CENTRE
DE RECHERCHES
MATHÉMATIQUES

Annual Report

2004
2005

CENTRE
DE RECHERCHES
MATHÉMATIQUES

Annual Report

2004
2005

Also available on the CRM's website
`www.crm.umontreal.ca`

ISBN 2-921120-42-9

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

Presenting the Annual Report 2004 – 2005

THIS year the quantity and impact of the CRM's diverse activities are more impressive than ever. In the year covered by this report, the CRM organized a most productive thematic year on the "Mathematics of Stochastic and Multiscale Modeling" put together by Anne Bourlioux and Paul Tupper assisted by a high-level international team. The CRM also organized numerous international conferences and workshops, including the major "Workshop on Computational Biology in the Post Genomics Era," held at CRM and initiated by the three Canadian mathematics institutes in collaboration with NRC. This workshop brought together, for the first time in Canada, university researchers with NRC scientists. Thanks to the prestigious NSERC Leadership Support Initiatives program CRM hosted an "Informal Semester in Symplectic Topology." Another notable event was the three-week "Short Program on Riemannian Geometry" organized by Vestislav Apostolov. The CRM also assisted with the registrations logistics of the "Quatrième colloque francophone sur les sondages," a major international colloquium. In fact, in the single 2004–2005 year, CRM organized 29 events of which 25 were held on its premises! This consists of four more activities than were offered the previous year, which was already extremely busy. In 2004–2005, CRM organized a record number advanced training schools, including the SMS (a NATO ASI), the Spring School on "Mini-invasive Procedures in Medicine and Surgery: Mathematical and Numerical Challenges," a "Summer School on Riemannian Geometry," the "Summer School on Stochastic Calculus for Applications: Theory and Numerics," and credited advanced courses such as the one given by Claude LeBris on "Multiscale Systems." In all, 1,459 participants from the four corners of the world were officially registered in these events. To all this, we must also add the seminar series organized by the centre's eight research laboratories (five of which were held in the CRM's seminar rooms), the special lectures given by the Aisenstadt Chair holders, by CRM prize winners (CRM–Fields, Aisenstadt, and CRM–SSC prizes) and those in our two weekly Colloquium series (one each in mathematics and statistics). This represents a few thousand participants in our activities in addition to the 1,459 registered participants in our international workshops and conferences.

The Centre's scientific programming is structured into a thematic program, a general program, a multidisciplinary/industrial program and an educational program. In addition there are the eight research laboratories in which most of the research work takes place. Our publication and postdoctoral fellowship programs complete the outline of our activities. Here is a brief description of each:

Thematic program The thematic program is the principal activity organized by the Centre in the accomplishment of its national mandate supported by NSERC. In general, themes alternate between subjects in pure mathematics and in applied mathematics, usually where mathematics borders with other sciences where they have considerable impact. In 2004-2005, the theme chosen was in the applications of mathematics in "Stochastic and Multiscale Modeling." It was a splendid program lead masterfully by Bourlioux and Tupper. Let the numbers speak for themselves: the program drew over 400 participants from around the world, several longterm visitors and postdoctoral researchers. It included several workshops, mini courses and two Aisenstadt Chair lecture series given by Andrew J. Majda (Courant Inst.) and Thomas Y. Hou (Caltech).

General program This program is comprised of the non-thematic events organized by CRM. The Séminaire de Mathématiques Supérieures (a NATO ASI) dealt with "Morse Theoretic Methods in Non-linear Analysis and Symplectic Topology" and drew 80 participants from about twenty countries and some 40 local participants. We have already mentioned the Fall 2004 "Informal Semester in Symplectic Topology" that had about 40 foreign participants, which greatly benefited local students and postdoctoral fellows. Following this semester, the Institute for Advanced Study in Princeton held a special workshop that largely echoed the semester. The general program included the Summer 2004 short program on Riemannian geometry and the workshop on K-Theory that inspired the Fields Institute's forthcoming thematic semester of Fall 2006; as well as the financing (in collaboration with the two other Canadian institutes) of activities organized by AARMS in the Atlantic provinces. In addition, it includes the four annual prizes awarded by CRM and the two colloquium series in mathematics and statistics or-

ganized jointly with ISM. These Colloquiums in which a world-renowned researcher addresses a large audience are particularly important for the training of graduate students. These activities are mainly supported by NSERC and FQRNT grants.

Multidisciplinary and Industrial Program Even though the development of mathematics is at the heart of the Centre's preoccupations, we have a very wide definition of these and an openness to its applications in other scientific fields. CRM is the host institution of the Québec network in computation and mathematical modeling (ncm_2). While NSERC financing of the network ended recently, ncm_2 still incorporates the Bell University Laboratories and serves to launch collaborative efforts. CRM is also a main partner of the Mathematics of Information Technology and Complex Systems (MITACS), a federally funded Network of Centres of Excellence. The industrial program organized by CRM in 2004 – 2005 was quite full with nine workshops, summer schools and special advanced courses. These activities included the launch of a CRM – CRIAQ – MITACS collaboration in January 2005 put together by CRM and held at the Office for Advanced Research of Bombardier Aerospace; as well as the first major workshop bringing together university and NRC researchers involved in computational biology, and the "Workshop on Latent Variable Models and Survey Data for Social and Health Sciences Research" funded jointly with the American institute, SAMSI (Statistical and Mathematical Sciences Institute), and the NSERC-funded National Program on Complex Data Structures. CRM also continued its initiatives in brain imaging with INSERM and the Institut universitaire de gériatrie de Montréal.

Research Laboratories In its transformation from a FCAR-funded research centre to a FQRNT-funded *regroupement stratégique*, CRM considerably expanded its membership base and created eight research laboratories to bring these members together, thus increasing substantially its funding base at FQRNT and partner universities. The laboratories, which only completed their second year of existence in 2004 – 2005, organized no less than a dozen weekly seminars and several workshops, in addition to those organized by CRM, including for instance, the "Workshop on Spectral Theory of Schrödinger Operators," the "Workshop on Dynamics in Statistical Mechanics," the "Analysis Day," the "Workshop on Low-dimensional Topology," the "Workