alessandra Savelli (Politecnico di Milano), Jeffrey Shallitt (Waterloo), Benjamin Steinberg (Carleton), Maurice H. ter Beek (ISTI-CNR, Italia), Denis Thérien (McGill), Vincent Vajnovszki (Bourgogne), Luca Q. Zamboni (North Texas)
Number of participants: 83

Le sujet du colloque Words'05 fut l'étude des mots avec l'accent sur le point de vue théorique. En particulier les aspects combinatoires algébriques et algorithmiques furent privilégiés. Les motivations pouvaient provenir d'autres domaines tels que l'informatique théorique. Ce colloque est le cinquième d'une série de colloques sur les mêmes sujets ; les précédentes éditions ont eu lieu à Rouen en 1997 et 1999, à Palerme en 2001 et à Turku en 2003. Le colloque comporta 6 conférences invitées et 28 communications dûment arbitrées et sélectionnées par le comité de programme. Ce comité était formé de Jean Berstel (Marne-la-Vallée), James Currie (Winnipeg), Clelia De Felice (Salerno), Aldo de Luca (Naples), Juhani Karhumäki (Turku), Jean Néraud (Rouen) et Christophe Reutenauer (UQÀM, président du comité de programme). Une centaine de personnes ont participé au colloque, dont 83 régulièrement inscrites. Les participants sont venus du Canada, des États-Unis, d'Italie, de France, de République tchèque, de Lettonie, d'Australie, de Finlande et de Pologne. Arturo Carpi, Maxime Crochemore, Michel Mendès France, Antonio Restivo, Jeffrey Shallit et Denis Thérien (remplaçant Volker Diekert) étaient les conférenciers invités.

Dans sa conférence, Antonio Restivo a explicité des liens entre la combinatoire des mots pure et dure, et des applications à la compression de textes. De même, l'exposé de Michel Mendès France, portant sur l'utilisation du procédé de diagonalisation de Cantor pour la définition de certains mots de dimension deux, a suscité de nombreuses questions de l'auditoire. Il faut mentionner aussi le très clair exposé d'Arturo Carpi, sur un sujet qui touche de près de nombreux conférenciers : les répétitions dans les mots. L'exposé de Boris Adamczewski (sur des travaux effectués avec Jean-Paul Allouche) a montré les nombreuses interactions entre la combinatoire des mots, la transcendance en théorie des nombres et l'approximation diophantienne par les fractions continues, reliées à une conjecture de Littlewood. Jacques Sakarovitch a présenté ses travaux avec Christiane Frougny et Shigeki Akiyama sur la représentation des nombres réels en base 3/2 et Petr Ambroz a exposé ses travaux sur la représentation tau-adique des nombres réels.

L'exposé de Benjamin Steinberg avait pour sujet le comptage des sous-mots, qui a été rapporté aux représentations triangulaires du monoïde libre (en collaboration avec Jorge Almeida, Stuart Margolis et Mikhail Volkov). Les mots de dimension 2 ont été introduits par Valérie Berthé (en collaboration avec Pierre Arnoux et Damien Jamet) pour l'approximation des surfaces, ainsi que par Thomas Fernique. Les substitutions symboliques constituent un thème central en combinatoire des mots, comme en font foi l'exposé de Thomas Fernique et celui de Sébastien Ferenczi, de même que celui de Bruce Sagan (portant sur un travail avec Emeric Deutsch), qui a donné des propriétés arithmétiques de la suite de Thue-Morse. Les mots sturmiens, leurs variantes et leurs généralisations sont un autre thème central de la combinatoire des mots et sont apparus dans les exposés de Jean-Pierre Borel, Julien Cassaigne (en collaboration avec Anna

Frid), Amy Glen, Peter Balazi et Gwénaël Richomme.

Une transformation nouvelle sur les mots, avec des application dans les algèbres de Hopf combinatoires, a été présentée par Jean-Christophe Novelli (en collaboration avec Jean-Yves Thibon) ; il s'agit de la parkisation, semblable à la standardisation des mots. Certains exposés ont été plus particulièrement consacrés à des thèmes de combinatoire des mots appliquée à la théorie des langages et au parallélisme : le mélange des suites de symboles, dans l'exposé de Maurice ter Beek et Jetty Kleijn, les machines séquentielles dans celui d'Aleksandrs Belovs et Janis Buls, les automates dans celui de Wit Forys et Tomasz Krawczyk, la reconnaissance des traces (monoïdes partiellement commutatifs libres) dans celui d'Alessandra Savelli, Luca Breveglieri et Stefano Crespi-Reghizzi. L'ensemble de ces communications, ainsi que les conférences invitées, a constitué de l'aveu des spécialistes un colloque cohérent et de très bonne qualité.

Des actes comportant les communications sélectionnées ont été édités par les Publications du LaCIM, dont le responsable éditorial est Srecko Brlek. Un numéro spécial de la revue *Theoretical Computer Science A* (TCSA) sera édité par Srecko Brlek et Christophe Reutenauer et comportera un choix d'articles sélectionnés et arbitrés selon les critères habituels de TCSA. Les organisateurs tiennent à remercier particulièrement Julie Martineau (Faculté des Sciences de l'UQÀM), France Maltais (UQÀM) et Lise Tourigny.

CIRGET – CRM Workshop on Khovanov Homology

September 30 – Oct 2, 2005, UQÀM
Organized by CIRGET

Organizer: Olivier Collin (UQÀM)
Speakers: Dror Bar-Natan (Toronto), Mikhail Khovanov (Columbia), Leonard Ng (Stanford), Ciprian Manolescu (Columbia), Jacob Rasmussen (Princeton), Lev Rozansky (UNC Chapel Hill), Adam Sikora (SUNY at Buffalo)
Number of participants: 25

Khovanov homology was first developed as a homology theory whose Euler characteristic was the famous and useful Jones polynomial in knot theory. It has been shown to be intriguingly close to other knot invariants coming from gauge theory and symplectic geometry, through the work of Ozvath and Szabo, Seidel and Smith among others, as explained brilliantly by Mikhail Khovanov during his lecture. The combinatorial nature of the theory has proved very useful and has been exploited by Rasmussen to derive what is perhaps the most elegant proof of the Milnor unknotting conjecture. It also has close ties to mathematical physics. The workshop, attended by many CIRGET members (professors, postdoctoral fellows and Ph.D. students), brought together mathematicians who have had a strong impact on the theory so they could discuss new developments in the field. The schedule left many free hours for discussion and research work, and a number of new research collaborations were initiated. Moreover, several Ph.D. students benefited from this introduction to the field; Liam Watson, for example, has been working in the area ever since the workshop. A follow-up event was organized by Dror Bar-Natan at the CMS Winter 2005 meeting.

Workshop on Survival Analysis

November 4 – 6, 2005, CRM
Organized by the Statistics Laboratory

Organizers: Masoud Asgharian (McGill), Thierry Duchesne (Laval), Brenda MacGibbon (UQÀM)
Speakers: Michal Abrahamowicz (McGill), Masoud Asgharian (McGill), David Beaudoin (Laval), Kheira Belhandouz (Montréal), Pierre-Jérôme Bergeron (McGill), Rebecca Betensky (Harvard), Richard Cook (Waterloo), Thierry Duchesne (Laval), Marc Fredette (HEC Montréal), James Hanley (McGill), Ella Huszti (McGill), Jerry Lawlesss (Waterloo), Martin F. Lysy (McGill), Louis-Paul Rivest (Laval), Mériem Said (INRS-ETE), Arusharka Sen (Concordia), Marie-Pierre Sylvestre (McGill), Alain Vandal (McGill), Mei-Cheng Wang (Johns Hopkins), Alex Whitmore (McGill)
Number of participants: 99

The main purpose of the workshop was to bring together faculty members and graduate students in Québec universities who are actively involved in research in survival analysis. The workshop provided them with a platform to communicate their recent activities and learn about new directions of research in this field. The workshop comprised four one-hour keynote talks delivered by Rebecca Betensky, Richard Cook, Jerry Lawless and Mei-Cheng Wang. Nine Québec researchers in survival analysis each gave a 45 minute talk. There were 6 poster presentations on various topics in survival analysis by Québec graduate students.

Jerry Lawless's keynote talk gave an overview of multivariate failure time analysis, emphasiz-

ing the difference between marginal models and those specified by conditional random effects. Multivariate versions of the Cox model and the accelerated failure time model were also presented. Richard Cook talked about recent developments in the analysis of recurrent event data. He proposed a method that could account for heterogeneity and offer protection against adaptive (or is it "informative"?) censoring, properties that are desirable in the analysis of clinical trial data. Rebecca Betensky's talk was mainly focused on goodness of fit tests for truncation distributions using prevalent cohort survival data. Mei-Cheng Wang presented an overview of the prevalent cohort survival analysis and recent advances in the field. They both addressed some aspects of recent advances in the field of survival analysis with informative censoring.

Michal Abrahamowicz presented her work with Todd MacKenzie on joint estimation of time dependent and nonlinear effects of continuous covariates in survival analysis. Thierry Duchesne summarized the recent literature on lifetime regression models based on time transformations and outlined ideas for further research in that area. Alex Whitmore presented joint work with Mei-Ling Lee that involved modeling time to event data using hitting time distributions. Louis-Paul Rivest presented a new method that uses a generalization of the copula-graphic estimator to estimate marginal survivor functions for truncated data when the times of truncation and the times of death are correlated. Marc Fredette discussed calibrating prediction intervals for recurrent events where they can be modelled using non-homogeneous Poisson processes.

Masoud Asgharian presented his collaborative work on survival data, which involved theoretical results for estimation of the survival function based on prevalent cohort survival data (with applications to the analysis of survival with dementia in Canada). Alain Vandal presented joint work with R. Gentleman and X. Liu on the bivariate NPMLE with censored data using a graph theoretical approach; he highlighted the challenges in nonparametric estimation with survival data. Arusharka Sen presented efficient estimators of linear functionals of a bivariate distribution function when each variable is subject to random censoring. James Hanley gave an entertaining lecture on the survival analysis of the Titanic survivors, which he used to illustrate the difference between current lifetables and cohort lifetables.

The workshop ended with a panel discussion moderated by Brenda MacGibbon. The panel discussants were Richard Cook and Rebecca Betensky. Beforehand the moderator had given the discussants a list of questions concerning present and future directions for research in survival analysis. Richard Cook, with the help of Brenda MacGibbon and Rebecca Betensky, highlighted how the research interests of the workshop speakers could be used to solve important problems related to survival analysis. These interests included: multivariate models; copula models; frailty models; nonparametric estimates of bivariate distributions; independent and dependent right censoring and interval censoring; marginal versus conditional methods; selection effects (length-biased sampling, left, right or interval truncation, truncation with multivariate failure time data, uncertain time origins); timescales; robust methods; goodness of fit; prediction of future outcomes.

The important problems he emphasized included: research on interval-censored data with covariates; marker processes (boundary crossing models, Markov models); prediction of failure times with censoring; receiver operating characteristic curves (fixed and time dependent covariates); recurrent events; Bayesian methods; genetic applications (including dimension reduction and multiplicity issues); joint modelling of longitudinal and failure time data; incorporation of classification and regression trees in survival analysis.

In conclusion, many of the participants in the workshop felt that their interest in survival analysis research had increased and were impressed by the wide array of open problems in the area. They were also happy to be exposed to the research done by their colleagues at various Québec universities; hopefully this workshop will be the beginning of more collaborative research.

Homotopy Theory Conference in Honor of Joe Neisendorfer's 60th Birthday

November 18 – 20, 2005, CRM
Organized by CIRGET

Organizer: Octav Cornea (Montréal)
Speakers: Martin Bendersky (CUNY, Hunter College), Frederick Cohen (Rochester), Brayton Gray (Illinois, Chicago), Steven Halperin (Maryland), Richard Kane (Western Ontario), Ran Levi (Aberdeen), Chuck McGibbon (Wayne State), Haynes Miller (MIT), Douglas C. Ravenel

(Rochester), Daniel Tanré (Lille), Laurence Taylor (Notre Dame)
Number of participants: 45

A conference celebrating Joe Neisendorfer's 60th birthday gathered 45 participants for two days at the CRM in a pleasant and friendly atmosphere. A number of young mathematicians and graduate students were among the participants. Chuck McGibbon presented a talk entitled *Joe Neisendorfer and his work, an appreciation*. The talks of the other speakers covered the development of some central themes in homotopy theory as well as some interactions with dynamical systems and singularity theory (in Bendersky's talk), with group theory (in Levi's talk), as well as with geometric topology in the talks by Laurence Taylor.

The Third Montréal Scientific Computing Days

February 25 – 26, 2006, CRM
Organized by the Applied Mathematics Laboratory

Organizers: Paul Tupper (McGill), Anne Bourlioux (Montréal), Thomas Wihler (McGill)
Speakers: Howard Elman (Maryland), Des Higham (Strathclyde)
Number of participants: 70

This was the third successive year of the Montréal Scientifc Computing Days. The two-day program consisted of two short courses given by guest lecturers, a sequence of short contributed talks, and a poster session. The purpose of the event was to bring together people from the nearby scientific computing community to learn about the latest techniques and exchange ideas. An important audience for the Days is graduate students. The short course lectures are given at the level of an advanced graduate student and the contributed lectures and poster session were conceived with students particularly in mind.

The first short course was given by Des Higam on Saturday and Sunday mornings. His topic was the theory and numerics of stochastic differential equations. On the first day he introduced the audience to the basics of random variables, Brownian motion, and stochastic differential equations. He assumed only a little undergraduate probability, thus making his presentation accessible to a wide audience. The next day he presented the Euler – Maruyama method for computing trajectories of stochastic differential equations. He introduced the concepts of strong and weak convergence and illustrated them with some numerical examples. He concluded with the problem of computing mean exit times from a region for a stochastic differential equation. This is an important problem in finance that needs to be solved in order to price some of the more exotic stock options being developed. At present there is no consensus on the best way to estimate mean exit times, but Higham's lecture brought the audience up to date on the best methods available.

The second short course was given by Howard Elman during the afternoons. He described in detail an approach to an important and difficult problem in scientific computing: solving the equations of incompressible fluid dynamics. He considered all computational aspects of the problem from the discretization to the linear algebra necessary for an efficient solution. This is a formidable task; so on Saturday Elman started with the simpler linear convection-diffusion equation. An important aspect of this problem is the presence of boundary layers when the diffusion coefficient is small. He showed how stabilization is used to overcome the limits of standard finite element schemes and described an effective preconditioner for this setting. On Sunday he tackled the incompressible Navier-Stokes equations in full. His approach through the linearized equations resulted in subsidiary problems, one of which was the convection-diffusion equation presented the day before. Elman concluded by demonstrating a Matlab software package for two-dimensional incompressible flow problems in which he had implemented the techniques described in his lectures.

Interspersed with the short-course lectures were contributed lectures of 15 minutes each. These were mostly given by students from nearby universities in Ontario and Québec. Other students presented posters on their work during the Saturday night pizza and poster session.

Mini-Course on the Interval in Graph Theory & Informal Workshop on Graph Theory

April 25 – May 25, 2006, CRM

Organizer: Gena Hahn (Montréal)
Speakers: Pierre Ille (Institut de Mathématiques de Luminy, CNRS), Kathie Cameron (Wilfrid Laurier), François Genest (Concordia), Mateja Šajna (Ottawa)
Number of participants: 9

Pierre Ille a donné un cours sur les intervalles dans les graphes pendant quatre semaines, à rai-

son de quatre heures par semaine. Le cours a été suivi d'activités libres et d'échanges. Un atelier informel sur la théorie des graphes a eu lieu du 19 au 24 mai. Pierre Ille y a présenté la preuve d'une conjecture de Sabidussi et une caractérisation des graphes infinis indécomposables. Kathie Cameron a donné une conférence intitulée *Finding an easily recognizable strong stable set* et Mateja Šajna une conférence intitulée *On the existence of regular self-complementary uniform hypergraphs*. Le sujet de la conférence de François Genest était le nombre de stabilité des puissances de la 5-roue.

Analysis Day 2006

May 1st, 2006, CRM
Organized by the Mathematical Analysis Laboratory

Organizer: Dmitry Jakobson (McGill)
Speakers: Octav Cornea (Montréal), Emmanuel Fricain (Lyon 1), Leonid Parnovski (University College, London)
Number of participants: 24

This activity is the second edition of the Analysis Day organized since 2004 – 2005 by the Mathematical Analysis Laboratory (which is only three years old). Emmanuel Fricain talked on reproducing kernel bases in the de Branges spaces, Octav Cornea on measuring Lagrangian manifolds and Leonid Parnovski on the distribution of lattice points in Euclidean and hyperbolic spaces.

Capture 2006: A Scientific Meeting and a Workshop on Capture – Recapture Models

May 1 – 5, 2006, Université Laval

Organizers: Gilles Gauthier (Laval), Louis-Paul Rivest (Laval)
Speakers: Rémi Choquet (CEFE, Montpellier), Gilles Gauthier (Laval), Bill Kendall (Patuxent Wildlife Research Center, Washington), Jean-Dominique Lebreton (CEFE, Montpellier), Roger Pradel (CEFE, Montpellier), Louis-Paul Rivest (Laval), Carl Schwarz (Simon Fraser)
Number of participants: 50

L'atelier a débuté par une journée de conférences le lundi 1er mai. L'allocution d'ouverture a été prononcée par M. Jean-Dominique Lebreton, membre de l'Académie des sciences de France et directeur du Centre d'Écologie Fonctionnelle et Évolutive (CEFE) de Montpellier. Elle portait sur la combinaison de données de capture-recapture et d'information démographique pour prédire la survie d'une espèce d'albatros. Les autres conférences ont été données par Bill Kendall, Carl Schwarz, Roger Pradel, Rémi Choquet, Gilles Gauthier et Louis-Paul Rivest. Ils ont traité de différents aspects, tant pratiques que théoriques, de l'utilisation des données de capture-recapture pour estimer des caractéristiques démographiques de populations animales. Une cinquantaine de personnes ont assisté à ces présentations.

Un atelier de formation à l'utilisation du logiciel M-Surge développé par le CEFE s'est déroulé du mardi 2 mai au vendredi 5 mai 2006. Une vingtaine de personnes, provenant de 6 pays différents, ont participé à cet atelier. Les formateurs étaient Jean-Dominique Lebreton, Roger Pradel, Rémi Choquet et Gilles Gauthier. Le logiciel M-Surge permet d'ajuster des modèles statistiques multi-états à des données de capture-recapture. De tels modèles permettent de faire varier les paramètres démographiques, tels le taux de survie, selon l'état de l'animal. Cet état peut être associé à l'âge de l'animal (jeune ou adulte), à sa localisation géographique (le lieu de sa capture) ou au fait d'avoir été capturé ou non à l'occasion précédente. Ils permettent également de calculer des taux de transition d'un état à l'autre. Cet atelier s'est terminé par des présentations des participants, le vendredi 5 mai, illustrant l'utilisation de M-Surge sur des données de différentes espèces animales.

Workshop on Probabilistic Symmetries and Their Applications

May 15 – 17, 2006, University of Ottawa
Sponsored by the Fields Institute, the University of Ottawa and CRM

Organizers: Gail Ivanoff (Ottawa), Raluca Balan (Ottawa)
Speakers: Federico Bassetti (Pavia), Kameswarrao Casukhela (Ohio State), André Dabrowski (Ottawa), Gail Ivanoff (Ottawa), Olav Kallenberg (Auburn), Rafal Kulik (Carleton & Sydney), Fabrizio Leisen (Modena e Reggio Emilia), Serguei Novak (Middlesex), Fabio Spizzichino (La Sapienza), Neville Weber (Sydney)
Number of participants: 35

The workshop was particularly timely in that 2006 marks the centenary of the birth of Bruno de Finetti, the Italian mathematician whose famous theorem on the structure of infinite exchangeable sequences initiated the study of probabilistic symmetries. The invited speakers were Olav Kallenberg, Fabio Spizzichino, Neville Weber and André Dabrowski. Professor Olav Kallenberg, currently the foremost re-

searcher in the field, gave the three keynote lectures, which gave an outstanding overview of the general theory of the major symmetries (contractability, exchangeability, and rotatability).

Professor Fabio Spizzichino gave a fascinating account of de Finetti's unique philosophy of statistical inference, as well as a lecture on an application of exchangeability in reliability theory. Professor Neville Weber's first lecture introduced the use of martingale techniques in the study of U-statistics, while his second focused on a more advanced analysis of the asymptotic behaviour of exchangeable arrays. Professor André Dabrowski discussed the relationship between positive dependence and exchangeability for sequences. The subject of Gail Ivanoff's talks was conditional symmetries on arrays, and the associated martingale structures and sampling properties. Contributed talks were given by Rafal Kulik, Federico Bassetti, Fabrizio Leisen and Kamesh Casukhela.

The participants came from Canada, the USA, Italy and Australia. Approximately half of the attendees were graduate students or postdoctoral fellows. All participants commented on the benefits of a broad exposure to an important subject, in an intimate environment that provided ample opportunity for interaction and discussion. It is hoped that some of the young researchers will be inspired to tackle some of the challenging open problems proposed by Professor Kallenberg. The organizers are pleased to acknowledge the co-sponsorship of the Institute of Mathematical Statistics. They wish to thank Atlas Mathematical Conference Abstracts for publishing the workshop abstracts free of charge.

Colloquium on Potential Theory — 74e congrès de l'Acfas

May 15 – 19, 2006, McGill University

Sponsors: Consulat général de France à Montréal, CRM, Mathematical Analysis Laboratory, FQRNT, Office of the Vice-Principal (Research & International Relations, McGill)
Organizer: Kohur Gowrisankaran (McGill)
Speakers: Hiroaki Aikawa (Hokkaido), Dominique Bakry (Toulouse), Lucian Beznea (Romanian Academy), Jürgen Bliedtner (Frankfurt), Khalifa El Mabrouk (Monastir), Stephen Gardiner (University College, Dublin), Ivan Gentil (Paris-Dauphine), Joe Glover (Florida), Wolfhard Hansen (Bielefeld), Farida Hmissi (Tunis), Klaus Janssen (Düsseldorf), Paul Koosis (McGill), Jaroslav Lukes (Charles, Prague), Nikolai Makarov (Caltech), Javad Mashreghi (Laval), Yoshihiro Mizuta (Hiroshima), Ivan Netuka (Charles, Prague), Eugen Popa (Iasi), Philippe Poulin (McGill), Nicolas Privault (La Rochelle), Josie Ryan (Milligan College, Tennessee)
Number of participants: 23

The colloquium consisted of twenty-one talks, each of them lasting 45 minutes. Each talk was attended by more or less all the participants. The talks generated a lot of interest in the most current research topics of the three principal areas of the theory. These areas are the classical potential theory from a modern perspective, the probabilistic aspects of the theory and the abstract cone settings with applications. An overwhelming number of talks were delivered in French and there were three Canadian participants (including a graduate student from McGill).

CRM – ISM Colloquium Series

The CRM, together with the Institut des sciences mathématiques du Québec (ISM), 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

Coordinators: Pengfei Guan (McGill), Alexander Shnirelman (Concordia)

September 9, 2005 Tom Graber (Caltech)
Towards a quantum McKay correspondence

September 16, 2005 Barry Mazur (Harvard)
Families of modular forms and their representations

September 23, 2005 Maciej Zworski (Berkeley)
Counting quantum states in chaotic scattering

September 30, 2005 Louis Nirenberg (New York University)
A geometric problem and the Hopf lemma

October 7, 2005 Richard Schoen (Stanford)
The Yamabe problem revisited

October 14, 2005 Yum-Tong Siu (Harvard)
Multiplier ideals] A new technique linking analysis and algebraic geometry

October 21, 2005 Fadil Santosa (Minnesota)
Seeing better with mathematics: *A mathematical problem arising in design of ophthalmic lenses*

October 28, 2005 Emmanuel Letellier (Paris 6)
From Kazhdan – Springer to the topological properties of the Riemann – Hilbert monodromy map

November 4, 2005 Alexander Shnirelman (Concordia)
The mystery of 2-dimensional fluid

November 11, 2005 Walter Craig (McMaster)
On the Boltzmann equation: *Global solutions in one spatial dimension*

November 18, 2005 Gregory Margulis (Yale)
Quantitative Oppenheim conjecture

November 25, 2005 Edward Nelson (Princeton)
The mystery of stochastic mechanics

December 2, 2005 Alexey Kokotov (Concordia)
Extremal properties of some functionals on the moduli space of genus two Riemann surfaces

December 9, 2005 Tamás Erdélyi (Texas A&M)
Excursions in unimodular polynomials

December 16, 2005 James W. Cogdell (Ohio State)
L-functions, modularity, and functoriality

January 6, 2005 Vašek Chvátal (Concordia)
Recent advances in solving the Travelling Salesman Problem

January 13, 2006 Michael Goldstein (Toronto)
Anderson localization for shifted and skew-shifted potentials: *Some recent developments*

January 20, 2006 Vitaly Bergelson (Ohio State)
Ergodic theory and the properties of large sets

January 27, 2006 Adrian Iovita (Concordia)
On the arithmetic of elliptic curves

February 3, 2006 G. M. Zaslavsky (Courant)
Nonergodic and nonmixing chaos and pseudochaos

February 10, 2006 Yousef Saad (Minnesota)
Solution of sparse matrix problems by domain decomposition-type methods

February 17, 2006 Roman Schubert (Bristol)
Universality in wave propagation for large times

February 24, 2006 Des Higham (Strathclyde)
A new model for protein-protein interaction networks

March 3, 2006 Fedor Bogomolov (Courant)
Geometry of algebraic varieties over small fields $(\overline{\mathbb{F}}_p, \overline{\mathbb{Q}})$

March 10, 2006 Peter Zograf (Steklov, St. Petersburg)
Witten-Kontsevich theory and Weil-Petersson volumes of moduli spaces of algebraic curves

March 17, 2006 Vladimir Retakh (Rutgers)
Algebras associated to directed graphs and related to factorizations of noncommutative polynomials

March 24, 2006 John Mather (Princeton)
Arnold Diffusion

April 7, 2006 Helmut Hofer (Courant)
Quantitative Symplectic Geometry

April 21, 2006 Alice Chang (Princeton)
Conformal invariants associated with a smooth measure

CRM – ISM – GERAD Statistics Colloquium

Coordinators: Christian Léger (Montréal), Pierre Duchesne (Montréal), Brenda MacGibbon (UQÀM), Arush Sen (Concordia), Russell Steele (McGill)

September 19, 2005 Rob Kass (Carnegie Mellon)
Bayesian curve fitting and neuron firing patterns

September 23, 2005 Bradley Efron (Stanford)
Fifty years of empirical Bayes

September 30, 2005 Reg Kulperger (Western Ontario)
A stochastic competing species model and ergodicity

October 7, 2005 Giles Hooker (McGill)
Diagnostics and extrapolation in machine learning: *Extending the functional ANOVA*

October 14, 2005 Richard Lockhart (Simon Fraser)
Bayes-assisted goodness-of-fit tests

October 21, 2005 Alejandro Murua (Montréal)
Analysis of health outcomes at the turn of the century

October 28, 2005 Jonathan Taylor (Stanford)
Deformation based morphometry, Roy's maximum root and recent advances in random fields

November 4, 2005 Jerry Lawless (Waterloo)
Multivariate failure time analysis

November 11, 2005 Bernd Sturmfels (Berkeley)
Algebraic factor analysis: *Tetrads, pentads and beyond*

November 18, 2005 David Binder (president of the SSC)
Why take a design-based approach to modeling data from complex surveys?

November 25, 2005 Josée Dupuis (Boston)
Genetic linkage analysis of quantitative traits in the Framingham heart study: *Open problems and statistical challenges*

November 25, 2005 Eric Kolaczyk (Boston University)
Network Kriging

December 2, 2005 Derek Bingham (Simon Fraser)
Sequential experiment design for contour estimation from computer simulators

December 9, 2005 James M. Curran (Auckland)
A MCMC method for resolving two-person DNA mixtures

January 20, 2006 Keith Knight (Toronto)
Boundaries, Poisson processes, and linear programs

January 27, 2006 Yulia R. Gel (Waterloo)
On strong consistency of the regularized least-squares estimates of infinite autoregressive models

February 3, 2006 Jamie Stafford (Toronto)
Iterated conditional expectations

February 10, 2006 Scott L. Zeger (Johns Hopkins)
Micronutrient supplementation, birth weight and infant mortality: *On estimation of percentile-specific, mediated intervention effects*

February 17, 2006 Shojaeddin Chenouri (Waterloo)
Data depth: *Theory, computations and applications*

February 24, 2006 Shelley Bull (Mount Sinai Hospital & University of Toronto)
Bias reduction of locus-specific effect estimates via the bootstrap in linkage scans for quantitative trait Loci

March 3, 2006 Vanja Dukic (Chicago)
A Bayesian SEIR approach to modeling smallpox epidemics

March 10, 2006 Xiao-Li Meng (Harvard)
How "crude" is Harvard President's calculation?

March 31, 2006 Yongzhao Shao (NYU School of Medicine)
Some recent developments in testing for finite mixture models

April 7, 2006 Fateh Chebana (INRS-ETE)
Locally asymptotically optimal tests for nonlinear time-series models

Multidisciplinary and Industrial Program

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

Activities of the Multidisciplinary and Industrial Program

Fifth Summer School in Quantum Computing

August 1 – 5, 2005, Université de Montréal
Sponsored by CIAR, MITACS and CRM

Organizers: Alain Tapp (Montréal), André Méthot (Montréal)
Speakers: Gilles Brassard (Montréal), Richard Cleve (Waterloo), Claude Crépeau (McGill), Daniel Gottesman (Perimeter), Patrick Hayden (McGill), Peter Høyer (Calgary), Michele Mosca (Waterloo), Barry Sanders (Calgary), Alain Tapp (Montréal), John Watrous (Calgary), Ronald de Wolf (Amsterdam)
Number of participants: 75

For the second time the Summer School in Quantum Computing, a tradition that is well established by now, took place in Montréal. In previous years it took place also in Toronto, Waterloo and Calgary. The School was targeted towards graduate students from the fields of computer science, physics and mathematics. No prior knowledge of quantum computing was assumed. It attracted around sixty students. Many of them were starting graduate studies in one of the Canadian research groups in quantum computing. Many others, who work in related areas, attended the school in order to get a basic knowledge of that field. Quantum computing is a recent research field at the frontier of computer science and physics. It is concerned with the use of the laws of quantum mechanics to process information. If a quantum computer is ever built, it will have significant impact on computer science in general, but most importantly on cryptology. The talks covered the following topics: introduction to the computation model of quantum information, quantum cryptography, Grover's search type algorithms, Shor's factoring algorithm, quantum information theory, proofs in the quantum world, error correction and fault tolerant computation, implementation of the quantum computer, non locality, pseudotelepathy and communication complexity.

Workshop High-Dimensional Partial Differential Equations in Sciences and Engineering

August 7 – 12, 2005, CRM
Sponsored by CRM, CERMICS (École Nationale des Ponts et Chaussées, France), IBM Canada Higher Education and Research Sector, Ministère délégué à la recherche et aux nouvelles technologies (France, ACI Nouvelles interfaces des mathématiques), Regroupement québécois sur les matériaux de pointe (RQMP), Vice-Rectorat à la recherche de l'Université de Montréal

Organizers: André Bandrauk (Sherbrooke), Michel Delfour (Montréal), Claude Le Bris (École Nationale des Ponts et Chaussées)
Speakers: André Bandrauk (Sherbrooke), Thomas Brabec (Center for Research in Photonics, Ottawa), Eric Cancès (ENPC), Goong Chen (Texas A&M), Michel Côté (Montréal), Pierre Degond (CNRS, Toulouse), Michel Delfour (Montréal), Matthias Ernzerhof (Montréal), Maria J. Esteban (Paris-Dauphine), André Fortin (Laval), Michael Griebel (IAM, Bonn), Wagdi Habashi (McGill), Tom R. Hurd (McMaster), Raymond E. Kapral (Lash Miller Chemical Labs, Toronto), Bernard Lapeyre (ENPC), Yvon Maday (Paris 6), David A. Mazziotti (Chicago), Robert G. Owens (Montréal), Anthony T. Patera (MIT), Gilles H. Peslherbe (Concordia), Andreas Savin (Paris 6), Luis A. Seco (Toronto), Robert E Wyatt (Texas at Austin)
Contributing students and postdocs: Gérard Lagmago-Kamta (Sherbrooke), Emmanuel Lorin de la Grandmaison (Sherbrooke), Roy Mahapatra (Wilfrid Laurier), Julien Salomon (Paris 6), Evgueni Sinelnikov (Laval)
Number of participants: 63 (including 19 students)

High-dimensional spatio-temporal partial differential equations are a major challenge for the scientific computing of the future. Up to now deemed prohibitive, they have recently become manageable by combining recent developments in numerical techniques, appropriate computer implementations, and the use of computers with parallel and even massively parallel architec-

tures. This opens new perspectives in many fields of applications. The kinetic plasma physics equations, many-body Schrödinger equation, Dirac and Maxwell equations for molecular electronic structure and nuclear dynamic computations, options pricing equations in mathematical finance, and Fokker-Planck and fluid dynamics equations for complex fluids, are examples of equations that can now be handled. This workshop brought together experts of international stature in that broad spectrum of areas to compare their approaches and bring out common problem formulations and research directions in the numerical solutions of high-dimensional partial differential equations. These equations are to be found in various fields of science and engineering but the emphasis was on chemistry and physics. The proceedings of the workshop will be published in the AMS Series *CRM Proceedings and Lecture Notes*.

International Workshop on Applied Dynamical Systems — Mechanics, Turbulence, Knots, Cockroaches, and Chaos

October 15 – 16, 2005, CRM
Sponsored by the Applied Mathematics Laboratory

Organizers: Jacques Bélair (Montréal), Sue Ann Campbell (Waterloo), Jeff Moehlis (UC Santa Barbara), N. Sri Namachchivaya (Illinois at Urbana-Champaign), Steve Shaw (Michigan State)
Speakers: Dieter Armbruster (Arizona State), Sue Ann Campbell (Waterloo), David Chillingworth (Southampton), Gabor Damokos (Budapest University of Technology and Economics), Daniel Koditschek (Pennsylvania), Robert Ghrist (Illinois at Urbana-Champaign), John Guckenheimer (Cornell), David Rand (Warwick), Richard Rand (Cornell), Steven Shaw (Michigan State), Eric Shea-Brown (Courant), Emily Stone (Montana)
Number of participants: 47

Cette conférence internationale visait à consolider les ponts entre les théoriciens et les utilisateurs des systèmes dynamiques, en réunissant des spécialistes d'expertises variées et venant d'horizons divers (génie, sciences, mathématiques) et en cherchant à identifier les directions émergentes de recherche de la discipline. Les utilisateurs des domaines du génie et des sciences appliquées y ont trouvé une occasion unique de s'approprier les plus récents développements de la théorie et les résultats mathématiques connexes, alors que les mathématiciens ont pris connaissance des applications les plus novatrices et les plus récentes. Les organisateurs avaient identifié et invité une douzaine de conférenciers qui avaient collaboré avec Philip Holmes à divers stades de sa carrière : leurs exposés ont permis d'illustrer les nombreux domaines où la théorie des systèmes dynamiques joue un rôle important dans l'interprétation d'observations expérimentales ou sous contôle.

Les sujets suivants ont été abordés : machinerie aéronautique (Campbell et Stone), outillage automobile (Shaw) et optimisation de la production de semi-conducteurs (Ambruster). Les présentations théoriques (en particulier celles de Guckenheimer, Chillingworth et Ghrist) ont eu une place importante dans cet atelier, ainsi que les applications à la biologie : dynamique de populations (Damokos), rythmes cellulaires (D. Rand et B. Rand) et interactions entre neurones (Shea-Brown). Daniel Koditschek remplaça brillamment Robert Full, présentant avec un enthousiasme contagieux ses travaux sur les robots cherchant à reproduire le très robuste comportement des cafards. Une douzaine de participants présentèrent également des affiches.

Un segment inédit de cette conférence fut un échange d'une heure environ sur l'état actuel de la dynamique nonlinéaire, en particulier les liens entre la théorie mathématique et les besoins de l'ingénierie et les stratégies à employer pour rapprocher les communautés de mathématiciens et d'ingénieurs. La conférence se déroula dans une atmosphère festive, eu égard à la célébration concomitante des remarquables réalisations de Philip Holmes durant les soixante premières années de sa vie.

Workshop on Mathematics in Brain Imaging and its Applications to Cognitive and Clinical Neurosciences

October 17 – 18, 2005, Institut universitaire de gériatrie de Montréal
Organized by the PhysNum Laboratory

Organizers: Habib Benali (CHU Pitié-Salpêtrière), Julien Doyon (Montréal), Jean-Marc Lina (École de Technologie Supérieure)
Speakers: Guillaume Marrelec (INSERM), Pierre Bellec (INSERM), Jean Daunizeau (Montréal), Julien Doyon (Montréal), Hugues Duffau (CHU Pitié-Salpêtrière), Saad Jbabdi (INSERM & Oxford), Odile Jolivet (Faculté de Médecine Pierre et Marie Curie), Jean-Marc Lina (École de Technologie Supérieure), Mélanie Pélégrini (Fac-

ulté de Médecine Pierre et Marie Curie), Vincent Perlbarg (INSERM)
Number of participants: 30

La capacité de visualiser *in vivo* les structures cérébrales mises en jeu par des tâches cognitives chez l'homme modifie en profondeur le domaine des sciences cognitives humaines. Pendant des décennies, l'étude de la cognition humaine se basait uniquement sur la présence de lésions et des symptômes neuropsychologiques associés. Avec l'avènement des techniques d'imagerie fonctionnelle de résolution spatio-temporelle toujours croissante, une nouvelle discipline apparaît : les neurosciences cognitives où l'image est le principal outil. Cette discipline jette un nouveau regard sur les relations fonctionnelles au sein du cerveau, telles que définies en psychologie ou en neuropsychologie.

L'imagerie neurofonctionnelle est un domaine de recherche pluridisciplinaire où l'analyse, la modélisation et le traitement du signal sont indispensables pour reconstruire et interpréter les données recueillies par les instruments. La mise en place de méthodes d'analyse fiables et robustes est un atout majeur pour tous les utilisateurs d'imagerie cérébrale. Ainsi, les aspects méthodologiques plus ancrés dans le secteur des mathématiques appliquées sont-ils devenus au fil des dernières années un thème important en imagerie médicale. En réunissant les principaux acteurs du regroupement CRM-CRIUGM (Centre de recherche de l'Institut universitaire de gériatrie de Montréal), cet atelier visait d'abord à consolider la collaboration entre les centres montréalais (CRM et CRIUGM) et l'unité 678 de l'INSERM (CHU Pitié-Salpêtrière). En invitant les membres de ces institutions à présenter leurs travaux, l'atelier donnait ainsi l'occasion d'illustrer ce regroupement international auprès de la communauté des neurosciences.

L'exposé de G. Marrelec, aujourd'hui chercheur à l'INSERM, mit en perspective les difficultés méthodologiques de traitement de la connectivité fonctionnelle en neuroimagerie. Ce thème fut repris par P. Bellec qui mit l'accent sur les aspects temporels de l'apprentissage via les réseaux. Le point de vue plus neuroscientifique de ce problème fut décrit par J. Doyon. La présentation de S. Jbabdi portait sur l'étude des fibres et des chemins géodésiques dans le cerveau. Ce thème, assez récent, fut évoqué dans la présentation du Docteur H. Duffau (neurochirurgien) comme un des outils pertinents pour la préparation d'une chirurgie du cerveau. Les exposés de J. Daunizeau et J.-M. Lina ont mis en perspective les aspects bayésiens et entropiques de la reconstruction des sources d'activation cérébrale. V. Perlbarg fit état de ses travaux à propos du bruit structuré présent en IRM. Finalement, H. Benali et M. Pélégrini ont présenté la recherche menée au sein de l'équipe de Paris (IMPARABL) ainsi que les outils logiciels qui y sont développés.

MITACS – MSRI – AFMnet – CRM Workshop on Therapeutic Efficacy in Population Veterinary Medicine

October 19 – 22, 2005, Banff International Research Station
Sponsored by MITACS, AFMnet, MSRI, CRM, Pfizer Animal Health, Scheringer-Plough Animal Health, Aventis

Organizers: Fahima Nekka (Montréal), Jacques Bélair (Montréal), Renée Bergeron (Laval), Jérôme del Castillo (Montréal), Jun Li (Montréal), Jeff Lucas (MITACS), Daniel Pettigrew (Fédération des Producteurs de Porcs du Québec), Don Schaffner (Rutgers)
List of participants: Jacques Bélair (Montréal), Madonna Benjamin (Elanco Animal Health), Renée Bergeron (Laval), Dave Bernier (Montréal), Jérôme del Castillo (Montréal), Hermann Eberl (AFMnet & Guelph), James France (AFMnet and University of Guelph), Harold G. Gonyou (Prairie Swine Centre), Bruce Groves (Pfizer Animal Health Canada), Tony Hayes (Guelph), Judith Lafrance (Laval), Ann Letellier (Montréal), Jeff Lucas (MITACS), Murray McLaughlin (AFMnet), Claude Miville (Fédération des Producteurs de Porcs du Québec), Fahima Nekka (Montréal), Alan Paulson (AFMnet and Dalhousie), Caroline-Emmanuelle Petit-Jetté (Montréal), Candido Pomar (Agriculture and Agri-Food Canada), Richard Reid-Smith (Public Health Agency of Canada), Steven Sanches (Montréal), Heidi Schraft (Lakehead), Alan Theede (Pfizer Animal Health Canada), Lisbeth Truelstrup (AFMnet & Dalhousie), Laurence T. Yang (St. Francis Xavier)

This workshop has been organized by the MITACS BIO5 team around the general theme of therapeutic efficacy in population veterinary medicine. It has brought together researchers working in applied mathematics, veterinary sciences, behavioural sciences as well as in microbiology and nutrition. The workshop was attended by academic researchers as well as speakers and participants from other public sectors (Agriculture and Agri-Food Canada and the Public Health Agency of Canada). Repre-

sentatives of Pfizer Animal Health and Elanco Animal Health were present. The conferences covered different aspects relating to animal collective therapy, especially in swine and poultry, in terms of determinants and outcomes. A complete portrait of animal behaviour in the context of therapeutic efficacy was drawn. A whole overview of the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) has been given to explain the national program of antimicrobial use in food animals and surveillance system for antimicrobial resistance arising from food animal production.

A general idea of mathematical approaches used to handle biological complexity has been given with emphasis on the need for collaborative efforts between mathematical sciences and experimental research. For instance, the researchers involved in the MITACS seed project used dynamical systems (represented by the multicompartmental approach defined by systems of ODE) with stochastic input. They analyzed the statistical properties of these systems in terms of stability and conservation of the dynamical system. This approach is new in pharmacokinetics and should be used in other areas of biology. The researchers also introduced competition mechanisms in collective behaviour that account for dynamical interactions between individuals, and this approach has to be put within the framework of hierarchical nonlinear models used for repeated measurement data.

During the workshop very interesting discussions took place, always balanced between the different areas of research. The presence of industrial researchers from Pfizer Animal Health in particular, allowed the researchers to gain a clear idea of the pharmaceutical industry expectations and practices. The workshop concluded with a discussion about collaborations and perspectives, that took place on October 22. From this discussion it emerged that the following questions were important and should be addressed. Is the veterinary use of antibiotics appropriate? How can we improve antibiotics use to make it safer and more efficient? How does the risk of using the labelled dose compare with the risk of using an unapproved one? Three main areas of research have been identified for the full MITACS project: impact of feeding behaviour on dosage efficacy, alternatives to antibiotics and their assessment, and risk analysis. The involvement of pharmaceutical companies in the MITACS project was also discussed.

The feedback from the participants was extremely positive. They found the workshop useful and were thankful for an opportunity to gain insight into MITACS and AFMnet. They were encouraged to see genuine collaboration between mathematicians, pharmacologists and animal behaviourists. They deemed the workshop to be a very useful brainstorming meeting.

Workshop
Current Issues in Functional Imaging with Optical Devices

May 11 – 12, 2006, CRM
Organized by the PhysNum Laboratory

Organizers: Habib Benali (CHU Pitié-Salpêtrière), Frédéric Lesage (École Polytechnique de Montréal), Jean-Marc Lina (École de Technologie Supérieure)
Speakers: Simon R. Arridge (University College, London), David Boas (Massachusetts General Hospital & Harvard Medical School), Claude Boccara (École supérieure de physique et de chimie industrielles de Paris), Emmanuel Candes (Caltech)
Number of participants: 80

Cet atelier a réuni près de 70 chercheurs et étudiants autour des méthodes optiques pour l'imagerie fonctionnelle dans le domaine biomédical. En effet, l'imagerie optique connaît des développements rapides, en particulier dans le domaine de l'optique proche infrarouge. Par exemple, la mesure in vivo des signaux optiques à très haute résolution temporelle permet l'étude anatomo-fonctionnelle du cortex cérébral. D'une façon générale, ces imageurs de nouvelle génération utilisent l'absorption de certaines molécules, qu'elles soient endogènes, comme l'hémoglobine, ou exogènes, comme les marqueurs moléculaires spécifiques de certaines pathologies (la maladie d'Alzheimer, par exemple). L'atelier a porté sur tous les aspects du domaine : la physiologie sous-jacente, les acquisitions, le traitement des données, la modélisation et les méthodes numériques de reconstruction d'images.

Expert reconnu au niveau international pour l'avancement de ces travaux en imagerie diffuse infra-rouge, D. Boas a ouvert l'atelier avec un exposé couvrant l'ensemble de la problématique de l'imagerie NIRS. Ce cours fut certainement une excellente entrée en matière pour appréhender l'ensemble du domaine, aussi bien les origines physiologiques que les aspects de modélisation. Son exposé sur ces questions méthodologiques était une transition vers le cours de S. Arridge, qui a présenté les équations de trans-

port décrivant la propagation de la lumière dans le milieu biologique. Son exposé, riche en informations sur les aspects techniques de la modélisation numérique du problème direct, a su mettre en perspective les difficultés de modélisation. Dans sa seconde moitié, ce cours aborda la résolution du problème inverse et les techniques de reconstruction d'images.

Ce sujet fut repris et développé par E. Candes, qui fit un cours des plus complets sur la synthèse tomographique par curvelets. Domaine relativement récent de l'analyse numérique, ce secteur des mathématiques appliquées n'en est pas moins un des plus dynamiques à l'heure actuelle. Incidemment, au moment où l'atelier avait lieu, E. Candes venait de recevoir le prix Waterman pour l'ensemble de son travail en analyse harmonique. Le dernier cours fut donné par C. Boccara, dont l'expertise en imagerie optique, sous toutes ses formes, est notoire. Son exposé a mis en persective l'ensemble des techniques optiques dans le cadre applicatif. Ce retour sur les aspects pratiques terminait de facon brillante l'ensemble des cours.

En s'adressant aux chercheurs et aux étudiants en neuroimagerie, ces quatre spécialistes ont réussi à couvrir tous les aspects de l'imagerie optique : la physique des acquisitions, la méthodologie du traitement et les applications cognitives et cliniques.

Workshop
Drug Intake Behavior and Pharmaceutical Practice: Data Acquisition and Modeling
May 15, 2006, CRM

Organizer: Fahima Nekka (Montréal)
Speakers Els Goetghebeur (Harvard & Ghent), Jun Li (Montréal), Fahima Nekka (Montréal), Jacques Turgeon (Montréal), John Urquhart (UC San Francisco & Maastricht), Bernard Vrijens (AARDEX Ltd., Switzerland & Liège)
Number of participants: 20

L'inobservance thérapeutique est un problème mondialement reconnu, avec des conséquences directes sur l'efficacité du traitement. Ce problème est particulièrement important dans le cas des maladies chroniques, avec un rôle jugé dominant dans la variabilité thérapeutique. De par la nature de ses caractéristiques variables, l'observance se prête bien aux méthodes stochastiques et statistiques, qui ont pour objectif de quantifier son effet dans une perspective d'optimisation de la stratégie d'administration médicamenteuse. Cet atelier visait à comprendre l'inobservance thérapeutique afin de la contrôler, et à cerner les pratiques et approches utilisées dans les outils de mesure de l'observance et dans son analyse. L'accent fut mis sur le rôle à attribuer aux différentes sources de variabilité, des sources induites par les formes pharmaceutiques elles-mêmes aux différents facteurs impliqués dans leur action pharmacologique, en passant par la façon dont les médicaments sont administrés.

L'atelier a réuni de grands spécialistes de l'inobservance, dont John Urquhart, qui est le fondateur de la discipline de la "pharmionique" et l'inventeur du système électronique MEMS pour la mesure de l'inobservance. L'importance de l'inobservance comme source majeure de la variabilité thérapeutique ainsi que son impact économique sur le système de santé ont été démontrés en faisant référence à plusieurs études pour des pathologies différentes dans des contextes différents.

Workshop Between Specialists of Brain and Spine Imaging and Mathematicians Interested in the Questions Arising from Imaging
May 23, 2006, CRM

Organizers: Habib Benali (CHU Pitié-Salpêtrière), François Lalonde (Montréal)
List of participants: Jean-François Angers (Montréal), Habib Benali (CHU Pitié-Salpêtrière), Yves Bourgault (Ottawa), Michel Delfour (Montréal), Julien Doyon (Centre de recherche de l'Institut universitaire de gériatrie de Montréal), Bernard Goulard (Montréal), Rick Hogue (Centre de recherche de l'Institut universitaire de gériatrie de Montréal), Tony Humphries (McGill), Frédéric Lesage (École Polytechnique), Jean-Marc Lina (École de Technologie Supérieure), Serge Rossignol (Montréal), Olivier Rousseau (Ottawa), Thomas P. Wihler (McGill)

Ces dernières années, plusieurs collaborations bilatérales ont pris forme, impliquant d'abord l'équipe PhysNum du CRM (B. Goulard, J.-M. Lina, F. Lesage) à Montréal et l'équipe IMPARABL-U678-INSERM (H. Benali) à Paris. Ces collaborations se sont étendues à plusieurs équipes du Regroupement Neuroimagerie Québec (les équipes de J. Doyon et S. Rossignol, en particulier). Le but de la rencontre avec d'autres chercheurs du CRM était d'étendre ces collaborations en persuadant des mathématiciens du CRM de se joindre au projet des mathématiques en imagerie cérébrale. L'atelier a comporté plu-

sieurs conférences (courtes) suivies de tables rondes.

Serge Rossignol expliqua que la compréhension des processus fonctionnels de la moelle épinière chez l'homme et chez l'animal constitue un enjeu majeur de santé publique. Il décrivit le travail de son équipe, c'est-à-dire l'étude des mécanismes de récupération fonctionnelle de la marche après lésion spinale chez le chat. Il dit qu'il est important de développer des outils mathématiques permettant d'établir des corrélations claires (dans un contexte physiologique cohérent) entre les changements électrophysiologiques des réflexes et les images en IRM ou en optique de la moelle. Rick Hogue décrivit les principes physiques qui sous-tendent l'imagerie par résonance magnétique.

Habib Benali expliqua que l'équipe IMPARABL développe des modèles mathématiques des processus physiologiques cérébraux. Elle propose un modèle des processus hémodynamiques et métaboliques mis en jeu lors de l'activation neuronale ; ce modèle comporte une trentaire d'EDO. Frédéric Lesage ajouta qu'on voit émerger l'imagerie optique (IO) diffuse comme une nouvelle modalité, qui permet de mesurer les changements du volume sanguin dans les régions corticales du cerveau grâce à la transmission de la lumière dans les tissus biologiques. L'utilisation du spectre infrarouge est prometteuse, mais elle pose le problème de la modélisation de la propagation de la lumière et de la reconstruction tomographique des images. La modélisation de la propagation de la lumière est difficile car l'information sur la distribution spatiale des tissus n'est pas souvent disponible.

Après les présentations, les chercheurs ont eu des échanges sur la complexité des problèmes physiologiques du cerveau et de la moelle épinière. Certains modèles comme ceux de FitzHugh-Nagumo-Rinzel, évoqués par H. Benali, sont utilisés aussi dans des applications cardiaques (tel que mentionné par Yves Bourgault). Il serait très intéressant que l'équipe PhysNum et celle d'Yves Bourgault aient des interactions. Les organisateurs de l'atelier pensent que l'objectif de sensibiliser les chercheurs du CRM a été atteint. D'autres échanges pourront avoir lieu afin de susciter l'intérêt des chercheurs du CRM pour la problématique cérébrale et celle de la moelle épinière.

NPCDS/MITACS Spring School on Statistical and Machine Learning: Topics at the Interface

May 23 – 27, 2006, CRM
Sponsored by MITACS

Organizers: Yoshua Bengio (Montréal), Hugh A. Chipman (Acadia), Russell Steele (McGill)
Speakers: Yoshua Bengio (Montréal), Hugh A. Chipman (Acadia), Antonio Ciampi (McGill), Helmut Kröger (Laval), Doina Precup (McGill), Russell Steele (McGill), Ji Zhu (Michigan)
Number of participants: 41

Research in Learning has a long history of cross-fertilization of ideas between Statistics and Computer Science, and the goal of this school was to continue this rich and mutually beneficial tradition. This event was taught by and directed at Statistical and Machine Learners. The week began with a one-day introduction to key concepts in statistical and machine learning. This introduction was an opportunity to stress (and contrast) the underlying philosophies of both disciplines. Several specific topics, originating in one of the two disciplines but containing significant contributions from each area, were then discussed in detail. Neural networks were covered during the second day, model-based clustering during the third, support vector machines during the fourth, and manifold learning and self-organizing maps during the fifth. Increasingly popular amongst machine learners, manifold methods attempt to identify a nonlinear subspace (surface) in a high-dimensional space, such that the data are all close to this surface. Connections of manifold methods to kernel methods, which form the basis of support vector machines, were also discussed.

The School was a tremendous success. The attendance remained mostly constant throughout the course of the workshop and initial feedback from the participants was overwhelmingly positive. The computational labs were extremely well received and were probably the most useful innovation with respect to the standard workshop model. The participants very much enjoyed applying what they learned during the lectures and the labs worked very well for learning and breaking up the day. Most of the participants knew some of the material presented, but very few (even among the speakers!) had been exposed to all of the material; as a result many participants learned a great deal and began applying some new techniques to their own research at the end of the lab periods. The or-

ganizers are very grateful to the Department of Computer Science and Operations Research (DIRO) for letting them use their computing facilities, which enhanced their ability to provide nice computing labs.

CRM Prizes

THE CRM created and administers, either alone or jointly, four of the eight major national prizes in the mathematical sciences, namely: the CRM – Fields – PIMS Prize, the Prize for Theoretical Physics awarded in collaboration with the Canadian Association of Physicists (CAP), the Prize for young researchers in Statistics awarded jointly with the Statistical Society of Canada (SSC), and the CRM Aisenstadt Prize awarded to rising young Canadian stars, selected by CRM's Scientific Advisory Panel. 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 2006 Awarded to Nicole Tomczak-Jaegermann

Nicole Tomczak-Jaegermann, this year's recipient, is one of the world's leading mathematicians working in functional analysis. She has made outstanding contributions to infinite-dimensional Banach space theory, asymptotic geometric analysis, and the interaction between these two streams of modern functional analysis. She is one of the few mathematicians who have contributed important results to both areas. In particular, her work constitutes an essential ingredient in a solution by the 1998 Fields Medalist W.T. Gowers of the homogeneous space problem posed by Banach in 1932.

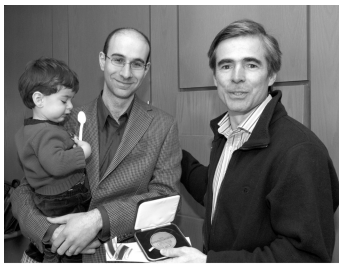
Professor Tomczak-Jaegermann received her Master's (1968) and Ph.D. (1974) degrees from Warsaw University in Poland. She held a position at Warsaw University from 1975 to 1983 and was visiting professor at Texas A&M University during 1981 – 1983. In 1983 she moved to the University of Alberta where she holds a Canada Research Chair in Geometric Analysis. She gave an invited lecture at the International Congress of Mathematicians in 1998, is a Fellow of the Royal Society of Canada, and received a Killam Research Fellowship and the Krieger-Nelson Prize Lectureship of the Canadian Mathematical Society. She has served the Canadian research community, in particular by sitting on NSERC and CMS committees, the Canada Council Killam Research Fellowship Committee, the Canada Research Chairs College of Reviewers, as well as the Scientific Board of BIRS. She has also served as the University of Alberta Site Director of PIMS and as Associate Editor of the Canadian Journal of Mathematics and the Canadian Mathematical Bulletin.

A detailed description of the achievements of Nicole Tomczak-Jaegermann may be found in *Le Bulletin du CRM* (Spring 2006), at the address `www.crm.umontreal.ca/rapports/bulletin/bulletin12-1.pdf`.

The CRM – Fields – PIMS Prize

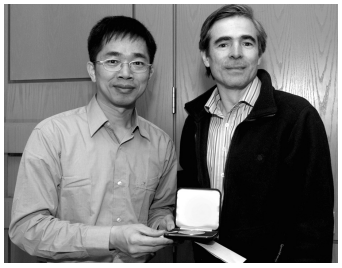
This prize was established in 1994 as the CRM – Fields prize to recognize exceptional research in the mathematical sciences in Canada. This is one of the two most prestigious prizes in mathematical sciences in Canada, in recognition of exceptional research achievements over a whole career. In 2005, PIMS 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), and David Boyd (2005).

André-Aisenstadt Prize 2006 Awarded Jointly to Iosif Polterovich and Tai-Peng Tsai



After obtaining his Master's degree from Moscow State University in 1995, Dr. Polterovich obtained his doctorate from the Weizmann Institute in 2000. Following postdoctoral experiences at the CRM, MSRI and the Max Planck Institute, Dr. Polterovich accepted a tenure-track position at the Université de Montréal, in 2002.

Dr. Polterovich works in geometric spectral theory, his broad variety of results being notable for both their importance and novelty. Perhaps most exciting was Polterovich's announcement in 2000 of an "explicit" formula for the heat invariants of a Riemannian manifold; these geometric invariants had been studied for more than fifty years, yet Polterovich presented them in a striking and useful way, which will undoubtedly be central to much forthcoming research by him and others.



After completing his B.Sc. at the National Taiwan University in 1991, Dr. Tsai obtained his Ph.D. from the University of Minnesota in 1998 under the supervision of Vladimir Sverak. Following a three-year postdoc at the Courant Institute, and a further year at the Institute for Advanced Study, Dr. Tsai became an assistant professor at UBC in 2002.

Dr. Tsai is an outstanding researcher in nonlinear partial differential equations. In recent work with Kang and Gustafson, Tsai obtained the optimal partial regularity result for the incompressible Navier–Stokes equation. He proved an even more remarkable result, i.e., the nonexistence of self-similar blow-up solutions (as proposed by Leray in 1934) with finite local energy in three dimensions. Tsai has also embarked on a deep and detailed study of long-time asymptotics in nonlinear Schrödinger equations with several coauthors. These papers reveal a variety and subtlety of behaviours, and are becoming quite influential.

A detailed description of the work of Iosif Polterovich and Tai-Peng Tsai may be found in *Le Bulletin du CRM* (Spring 2006), at the address `www.crm.umontreal.ca/rapports/bulletin/bulletin12-1.pdf`.

The André-Aisenstadt Prize

Created in 1991, the André-Aisenstadt Mathematics Prize is intended to recognize and reward research achievements in pure and applied mathematics by talented young Canadian mathematicians. This prize consists of a $3,000 award and a medal. The recipient is chosen by the CRM's advisory committee. At the time of consideration, candidates must be Canadian 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), and Ravi Vakil (2005).

CAP – CRM Prize 2006 Awarded to John Harnad

The 2006 CAP–CRM Prize was awarded to John Harnad (Concordia University), for his outstanding contributions to the theory of integrable systems with connections to gauge theory, inverse scattering and random matrices. Combining a vivid intuition of physical systems with a sound mastery of the geometrical aspects of the theory, his work has had, in the last thirty years, a deep and lasting impact on our understanding of these subjects.

After obtaining a B.Sc. from McGill University in 1967 and a M.Sc. from the University of Illinois in 1968, John Harnad did a D.Phil. in theoretical physics at the University of Oxford under the direction of Professor J.C. Taylor. Af-

ter postdoctoral years at the Eötvős Institute in Budapest and Carleton University in Ottawa (1972 – 1975), he became a research associate at the CRM (1975 – 1984), and an associate professor at the Stevens Institute of Technology (1985 – 1986) and the École Polytechnique de Montréal (1986 – 1989). He became a faculty member at Concordia University in 1989 and is now the director of the Mathematical Physics Laboratory at the CRM.

He began his career as an elementary particle physicist. Turning towards non-Abelian gauge theories, he developed, with collaborators and students, the theory of dimensional reduction and applied it to obtain a great number of exact invariant solutions of the classical Yang – Mills equations and their supersymmetric extensions. Those investigations are still quoted by both mathematicians and physicists.

Since the early 1980s, John Harnad has been mainly working on the theory of classical and quantum integrable systems and has become one of the world leaders in this field. Numerous and important, his contributions include: nonlinear superposition formulas for certain types of nonlinear ordinary differential equations that later turned out to figure as Bäcklund transformations for soliton type equations; the introduction of the soliton correlation matrix in soliton theory, relating the inverse spectral approach to the holonomic quantum field approach of Sato et al.; the Hamiltonian theory of quasi-periodic solutions of integrable partial differential equations and the introduction of spectral Darboux coordinates; the introduction of "dual isomonodromic deformations" in the general framework of the Hamiltonian theory of isomonodromic deformations.

John Harnad's most recent work is devoted to the theory of random matrices. He and his collaborators have established a relationship between isomonodromic deformations and the spectral theory of random matrices. This enabled them to establish connections between isomonodromic tau functions, orthogonal and biorthogonal systems of polynomials associated to random matrices, and the corresponding correlation functions. John Harnad has been invited to give a plenary lecture during the 2006 CAP (Canadian Association of Physicists) Congress at Brock University in St. Catharines, Ontario (June 11 – 14, 2006).

A detailed description of the achievements of John Harnad may be found in *Le Bulletin du CRM* (Fall 2006), at the address `www.crm.umontreal.ca/rapports/bulletin/bulletin12-2.pdf`.

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 consits 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), and Robert C. Myers (2005).

CRM – SSC Prize 2006 Awarded to Jeffrey Rosenthal

Jeffrey Rosenthal, Professor in the Department of Statistics at the University of Toronto, is the 2006 winner of the CRM – SSC prize. Dr. Rosenthal's elegant and landmark results set him as one of the leaders in the development of Markov Chain Monte Carlo methods. Within 15 years of his Ph.D., Jeffrey Rosenthal has made outstanding contributions to asymptotic theory related to Markov processes and, with great insight and ingenuity, to clarifying the practical implications of the theory in this area. Jeffrey Rosenthal is a powerful researcher, gifted with a natural ability to explain difficult concepts. His extensive collaborations reflect his expansive interests and his emphasis on practical aspects of theoretical results.

Jeffrey Rosenthal received his B.Sc. from the University of Toronto in 1988, and his M.A. (1990) and Ph.D. (1992) from Harvard University. His Ph.D. supervisor was Persi Diaconis and it was at Harvard that Jeffrey Rosenthal's interest in applications and practical issues was piqued. In a series of elegant papers rich in mathematical analysis, Jeffrey Rosenthal has studied con-

vergence rates of MCMC algorithms for hybrid samplers, slice samplers, time-inhomogeneous chains and time-sampled chains. He has published several key theoretical papers in the *Annals of Applied Probability*, the *Annals of Probability*, the *Annals of Statistics*, and *Advances in Applied Mathematics*, while papers in the *Journal of the American Statistical Association*, *Statistical Science* and the *SIAM Review* pay great attention to practical issues. Jeffrey Rosenthal has received many honours and awards over his career, including his election as IMS Fellow in 2005.

This announcement of the 2006 CRM – SSC Prize was made at University of Western Ontario in London, site of this year's Annual Meeting of the Statistical Society of Canada. A detailed description of the work of Jeffrey Rosenthal may be found in *Le Bulletin du CRM* (Fall 2006), at the address `www.crm.umontreal.ca/rapports/bulletin/bulletin12-2.pdf`.

The CRM – SSC Prize

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

Jeffrey Rosenthal is the eighth 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), and Jiahua Chen (2005).

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 will feature outstanding lecturers able to convey the beauty and power of mathematical research to a wide audience. This year two lecturers were invited within the framework of this new outreach program, Jean-Marie De Koninck and Ivar Ekeland.

Jean-Marie De Koninck

The first lecture in the series of *Grandes Conférences du CRM* took place on Wednesday, March 29, at 8PM in the Pavillon Jean-Coutu of the Université de Montréal. The speaker was Jean-Marie De Koninck of Université Laval, a mathematician well-known for his scientific achievements and for his involvement in the introduction of mathematics to a general audience. In 2005, Jean-Marie De Koninck received the "Scientifique de l'année" Prize from the Société Radio-Canada, which has recognized, for twenty years, the involvement and achievements of a Québec scientist. It was the first time that this honor was awarded to a mathematician. The jury of the Prize wanted to acknowledge the involvement of Jean-Marie De Koninck in the project *Sciences et mathématiques en action* (SMAC). The Web site of the project, and the humoristic *Show Math* presented to more than 3000 high school students, illustrate the use of mathematics in everyday life. This prize is only one of the numerous distinctions awarded to Jean-Marie De Koninck in the course of his career; other distinctions include the Order of Canada in 1994, the National Order of Quebec in 1999, and the Adrien-Pouliot Prize of the Canadian Mathematical Society in 2004.

Jean-Marie De Koninck is a well-known figure in Quebec: since 1976, he has been a sports analyst for the Olympic games swimming competitions and other sports events at Radio-Canada, and he is also the founder of Opération Nez Rouge, which was launched in Quebec City in 1984 to prevent car accidents caused by drinking and driving in the holiday season. This highly original and efficient program then spread to every region of Quebec, and has now crossed national boundaries; indeed, similar programs have been adopted in France, Switzerland and Portugal. In 2000 and 2001, Jean-Marie De Koninck was also the host of 29 installments of the television show *C'est mathématique*!, which aired on Canal Z, Canal Savoir and TFO. He is also a regular guest on many scientific radio and television programs, and whenever he is invited to do so, his enthusiasm and talent for popularization of mathematics and science allows him to reach the general public. Thanks to Jean-Marie De Koninck, the drivers of Quebec can learn about the Riemann hypothesis while fighting morning traffic!

Jean-Marie De Koninck's lecture was followed by more than 250 people, among them, of course, his fellow mathematicians, but also students at all levels (university, CEGEP, high school), and scientists from many disciplines. His talk, entitled *When reality outplays intuition*, focused on certain mathematical questions where intuition can be misleading, such as the famous Birthday Paradox. If we want to invite enough people to guarantee that two of them were born the same day of the year, we need of course 367 persons (let's not forget leap years!). But if we only want to achieve a 50% probability that two guests have the same birthday, it is enough to invite 23 guests. And if we invite 60 guests, the probability of having two guests with the same birthday is greater than 99%! With several similar examples from geometry, number theory and probability, Jean-Marie De Koninck showed how intuition can mislead us.

Jean-Marie De Koninck concluded his lecture by a problem that still concerns researchers in number theory, namely a well-known conjecture posed by Hardy and Littlewood in 1922. According to this conjecture, there are infinitely many twin primes, i.e., primes p such that $p+2$ is also a prime, for example 5 and 7, 11 and 13, or 101 and 103. We can generalise this conjecture to triplets of prime numbers, for example primes p such that $p+2$ and $p+6$ are also prime, for instance 11, 13 and 17, or 41, 43 and 47. We can also generalize the conjecture to quadruplets of prime numbers, and so on. The Generalised Twin Prime conjecture of Hardy and Littlewood contains all those particular cases. Even if no case of the conjecture has been solved, there is a lot of evidence, both theoretical and computational, for the validity of the conjecture.

Another conjecture of Hardy and Littlewood says that the function $\pi(x)$, which represents the number of primes at most equal to x, is convex, i.e., there are always more primes in the interval $[1, y]$ than in any of the intervals $[x, x+y]$ for any value of x. In this case also, computer testing seems to indicate the validity of the conjecture. But it was shown in 1973 by Hensley and Richards that the two conjectures of Hardy and Littlewood are incompatible, which means that both cannot be true! How can our intuition be so misleading? We can now show that if the Generalised Twin Prime conjecture is true (this is what most of the experts believe), then there exists an interval $[x_0, x_0 + 4893]$ containing more primes than the interval $[1, 4893]$. But we can also estimate empirically that to write x_0, between 1057 and 1590 decimal digits are necessary!

With his lecture, Jean-Marie De Koninck succeeded once more in his role as ambassador of mathematics to the wide audience attending his talk, while intriguing his fellow mathematicians.

Ivar Ekeland

On May the 4th 2006, at the IBM amphitheater of the École des HÉC de Montréal, Professor Ivar Ekeland delivered to a large and enthusiastic audience the second of the *Grandes Conférences du CRM*. This distinguished mathematician, who has been the Director of PIMS since 2003, holds a Canada Research Chair in Mathematical Economics at UBC. Educated at the École Normale, he taught at the Université de Paris-Dauphine from 1970 to 2003 and was its President from 1989 to 1994. He was also the Director of the Centre de Recherche en Mathématiques de la Décision and the Institut Finance Dauphine. His scientific achievements were acknowledged with prizes from the Académie des Sciences de Paris, the Société Mathématique de France as well as the Académie des Sciences de Belgique.

Anxious to reach a large audience, he wrote books of popularization and personal thoughts, such as *Le calcul, l'imprévu* and *Au hasard*, for which he was awarded the Prix Jean-Rostand of the Association des Écrivains Scientifiques de France and the Prix d'Alembert of the Société Mathématique de France. His May 4th lecture borrowed the title of his latest book, *Le meilleur des mondes possibles*.

Ekeland started his lecture by drawing a parallel between the fate of la Sagouine, Antonine Maillet's character, who wonders why the world is the way it is, and that of Archimedes, who, for the sheer sake of science, wonders how the world is. Why and how, two drastically different questionings that did, nevertheless, intersect at a given point of History, when, in 1744, Pierre Moreau de Maupertuis fancied he could answer both questions at the same time through his variational principle of least action.

As pointed out by our lecturer, this principle found its origin in the theory of light. Already in Antiquity, Hero of Alexandria had derived the law of reflection by assuming that light follows a path of minimal length. In the 17th Century, Descartes thought he had proved the law of refraction, wrongly so, though, since he had attributed light a greater speed in water than in air! Assuming the opposite, Fermat managed to recover this law by assuming that light travels from one point to another in such a way as to minimize the time spent.

According to Maupertuis, light follows neither the shortest, nor the fastest path: it travels so as to minimize the action, an ill-defined quantity that he chose in such a way as to recover the law of refraction when using Descartes' wrong assumption about the speed of light. Such a dubious achievement could hardly have secured Maupertuis immortality, had he not decided to generalize his principle of least action so that all the laws of classical mechanics could be derived from it. According to this principle, amongst all possible paths nature chooses precisely that one for which action is a minimum, a notion that seems to ascribe a decisional power to nature. Maupertuis quickly took the step that led him to conclude that his principle is a bridge between physics and metaphysics. Indeed, he writes: "Once it is known that all the laws of motion stem from the principle of the best, one cannot doubt that they have been settled by an almighty Being full of wisdom."

Maupertuis suffered a miserable end. Koenig, once a friend, claimed that Leibniz had stated the principle of least action before Maupertuis in a letter that he was unable to find again. Maupertuis' reaction triggered a quarrel followed by

a flood of lampoons. Voltaire intervened and left posterity a ridiculous image of Maupertuis and Leibniz in *L'histoire du docteur Akakia* and *Candide*. Still, although incompetent at physics and mathematics, Maupertuis had had a right intutition. It would fall to Euler and Lagrange to define action correctly and to formulate the variational principle that makes it stationary. The metaphysical dimension would be cast aside.

Physics gives us no reason to think that our world is organized in view of a given end, or that is is better or worse than any other world. At the end of his talk, Ivar Ekeland reviewed rapidly the situation in other fields. He mentioned Darwin, according to whom perfection is not absolute since a species may be perfectly well adapted here without being so elsewhere, as well as Hayek, an economist for whom the best is the enemy of the good. And he concluded very wisely that both Archimedes and la Sagouine would have advantage to meet: he would encourage her to think on her own, while she would convince him that he should communicate better and ponder over real problems. A piece of advice she could certainly not give Ivar Ekeland: his talk, full of stimulating thoughts, was a real tour de force: not a single equation!

CRM Partnerships

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

CRM Partners

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

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

International and National Collaborations

In 2005 – 2006, the CRM collaborated with or received financial assistance from the following institutions: the National Science Foundation (NSF), INSERM (Paris), the Clay Foundation, DIMATIA (Prague), IBM, INRIA, the ALGANT programme, École Nationale des Ponts et Chaussées, Mathematical Sciences Research Institute (MSRI), the University of Havana (Cuba), the Banff International Research Station (BIRS), the Groupe d'études et de recherche en analyse des décisions (GERAD), and the Regroupement québécois sur les matériaux de pointe (RQMP).

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), the École Normale Supérieure (France), the Isaac Newton Institute, the Institut des Hautes Études Scientifiques (IHÉS, France), and BIRS.

Associations and Professional Societies

The CRM maintains close ties with the different professional societies in the mathematical sciences: CMS, CAIMS, SSC and CAP. The president of the CMS is an ex-officio member of the CRM Scientific Advisory Committee. The CRM also supports 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 305 scientists, 611 students and 169 partner organizations working on 32 ongoing projects, involving 48 Canadian universities. 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 2005–2006, it gave support to three workshops partially sponsored by the CRM, whose reports are included in the section on the CRM multidisciplinary and industrial program: the Fifth Summer School in Quantum Computing, the MITACS–MSRI–AFMnet–CRM Workshop on Therapeutic Efficacy in Population Veterinary Medicine, and the NPCDS/MITACS Spring School on Statistical and Machine Learning.

National Program on Complex Data Structures (NPCDS)

This initiative was developed in partnership with the three mathematical sciences institutes and the reallocations committee during the recently completed reallocations exercise at NSERC. The program was funded by NSERC for four years for a total of $687,000. An additional $200,000 has been committed to the program by the institutes. The National Program was conceived as a model for a national network in the statistical sciences, in partnership with the mathematics institutes. The broad goal of the proposal is to foster nationally coordinated projects with substantial interactions with the large community of scientists involved in the analysis of complex data sets, and to establish a framework for the national networking of research activities in the statistical community. The original proposal targeted the development and application of statistical methods for the analysis of data obtained from complex survey sample designs and longitudinal biological, epidemiological and medical studies. More specific objectives of the program include the development of collaborations between university and extra-university researchers, and the provision of training for graduate students in important scientific areas through these collaborations.

NPCDS Projects

Statistical Methods for Complex Survey Data
Project Leader: Changbao Wu (Waterloo)

Canadian Consortium on Statistical Genomics
Project Leader: Rafal Kustra (Toronto)

Data Mining with Complex Data Structures
Project Leaders: Hugh Chipman (Acadia), Antonio Ciampi (McGill), Theodora Kourti (McMaster), Helmut Kröger (Laval)

Design and Analysis of Computer Experiments for Complex Systems
Project Leader: Derek Bingham (Simon Fraser)

Forests, Fires and Stochastic Modeling
Project Leaders: John Braun (Western Ontario), Charmaine Dean (Simon Fraser), Dave Martell (Toronto)

NPCDS Workshops

Workshop on Spatial/Temporal Modeling for Marine Ecosystems
August 17–19, 2005, Dalhousie University
Organizers: Mike Dowd (Dalhousie), Chris Field (Dalhousie), Joanna Mills Fleming (Dalhousie)

Workshop on Current Issues in the Analysis of Incomplete Longitudinal Data
October 13–15, 2005, Fields Institute
Organizers: Peter Song (Waterloo), Michal Abrahamowicz (McGill), Richard Cook (Waterloo), Paul Gustafson (UBC), Liqun Wang (Manitoba)

Workshop on Data Mining
November 10–12, 2005, Fields Institute

Organizers: Hugh Chipman (Acadia), Antonio Ciampi (McGill), Theodora Kourti (McMaster), Helmut Kröger (Laval), Michael Vainder (Generation 5)

NPCDS/MITACS Spring School on Statistical and Machine Learning: Topics at the Interface
May 23 – 27, 2006, CRM
Organizers: Yoshua Bengio (Montréal), Hugh A. Chipman (Acadia), Russell Steele (McGill)

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, Dalhousie University, Memorial University, Mount Allison University, Saint Francis Xavier University, Saint Mary's University, the University of New Brunswick and the University of Prince Edward Island.

AARMS Scientific Activities

Sixth Annual Bluenose Numerical Analysis Day
June 10, 2005, Cape Breton University
Organizer: Shaohua George Chen (Cape Breton)

AARMS Summer School 2005
July 17 – August 14, 2005, Dalhousie University
Organizers: Renzo Piccinini (Milano-Bicocca), Tony Thompson (Dalhousie)

Christopher Field Retirement Symposium
August 15, 2005, Dalhousie University
Organizers: Joanna Mills Fleming (Dalhousie), David Hamilton (Dalhousie)

NPCDS Workshop: Spatial/Temporal Modeling for Marine Ecosystems
August 17 – 19, 2005, Dalhousie University
Organizers: Mike Dowd (Dalhousie), Chris Field (Dalhousie), Joanna Mills Fleming (Dalhousie)

APICS 2005: Symposium on Graph Theory and Combinatorics
October 21 – 23, 2005, Acadia University
Organizer: Nancy Clarke (Acadia)

APICS 2005: Workshop on Robust and Computationally Intensive Statistical Models
October 21 – 23, 2005, Acadia University
Organizer: Hugh Chipman (Acadia)

Atlantic Analysis Days
January 20 – 21, 2006, Dalhousie University
Organizer: John Borwein (Dalhousie)

East Coast Combinatorics Conference
April 1-2, 2006, University of Prince Edward Island
Organizer: Shannon Fitzpatrick (Prince Edward Island)

Atlantic Canada General Relativity Meeting
University of New Brunswick, May 5 – 7, 2006
Organizers: Arundhati Dasgupta (New Brunswick), Jack Gegenberg (New Brunswick), Robert McKellar (New Brunswick)

Academic Partners

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

With the financial support of the Université de Montréal, McGill University, the Université du Québec à Montréal, Concordia University, and Université Laval, as well as grants from NSERC and the Fonds québécois de recherche sur la nature et les technologies (FQRNT), the

CRM finances the activities of its eight laboratories, which collectively represent the most active branches of the mathematical sciences. These laboratories are the perfect illustration of scientific vitality and serve to feed the national and international scientific programs of the CRM. Please refer to the section "Research Laboratories" for reports describing the activities of each of these laboratories.

Association with the University of Ottawa

In 2003, the Department of Mathematics and Statistics of the University of Ottawa became a member of the Centre de recherches mathématiques (CRM). In partnership with the University of Ottawa, the CRM co-finances the *CRM – University of Ottawa Distinguished Lecture Series*, postdoctoral fellowships, and teaching releases so that University of Ottawa faculty members can undertake research with colleagues in the CRM's laboratories or participate in CRM scientific activities. The activities below were made possible through sponsorship by 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.

Cocycles and cocycle categories
Rick Jardine (University of Western Ontario), October 21, 2005

Algebraic Topology as a Tool for the Analysis of High-Dimensional Data
Gunnar Carlsson (Stanford University), February 10, 2006

Putting a Match to Square Ice
Georgia Benkart (University of Wisconsin at Madison), March 24, 2006

Coupled Systems: *Theory and Examples*
Marty Golubitsky (University of Houston), April 28, 2006

Workshop on Probabilistic Symmetries and Their Applications

May 15 – 17, 2006, University of Ottawa
Sponsored by the Fields Institute, the University of Ottawa and the CRM

Organizers: Gail Ivanoff (Ottawa), Raluca Balan (Ottawa)

More information on this workshop may be found in the "General Program" section of this report.

Network for Computing and Mathematical Modeling (ncm_2)

The CRM is one of the founding members of the Network for Computing and Mathematical Modeling (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 modeling. The research of the network focuses on five major themes: risk management, information processing, imaging and parallel computing, transport and telecommunications, and health and electronic commerce. The 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).

Laboratoires universitaires Bell (LUB)

The CRM is an active participant in Laboratoires universitaires Bell, a joint project between the ncm_2 and Bell. The goal of the Laboratories is to make innovations in the field of multimedia research and applications (mainly interactive applications aimed at the general public, electronic commerce applications and new generations of networks), as well as to promote the training of a highly qualified, international calibre workforce in these areas.

Québec Neuroimaging Initiative (RNQ)

In recent years, CRM's PhysNum laboratory has developed a strong collaborative network with various partners in neuroimaging in the Montréal area. This network became an officially recognized network with the founding of the "Regroupement Neuro-imagerie 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. The reader will find below brief summaries of the meetings that took place in 2005 – 2006, as well as a report on the 17th Canadian Conference on Computational Geometry.

CMS/CSHPM Summer 2005 Meeting

June 4 – 6, 2005, University of Waterloo

Meeting director: Alexandru Nica (Waterloo)

The Summer 2005 Meeting of the Canadian Mathematical Society welcomed a record number of 540 participants — the first meeting to have more than 500 participants. This was a joint meeting with CSHPM (the Canadian Society for the History and Philosophy of Mathematics). The public lecture was given by Moshe Milevsky from York University and was titled *The mathematics of silly investment strategies, or how to win the Globe and Mail's stock picking contest*. The plenary speakers were Len Berggren (Simon Fraser), Keith Devlin (Stanford), Dan Freed (Texas at Austin), Robert McCann (Toronto), Andrei Okounkov (Princeton), Gilles Pisier (Paris 6 and Texas A&M), and Ken Ribet (Berkeley).

The CMS was pleased to present lectures from its research prize winners, namely, the Krieger – Nelson Prize Lecture, given by Barbara Lee Keyfitz (Fields Institute and the University of Houston), and the Jeffery-Williams Lecture, given jointly by Edward Bierstone and Pierre Milman (both from the University of Toronto). The CMS Excellence in Teaching Lecture was given by Philip Loewen (UBC). The meeting hosted a record number of 23 parallel special sessions, covering a wide range of mathematical research interests, and also aspects of mathematics education and of the history and philosophy of mathematics. The special sessions and their organizers may be found below.

Automatic Sequences and Related Topics
Organizers: Jean-Paul Allouche (Orsay), Jeffrey Shallit (Waterloo)

Combinatorics and Geometry
Organizer: Ian Goulden (Waterloo)

Complex Variables
Organizers: Thomas Bloom (Toronto), Paul Gauthier (Montréal)

Discrete and Computational Geometry
Organizers: Leroy J. Dickey (Waterloo), Asia Ivic Weiss (York)

Dynamical Systems
Organizers: Sue Ann Campbell (Waterloo), Yuming Chen (Wilfrid Laurier), Huaiping Zhu (York)

Exploratory Classroom Problems in Calculus
Organizer: Peter Taylor (Queen's)

Functional Equations and Their Applications
Organizers: Janos Aczel, Che-Tat Ng (Waterloo)

General Topology and Its Applications
Organizers: E.D. Tymchatyn (Saskatoon), A. Karassev, M. Tuncali, V. Valov (Nipissing)

Geometric Topology
Organizers: Hans Boden (McMaster), Doug Park, Mainak Poddar (Waterloo)

History and Philosophy of Mathematics (CSHPM Session)
Organizer: Duncan Melville (St. Lawrence)

History of Mathematics from Medieval Islam to Renaissance Europe (CSHPM Session)
Organizers: Rob Bradley (Adelphi), Glen van Brummelen (Bennington College)

Invariant Theory and Differential Geometry
Organizers: Ray MacLenaghan (Waterloo), Roman Smirnov (Dalhousie)

L-Functions and Algebraic Curves
Organizers: Yu-Ru Liu, David McKinnon, Michael Rubinstein (Waterloo)

Mathematical Aspects of Quantum Information
Organizers: Daniel Gottesman (Perimeter), Achim Kempf (Waterloo), David Kribs (Guelph), Mike Mosca (Waterloo)

Mathematics from Ancient to Modern Times
Organizers: Richard O'Lander, Ronald Sklar (St John's)

Mathematics of Actuarial Finance
Organizer: Tom Salisbury (York & Fields Institute)

Mathematics of Computer Algebra and Analysis
Organizers: Keith Geddes, Mark Giesbrecht, George Labahn, Arne Storjohann (Waterloo)

Nonlinear Partial Differential Equations
Organizers: Robert McCann (Toronto), Walter Craig (McMaster), Catherine Sulem (Toronto)

Operator Algebras, Operator Spaces and Harmonic Analysis
Organizers: Ken Davidson, Brian Forrest (Waterloo)

Random Graphs and Their Applications
Organizers: Anthony Bonato (Wilfrid Laurier), Penny Haxell, Nicholas Wormald (Waterloo)

Representation Theory
Organizer: Wentang Kuo (Waterloo)

String Theory and Integrable Systems
Organizers: Lisa Jeffrey (Toronto), Boris Khesin (Toronto), Rob Myers (Perimeter Institute)

Contributed Papers Session
Organizer: Peter Hoffman (Waterloo)

The Meeting Committee gratefully acknowledges the support of the following institutions: the University of Waterloo (Faculty of Mathematics and Department of Pure Mathematics), the CRM, the Fields Institute, MITACS, PIMS, A.K. Peters, the Institute for Quantum Computing (IQC), Springer, the University of Guelph, and Queen's University (Department of Mathematics and Statistics).

Annual Meeting of the Statistical Society of Canada

June 12 – 15, 2005, University of Saskatchewan

Organizers: Program Committee Chair, Augustine Wong (York); Biostatistics Section, Gordon Fick (Calgary); Business and Industrial Statistics Section, Stefan Steiner (Waterloo); Survey Methods Section, Changbao Wu (Waterloo)

The thirty-third Annual Meeting of the Statistical Society of Canada has brought together researchers in statistics and probability and users from academia, government and industry. The meeting featured three workshops, some 40 invited paper sessions and a number of contributed paper sessions. SSC 2005 was sponsored by the CRM, the Fields Institute, PIMS, MITACS, the University of Saskatchewan, AON Consulting, MyTravel Sinfonia and W.H. Freeman.

The Presidential Invited Address was given by Barbara Lee Keyfitz (Fields Institute), the Gold Medal Address by Keith Worsley (McGill) and the CRM – SSC Award Address by Jiahua Chen (Waterloo). The Pierre-Robillard Award Address was given by Zeny Zhe-Qing Feng (Waterloo & Yale), and the *Canadian Journal of Statistics* Award Address was given by Naomi S. Altman (Penn State) and Julio C. Villarreal (Cornell). The Special Invited Addresses of the Sections were given by Jerry Lawless (Waterloo), Randy Sitter (Simon Fraser) and Gerald van Belle (University of Washington).

CAIMS Annual Meeting 2005

June 16-18, 2005, University of Manitoba

Organizers: Abba Gumel (Manitoba), Rob McLeod (Manitoba)

This meeting featured six themes, each of which was addressed by a plenary speaker. Here are the themes, with the names of the plenary speakers within parentheses: dynamical systems and mathematical biology (Michael Mackey, McGill); signal processing (Simon Haykin, McMaster); mathematics in industry (Heinz Engl, Austrian Academy of Sciences, and Sam Howison, Oxford); bioinformatics (Ruben Zamar, UBC); computational mathematics (Sebastian Reich, Imperial College); pattern recognition (Tin Kam Ho, Bell Laboratories). The Research Prize Lecture was given by Michel Fortin (Laval), and two Doctoral Dissertation Award Lectures were given by Ovidiu Voitcu (Alberta) and Lindsay Anderson (Western Ontario), respectively. The CAIMS meeting also featured contributed lectures and 32 invited lectures. The meeting was sponsored by the University of Manitoba (including the Institute of Industrial Mathematical Sciences), the CRM, the Fields Institute, PIMS, MITACS and Western Economic Diversification Canada.

17th Canadian Conference on Computational Geometry

August 10-12, 2005, University of Windsor

Organizer: Asish Mukhopadhyay (Windsor)

Computational Geometry deals with geometric problems from an algorithmic point of view. The Canadian Conference on Computational Geometry has played a pioneering role in the nurture and development of this area. The number of attendees at the 17th Canadian Conference on Computational Geometry was 91, with students accounting for nearly a third of the total. A total of 75 papers were accepted for presentation at the Conference. The presentations were organized into two parallel sessions with

each presentation lasting 20 minutes, including a question period. The main highlights of the Conference were three invited talks, one on each day of the Conference, and an open problems session, chaired by Erik Demaine (MIT) and Joseph O'Rourke (Smith College). The first invited talk was by Jeffe Erickson (Illinois at Urbana-Champaign). Dr. Erickson spoke about computing optimal graph structures in topological spaces and posed a host of interesting open problems. The second invited talk was the Erdős memorial lecture by Joseph O'Rourke (Smith College). Dr. O'Rourke held the audience in thrall by revealing the connections between his current work on linkages that lock and protein folding. The third invited talk was by Sudipto Guha (University of Pennsylvania). Dr. Guha spoke about the applicability of geometry to the resolution of nonlinear problems in the streaming model of computation. The Conference was supported by the University of Windsor, the CRM, the Fields Institute and PIMS.

CMS Winter 2005 Meeting

December 10 – 12, 2005, University of Victoria

Meeting director: Ahmed R. Sourour (Victoria)

The Winter 2005 Meeting of the Canadian Mathematical Society welcomed 322 participants. The plenary speakers were Robert Guralnick (Southern California), Uffe Haagerup (South Denmark), Bryna Kra (Northwestern), Andrew Majda (Courant), and Oded Schramm (Microsoft). The CMS was pleased to present lectures from its prize winners, namely, the Coxeter-James Prize Lecture, given by Robert McCann (Toronto), the Doctoral Prize Lecture, given by Vasilisa Shramchenko (Concordia), and the Adrien-Pouliot Prize Lecture, given by Katherine Heinrich (Regina). Professor Yu-Ru Liu (Waterloo) received the G. de B. Robinson award. The invited sessions and their organizers may be found below.

Applied Partial Differential Equations
Organizers: Anne Bourlioux (Montréal), Reinhard Illner (Victoria), Boualem Khouider (Victoria)

Combinatorics
Organizers: Peter Dukes (Victoria), Frank Ruskey (Victoria)

Discrete and Convex Geometry
Organizers: Karoly Bezdek (Calgary), Jozsef Solymosi (UBC)

Ergodic Theory
Organizers: Christopher Bose (Victoria), Andres del Junco (Toronto)

Graph Theory
Organizers: Jing Huang (Victoria), Kieka Mynhardt (Victoria), Wendy Myrvold (Victoria)

History of Mathematics
Organizer: Len Berggren (Simon Fraser)

Life Beyond Calculus
Organizers: Malgorzata Dubiel (Simon Fraser), Veselin Jungic (Simon Fraser)

Mathematics Inspired by Biological Models
Organizers: Fred Brauer (UBC), Pauline van den Driessche (Victoria)

Matrix Analysis
Organizers: Man-Duen Choi (Toronto), Douglas Farenick (Regina)

Nonlinear Analysis
Organizers: Martial Agueh (Victoria), Ivar Ekeland (PIMS), Robert McCann (Toronto)

Operator Algebras
Organizers: Marcelo Laca (Victoria), John Phillips (Victoria)

Probability
Organizers: Martin Barlow (UBC), Edwin Perkins (UBC)

Topology
Organizer: Dale Rolfsen (UBC)

Variational Analysis and Optimization
Organizers: Jiming Peng (McMaster), Jane Ye (Victoria)

Contributed Papers Session
Organizer: C. Robert Miers (Victoria)

The following institutions sponsored the CMS Winter 2005 Meeting: the University of Victoria (Department of Mathematics and Statistics, Faculty of Science, Faculty of Engineering, Faculty of Graduate Studies), the CRM, the Fields Institute, MITACS, PIMS, Simon Fraser University (Department of Mathematics and Statistics), and the University of British Columbia (Department of Mathematics and Faculty of Science).

Mathematical Education

As part of its mandate to promote and stimulate research in the mathematical sciences, at every level, the CRM provides funding and support for many activities and programs related to mathematical education and the training of researchers. Many of these activities and programs are carried out jointly with the ISM (Institut des sciences mathématiques) that the CRM created in 1991.

Institut des sciences mathématiques (ISM)

Created in 1991 by the departments of mathematics and statistics of the four Montréal universities on the iniative of the CRM, 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 centers 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 harmonisation of graduate programs
The ISM was created to bring together the strengths of its member departments, in order to turn them into a great school of mathematics. Thus the ISM coordinates the graduate studies of the mathematics departments, supports the sharing of expertise among its researchers and facilitates student mobility between the Montréal universities.

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

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

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

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

CRM – ISM Postdoctoral Fellowships

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

2005 – 2006 Postdoctoral Fellows

Abdellatif Bourhim (Ph.D. 2001, Rabat) worked in analysis with Thomas Ransford, from

Laval University. He has accepted a faculty position at the Université de Moncton.
Harald Helfgott (Ph.D. 2003, Princeton) worked with Andrew Granville, from the Université de Montréal, on number theory, elliptic curves, and automorphic forms and combinatorics. He has accepted a faculty position at the University of Bristol, in England.
Emmanuel Lorin de la Grandmaison (Ph.D. 2001, ENS Cachan) worked in applied mathematics with André Bandrauk, from the Université de Sherbrooke. He is pursuing his postdoctoral studies at the Université de Sherbrooke.
Joseph Maher (Ph.D. 2002, UC Santa Barbara) worked in geometry and topology with Steven Boyer, from UQÀM. He has accepted a faculty position at the Oklahoma State University.
Andrew McIntyre (Ph.D. 2002, SUNY Stony Brook) has worked in mathematical physics and analysis with Dmitry Korotkin, from Concordia University. He is pursuing his postdoctoral studies at Concordia University.
Ye Tian (Ph.D. 2003, Columbia) worked in number theory with Henri Darmon, from McGill University. He has accepted a faculty position in China.
Jensen Bernt Tore (Ph.D. 2003, NTNU) worked in algebra with Thomas Brüstle, from the Université de Sherbrooke. Jensen Bernt Tore has accepted a postdoctoral fellowship from the Norwegian University of Science and Technology (NTNU), in Trondheim (Norway).

Undergraduate Summer Scholarships

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

Agnès Beaudry (McGill)
Topic: Euclidean algorithms in k-steps in real quadratic number fields
Duration: 4 months
Supervisor: Pierre Charollois
This scholarship was cofinanced by Henri Darmon's research funds.
Yuriy Svyrydov (McGill)
Topic: Different modes of convergence for the numerical solution of stochastic differential equations
Duration: 2 months (May – June)
Supervisor: Benoit Charbonneau
This scholarship was cofinanced by Paul Tupper's research funds.
Christelle Vincent (McGill)
Topic: Évacuation de tableaux de Young, deux conjectures de Schützenberger
Duration: 2 months
Supervisor: Aaron Lauve
This scholarship was cofinanced by Benoit Larose's research funds.
Martin Gariépy (Université de Montréal)
Topic: Théorie du revêtement en géométrie
Duration: 4 months
Supervisor: Samuel Lisi
This scholarship was cofinanced by François Lalonde's research funds.

ISM Graduate Student Conference

The eighth ISM Graduate Student Conference (Colloque panquébécois annuel des étudiants) took place at Université Laval on May 23 – 25, 2006. It was attended by 104 participants, including 90 students from eight Canadian universities. The Conference offered the students a great opportunity to meet, to present their research work and to exchange ideas with their peers. The Conference had three streams: *statistics*, *pure mathematics* and *applied mathematics*. Two of the six plenary lectures were reserved for each stream, and 30 lectures were given by students. Each stream had its own meeting room, and thus the participants could go on discussing mathematics after the lectures. The Conference was also an opportunity to promote the mathematical sciences in front of a wide audience; on Tuesday, May 23, Jean-Marie De Koninck (Université Laval) presented *ShowMath*, his mathematical show for the general public. This show was attended by the Conference participants, but also by about 100 other persons: students from all levels (grade school, high school and college) and some parents and teachers.

The organizers wanted the students to present their research work in a lucid way, and they decided to award prizes to the two best presentations in each of the three streams. They enlisted the support of some institutions, which responded with enthusiasm and provided their own selection committees. In statistics, the prizes were awarded by the ASSQ and the Canada Research Chair of Professor Louis-Paul Rivest (Université Laval). In applied mathematics, the prizes were awarded by GIREF (Université Laval) and DRDC Valcartier, which had a kiosk on the conference site and contributed

substantially to the Conference. In pure mathematics, the prizes were awarded by CICMA, the Analysis Group of the Mathematics Department and the Canada Research Chair of Professor Thomas Ransford (Université Laval).

ISM "Sur la Route" Colloquium

In the same vein as the ISM Graduate Student Conference, the "Sur la Route" Colloquium is organized by and geared towards students. This colloquium was initiated by students from the Université de Sherbrooke, and this year, it took place on October 14 – 16, 2005, at the Camp Les Sommets, in the Eastern Townships. It was attended by approximately forty students from the ISM universities, of which around fifteen gave talks.

Plenary lectures

Fonctions analytiques discrètes ou empilements de cercles
Virginie Charette, Université de Sherbrooke

Systèmes dynamiques chaotiques et indice de Conley
Sara Derivière, Université de Sherbrooke

La conjecture de dimension finitiste
François Huard, Bishop's University

Organizing committee: Jennifer Bélanger, Sylvain Bérubé, Julie Dionne, Jean-Philippe Morin, Charles Paquette, David Smith

Other Joint Initiatives

ESSO/CMS Math Camps 2005

The ESSO/CMS Math Camp Program started in 1999 with three camps, and the program has now grown to include at least one camp in every province. The support received from the sponsors enables the Canadian Mathematical Society to make these camps accessible to students from across Canada who demonstrate an interest and excellence in mathematics. In 2005, there were thirteen regional math camps in ten provinces, as well as a national camp.

Organized by Daniel Gatien and Matthieu Dufour, the national camp was held at the John Abbott cegep from July 3 to 9, 2005. The National Camp is designed primarily for younger Canadian students with at least two years remaining in high school and with the potential to compete at the Mathematical Olympiad level. The selection of invited students is based upon their results in various mathematics competitions. Presentations on specific topics and the various problem solving sessions are run by local area teachers and faculty members as well as former IMO team members.

The Regional Camps are intended to provide some mathematics enrichment in a fun and rewarding environment. Each camp invites between 20 and 30 students (from grade 9 to 11) on the basis of national or regional mathematics competitions as well as recommendations from teachers. The 2005 regional camps took place at the Sir Wilfred Grenfell College, the University of New Brunswick, the University of Prince Edward Island, the Université du Québec à Rimouski, Simon Fraser University, Dalhousie University, the University of Ottawa, the University of Calgary, Brock University, the University of Western Ontario, the University of Manitoba and the University of Regina.

Finally, the 2005 IMO Training Seminar, designed to prepare a team of Canadian students for the International Mathematical Olympiad (IMO), took place from June 25 to July 10, 2005, and was organized by the University of Calgary and BIRS (Banff International Research Station).

The sponsors of the Math Camp Program are: the Imperial Oil Foundation, the Canadian Mathematical Society, NSERC PromoScience, CRM, the Fields Institute, the Pacific Institute for the Mathematical Sciences, the Association Mathématique du Québec, the host universities, and the governments of New Brunswick, Alberta, the Northwest Territories, Newfoundland and Labrador, Nova Scotia, Québec, Ontario and Saskatchewan.

2005 AMQ Mathematics Camp

June 18 – July 1, 2005, UQÀM

Organizers: Pierre Bouchard (UQÀM) and Matthieu Dufour (UQÀM)

For the fifth year in a row, the Camp was held at UQÀM. In 2005, there were 22 participants, who had the opportunity to meet with mathematicians and people who use mathematics in their work. Every day, one or more lecturers presented topics of interest, and the participants shared in an unforgettable experience with more than twenty other "fans" of mathematics. For the duration of the camp, the participants could use the UQÀM computers. In 2005 (as in 2003 and

2004), they visited the national park of Mont-Mégantic, in particular the telescope and the observatory.

Research Laboratories

THE nine CRM research laboratories are where a substantial part of the Canadian research effort in the mathematical sciences takes place. They span 12 universities in Quebec and Ontario (Montreal, McGill, UQÀM, Concordia, Laval, Sherbrooke, École Polytechnique, HÉC, UQTR, Ottawa, Carleton, Queen's). Each of the laboratories hosts an average of 20 professors, 50 graduate students, and 15 postdoctoral fellows, organizes workshops and inter-university seminars on a regular basis, and coordinates a unified graduate school (involving five, six or seven universities), with funding coming from a wide variety of sources. The dedicated involvement of lab members in the CRM's activities is a driving force in bringing leading scientists to the Center. It also ensures that students and postdoctoral fellows receive an excellent preparation for the thematic programs, through special advanced courses, mini-courses, and student seminars. These labs are the most effective way to transfer the results of our international programming to Canadian scientists.

Applied Mathematics

Description

Applied and computational mathematics is a very active area of research with a long tradition, as well as many young faculty members, in the greater Montreal area. With modern computing equipment, it has become possible to simulate problems and compute solutions that were out of reach a few decades ago: this has been a tremendous driving force in recent developments in applied and computational mathematics.

The objective of the Laboratory is to encourage further scientific exchanges both amongst its members and outside the group. It is characterized by the intensity of its multidisciplinary collaborations, with all the members working on the development of mathematical models and numerical methods for applications to science and engineering. The members of the Laboratory work in a wide range of applications (fluids, solids, physics, biology, etc.), using a wide variety of tools (optimization, numerical analysis, dynamical systems, etc.), and are very active in both research and training, supervising a large number of graduate students and postdoctoral fellows.

One characteristic of this laboratory is the sustained collaboration of its members with researchers in other fields: for instance, André Bandrauk and Nilima Nigam are members of RQMP (Regroupement québécois des matériaux de pointe), Sebius Doedel and Jacques Bélair are members of the Centre for Nonlinear Dynamics in Physiology at McGill, Martin Gander and Michel Delfour are members of GIREF, Anne Bourlioux collaborates with computer scientists and mechanical engineers in an industrial project sponsored by MITACS, while Peter Bartello, André Bandrauk, and Sebius Doedel hold positions completely or partly outside mathematics departments.

The Laboratory organizes the Montreal Scientific Computing Days each February, as well as other workshops. It has two regular seminars running during the academic year, a weekly applied mathematics seminar and a biweekly computational science and engineering seminar. It also supports postdoctoral fellows and summer students as well as Canadian and international visitors.

News and highlights

The Laboratory and its members remain very active, as it welcomed two new members this year: Tucker Carrington (Montréal) and Thomas Wihler (McGill). The Laboratory organizes two seminars, described below, and the Montreal Scientific Computing Days in February, whose purpose is to bring together people in the nearby scientific computing community so that they learn about the latest techniques and exchange ideas. In addition, Sebius Doedel, Nilima Nigam and Jacques Bélair organized workshops, described below. The Laboratory members are also very visible at the national and international levels in applied and industrial mathematics. André Bandrauk was awarded the 2005 Urgel Archambault Prize by ACFAS (l'Association francophone pour le savoir), and is the second laboratory member honored in this way, following Michel Delfour who was honored in 1995. Paul Tupper was awarded the Twelfth Leslie Fox

Prize in June 2005, an award given once every two years to a Numerical Analyst less than 31 years old. Anne Bourlioux continues to serve on the board of directors of CAIMS.

Laboratory members were also very active in workshop and conference organization, in addition to the Laboratory sponsored events. Michel Delfour and André Bandrauk along with Claude Le Bris organized the *High-dimensional Partial Differential Equations in Science and Engineering* workshop at the CRM in August 2005. At BIRS, Paul Tupper was one of the organizers of *Mathematical Issues in Molecular Dynamics* in June 2005, and Jacques Bélair was a member of the organizing committee for the *MITACS – MSRI – AFMnet – CRM Workshop on Therapeutic Efficacy in Population Veterinary Medicine* in October 2005. Anne Bourlioux organized a session on Applied PDEs at the 2005 CMS Winter Meeting in Victoria. Sebius Doedel also organized a minisymposium on *Numerical Bifurcation Techniques* at the Euromech Nonlinear Dynamics Conference in the Netherlands in August 2005. The members also gave countless invited lectures and conference presentations, including Martin Gander who gave an invited topical talk at the 2005 SIAM Annual Meeting.

Paul Tupper and Nilima Nigam have both been invited to the Abel Symposium in May 2006. Nilima Nigam was on the organizing committee for the Fields – MITACS Industrial Problem-Solving Workshop in August 2006. André Bandrauk is co-director of the *Attosecond Science Workshop* that took place at the University of California at Santa Barbara in August/September 2006. Anne Bourlioux was a plenary speaker at the Canadian Combustion Institute Spring Meeting in May 2006, and organized a session on Scientific Computing at the joint CAIMS/MITACS Meeting in June 2006. Tucker Carrington organized an invited mini-symposium on *Eigenvalues in computational chemistry* at the GAMM – SIAM Applied Linear Algebra Conference in Germany in July 2006. Sebius Doedel was a member of the program committee for the workshop *Applied Dynamical Systems*, held at the University of Ghent in June 2006. Finally, Tony Humphries, Sebius Doedel, Paul Tupper and Jacques Bélair are all involved in the organization of the Thematic Semester on Applied Dynamical Systems that will take place at the CRM in the Summer and Fall of 2007.

Students, postdoctoral fellows and visitors

The Laboratory hosted a number of scientific visitors including Steve Thomas (NCAR), Annalisa Buffa (IMATI, Italy), Jay Gopalakrishnan (Florida), Alain Dervieux (INRIA, France), Anita Layton (Duke), Jiannong Fang (EPFL, Switzerland), Marc Thiriet (INRIA), Jean-Paul Zolésio (INRIA), and in total over 25 seminar speakers came from outside Québec. In 2005 – 2006, 2 undergraduate students, 23 master's students, 26 Ph.D. students and 11 postdoctoral fellows were supervised by Laboratory members.

Seminars

The regular core activity of the Laboratory is the weekly Monday Applied Mathematics seminar. This year, it was organized by Robert Owens, who lined up 28 speakers covering a very wide range of interesting topics in applied mathematics. The seminars were held at McGill and at the CRM, and the series included one joint seminar with Computational Science and Engineering. The seminar series remains well attended not just by Laboratory members along with their students and post-doctoral fellows, but by many members of the Montreal applied mathematics community, and provides a weekly occasion for the Montreal applied mathematics community to congregate.

Complementary to that core seminar, and in line with the strong multidisciplinary orientation of this group, the Laboratory was also involved in organizing and sponsoring the biweekly Computational Science and Engineering (CSE) Seminar at McGill, organized this year by Abdelkader Baggag (CLUMEQ, McGill), which featured 11 speakers, in addition to one joint Applied Mathematics/CSE seminar.

Workshops, special sessions and others

Under the sponsorship of the Applied Mathematics Laboratory, members of the Laboratory organized the following workshops in 2005–2006. Descriptions of the first and third of these workshops may be found in the "General Program" section of this report, and a description of the second may be found in the "Multidisciplinary and Industrial Program" section.

Mini-workshop on Computational Aspects of Dynamical Systems
July 15, 2005, Concordia
Organizer: Sebius Doedel (Concordia)

International Workshop on Applied Dynamical Systems — Mechanics, Turbulence, Knots, Cockroaches, and Chaos
October 15 – 16, 2005, CRM
Organizers: Jacques Bélair (Montréal), Sue Ann Campbell (Waterloo), Jeff Moehlis (UC Santa Barbara), N. Sri Namachchivaya (Illinois at Urbana-Champaign), Steve Shaw (Michigan State)

The Third Montreal Scientific Computing Days
February 25 – 26, 2006, CRM
Organizers: Paul Tupper (McGill), Anne Bourlioux (Montréal), Thomas Wihler (McGill)

Advances in Computational Scattering
February 18 – 23, 2006, Banff International Research Station (BIRS)
Organizers: David Nicholls (Illinois at Chicago), Nilima Nigam (McGill), Fernando Reitich (Minnesota)
This 5-day workshop was a very successful event, drawing together experts in the numerical simulation of electromagnetic, elastic and acoustic scattering problems, with expertise ranging from finite element methods to geometrical optics, asymptotics and boundary element methods. The mathematicians in attendance included some of the very top names in the field. This was an opportunity for the community to share the latest results in the area, and also to map out open problems and challenges for the future. A collection of these open problems will be released soon as a Banff Report.
The meeting also offered several opportunities for informal discussions between experts and young mathematicians (graduate students and postdocs), and many new collaborations were started. A novel poster-session idea was implemented, and was very successful in sparking discussions between participants. Another novel feature of the meeting was the informal "introductory lectures" given by world experts to the attending graduate students, including lectures on mixed finite elements, combined boundary-field methods, high-frequency integral equation solvers, and edge finite elements. A direct consequence of this interaction was that at least four of the graduate students found interesting open problems to work on during their doctoral studies.
The Applied Mathematics Laboratory funded the travel of the graduate students from Québec to Banff. This support benefited the graduate students themselves, but in addition freed other sources of funding that will be used to attract graduate students and postdocs from abroad.

Members of the Laboratory

Regular members

Robert G. Owens (Montréal) *Director*
Mechanics, numerical simulation of complex fluids.

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

Paul Arminjon (Montréal)
Numerical methods in fluid mechanics.

André D. Bandrauk (Sherbrooke)
Quantum chemistry.

Peter Bartello (McGill)
Turbulence, CFD.

Jacques Bélair (Montréal)
Dynamical systems in physiology.

Anne Bourlioux (Montréal)
Modeling, numerical simulation in turbulent combustion.

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

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

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

Nilima Nigam (McGill)
Applied analysis, numerical methods in electromagnetism.

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

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

Jian-Jun Xu (McGill)
Asymptotics and numerical analysis, nonlinear PDEs, material science.

Associate Members

Tucker Carrington (Montréal)
Chemical dynamics.

Martin J. Gander (Genève)
Domain decomposition, preconditioning.

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 a new expertise in many aspects of analytic number theory with the recent arrival of Andrew Granville, one of the leaders in the field. 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

In 2005 – 2006, most of the scientific activities organized by CICMA were part of the thematic year on analysis (p-adic or classical) in number theory. Analysis in number theory is a broad theme, including such diverse topics as the p-adic Langlands program, arithmetic cycles on Shimura varieties, the analytic properties of L-functions and additive combinatorics. The first half of the year (i.e., the fall of 2005) was devoted to the applications of p-adic analysis to arithmetic and number theory, while the second half (i.e., the winter and spring of 2006) was devoted to analytic number theory.

The beginning of the year (September and October 2005) featured activities organized by Adrian Iovita on p-adic families of modular forms and the p-adic Langlands program. The lectures by Hida, Tilouine and Colmez dealt with these timely topics, in particular the proof by Colmez of the p-adic Langlands correspondence for $\mathrm{GL}(2)$ (based on the theory of (ϕ, Γ)-modules), and the study by Tilouine of the p-adic families and Galois representations related to the Siegel modular forms. The workshop that took place in September was an opportunity to emphasize the many remarkable advances due to Breuil, Colmez, Emerton, Khare et Kisin.

In the fall of 2005 the conjectures of Stark and their versions in the context of elliptic curves were also an important topic. A workshop that took place in November was attended by Stark himself and enabled several members of CICMA (e.g., Eyal Goren, David Dummit and Henri Darmon), as well as several postdocs and visitors

(e.g., Pierre Charollois, Mak Trifkovic and Samit Dasgupta), to present their results, which throw a new light on Stark's conjectures.

The third theme of the first half of the thematic year was the intersection of algebraic cycles on Shimura varieties and the relationship between these intersection numbers and the Fourier coefficients of automorphic forms. Several lecturers (such as Burgos, Kramer and Bruinier) presented the latest approaches to the theory of arithmetic intersection, based on Arakelov theory. Other researchers (Bruinier and Kudla) spoke on the relationships with the theory of automorphic forms and theta-correspondences.

The activities of the second half of the year, organized mainly by Chantal David and Andrew Granville, revolved around analytic number theory. This semester featured several highlights. The first activity was a workshop on the analytic properties of L-functions, organized by Chantal David, and featuring a series of lectures by Philippe Michel on problems of equidistribution and a series of lectures by Soundararajan, one of the Aisenstadt chairs of the thematic year.

The second activity was a workshop on the anatomy of integers that took place on March 13 – 17 and was attended by 70 participants. This workshop highlighted the proof of the existence of "small gaps" between prime numbers, due to Goldston, Pintz and Yildirim and based on sieve theory. Goldston himself gave a series of lectures on this work. Kevin Ford also gave a series of beautiful lectures on his work regarding the divisor distribution of an integer. Soundararajan spoke of his improvement of the Polya – Vinogradov inequality (obtained with Andrew Granville), and of his work with Lagarias on smooth solutions of the equation $a + b = c$.

The CRM – Clay School on Additive Combinatorics took place at the Université de Montréal from March 30 to April 5, and was attended by more than 100 participants. The series of lectures given by the two organizers, Jozsef Solymosi (UBC) and Andrew Granville (Université de Montréal), were followed by the plenary talks of the world-renowned mathematicians Ben Green (University of Bristol) and Terry Tao (UCLA). Green and Tao explained Gowers' approach to proving Szemeredi's theorem. The School on Additive Combinatorics was followed by a workshop on the same topic, one of the most successful workshops ever organized by the CRM since it was attended by more than 145 participants. Several of the world leaders in analysis, Bourgain, Gowers, Tao, Green, Konyagin (a group including Fields medallists and potential Fields medallists) attended this workshop.

The thematic year was especially successful in that many visitors, young researchers and postdoctoral fellows spent several months and even the whole academic year at the CRM. The regular members of CICMA were thus able to initiate collaborations with them. For instance, in collaboration with Guillaume Ricotta and Djordje Milicevic, Chantal David studied the non-vanishing of cubic twists of elliptic curves on a field containing the cube roots of unity. In collaboration with Alina Cojocaru and Antal Balog, Chantal David is pursuing a different project on a conjecture of Koblitz that can be considered as the analogue of the twin prime conjecture in the context of elliptic curves. Antal Balog, another visitor to the CRM, has studied these conjectures in the past and made progress on them.

Henri Darmon was able to embark on new research projects with four of the postdoctoral fellows and two visitors to the CRM (Pierre Charollois, Samit Dasgupta, Kartik Prasanna, Ye Tian, Gonzalo Tornaria and Mak Trifkovic). During the stay of Soundararajan at the CRM as Aisenstadt Chair holder, Andrew Granville developed his projects with him on the distribution of values taken by multiplicative functions. Granville also collaborated with Antal Balog on this topic.

Eyal Goren continued his collaboration with Payman Kasaei on the Katz-style geometric approach to the theory of p-adic modular forms; he also continued his collaboration with Fabrizio Andreatta. The visits by Bruinier and Kudla in December 2005 may result in collaborations between them and Eyal Goren and increased Goren's desire to further his understanding of Borcherds theory. Adrian Iovita had further exchanges with Tilouine and Hida, which may lead to discoveries regarding the p-adic families of automorphic forms on higher-order reductive groups.

Students, postdoctoral fellows and visitors

The above summary of the thematic year shows that CICMA hosted a great number of visitors in 2005 – 2006, and the names of many visitors appear in the "Thematic Program" section of this report. Also, in 2005 – 2006, 2 undergraduate students, 25 master's students, 29 Ph.D. students and 20 postdoctoral fellows were supervised by Laboratory members.

Seminars

The Québec – Vermont Number Theory Seminar is the main scientific activity of CICMA (when there is no thematic program on number theory!). The Seminar is held every second Thursday for a full day and is attended by about 30 regular participants from Montréal, Vermont, Québec and Ottawa. In 2005 – 2006, Henri Darmon was the Seminar coordinator from September to December 2005, and Chantal David was coordinator from January to May 2006. The Seminar consisted of 49 lectures, including several lectures on the finite subgroups of Lie groups by Jean-Pierre Serre.

Workshops, special sessions and others

We refer the reader to the "Thematic Program" section of this report.

Members of the Laboratory

Regular members

Henri Darmon (McGill) *Director*
Algebraic number theory, geometry, arithmetic, L-functions, diophantine equations, elliptic curves.

Chris Cummins (Concordia)
Group theory, modular functions, moonshine.

Chantal David (Concordia)
Analytic number theory, L-functions.

Jean-Marie De Koninck (Laval)
Analytic number theory: distribution of prime numbers, factorization of numbers, asymptotic behaviour of arithmetic functions, Riemann zeta function.

David S. Dummit (Vermont)
Algebraic number theory, arithmetic algebraic geometry, computational mathematics.

David Ford (Concordia)
Computational number theory, algorithmic number theory.

Eyal Z. Goren (McGill)
Arithmetic geometry, algebraic number theory, moduli spaces of abelian varieties, Hilbert modular forms, p-adic modular forms.

Andrew Granville (Montréal)
Analytic number theory, arithmetic geometry, combinatorics.

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

Olga Kharlampovich (McGill)
Combinatorial theory of groups and Lie algebras.

Hershy Kisilevsky (Concordia)
L-functions, Iwasawa theory, elliptic curves, class field theory.

John Labute (McGill)
Pro-p-groups, Lie Algebras, Galois Theory.

Claude Levesque (Laval)
Algebraic number theory, units, class number, cyclotomic fields.

Michael Makkai (McGill)
Mathematical logic.

John McKay (Concordia)
Computational group theory, sporadic groups, computation of Galois groups.

Alexei G. Miasnikov (McGill)
Group theory.

M. Ram Murty (Queen's)
Number theory: Artin's conjecture, elliptic curves, modular forms, automorphic forms, Langlands program, Selberg's conjectures, sieve methods, cryptography.

Jonathan Pila (McGill)
Number theory, especially algorithmic and Diophantine problems.

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 UQÀM, now comprises seventeen professors together with a large number of postdoctoral fellows and graduate students. The main themes to be pursued in the coming years include Dehn surgery and Thurston geometrization; quantization of Hitchin systems and the geometric Langlands program; classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; and Hamiltonian dynamical systems.

News and highlights

Virginie Charette (Ph.D. from Maryland in 2000, postdoctoral fellowship at McMaster in 2000–2002) will officially become a member of CIRGET on June 1, 2006. She took up a position at the Université de Sherbrooke in 2005 after spending several years at the University of Manitoba. Her research focuses on the study of discrete group actions on affine manifolds and Lorentz geometry. Various honours were bestowed on CIRGET members over the last twelve months. François Lalonde was invited to give the Distinguished Visitor Lecture Series at Stanford University in the fall of 2005 and he has been invited to give a 45-minute talk in the geometry section of the ICM Madrid 2006. John Harnad was awarded the 2006 CAP–CRM Prize in theoretical and mathematical physics, Niky Kamran is the recipient of a Killam fellowship for the years 2006–2008, and Iosif Polterovich was awarded the 2006 André-Aisenstadt Prize, which recognizes outstanding research achievement by a young mathematician.

Students, postdoctoral fellows and visitors

CIRGET had an impressive group of postdoctoral fellows this year: Benoit Charbonneau, Jianjun Chuai, David Duchemin, Nicola Gambino, Paolo Ghiggini, Shengda Hu, Alexander Ivrii, Samuel Lisi, Joseph Maher, Ramin Mohammadalikhani, Erwan Rousseau, Stephan Tillmann, and Mark Weber. Charbonneau, Chuai, Duchemin, Gambino, Ghiggini, Hu, Lisi, and Rousseau will be continuing in Montréal next year. Alexander Ivrii has accepted a postdoctoral position at Technion, Joseph Maher will begin a tenure-track position at Oklahoma State University in September, Stephan Tillmann will begin a postdoctoral position at the University of Melbourne, and Mark Weber has obtained a postdoctoral position at Macquarie University in Sydney, Australia. CIRGET members have supervised nine undergraduate research students and one cégep student during the summer of 2006. Altogether, in 2005–2006, 10 undergraduate students, 30 master's students, 14 Ph.D. students and 16 postdoctoral fellows were supervised by Laboratory members.

In addition to its many seminar and conference visitors, CIRGET also welcomed many researchers. Davide Batic (ETH) visited Niky Kamran; Baojun Bian (Shanghai) visited Pengfei Guan; Stephan De Bièvre (Lille) visited Niky Kamran; Alberto Encisco (Universidad Complutense, Madrid) visited Niky Kamran; Michael Levitin (Heriot-Watt, Edinburgh) visited Iosif Polterovich; Susan Niefield (Union College) vis-

ited André Joyal; Louis Nirenberg (NYU) visited Pengfei Guan; Ketty de Rezende (Campinas, Brazil) visited Octav Cornea; Richard Schoen (Stanford) visited Pengfei Guan; Mariana Silveira (Campinas, Brazil) visited Octav Cornea; Xi Zhang (Zhejiang University) visited Pengfei Guan; Xingru Zhang (SUNY Buffalo) visited Steven Boyer.

Seminars

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 Olivier Collin, is a general seminar series attended by all CIRGET members. Most of the talks in this seminar are given by invited speakers who stay at the centre for short research visits. To complement this general seminar, CIRGET organized two more specialized seminars and one working group, so that three poles of research were developed: geometric group theory (organized by Dani Wise), symplectic topology (organized by Octav Cornea), and 3-dimensional topology (organized by Steven Boyer). There was a healthy amount of interaction between these three poles as many CIRGET members attended at least two seminars, if not three, on a regular basis. Indeed, scientific activity at CIRGET truly flourished this year, thanks in large part to the high mathematical level and commitment of the postdoctoral fellows, whose presence stimulated faculty members and students alike.

CIRGET graduate students from UQÀM, Université de Montréal and McGill continued to participate in the CIRGET Junior Seminar, organized by a doctoral student, Baptiste Chantraine. This seminar gives graduate students a forum to present their research to their peers and to practice giving talks in a relaxed setting. It has also created a natural meeting place for the students, who now form a cohesive interuniversity student body.

Workshops, special sessions and others

The following workshops were organized by members of CIRGET, and their descriptions may be found in the "General Program" section of this report.

Short Program on Random Matrices, Random Processes and Integrable Systems
June 20 – July 8, 2005, CRM
Organized with the Mathematical Physics Laboratory
Organizers: John Harnad (Concordia), Jacques Hurtubise (McGill)

CIRGET – CRM Workshop on Khovanov Homology
September 30 – Oct 2, 2005, UQÀM
Organizer: Olivier Collin (UQÀM)

Homotopy Theory Conference in Honor of Joe Neisendorfer's 60th Birthday
November 18 – 20, 2005, CRM
Organizer: Octav Cornea (Montréal)

In addition, as a follow-up to the thematic semester in symplectic topology held in the fall of 2004, Octav Cornea, David Ellwood, Helmut Hofer, François Lalonde, and Katrin Werheim organized a workshop on the Cluster-Polyfold setup for Lagrangian Floer homology. This workshop was held on October 10 – 05, at the Institute for Advanced Study in Princeton, and was partially subsidized by CIRGET. It has led to a major research collaboration between Cornea, Hofer, Lalonde and Werheim on the analytical foundations of the cluster theory.

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.

Olivier Collin (UQÀM)
Invariants of knots and 3-manifolds arising from global analysis.

Octav 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.

LaCIM

Description

LaCIM is a research laboratory of the Université du Québec à Montréal, which was officially established in 1989. Its research activities concentrate on enumerative algebra, algebraic combinatorics, computer science and their applications to other scientific domains, such as the analysis of algorithms, statistical mechanics and computational biology. LaCIM has been one of the eight research laboratories of the CRM since 2002.

Research areas

Discrete mathematics has lately become an important field of practical research, reflected in a new heading in Mathematical Reviews (Algebraic Combinatorics, 05E), with subheadings indicating interactions with the newest areas of mathematics, such as group representations, quantum groups, discrete algebraic geometry, and special functions. Combinatorics benefits from the revival of the concrete computational aspect in mathematics after decades of abstract structuralism. Algebra is enriched in a fundamental manner by combinatorics, as the commutative algebra book by Eisenbud demonstrates by highlighting constructive geometric methods. Moreover, combinatorics can be applied to computer science (theory of automata, analysis of algorithms), to statistical physics (computation of configuration spaces and of critical exponents, discrete models), and bioinformatics (combinatorics of words applied to genomic sequences). The usefulness and applicability of this dynamic research field are especially obvious in the modern world, where discrete structures (trees, graphs, permutations) play an increasingly important role in communications, networks and search engines.

News and highlights

Srecko Brlek is the new director of LaCIM and the members of LaCIM are serving on many scientific committees. For instance, in 2005 – 2006, François Bergeron was President of a Grant Selection Committee (GSC 337) for NSERC. Srecko Brlek was consulted as an expert by the Italian equivalent of NSERC, i.e., the Italian commission for the evaluation of research. Srecko Brlek and Christophe Reutenauer are members of the editorial board of the Hungarian journal *Pure and Applied Mathematics*, as well as of the permanent committee overseeing the WORDS conference. Cédric Chauve was a member of the program committee of RECOMB 2006 (Comparative Genomics Workshop), and Sylvie Hamel of the program committee of CBGI 2005 (International Conference on Computational Biology and Genome Informatics). Alain Goupil is a member of the permanent committee of the FPSAC conference (Formal Power Series and Algebraic Combinatorics). Gilbert Labelle and Christophe Reutenauer belong to the editorial board of the *Annales des sciences mathématiques du Québec* and Christophe Reutenauer to the editorial board of the *Journal of Algebraic Combinatorics*. Pierre Leroux belongs to the editorial boards of the journal *Discrete Mathematics* and the *Electronic Journal of Combinatorics*.

The NSERC University Faculty Award of Sylvie Hamel was renewed for two years (2006 – 2008). Daniel Lemire, a new collaborating member of LaCIM, was awarded a grant from FQRNT under the program "Établissement de nouveaux chercheurs." Marni Mishna, whose doctoral studies were supervised by François Bergeron, has been holding an UFA position at Simon Fraser University since 2005. Hamadou Sardaouna, who was a student of Srecko Brlek and John Mullins and defended his thesis in the summer of 2006, was offered a prestigious postdoctoral fellowship by the École Polytechnique in Paris. The authors V. Makarenkov, D. Kevorkov and P. Zentilli were awarded the "Best Presentation Award" at the conference of the Society for Biomolecular Screening held in Geneva in September 2005.

Students, postdoctoral fellows and visitors

Annie Château continued her work as postdoctoral fellow with Cédric Chauve. Nicola Gambino, who had a postdoctoral fellowship at Oxford, is now a postdoctoral fellow at LaCIM. The postdoctoral fellow Aaron Lauve joined LaCIM in September 2005 and is supervised by Christophe Reutenauer. Andrei Gagarin is continuing his work as postdoctoral fellow under the supervision of Vladimir Makarenkov and collaborates with Gilbert Labelle and Pierre Leroux. From November 2004 to November 2005, Vladimir Makarenkov supervised Vincent Devloo jointly with François Major (Université de Montréal).

Some researchers who were postdoctoral fellows at LaCIM have been offered academic positions. In particular, Sara Faridi was awarded an UFA position at Dalhousie University, Mercedes Rosas a position at Seville, Riccardo Biaggioli a position at Lyon, Peter McNamara a position at Bucknell University (Pennsylvania), Manfred Schocker a position at the University of Wales at Swansea, and Sylvie Corteel a research position at CNRS in Versailles. Axel Pavillet defended his thesis under the supervision of Timothy Walsh and now holds an academic position at Keyano College (Fort McMurray, Alberta). In the summer of 2005, LaCIM organized an 8-week session for beginning students, in order to introduce them to mathematical research; actually, it hosted undergraduates and 2 cégep students (from the Brébeuf and Bois-de-Boulogne cégeps). In 2005 – 2006, 3 undergraduate students, 29 master's students, 22 Ph.D. students and 7 postdoctoral fellows were supervised by Laboratory members.

Gregg Musiker and Adriano Garsia (UCSD) and Jeremy L. Martin (University of Kansas) visited François Bergeron. Gregg Musiker delivered a remarkable lecture on the combinatorial aspects of the Weil zeta functions of elliptic curves on a finite field. Francesco Pappalardi (Roma), Laurent Habsieger (Lyon) and Marc Conrad (Luton, UK) were invited by Srecko Brlek to give lectures on combinatorial number theory. Srecko Brlek also invited Sébastien Ferenczi and Michel Mendès France. Boris Adamczewski visited LaCIM within the framework of a cooperative project with the Université de Lyon (Centre Jacques Cartier), of which the coordinators were Laurent Habsieger (Lyon) and Srecko Brlek. Within the framework of another international project, supported by CNRS and including LaBRI (Université Bordeaux 1) on the French

side, LaCIM hosted the following Ph.D. students: Pascal Ochem, Jérémie Chalopin, François de Vieilleville, Olivier Bernardi and Rodrigue Ossamy. This project will last 3 years and is coordinated by Srecko Brlek and Olivier Guibert (LaBRI).

Cédric Chauve invited many researchers within the framework of yet another cooperative project between Québec and France: Guillaume Fertin (Nantes), Stéphane Vialette (LRI), Christophe Paul (CNRS, LIRMM), Séverine Bérard (INRA), Guillaume Blin (Marne-la-Vallée) and Julia Mixtacki (Bielefeld). Miguel Mendez (Universidad Central de Venezuela) spent a sabbatical year at LaCIM and worked mostly with Gilbert Labelle and Pierre Leroux. Vladimir Makarenkov invited Bruno Leclerc (EHESS, Paris) and Mel Janowitz (DIMACS & Rutgers). Manfred Schocker (Oxford), Jacques Sakarovitch (Paris), Gérard Jacob (Lille), Vladimir Retakh (Rutgers), Claudia Malvenuto (Roma), Jacob Greenstein (UC Riverside) and Christophe Hohlweg (Fields Institute) visited Christophe Reutenauer.

Seminars

The LaCIM Combinatorics and Theoretical Informatics Seminar plays an important role in bringing together the Laboratory members. Srecko Brlek and Christophe Reutenauer are the coordinators of the LaCIM Seminar. In 2005–2006, this seminar featured 32 lectures, attended by around 25 participants each Friday.

Workshops, special sessions and others

The fifth Words conference (Words 2005) was organized by Srecko Brlek and Christophe Reutenauer in September 2005.

5th International Conference on Words
September 13–17, 2005, LaCIM (UQÀM)
Sponsors: CRM, Ministère de l'Éducation, du Loisir et du Sport du Québec, Faculté des Sciences de l'UQÀM, PIMS, VSIS ConfTool, Chaire de Recherche du Canada en algègre, combinatoire et informatique mathématique, Café Rico (Montréal)
Organizers: Srecko Brlek (UQÀM), Cédric Chauve (Simon Fraser/UQÀM), Annie Lacasse (UQÀM), André Lauzon (UQÀM), Geneviève Paquin (UQÀM)

The reader will find a description of this conference in the "General Program" section of the present report. Cédric Chauve organized the Phylogenomics 2006 meeting in Ste-Adèle (Québec), in March 2006. Alain Goupil was a member of the organizing committee of FPSAC'05 (Taormina, Sicily). Vladimir Makarenkov was a member of the organizing committee of the *Douzièmes journées de la Société Francophone de Classification* (May 30–June 1, 2005).

Members of the Laboratory

Regular members

Srecko Brlek (UQÀM) *Director*
Combinatorics of words, algorithmics.

Robert Bédard (UQÀM)
Representations of finite groups, Lie theory.

François Bergeron (UQÀM)
Combinatorics, algebra, representations of finite groups.

Cédric 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.

Gilbert Labelle (UQÀM)
Enumerative combinatorics, analysis.

Pierre Leroux (UQÀM)
Enumerative and algebraic combinatorics.

Vladimir Makarenkov (UQÀM)
Computational biology, mathematical classification.

John Mullins (École Polytechnique de Montréal)
Analysis of cryptographic protocols and e-commerce protocols, formal semantics, secure mobile code specification, operational concurrency models

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

Denis Thérien (McGill)
Complexity theory, logic, combinatorics, probability theory.

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

Associate members

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

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

Cédric Lamathe (UQÀM)
Combinatorics of tree-like structures, theory of species, indicator series of partially labeled structures and asymmetric structures.

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

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.

Yves Chiricota (UQÀC)
Computer graphics, mathematical methods in computer graphics, combinatorics, computational geometry, symbolic computation.

Sylvie Corteel (CNRS)
Enumerative and bijective combinatorics, partitions of integers and q-series.

Adriano Garcia (UC San Diego)
Algebraic combinatorics, symmetric functions, harmonic and co-invariant spaces, quasiharmonic and quasi-invariant functions.

André Joyal (UQÀM)
Algebraic topology, category theory.

Jacques Labelle (UQÀM)
Combinatorics, topology.

Louise Laforest (UQÀM)
Data structures, combinatorics, asymptotic analysis, quaternary trees.

Daniel Lemire (TELUQ)
Database theory, data warehousing, multidimensional databases (OLAP), data mining, time series, collaborative filtering, information retrieval.

Simon Plouffe
Integer sequences, generalized expansions of real numbers.

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

Mathematical Analysis

Description

At the same time classical and central to modern mathematics, analysis involves studying continuous systems, from dynamical systems to solutions of partial differential equations and spectra of operators. The Analysis Laboratory was created four years ago. Currently the Laboratory has 31 regular and 7 associate members working at eight different universities in Québec, the USA and France. The research areas of the members of the Laboratory are the

following: 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 (member of CIRGET and the Mathematical Analysis Laboratory) was awarded the André-Aisenstadt Prize. Javad Mashregi has just published a book entitled *Analyse abstraite*. Frédéric Gourdeau was awarded the CMS Excellence in Teaching Award at the CMS Summer 2006 Meeting in Calgary. Alina Stancu (Concordia) and Octav Cornea (Montréal) have become associate members of the Laboratory.

Students, postdoctoral fellows and visitors

The Laboratory welcomed 10 postdoctoral fellows in 2005–2006. Abdellatif Bourhim worked in operator theory at Université Laval; Emily Dryden, in spectral geometry at McGill; A. Ivrii, in geometric analysis at McGill and the CRM; M. Merkli, in mathematical physics at McGill; Mario Roy, in dynamical systems at Université Laval; V. Shramchenko, in analysis at Concordia and the CRM. Chadi Nour worked at the Université de Montréal under the supervision of R. Stern; Changzhong Zhu, at the Université de Montréal under the supervision of P. Gauthier; Sara Derivière, at the Université de Sherbrooke under the supervision of Tomasz Kaczynski; and Biao Wu, at Carleton University under the supervision of D. Dawson. Also, in 2005–2006, 8 undergraduate students, 35 master's students and 31 Ph.D. students were supervised by Laboratory members.

The Mathematical Analysis Laboratory also welcomed many researchers. G. Karadzhov (Bulgarian Academy of Sciences) visited G. Dafni; M. Levitin visited D. Jakobson and I. Polterovich; S. De Bièvre (Lille) visited V. Jaksic; E. Fricain (Lyon) visited P. Koosis and J. Mashreghi; Y. Last (Hebrew University) visited V. Jaksic; A. Soshnikov (UC Davis) visited V. Jaksic; Ariel Blanco visited T. Ransford; Zengjian Lou (Shantou) visited the Laboratory from January 12 to February 11, 2006; E.S. Zeron visited P. Gauthier; A. Komech visited A. Shnirelman; R. Schubert visited D. Jakobson, I. Polterovich and J. Toth; A. Strohmaier visited D. Jakobson; L. Parnovski visited D. Jakobson and I. Polterovich; R. Shvydkoi and Y. Gliklikh visited Shnirelman; S. Zelditch visited J. Toth and V. Jaksic; A. Marino and C. Saccon (Pisa) visited M. Frigon.

Seminars

The members of the Mathematical Analysis Laboratory organize several seminars at four main locations. At Université Laval, Javad Mashreghi and Jérémie Rostand organize an Analysis Seminar, which featured 13 talks in 2005–2006, and Javad Mashreghi organizes an Analysis Workshop, which also featured 13 talks. Galia Dafni (Concordia) and Ivo Klemes (McGill) organize jointly the McGill/Concordia Analysis Seminar, which featured 22 talks in 2005–2006. At the Université de Montréal, Christiane Rousseau organizes a Seminar in Nonlinear Analysis and Dynamical Systems that featured 20 talks in 2005–2006. Finally, at the Université de Sherbrooke, Madjid Allili, Virginie Charette, François Dubeau and Tomasz Kaczynski organize a Seminar in Computational Geometry and Topology that featured 19 talks in 2005–2006.

Workshops, special sessions and others

In 2005–2006, members of the Mathematical Analysis Laboratory organized three meetings whose descriptions may be found in the "General Program" section of this report.

"Probability and Mathematical Physics," a Conference Celebrating the 65th Birthday of Stanislav Molchanov
June 27–July 1, 2005, CRM

Organizers: Don Dawson (Carleton & McGill), Vojkan Jaksic (McGill), Boris Vainberg (UNC Charlotte)

Analysis Day, 2006 May 1st, 2006, CRM *Organizer*: Dmitry Jakobson

Colloquium on Potential Theory — 74e congrès de l'Acfas May 15 – 19, 2006, McGill University *Sponsors*: Consulat général de France à Montréal, CRM, Mathematical Analysis Laboratory, FQRNT, Office of the McGill Vice-Principal (Research & International Relations) *Organizer*: Kohur Gowrisankaran (McGill)

Members of the Laboratory

Regular members

Dmitry Jakobson (McGill) *Director*
Pure mathematics, global analysis, spectral geometry, quantum chaos, harmonic analysis, eigenvalues and eigenfunctions.

Line Baribeau (Laval)
Complex and functional analysis, Banach algebras, holomorphic iterations, discrete groups.

Abraham Boyarsky (Concordia)
Dynamical systems.

Francis H. Clarke (Lyon 1)
Nonlinear and dynamic analysis, control theory, calculus of variations.

Galia Dafni (Concordia)
Harmonic analysis, partial differential equations, several complex variables.

Donald A. Dawson (Carleton & McGill)
Probability, stochastic processes.

S. W. Drury (McGill)
Harmonic analysis, matrix theory.

Richard Duncan (Montréal)
Ergodic theory, martingale theory, probability theory in Banach spaces.

Richard Fournier (Dawson College)
Complex analysis, function theory.

Marlène Frigon (Montréal)
Nonlinear analysis, differential equations, fixed point theory, critical point theory, multivalent analysis.

Paul M. Gauthier (Montréal)
Complex analysis, holomorphy, harmonicity, analytic approximation.

Pawel Gora (Concordia)
Ergodic theory, dynamical systems, fractal geometry.

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

Kohur Gowrisankaran (McGill)
Potential theory.

Vojkan Jaksic (McGill)
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 (CUNY Lehman College)
Automorphic forms and their spectral theory, analytic number theory, spectral and scattering theory of manifolds.

Iosif Polterovich (Montréal)
Geometric applications of spectral analysis.

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, singulari-

ties, bifurcations, algebraic curves, primary integral.

Alexander Shnirelman (Concordia)
Applications of geometric analysis to fluids and "weak" solutions of the Euler and Navier–Stokes equations.

Ron J. Stern (Concordia)
Functional analysis and theory of operators, linear and nonlinear systems, non-smooth analysis, stability, optimal control.

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

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

Associate members

Octav Cornea (Montréal)
Algebraic topology, dynamical systems.

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)
Applied analysis, numerical methods in electromagnetism.

Alina Stancu (Concordia)
Geometric analysis.

Mathematical Physics

Description

The mathematical physics group is one of the oldest and most active at the CRM. It consists of fourteen regular members, all full-time faculty at five Quebec Universities, and fourteen associate members. The Laboratory also includes eight research associates and postdoctoral fellows, and lab members supervise or cosupervise the thesis work of fifty-one master's and doctoral students. The group hosts many visiting researchers and carries out research in many of the most active areas of mathematical physics: coherent nonlinear systems in fluids, optics and plasmas; classical and quantum integrable systems; the spectral theory of random matrices; percolation 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

There was a substantial reorganization of the Laboratory membership this year. Five members who were concurrently associated with other CRM laboratories chose to demote their PhysMath membership status to Associate, and four new external associate members were added: Bertrand Eynard (CEA, Saclay), Alexander Its (IUPU Indianapolis), Robert Conte (CEA, Saclay) and Jean-Pierre Gazeau (Paris 7). This raised our membership to a total of 28, of whom 14 are regular (i.e., voting) members and 14 are associate members. The addition of four new members of international distinction, who have also been regular visitors at the CRM for a number of years, and are engaged in ongoing collaborations with our regular members, adds a further international dimension to our group.

In September 2005, a Doctorate Honoris Causa was conferred upon Jiri Patera for his contributions to the application of Lie theoretic methods

in physics and the mathematical theory of quasicrystals. In October 2006, a similar distinction will be conferred upon Pavel Winternitz. John Harnad was awarded the 2006 CAP – CRM Prize in Theoretical and Mathematical Physics at the annual Congress of the Canadian Association of Physicists (CAP), which took place at Brock University in June 2006. This award is given annually jointly by the CAP and the CRM, "in recognition of exceptional achievements in theoretical and mathematical physics." Harnad is the third recipient of the award amongst the members of the CRM PhysMath Lab — the previous winners being Pavel Winternitz (2002) and Jiri Patera (2004). The selection committee is chosen jointly by the CAP and the CRM, and consists of physicists and mathematicians from both Canada and the United States. It was chaired this year by David Brydges (UBC), who was President of the International Mathematical Physics Union last year.

John Harnad was also asked to organize, jointly with Jinho Baik (Michigan), the session on random matrices at this year's International Congress of Mathematical Physics (ICMP), which took place in Rio de Janeiro in August 2006. The ICMP occurs every three years. Amongst our student successes, Vasilisa Schramchenko, who completed her Ph.D. at Concordia in 2005 under the direction of Dmitry Koroktin, won the CMS Prize for the best doctoral thesis in mathematics in Canada, as well as the Governor General's gold medal for the best doctoral thesis in all subjects at Concordia. She was awarded an Alexander Von Humboldt Fellowship, which she has held this past year at the Max Planck Institute in Bonn, and an EPSRC postdoctoral research fellowship, which she will be holding throughout the coming year at the Mathematical Institute in Oxford. She was also offered an E.U. Marie Curie fellowship, which she had to decline because of the two postdoctoral awards that she had already accepted.

Students, postdoctoral researchers and visitors

The following researchers are postdoctoral fellows or research associates who worked this year under the supervision of one or more of the regular members of the PhysMath Lab (the names of the supervisors are listed within parentheses): Hakan Ciftci (R. Hall), Michael Germain (J. Patera), Andrew McIntyre (D. Korotkin), Man Yue Mo (J. Hurtubise, M. Bertola), Gabor Pusztai (J. Harnad), Libor Snobl (M. Grundland, P. Winternitz), Ismet Yurdesen (M. Grundland, P. Winternitz), Armen Atoyan (research associate, J. Patera). Amongst our current postdoctoral fellows, Man Yue Mo has been awarded a new postdoctoral research position at the University of Bristol for 2006 – 2007. Former postdoctoral fellows and students moving to new research and teaching positions include: Jorgen Rasmussen, who started a two-year appointment in September 2005 as Research Fellow at the University of Melbourne; Igor Loutsenko, who began a position as Marie Curie Research Fellow at the Oxford Center for Industrial and Applied Mathematics (OCIAM); Libor Snobl, who is now assistant professor in the Department of Physics, Czech Technical University. In 2005 – 2006, 27 master's students and 24 Ph.D. students were supervised by Laboratory members.

The following is a list of researchers who visited the Laboratory in 2005 – 2006 (their affiliation and the name of their host are indicated within parentheses): Leonid Chekhov (Steklov Mathematical Institute, D. Korotkin), S. Rukolajne (St. Petersburg, D. Korotkin), Vladimir Dorodnitsyn (Russian Academy of Sciences, P. Winternitz), A. Kokotov (D. Korotkin), Anatoliy Klimyk (Prague, J. Patera), Decio Levi (Roma Tre, P. Winternitz), P. Zograf (Steklov Institute, Korotkin), V. Enolskii (Kiev, J. Harnad), Vojkan Zakrzewski (Durham, M. Grundland), Roman Smirnov (Dalhousie, P. Winternitz), O. Sanchez (Havana, S.T. Ali), Zora Thomova (SUNY Syracuse, P. Winternitz), Rutwig Campoamor-Stursberg (Complutense, P. Winternitz), Stephan De Bièvre (Lille, Y. Saint-Aubin), Alexander Strasburger (Agricultural University, Warsaw, M. Grundland), Paul Wiegmann (Chicago, J. Harnad), F. Bagarello (Palermo, S.T. Ali), Javier Negro (Valladolid, V. Hussin), Willy Hereman (Colorado School of Mines, M. Grundland).

Seminars

The usual weekly seminar series in Mathematical Physics took place at the CRM every Tuesday afternoon, throughout both terms, with active participation by members, visitors, postdoctoral fellows and students. Approximately half the talks were given by visiting invited speakers. In addition, a new *Working Seminar on Random Matrices, Isomonodromic Deformations and Riemann – Hilbert Problems* was launched. It takes place every Thursday at Concordia, again with active participation of many Laboratory members, postdoctoral fellows, students and visitors.

Workshops, special sessions and others

Short Program on Random Matrices, Random Processes and Integrable Systems
June 20 – July 8, 2005, CRM
Organized with CIRGET
Organizers: John Harnad (Concordia), Jacques Hurtubise (McGill)
This was a major event among the CRM scientific activities of the year. It was organized by two of the PhysMath Lab members, John Harnad and Jacques Hurtubise, with active participation by several more of its members (Dmitry Korotkin, Marco Bertola), postdoctoral fellows (Man Yue Mo, Gabor Pusztai, Ismet Yurdesen) and Ph.D. students (Julia Klochko, Ferenc Balogh). A description of this workshop may be found in the "General Program" section of this report.

9th International Workshop on Wavelets, Differential Equations and Differential Geometric Methods
February 20 – 24, 2006, Havana (Cuba)
This is an annual event, organized jointly by S.T. Ali and members of the Department of Physics of the University of Havana. This year's event was a relatively modest one, but gave the opportunity to prepare the next workshop, which will take place in February 2007 and will represent the tenth anniversary of the series. The scale of the next event will be much larger.

Advanced course by Peter Zograf, a visitor to the Laboratory
January 2006 – April 2006
A special series of lectures was given by Peter Zograf of the Steklov Mathematical Institute (Moscow). It was entitled *Selected Topics in Mathematical Physics: Graphs, Moduli and Quantum Field Theory*. The aim of this series was to survey some of the most striking applications of combinatorics to algebraic geometry, which go back to the pioneering work of Witten, Kontsevich, Okounkov and others.

Mini-lecture series by Stephan De Bièvre May 2006 – June 2006
Stephan De Bièvre (Lille) visited the CRM at the invitation of A. Granville, V. Jaksic and Y. Saint-Aubin. He gave a series of five lectures on *Unruh radiation*, using a pedagogical approach that allowed graduate students to understand both the principal mathematical difficulties of the subject and their physical consequences. The lectures were attended by mathematics and physics students from McGill and the Université de Montréal.

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.

Jiri 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 Conte (CEA Saclay)
Integrable and partially integrable systems, Painlevé analysis, exact solutions, finite difference equations.

Chris Cummins (Concordia)
Group theory, modular functions, moonshine.

Stéphane Durand (Cégep Édouard-Montpetit)
Classical and quantum physics, mathematical physics, symmetries, parasupersymmetries, fractional supersymmetries, KdV equations, quantum mechanics, relativity.

Bertrand Eynard (CEA Saclay)
Matrix models, integrable systems, string theory, relationship between matrix models, integrability and algebraic geometry.

Jean-Pierre Gazeau (Paris 7)
Coherent states, wavelets, relativistic quantum frames, symmetry groups for beta-lattices.

Alexander Its (IUPU Indianapolis)
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 Jaksic (McGill)
Mathematical physics, quantum statistical mechanics, random Schrödinger operators.

Niky Kamran (McGill)
Geometric approach to partial differential equations.

François Lalonde (Montréal)
Symplectic topology and geometry, global analysis on manifolds, infinite dimensional transformation groups.

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

Alexander Shnirelman (Concordia)
Applications of geometrical analysis to fluids and "weak" solutions of the Euler and Navier – Stokes equations.

John A. Toth (McGill)
Microlocal analysis, partial differential equations.

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

Many activities of the PhysNum Laboratory take place at the CRM itself; thus PhysNum increases the visibility of the CRM in the field of applied mathematics. PhysNum is not a large laboratory but it has extensive collaborations with research groups in neuroimaging, in Montréal and elsewhere: the Regroupement Neuroimagerie Québec (under the guidance of Yves Joanette

and Julien Doyon), the GRENE (directed by Franco Lepore, from the Department of Psychology of the Université de Montréal), and the quantitative imaging group of INSERM (Unité 494) in Paris, directed by Habib Benali. PhysNum uses most of its financial resources to support students who carry out their research at the CRM. The joint projects between PhysNum and the groups just mentioned are all related to mathematical imaging, especially in the medical field, and encompass the following themes:

- analysis and modeling using wavelets (thermodynamic formalism, graphical models);
- fractal and multifractal analysis (materials analysis, angiogenesis, turbulent signals);
- the probabilistic approach for solving inverse problems (maximum entropy inference, independence graphs).

These tools are used in several clinical and cognitive subfields. The aforementioned research groups, which study applications to neurology, are interested in developing a better methodology for their problems and are considering long-term collaborations with the PhysNum team.

The evolution of PhysNum

In the last two years, PhysNum has increased its interactions with other research centres, some of which are close to the CRM (CRIUGM1, CERNEC2, CRSN3 and MNI4), and some are abroad (the U-678 laboratory of INSERM in France). Generally speaking, by focusing on biomedical applications, the PhysNum members have set themselves more precise research goals. Two consequences follow from this situation. First, PhysNum is now a laboratory that carries out "targeted research," which means that it is defined more by its application domain than by a specific area of mathematics. Its research themes span a large array of domains, for instance dynamical models, statistics, Bayesian models, and wavelet analysis.

Second, the work of some researchers now takes place in close proximity to the laboratories where the researchers concerned with applications and their equipment are located. Thus PhysNum includes a team working on the methodology of brain imaging (MIC), which is part of the CRM but is located at the CRIUGM, a geriatrics research centre in Montréal. In the short and medium term, some PhysNum researchers will collaborate with a CERNEC team and the team of neuroscientists at the Sainte-Justine Hospital. Experience has shown that the inclusion of CRM members into these research centres was needed in order to "merge" the point of view of the mathematician and that of the neuroscientist. The CRM, however, always initiates these collaborations and plays a pivotal role in the partnerships.

News and highlights

One of the highlights of the year 2005 – 2006 was the visit of Habib Benali, who spent 10 months at the CRM and the CRIUGM. Habib Benali is the director of the Unité U-678 of INSERM (Paris). His visit strengthened the local collaborations (between the CRIUGM and the CRM, for instance) and the international ones, since he is one of the main instigators of a joint laboratory between INSERM and the Université de Montréal, where the CRM will play an important role.

Several research projects were started in 2005 – 2006, including projects in optics, thermoacoustics and magnetoencephalography, corresponding to diverse brain imaging technologies. Within the last 18 months, these technologies became available in Québec for the first time, and shortly thereafter some mathematical problems related to these technologies were addressed by the PhysNum team. Here are some of these projects.

Bayesian inference and entropy inference in MEG/EEG and optics imaging (J.-M. Lina, F. Lesage, H. Benali, B. Goulard)
This theme includes the following subthemes: study of various methods for analyzing time series, applications to fusion of IRMf and EEG data, sources location in optical imaging. The research work will be carried out in collaboration with the Functional Neuroimaging Unit of the Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal (CRIUGM). The researcher N. Saadhenji takes part in the acquisition of optical imaging data and develops tools for analyzing the data.

Circular tomography and reconstruction of thermoacoustic sources (J.-M. Lina, F. Lesage)
Photoacoustic imaging is being developed as a molecular neuroimaging method for small animals, because of the interesting properties of the resulting images. CRIUGM has acquired photoacoustic equipement, and image reconstruction and denoising techniques must be designed in order to optimize the quality of the data. We propose to develop an image reconstruction technique based on curvelets, a wavelet basis adapted to the one-dimensional structures contained in images.

Analysis of metabolic activities in IRMf (H. Benali, J.-M. Lina)
The mathematical modeling of the neurological, physiological and biochemical processes underlying the activity of the brain enables one to describe mechanisms through which metabolism adapts to stimulation. In this way one can explain the correlations between electrical, metabolic and hemodynamic phenomena. Recent work in the cognitive sciences demonstrates the close link between the local field potentials and the IRMf signal (BOLD). Thus mathematical modeling plays an ever more important role in the interpretation of the BOLD signal and its relationships with the activation of neuron populations. One must design parametrized models, different from the convolution models, that take into account the constraints of physiological modeling (i.e., nonlinear differential equations), in order to estimate quantitative parameters from metabolic activities (neuron activation and neuron population location, for instance).

Analysis of functional connectivity networks (H. Benali)
This project consists in proposing macroscopic models for the functional brain network. The functional connectivity models that we have developed only provide an instantaneous snapshot of the interactions between functional areas; therefore, they yield litte information on the dynamical aspects of the networks considered. Thanks to the detection models in IRMF, the sources location models in MEG/EEG, and the oriented Markov graphical statistical models (also known as causal Markov models), it is becoming possible to study the dynamical and functional relationships between populations of activated neurons. From a mathematical point of view, understanding the emergence of a cohesive functional area through synchronized oscillators is a very general problem, involving dynamical systems and the reaction-diffusion equation. The evolution of functional connectivity can be monitored through repeated examinations, and these observations will lead to models of functional brain reorganization.

Fractal analysis and porous media (F. Nekka)
New information and measurement technologies enable one to measure signals of an exceedingly complex nature. For example, the design of synthetic polymers has been revolutionized by the recent achievements in high-resolution, broad-mass-range spectrometry. Wave propagation and scattering through porous media and highly ramified materials give rise to (spatial) signals that can be considered as defined on fractal systems. A central concern when processing such complex data is to use tools that extract the maximum information with the least degeneracy. The autocorrelating process, expressed through the autocorrelation function (ACF), is a classical mathematical method widely used in engineering and applied sciences to reorganize intrinsic similarities hidden in a structure. On the other hand, fractal methods enable one to quantify efficiently complex information based on existing similarities. The inadequacy of traditional methods and the known limitations of popular fractal methods led F. Nekka to combine both approaches in order to create more powerful and less degenerate methods. F. Nekka and her research group have achieved much progress in this endeavour and the application of complexity analysis to polymers and porous media. The latter application has been prompted by her pharmaceutical research interests because these media are widely used as vehicles for drug delivery.

Phase synchrony and entropic measures in EEG of epileptic patients (J.-M. Lina)
This project deals with the study of the intracranial EEG signal in epileptic patients. We propose to characterize and detect the intercritical peaks using two approaches that will be merged eventually. The first approach consists in measuring the synchrony variations in the instantaneous phase of the signal. It is already known that this measure is one of the predictors of some types of acute epileptic fits. The second approach consists in measuring order indices (Holder) in individual signals or synchronized electrode pairs. We will combine these measures with the synchrony measure by using complex and analytic filters to obtain a discrete wavelet representation. These new techniques will be tested on real

signals, in collaboration with J. Gotman and F. Dubeau from the Montreal Neurological Institute (McGill). We are considering applying these techniques to the case of Alzheimer patients.

Students

In 2005–2006, 5 master's students and 5 Ph.D. students were supervised by PhysNum members. One of the doctoral students, J. Daunizeau, presented a thesis jointly at the Université Paris 11 and the Université de Montréal. He worked mostly at the CRM and defended his thesis in September 2005.

Workshops, special sessions and others

The two workshops listed below were organized by PhysNum. The reader may find their descriptions in the "Multidisciplinary and iNdustrial Program" section of this report.

Workshop on Mathematics in Brain Imaging and its Applications to Cognitive and Clinical Neurosciences
October 17–18, 2005, Institut universitaire de gériatrie de Montréal
Organizers: Habib Benali (CHU Pitié-Salpêtrière), Julien Doyon (Montréal), Jean-Marc Lina (ÉTS)

Workshop
Current Issues in Functional Imaging with Optical Devices
May 11–12, 2006, CRM
Organizers: Habib Benali (CHU Pitié-Salpêtrière), Frédéric Lesage (École Polytechnique de Montréal), Jean-Marc Lina (ÉTS)

Moreover, PhysNum members were involved in a workshop organized to foster collaborations between them and other CRM mathematicians. In particular, PhysNum wants to persuade these mathematicians to contribute to the brain imaging project. The description of this workshop may be found in the same section as the other two.

Workshop Between Specialists of Brain and Spine Imaging and Mathematicians Interested in the Questions Arising from Imaging
May 23, 2006, CRM
Organizers: Habib Benali (CHU Pitié-Salpêtrière), François Lalonde (Montréal)

Members of the Laboratory

Regular members

Jean-Marc Lina (ÉTS) *Director*
Wavelets, statistical modeling and brain imaging, machine learning.

Alain Arnéodo (CNRS)
Fractals and wavelets.

Habib Benali (CHU Pitié-Salpêtrière)
Quantitative analysis in brain imaging, medical imaging and multimodal systems.

Line Garnero (Hôpital de la Salpêtrière)
Magnetoencephalography.

Bernard Goulard (Montréal)
Brain imaging.

Frédéric Lesage (École Polytechnique de Montréal)
Conformal theory, integrable systems, inverse problems, optical imaging.

Fahima Nekka (Montréal)
Fractal analysis, porous systems, wavelets.

Associate Member

Keith J. Worsley (McGill)
Statistics of brain mapping, geometry of random images in medicine and astrophysics.

Statistics

Description

Statistics is central to many endeavours in society. Whether it be through surveys from sampling, clinical trials to study various biomedical treatments or experimental designs in agriculture or industry, statistical methodology can be found everywhere in science. Recently, statistics has undergone a revolution in its techniques and approaches. This revolution has been driven by the need to analyze very large data sets and data with more complex structure, and by the ad-

vent 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 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 of an important renewal of the academic personnel. This structure allows the Québec community to benefit from a new Pan-Canadian program in the analysis of complex data 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 neuronal networks, survey sampling, analysis of functional data, statistical analysis of images, dependence structures, Bayesian analysis, analysis of time series and financial data, and resampling methods.

News and highlights

The year 2005 – 2006 was an excellent one for the Laboratory members. The Tier 1 Canada Research Chair in Statistical Machine Learning, held by Yoshua Bengio, was changed into a Tier 2 Chair in June 2005. Moreover, Yoshua Bengio has just been awarded an NSERC – CGI Industrial Research Chair on High-Dimensional Data Mining for E-Finance. These developments are a testimony to the excellence of Yoshua Bengio's work. Jean-François Quessy, assistant professor at UQTR, received the Pierre-Robillard Award (rewarding the best thesis in statistics) at the Annual Meeting of the Statistical Society of Canada (SSC) in May 2006. His advisors were Christian Genest and Bruno Rémillard. On the other hand, Christian Genest, president of the Association des statisticiennes et statisticiens du Québec, has been President-elect of the SSC since last July, an honour that matches his great leadership.

Belkacem Abdous has just started a three-year term as a member of the NSERC Grant Selection Committee for statistics. Last June, Christian Léger became the Secretary for the SSC Meetings. In this position he will supervise the scientific and logistical planning of the annual meetings. The termination of the NSERC Reallocations Exercise has important implications for the financing of the CRM and that of the NPCDS (National Program on Complex Data Structures), which is vital for statisticians. Christian Léger, who is President of the NPCDS Governing Board, also belongs to a Liaison Committee with NSERC whose goal is to suggest avenues for continued financing of these programs. David Wolfson and Yogendra Chaubey are devoting most of their efforts to developing their respective departments, which they have been chairing since June 2005.

The Statistics Laboratory had its first official meeting in September 2005; this meeting coincided with the two lectures of Brad Efron. The Laboratory statutes were adopted, and for the first time, the director of the Laboratory was elected. In 2005 – 2006, Éric Marchand, who is a statistician and chairs the Departement of Mathematics of the Université de Sherbrooke, asked the Laboratory for its support in developing the field of statistics within his department. The Laboratory granted some financial support to the Department. Since the Université de Sherbrooke is now contributing to the CRM, the Laboratory will increase its support, especially through the partial financing of the Statistics Seminar held at the Université de Sherbrooke.

The Laboratory members continued to be highly visible in 2005 – 2006. Here are some of the most prestigious lectures that they gave. Keith Worsley was a plenary speaker at the *European Meeting of Statisticians* held in Oslo. He was also an invited speaker at the following conferences: *Interface 2006, 38th Symposium on the interface of statistics, computing science, and applications*, and the *Pacific Northwest Statistics Meeting*. In June 2005, he gave the Gold Medal Address at the Annual Meeting of the SSC; the SSC Gold Medal is the most prestigious Canadian prize for research in statistics. Jim Ramsay was invited to speak at the *International Meeting of the Psychometric Society* in the Netherlands. At the conference of the *International Association of Statistical Computing* held in Cyprus, he was an invited speaker for a series of four sessions on the theme "Statistics for Functional Data."

Finally, although the competition for FQRNT funds remained fierce in 2005 – 2006, a team consisting of Laboratory members and headed by Keith Worsley obtained a FQRNT team grant. The other members of the team are Masoud Asgharian, Lawrence Joseph, Brenda MacGibbon, Jim Ramsay, Russ Steele, Alain Vandal and David Wolfson. Indeed, in the mathematical sciences, grants were awarded to two teams only,

one in mathematics and one in statistics. Jim Ramsay, along with a team of engineering professors from Queen's, also obtained financing from MITACS for a new project on the estimation of the parameters of systems of differential equations. Moreover, he obtained financing from NPCDS in order to organize a workshop on the modeling of climate, in collaboration with mathematicians and statisticians from the University of Alberta, the University of British Columbia and Agro-Canada. In due course, this workshop should lead to a MITACS project.

Students, postdoctoral fellows and visitors

Laboratory members are very much involved in the training of HQP. Indeed, within their respective departments, statisticians are usually among those who train the largest number of students. As mentioned above, the former student Jean-François Quessy received the Pierre-Robillard Award. The students and postdoctoral fellows trained by Laboratory members are offered high-profile positions. For instance, Giles Hooker, who was supervised by Jim Ramsay as a postdoctoral fellow, has just accepted a tenure-track position at Cornell University. The Laboratory hosted several visitors during the year. Altogether, in 2005 – 2006, 5 undergraduate students, 90 master's students, 56 Ph.D. students and 8 postdoctoral fellows were supervised by Laboratory members.

Seminars

On a weekly basis, the scientific life of the Laboratory revolves around two seminars, the Colloque CRM – ISM – GERAD de statistique in Montréal and the Statistics Seminar at Université Laval in Québec City. In 2005 – 2006, the latter seminar featured 20 lectures. The lectures of the Colloque CRM – ISM – GERAD are listed at the end of the "General Program" section of this report. Finally, in September 2005, the Statistics Laboratory was honored by the visit of Professor Bradley Efron (Stanford), who gave two lectures, including a Grande conférence du rcm_2. His two lectures were attended by more than 100 and 150 participants, respectively.

Workshops, special sessions and others

In 2005 – 2006, the main scientific activity of the Laboratory was a three-day workshop on survival analysis. Two other activities were organized by Laboratory members: a workshop on capture – recapture models and a school on statistical and machine learning. The reader will find the descriptions of the two workshops in the "General Program" section of this report, and the description of the School in the "Multidisciplinary and Industrial Program" section.

Workshop on Survival Analysis
November 4 – 6, 2005, CRM
Organizers: Masoud Asgharian (McGill), Thierry Duchesne (Laval), Brenda MacGibbon (UQÀM)

Capture 2006: A Scientific Meeting and a Workshop on Capture – Recapture Models
May 1 – 5, 2006, Université Laval
Organizers: Gilles Gauthier (Laval), Louis-Paul Rivest (Laval)

NPCDS/MITACS Spring School on Statistical and Machine Learning: Topics at the Interface
May 23 – 27, 2006, CRM
Sponsored by MITACS
Organizers: Yoshua Bengio (Montréal), Hugh A. Chipman (Acadia), Russell Steele (McGill)

Members of the Laboratory

Regular members

Christian Léger (Montréal) *Director*
Resampling methods, adaptive estimation, model selection, robustness, applications in data mining.

Belkacem Abdous (Laval)
Biostatistics, health research methodology, construction and validation of measuring tools in the health sector.

Jean-François Angers (Montréal)
Decision theory, Bayesian statistics, robustness

with respect to prior information, function estimation.

Masoud Asgharian (McGill)
Survival analysis, changepoint problems, simulated annealing and its variants, optimization.

Yoshua Bengio (Montréal)
Statistical learning algorithms, neural networks, nucleus models, probabilistic models, data mining, applications in finance and statistical language modeling.

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, modeling 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 (HÉC)
Extreme values, robustness.

René Ferland (UQÀM)
Probability, stochastic processes, applications to financial mathematics.

Sorana Froda (UQÀM)
Nonparametric methods in function estimation, applications of stochastic modeling 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.

Brenda MacGibbon (UQÀM)
Mathematical statistics, decision theory, biostatistics.

François Perron (Montréal)
Decision theory, multidimensional data analysis, Bayesian statistics.

James Ramsay (McGill)
Functional data analysis, smoothing and nonparametric regression, curve registration.

Bruno Rémillard (HÉC)
Probability theory, empirical processes, time series, nonlinear filtering, applications in finance.

Louis-Paul Rivest (Laval)
Linear models, robustness, directional data, sampling, 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 modeling, multiple imputation.

Alain C. Vandal (McGill)
Biostatistics, nonparametric survival estimation and graph theory, imaging, capture – recapture models.

David B. Wolfson (McGill)
Changepoint problems, survival analysis, Bayesian statistics, optimal design, applications in medicine.

Keith J. Worsley (McGill)
Statistics of brain mapping, geometry of random images in medicine and astrophysics.

Publications

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

Recent Titles

The following list of Recent Titles contains books that appeared in 2004 – 2005 or that will be published soon.

American Mathematical Society
CRM Monograph Series

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

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.

American Mathematical Society
CRM Proceedings & Lecture Notes

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.

Springer
CRM Series in Mathematical Physics

Marc Thiriet, *Biology and Mechanics of Blood Flows* (to appear)

Les Publications CRM

Laurent Guieu & Claude Roger, *L'Algèbre et le Groupe de Virasoro* (to appear)

Previous Titles

American Mathematical Society
CRM Monograph Series

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

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

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

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

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

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

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

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

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

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

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

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

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

James D. Lewis, *A Survey of the Hodge Conjecture*, 2e édition, vol. 10, 1999 (with an appendix by B. Brent Gordon).

*Yves Meyer, *Wavelets, Vibrations and Scaling*, vol. 9, 1997.

*Ioannis Karatzas, *Lectures on Mathematics of Finance*, vol. 8, 1996.

John Milton, *Dynamics of Small Neural Populations*, vol. 7, 1996.

*Eugene B. Dynkin, *An Introduction to Branching Measure-Valued Processes*, vol. 6, 1994.

Andrew M. Bruckner, *Differentiation of Real Functions*, vol. 5, 1994.

*David Ruelle, *Dynamical Zeta Functions for Piecewise Monotone Maps of the Interval*, vol. 4, 1994.

V. Kumar Murty, *Introduction to Abelian Varieties*, vol. 3, 1993.

Maximilian Ya. Antimirov, Andrei A. 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

Jacques Hurtubise & Eyal Markman (eds.), *Algebraic Structures and Moduli Spaces*, vol. 38, 2004.

Piergiulio Tempesta, Pavel Winternitz, John Harnad, Willard Miller Jr., Georgo Pogosyan & Miguel A. Rodriguez (eds.), *Superintegrability in Classical and Quantum Systems*, vol. 37, 2004.

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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.

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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.

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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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Luc Vinet & Gordon Semenoff (eds.), *Particles and Fields*, 1998.

Springer
CRM Subseries of the Lecture Notes in Statistics

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

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

CRM Publications

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.

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Wendy G. McKay, Jiří Patera & David W. Rand, *Tables of Representations of Simple Lie Algebras*. Volume I. Exceptional Simple Lie Algebras, 1990.

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Wendy G. McKay, Jiří Patera & David W. Rand, *SimpLie*, 1990 (software and user guide).

Francis H. Clarke, *Optimization and Nonsmooth Analysis*, Montréal, 1989.

Samuel Zaidman. *Une introduction à la théorie des équations aux dérivées partielles*, 1989.

*Yuri I. Manin, *Quantum Groups and Noncommutative Geometry*, Les Publications CRM, 1988.

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

Les Presses de l'Université de Montréal Aisenstadt Chair Collection

Laurent Schwartz, *Semimartingales and Their Stochastic Calculus on Manifolds*, 1984.

*Yuval Ne′eman, *Symétries, jauges et variétés de groupe*, 1979.

*R. Tyrrell Rockafellar, *La théorie des sous-gradients et ses applications à l'optimisation, fonctions convexes et non convexes*, 1979.

*Jacques-Louis Lions, *Sur quelques questions d'analyse, de mécanique et de contrôle optimal*, 1976.

*Donald E. Knuth, *Mariage 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 the International Press).

Pierre Ferland, Claude Tricot & Axel van de Walle, *Fractal Analysis User's Guide*, 1994 (a collaboration with the AMS).

Hedy Attouch, Jean-Pierre Aubin, Francis Clarke & Ivar Ekeland (eds.), *Analyse non linéaire*, 1989 (a collaboration with Gauthiers-Villars).

Videos

Efim Zelmanov, *Abstract Algebra in the 20th Century*, 1997.

Serge Lang, *Les grands courants*, 1991

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Laurent Schwartz, *Le mouvement brownien*,1990.

Laurent Schwartz, *Une vie de mathématicien*, 1989.

CRM Preprints

Ayoub, N., *An L^2 inequality for real polynomials*, CRM-3216, April 2006

Bertola, M., *Biorthogonal polynomials for 2-matrix models with semiclassical potentials*, CRM-3205, October 2005

Bertola, M., *Commuting difference operators, spinor bundles and the asymptotics of pseudo-orthogonal polynomials with respect to varying complex weights*, CRM-3217, May 2006

Bertola, M., Harnad, J., Its, A., *Dual Riemann – Hilbert approach to biorthogonal polynomials*, CRM-3206, 2005

Bertola, M., Mo, M. Y., *Isomonodromic deformation of resonant rational connections*, CRM-3189, July 2005

Colin, F., Frigon, M., *Systems of singular Poisson equations in unbounded domains*, CRM-3177, January 2005

Dellacherie, S., *Existence et unicité d'une solution classique à un modèle abstrait de vibration de bulles de type hyperbolique-elliptique*, CRM-3200, September 2005

Dellacherie, S., Lafitte, O., *Solutions autosemblables pour l'équation de la chaleur avec coefficients discontinus*, CRM-3207, December 2005

Fournier, R., Ruscheweyh, S., Salinas, L., *On a question of Brézis and Korevaar concerning a class of square-summable sequences*, CRM-3215, April 2006

Grundland, A. M., Huard, B., *Rank-k solutions described by hyperbolic systems*, CRM-3197, September 2005

Haddou, M., Perron, F., *Nonparametric estimation of a cdf with mixtures of cdf concentrated on small intervals*, CRM-3210, January 2006

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Kolyshkin, A. A., Vaillancourt, R., Volodko, I., *Complex Ginzburg – Landau equation for suddenly blocked unsteady channel flow*, CRM-3194, August 2005

Kolyshkin, A. A., Vaillancourt, R., Volodko, I., *Weakly nonlinear analysis of rapidly decelerated channel flow*, CRM-3198a, September 2005

Kolyshkin, A. A., Vaillancourt, R., Volodko, I., *Approximative method for the calculation of the change in impedance due to a flaw in a conducting cylindrical Layer*, CRM-3212, January 2006

Krejci, P., Sorine, M., Sainte-Marie, J., Urquiza, J. M., *Modelling and simulation of an active fibre for cardiac muscle*, CRM-3208, January 2006

Madrane, A., El Boukili, A., Vaillancourt, R., *A new overlapping unstructured grid algorithm*, CRM-3203, October 2005

Morimoto, A., Ashino, R., Vaillancourt, R., *Multiwavelet neural network preprocessing*, CRM-3213, March 2006

Morimoto, A., Shimano, Y., Ashino, R., Vaillancourt, R., *Wavelet and block singular value image denoising*, CRM-3202, October 2005

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Sharp, P. W., Vaillancourt, R., *Efficient order-five second-derivative explicit Runge – Kutta pairs with interpolants*, CRM-3193, August 2005

Sharp, P. W., Vaillancourt, R., *Explicit Pouzet Runge – Kutta pairs for Voltera integro-differential equations*, CRM-3234, May 2006

Sharp, P. W., Vaillancourt, R., *New Nyström pairs for the general second-order problem*, CRM-3235, May 2006

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Scientific Personnel

CRM Members in 2005 – 2006

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Each year the CRM plays host to a great number of postdoctoral fellows. Their funding is provided by the NSERC and FQRNT postdoctoral programs, the NATO international program administered by NSERC, the CRM (usually in collaboration with the ISM), the CRM's research laboratories, and individual research grants from CRM members. The list below includes postdoctoral fellows in residence at the CRM and those co-funded by the CRM. Some of the fellows were in residence at the CRM for only part of the year. The affiliation given is the institution where the doctorate was obtained.

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Yurdusen, Ismet, Middle East Technical University

Long-term Visitors

Each year the CRM hosts a large number of visitors. The majority come to the Centre to participate in scientific activities organized or co-organized by the CRM. In the year 2005-2006, 676 such participants registered in the thematic program workshops, 488 in activities of the general program and 369 in those of the industrial and multidisciplinary program. The following list only includes visitors who were in residence for at least four weeks.

Adhikari, Sukumar Das, Harish-Chandra Institute

Agboola, Adebisi, UC Santa Barbara

Arefijamaal, A., Meshhed

Asatryan, Davit, National Academy of Sciences, Armenia

Balog, Antal, A. Rényi Institute

Batubenge, Augustin, Witwatersrand

Benali, Habib, CHU Pitié-Salpêtrière

Bhargava, Manjul, Princeton

Bhowmik, Gautami, Lille 1

Blomer, Valentin, Toronto

Boyko, Vyacheslav, National Academy of Sciences of Ukraine

Campoamor-Stursberg, Otto Rutwig, Complutense

Chekhov, Leonid, Steklov Mathematical Institute

Chen, Huaihui, Nanjing Normal University

Christopher, Colin, Plymouth

Cilleruelo, Javier, Universidad Autónoma de Madrid

Cojocaru, Alina Carmen, Princeton

Coleman, Mark David, Manchester

Colmez, Pierre, Paris 6

Croot, Ernest S., Georgia Institute of Technology

Dasgupta, Samit, Harvard

De Bièvre, Stephan, Université des Sciences et Technologies de Lille

De Koninck, Jean-Marie, Laval

Deshouillers, Jean-Marc, Bordeaux

Dumortier, Freddy, Limburgs Universitair Centrum

Elashvili, Alexandre, Academy of Sciences of Georgia

Elekes, Győrgy, Eőtvős Loránd

Enolskii, Victor, National Academy of Sciences of Ukraine

Erdélyi, Tamás, Texas A&M

Fang, Jiannong, École Polytechnique de Lausanne

Fehr, Laszlo, Research Institute for Particle and Nuclear Studies

Fernandez, David J., CINVESTAV

Fleischer, Isidore

Fricain, Emmanuel, Lyon 1

Friedlander, John, Toronto

Gao, Peng, Michigan

Garg, Gagan, Indian Institute of Science

Green, Ben, Bristol

Hamilton, Mark, University of Toronto

Hariton, Alexander J., MIT

Hereman, Willy, Colorado School of Mines

Hida, Haruzo, UC Los Angeles

Ille, Pierre, Institut de mathématiques de Luminy

Jimenez Urroz, Jorge, Universitat Politècnica de Catalunya

Karadzhov, Georgi Eremiev, Bulgarian Academy of Sciences

Khan, Rizwan, Institute for Advanced Study

Klimyk, Anatoliy, Bogolyubov Institute

Konyagin, Sergei, Moscow State

Lafaye de Micheaux, Pierre, Pierre Mendès France

Levi, Decio, Roma Tre

Levitin, Michael, Heriot-Watt

Liquet, Benoît, Pierre Mendès France

Logan, Adam, Liverpool

Luca, Florian, UNAM

Lucier, Jason Bryan, Waterloo

Majard, Dany, Méditerranée

Mantovan, Elena, UC Berkeley

Martin, Greg, UBC

Milicevic, Djordje, Princeton

Moroz, Boris, Bonn

Mosaki, Élie, Lyon 1

Mukhopadhyay, Anirban, IMSc Chennai

Murty, M. Ram, Queen's

Nang, Philibert, Tsukuba

Neisendorfer, Joseph, Rochester

Ng, Nathan, Ottawa

Pappalardi, Francesco, Roma Tre

Pasol, Vicentiu, Boston

Prakash, Gyan, Harish-Chandra Institute

Reznikov, Andrei, Weizmann Institute

Royer, Emmanuel, Montpellier 3

Saad, Nasser, Prince Edward Island

Sabitova, Maria, Pennsylvannia

Safapour, A., Meshhed

Saksida, Pavle, Ljubljana

Sárkőzy, András, Eőtvős Loránd

Schneider, Peter, Münster

Schubert, Roman, Bristol

Shen, Hui, UBC

Skorobogatov, Alexei, Imperial College

Smirnov, Roman, Dalhousie

Solymosi, Jozsef, UBC

Soundararajan, Kannan, Michigan

Strasburger, Aleksander, Bialystok

Tanré, Daniel, Lille 1

Tao, Terence, UC Los Angeles

Tavassoly, M. K., Isfahan

Taylor, Jonathan, Stanford

Teleman, Andrei, Provence

Thangadurai, R., Harish-Chandra Institute

Thiriet, Marc, INRIA Rocquencourt

Thomova, Zora, SUNY Syracuse

Tian, Qingchun, McGill

Tilouine, Paris 13

Tolar, Jiří, Czech Technical University

Tornaria, Gonzalo, Texas à Austin

Tsemo, Aristide, ICTP

Van Luijk, Ronald, UC Berkeley

Vatsal, Vinayak, UBC

Vu, Van H., UC San Diego

Vulpe, Nicolae, Académie des Sciences of Moldavie

Watkins, Mark, Sydney

Winterhalder, Axel, Universidade Estadual do Moranhao

Witte, Nicholas, Melbourne

Wooley, Trevor, Michigan

Yatracos, Yannis, National University of Singapore

Zeron, Eduardo Santillan, Cinvestav-IPN

Zhang, Yuanli

Zhao, Liangyi, Toronto

Zhedanov, Alexei, Donetsk Institute for Physics and Technology

Zhu, Hongmei, York

Zograf, Peter, Steklov Institute

Zolésio, Jean-Paul, INRIA Sophia-Antipolis

Short-term Visitors

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

Adler, Mark, Brandeis

Adler, Robert, Technion

Artes, Joan Carles, Universitat Autònoma de Barcelona

Banks, William, Missouri

Bilu, Yuri, Bordeaux 1

Bleher, Pavel, IUPU Indianapolis

Bodner, Mark, MIND Institute

Bourgain, Jean, Institute for Advanced Study

Chipman, Hugh A., Acadia

Deift, Percy, Courant Institute

Di Francesco, Philippe, CEA Saclay

Dorodnitsyn, Vladimir, Keldysh Institute

Duke, William, UCLA

Ekeland, Ivar, UBC

Ford, Kevin, Illinois à Urbana-Champaign

Fouque, Jean-Pierre, North Carolina State

Germinet, François, Cergy-Pontoise

Goldston, Daniel, San Jose State

Gowers, William Timothy, Cambridge

Heath-Brown, Roger, Oxford

Its, Alexander, IUPU Indianapolis

Ivanova, Natalia, Brock

Jackiw, Roman W., MIT

Kazakov, Vladimir, École Normale Supérieure

Kra, Bryna, Northwestern

Kröger, Helmut, Laval

Kuijlaars, Arno, Katholieke Universiteit Leuven

Last, Yoram, Université hébraïque

Le Bris, Claude, École Nationale des ponts et chaussées

Lemire, Frank, Windsor

Lindenstrauss, Elon, Princeton

Longo, Matteo, Strasbourg 1

Marklof, Jens, Bristol

McLaughlin, Kenneth, UNC Chapel Hill

Michel, Philippe, Montpellier 2

Milson, Robert, Dalhousie

Murty, V. Kumar, Toronto

Okounkov, Andrei, Princeton

Orlov, Aleksander Yu., Institute of Oceanology

Parnovski, Leonid, University College, London

Rochon, Frédéric, MIT

Rudnick, Zeev, Bristol

Ruzsa, Imre, Hungarian Academy of Sciences

Saad, Yousef, Minnesota

Semenoff, Gordon, UBC

Sharifi, Romyar, McMaster

Siddiqi, Abul Hasan, King Fahd University of Petroleum & Minerals

Sircar, Ronnie, Princeton

Soshnikov, Alexander, UC Davis

Stark, Harold, UC San Diego

Tocon, Maribel, Ottawa

Tracy, Craig A., UC Davis

Tsai, Tai-Peng, UBC

Tschinkel, Yuri, Göttingen

Tvalavadze, Marina, Memorial University of Newfoundland

Tvalavadze, Tim, Memorial University of Newfoundland

Ullmo, Emmanuel, Paris 11

van Moerbeke, Pierre, Université Catholique de Louvain

Venkatesh, Akshay, MIT

Widom, Harold, UC Santa Cruz

Wiegmann, Paul, Chicago

Zabrodin, Anton, ITEP

Zeitouni, Ofer, Minnesota

Zhu, Ji, Michigan

Zhukavets, Natalia, Czech Technical University

Zinn-Justin, Paul, Paris 11

Zuber, Jean-Bernard, Paris 6

Governance and Scientific Guidance

Bureau de direction

THE Bureau de direction consists of 8 to 11 members from the Université de Montréal and 2 to 5 members from the outside. The rector of the university and the dean of the Faculté des arts et sciences are represented on the Bureau. (Note that the new CRM statutes that will come into effect in 2007, will make the Bureau de direction, an interuniversity Board. Indeed, except for vice-principal of research and the FAS dean, university partners will be represented equally in the new Bureau, which will have up to 13 members.) Its role is to adopt the policies of the Centre, to recommend the nomination and the promotion of researchers and the apointment of regular members, to advise the director on the preparation of the budget and the university on the choice of the director.

Syed Twareque Ali
Concordia University

Yoshua Bengio
Université de Montréal

François Bergeron
Université du Québec à Montréal

Michel Delfour
Université de Montréal

Joseph Hubert, doyen
Faculté des arts et des sciences
Université de Montréal

Véronique Hussin
Université de Montréal

Niky Kamran
McGill University

François Lalonde
Université de Montréal

Javad Mashreghi
Université Laval

Christiane Rousseau
Université de Montréal

Jacques Turgeon
Université de Montréal

Chantal David (Concordia University) **Andrew Granville** (Université de Montréal), **Christian Léger** (Université de Montréal), and **Jean LeTourneux** (Université de Montréal), all Deputy Directors of the CRM, were invited members.

Scientific Advisory Committee

THE Scientific Advisory Panel advises the CRM on all scientific orientations: selection, organisation and elaboration of the thematic programs (annual programs, semestral programs and short programs), elaboration of the general and multidisciplinary programs and all other important activities.

The Scientific Advisory Panel meets at the CRM at least once a year during a weekend of October and several times a year by electronic mail. Here is a list of its members:

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 Saint 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 board 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 École Polytechnique and a Ph.D. in mathematics. A differential geometer by training, he has been interested by the mathematical aspects of physical theories: Dirac operators and spins, and general relativity. His areas of specialty are the geometrical estimation of eigenvalues of Laplace – Beltrami operators, Kählerian geometry and, more re-

cently, Finslerian geometry. Jean-Pierre Bourguignon directs advanced research classes at CNRS. He is the Director of Institut des hautes études scientifiques (IHES) at Bures-sur-Yvette and Professor of Mathematics at École Polytechnique. From 1990 to 1992, he served as President of the Société mathématique de France and from 1995 to 1998 of the European Mathematical Society. He is a member of several scientific advisory committees in Europe. Since 1996, he is a member of Academia Europaea and since 2002 a foreign associate of the Spanish Royal Academy.

H. E. A. (Eddy) Campbell is Vice President (Academic) and Pro Vice Chancellor at Memorial University of Newfoundland. He received his Ph.D. from the University of Toronto in 1981. He was an NSERC postdoctoral fellow at the University of Western Ontario from 1981 to 1983 before joining Queen's University in 1984. He was Head of the Department of Mathematics and Statistics at Queen's from 1995 to 2000, and Associate Dean of the Faculty of Arts and Science at Queen's from 2000 to 2004. Eddy Campbell was also President of the Canadian Mathematical Society from 2004 to 2006. He is a specialist in algebraic topology and invariant theory and the connections between them.

Jean-Louis Colliot-Thélène is directeur de recherche at the Centre national de la recherche scientifique (CNRS) at UMR 8628 (Université de Paris-Sud, Orsay). He specializes in algebraic geometry and its links to arithmetic. He obtained a Doctorat d'État (1978) from Paris-Orsay. He is a member of the editorial boards of *Annales scientifiques de l'École Normale Supérieure* (of which he was editor-in-chief until recently), the *Journal of Number Theory* and the *Journal of K-Theory*. Jean-Louis Colliot-Thélène is one of the main organizers of the 2005 – 2006 Thematic Program at MSRI (Berkeley).

Walter Craig is Canada Research Chair of Mathematical Analysis and its Applications at the Department of Mathematics and Statistics of McMaster University. He received degrees from the University of California, Berkeley (B.A., 1977) and from the Courant Institute of Mathematical Sciences, New York University (M.Sc., 1979, and Ph.D., 1981) and has held positions at Brown University and Stanford University before joining McMaster. He is principally interested in linear and nonlinear partial differential equations, Hamiltonian dynamical systems, fluid dynamics, quantum mechanics, and nonlinear functional analysis. He is a member of the editorial boards of *SIAM: Mathematical Analysis* and the Fields Institute and a Council member of the American Mathematical Society.

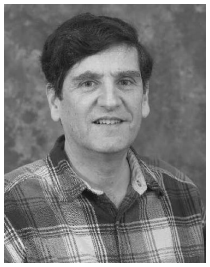
Mark Haiman is a Professor at the Department of Mathematics of the University of California, Berkeley. He received his degrees from the Massachusetts Institute of Technology in Computer Science and Electrical Engineering (B.Sc., 1979) and in Mathematics (Ph.D., 1984). His research interests are in algebraic combinatorics, algebraic geometry, representation theory, and lattice theory. He is a member of the editorial board of *Algebra universalis*.

A mathematician and physicist by training, Francois Lalonde holds a Doctorat d'État (1985) from the Université de Paris-Sud Orsay in the field of differential topology. His fields of interests include symplectic topology, Hamiltonian dynamics and the study of infinite-dimensional groups of transformations. He is member of the Royal Society of Canada since 1997 and was a Killam Research Fellowship recipient in 2000 – 2002. He holds the Canada Research Chair in the field of Symplectic Geometry and Topology at the Department of Mathematics and Statistics of Université de Montréal. Plenary speaker at the First Canada – China congress in 1997, part of his works in collaboration with Dusa McDuff was presented in her plenary address at the ICM 1998 in Berlin. He was an invited speaker at the ICM 2006 in Madrid.

Richard Lockhart is a Professor at the Department of Statistics and Actuarial Science Simon Fraser University. He received a B.Sc. in Mathematics from the University of British Columbia (1975) and degrees in Statistics from the University of California, Berkeley (M.A., 1976, Ph.D., 1979). A former Editor of the *Canadian Journal of Statistics*, he has also served on the Advisory Committee on Statistical Methods of

Statistics Canada. He was President of the Statistical Society of Canada in 199 – 1997. Much of his work is in the area of model assessment, generally in the form of goodness-of-fit.

Mitchell Luskin is a Professor of Mathematics at the University of Minnesota, a Fellow of the Minnesota Supercomputing Institute and a member of the graduate faculty of the Department of Aerospace Engineering and Mechanics of the University of Minnesota. He holds degrees in Mathematics from Yale University (B.Sc., 1973) and the University of Chicago (M.Sc., 1976, Ph.D., 1977). His research interests include numerical analysis, scientific computing, applied mathematics, partial differential equations, computational materials science, and computational physics. He delivered an invited lecture at the International Congress of Mathematicians held in Beijing in 2002. He is a member of the editorial boards of *Dynamics and Differential Equations*, the *International Journal of Computational and Numerical Analysis and Applications*, *Communications in Applied Analysis*, the *International Journal of Differential Equations and Applications*, and *the International Journal of Pure and Applied Mathematics*.



Carl Pomerance is a Professor at the Department of Mathematics of Dartmouth College. From 1999 to 2003, he was a member of the technical staff of Bell Labs-Lucent Technologies. He holds degrees from Brown University (B.A., 1966) and from Harvard University (M.A., 1970, Ph.D., 1972). A number theory specialist, he has received numerous prizes and awards including the Levi L. Conant Prize of the American Mathematical Society. He is one of the editors-in-chief of *Integers*: *The Electronic Journal of Combinatorial Number Theory* and a member of the editorial board of the *Journal of Supercomputing* and the AMS Undergraduate Book Series.

Peter Shalen is a Professor at the Department Mathematics, Statistics and Computer Science at The University of Illinois at Chicago. He received his B.A. from Harvard College (1966) and his Ph.D. from Harvard University (1972). He also spent a year as an undergraduate at École Normale Supérieure in Paris. His main research interests are 3-dimensional topology, hyperbolic geometry, and geometric and combinatorial group theory. He is associate editor of the *Journal of Knot Theory and its Ramifications* and was the geometric topology editor of the *Transactions of the American Mathematical Society* from 1992 to 2000.

Steven Zelditch is a Professor of Mathematics at Johns Hopkins University. He received his Ph.D. from the University of California, Berkeley, in 1981. A past member of the editorial board of *Annales Scientifiques de l'École Normale Supérieure*, he is presently on the editorial board of the *American Journal of Mathematics*. His research centers around applications of microlocal analysis to problems concerning: asymptotics of eigenfunctions/eigenvalues on Riemannian manifolds, statistical algebraic geometry, problems of mathematical physics ranging from quantum chaos to 2D Yang – Mills to string/M theory.

Jacques Turgeon, Vice-Principal (Research), Université de Montréal, is ex-officio member of the Advisory Committee. **Chantal David** (Concordia University), **Andrew Granville** (Université de Montréal), **Christian Léger** (Université de Montréal), and **Jean LeTourneux** (Université de Montréal), all Deputy Directors of the CRM, are invited members of the Committee.

CRM Administrative and Support Staff

The Director's Office

François Lalonde
Director

Christian Léger
Acting Director (Fall 2005), Deputy Director

Chantal David
Deputy Director, Theme Years and Theme Semesters

Andrew Granville
Deputy Director, CRM Prizes

Jean LeTourneux
Deputy Director, Publications

Administration

Vincent Masciotra
Head of Administration

Michèle Gilbert
Administrative Assistant

Muriel Pasqualetti
Administrative Assistant

Guillermo Martinez-Zalce
Research Laboratories Administrative Coordinator

Diane Brulé-De-Filippis
Secretary

Josée Simard
Secretary

Scientific Activities

Louis Pelletier
Coordinator

Josée Laferrière
Assistant

Sakina Benhima
Project Manager (on maternity leave starting in September 2005)

Josée Simard
Project Manager (starting in September 2005)

Computer Services

Daniel Ouimet
Systems Administrator

André Montpetit
Office Systems Manager (half time)

François Cassistat
Technical Assistant

Publications

André Montpetit
TeX Expert (half time)

Louise Letendre
Technician

Communications

Suzette Paradis
Communications Officer and Webmaster

Mélisande Fortin-Boisvert
Annual Report Coordinator

Statement of Revenue and Expenditures for the Fiscal Year Ending on May 31, 2006

Statement of Revenue and Expenditures for the Fiscal Year Ending on May 31, 2006

	NSERC-Centre	NSERC-NPCDS	FQRNT-Centre	CÉDAR UdeM	Other Universities	Endowment Funds	Partners & Researchers	Other Sources	TOTAL
REVENUE									
Operating grants	966 000	57 100	455 000	-	-	-	-	-	1 478 100
Université de Montréal grant (Researchers)	-	-	-	515 000	-	-	-	-	525 000
Université de Montréal grant (Operations)	-	-	-	361 000	-	-	-	-	341 000
UQÀM grant	-	-	-	-	120 000	-	-	-	120 000
McGill University grant	-	-	-	-	100 000	-	-	-	100 000
Concordia University grant	-	-	-	-	50 000	-	-	-	50 000
Université Laval grant	-	-	-	-	30 000	-	-	-	30 000
University of Ottawa grant	-	-	-	-	30 000	-	-	-	30 000
National Science Foundation grants	-	-	-	-	-	-	-	85 605	85 605
MITACS contributions	-	-	-	-	-	-	-	27 500	27 500
Clay Institute contribution	-	-	-	-	-	-	-	20 000	20 000
DIMATIA (Prague) contribution	-	-	-	-	-	-	-	3 407	3 407
Contributions for Colloquia (ISM & GERAD)	-	-	-	-	-	-	20 047	-	20 047
Other contributions for workshops	-	-	1 500	4 000	-	-	-	12 262	17 762
ISM contribution for CRM-ISM Postdoctoral fellows	-	-	-	-	-	-	52 500	-	52 500
Matching contributions for Postdoctoral fellows	-	-	-	-	-	-	288 995	-	288 995
Matching contributions for workshops	-	-	-	-	-	-	55 206	-	55 206
Endowments (Aisenstadt & Bissonnette)	-	-	-	-	-	49 455	-	-	49 455
Publications, Registration fees and other revenue	-	-	-	223	-	-	-	53 263	53 486
TOTAL REVENUE	**966 000**	**57 100**	**456 500**	**870 223**	**330 000**	**49 455**	**416 748**	**202 036**	**3 348 063**

(*continued on next page*)

	NSERC-Centre	NSERC-NPCDS	FQRNT-Centre	CÉDAR UdeM	Other Universities	Endowment Funds	Partners & Researchers	Other Sources	TOTAL
EXPENDITURES									
SCIENTIFIC PROGRAMS - CENTRE									
Thematic rogram									
Aisenstadt Chairs	10 937	-	4 234	-	-	14 923	-	11 522	41 616
Visiting researchers	82 252	-	41 991	-	-	-	12 000	55 559	191 802
CRM-ISM Postdoctoral fellows (2)	37 761	-	-	-	-	-	9 667	-	47 428
Workshops and schools 2005-2006	155 589	-	455	-	-	-	-	53 777	209 821
Workshops and schools (Preceding years)	(1 592)	-	-	-	-	-	-	12 952	11 360
Total - Thematic program	284 947	-	46 680	-	-	14 923	21 667	133 810	502 028
General program	103 503	-	48 251	6 121	-	23 859	61 241	43 644	286 620
Industrial and multidisciplinary program	20 443	-	3 395	4 089	-	-	-	39 153	67 080
National Program on Complex Data Structures (NPCDS)	-	131 625	-	-	-	-	-	200	131 825
Postdoctoral fellows and students	73 667	-	-	(2 555)	30 000	-	331 828	-	432 940
SCIENTIFIC PROGRAMS -RESEARCH LABORATORIES									
Course releases	-	-	15 000	-	54 400	-	-	-	69 400
Visiting researchers - Thematic program 2005-2006	-	-	35 486	-	19 000	-	-	-	54 486
Visiting researchers and travel	3 000	-	13 214	3 000	48 599	-	-	-	67 813
Workshops and seminars	-	-	27 676	3 219	34 059	-	-	7 559	72 513
Postdoctoral fellows	36 000	-	-	57 000	81 032	-	-	-	174 032
Students	24 000	-	18 500	51 047	9 860	-	-	-	79 407
Administrative support	-	-	41 500	-	68 071	-	-	-	109 571
Total - Laboratories	63 000	-	151 377	114 265	315 021	-	-	7 559	651 222
Other scientific expenditures									
Univ. de Montréal researchers	-	-	-	515 020	-	-	-	-	515 020
College researchers	-	-	32 559	-	-	-	-	-	32 559
Course releases	-	-	22 500	-	-	5 000	-	5 999	28 499
Visiting researchers	2 884	-	-	4 851	-	-	1 343	1 000	5 228
Publicity (activities' posters), Bulletin, Annual report	16 112	-	-	3 457	-	-	-	1 154	20 723
Total - Other scientific expenditures	18 996	-	55 059	523 328	-	5 000	1 343	8 153	611 880
Personnel (Non-academic)	355 469	-	215 373	182 766	-	-	-	19 725	773 333
Academic management, Advisory committee, Networking	1 900	-	7 381	89 350	-	-	-	1 256	99 887
Operating and computing expenditures	23 712	-	27 510	49 448	-	-	992	19 222	120 885
TOTAL EXPENDITURES	**945 637**	**131 625**	**555 026**	**966 813**	**345 021**	**43 781**	**417 072**	**272 723**	**3 677 698**
YEAR-END BALANCE	**20 363**	**(74 525)**	**(98 526)**	**(96 590)**	**(15 021)**	**5 674**	**(324)**	**(70 687)**	**(329 635)**

Mandate of the CRM

THE Centre de recherches mathématiques (CRM) was created in 1969 by the Université de Montréal through a special grant from the National Research Council of Canada. It became an NSERC national research centre in 1984. It is currently funded by NSERC (Natural Sciences and Engineering Research Council), by the Government of Québec through the FQRNT (Fonds québécois de la recherche sur la nature et les technologies), by the Université de Montréal, as well as McGill University, Université du Québec à Montréal, Concordia University, University of Ottawa, Université Laval and by private donations. The mission of the CRM is to support research in mathematics and closely related disciplines and to provide leadership in the development of the mathematical sciences in Canada.

The CRM carries on its mission and national mandate in several ways:

- its general program and its multidisciplinary and industrial program provide funding for conferences and special events at the CRM and across the country,
- each year it invites, through the Aisenstadt Chair, one or more distinguished mathematicians, to give advanced courses as part of its thematic program,
- it awards four prizes yearly: the CRM – Fields – PIMS Prize recognizing major contributions to mathematics, the Aisenstadt Prize given for outstanding work done by a young Canadian mathematician, the CAP – CRM Prize for exceptional achievement in theoretical and mathematical physics, and the CRM – SSC Prize for exceptional contributions to statistics in early career,
- it publishes technical reports and about ten books per year. 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 in place last year, funded in partnership with other organizations and researchers,
- it informs the community of its activities through its newsletter, *Bulletin du CRM*, and its web site at `www.CRM.UMontreal.CA`,
- it participates, with the other two Canadian institutes, in groundbreaking national initiatives. One example is the MITACS project (Mathematics of Information Technology and Complex Systems). The institutes sponsor the Annual Meetings of the Mathematical Sciences Societies (CMS, SSC, CAIMS), the development of the mathematical sciences in the Atlantic provinces through AARMS, and other activities organized outside the three institutes. They also participate in the National Program on Complex Data Structures jointly with the Canadian statistical community.

This national mandate is complemented by, and indeed supported by, a long-standing vocation of promoting research in the mathematical sciences in Québec. For instance,

- the CRM supports research through its eight research laboratories spanning most of the important areas of the mathematical sciences,
- it supports, through partnership agreements, a group of local researchers chosen mainly from departments of mathematics and statistics, but also computer science, physics, economics, engineering, etc.,
- it organizes series of regular seminars and lecture courses on different areas of the mathematical sciences,
- it sponsors joint activities with the ISM (Institut des sciences mathématiques) including the weekly CRM/ISM colloquium, graduate courses offered by distinguished visitors and a program of postdoctoral fellowships,
- it works actively at developing contacts with industry. Its joint activities with liaison and research centres (CIRANO, CRIM and MITACS) and research centres doing applied research (CRT, GERAD, INRS-EMT, and INSERM) led to the creation of industrial networks. The most recent ones involved, in 2004 – 2005, Bombardier Aerospace and the Brain Imaging Unit CRM-IUGM-INSERM.

The CRM fulfils its national mission by involving the largest possible number of Canadian mathematicians in its scientific programs, both as participants and as organizers. It also supports many events taking place outside Montréal and the Province of Québec. It is recognized worldwide as one of the major institutes in the mathematical sciences. The director of the CRM is assisted by two managerial structures: the Bureau de direction and the Scientific Advisory Committee. The Advisory Committee is a group of internationally renowned mathematicians from Canada and abroad, who approve scientific programs and thematic years, choose recipients of the Aisenstadt Prize and suggest new scientific ventures to explore.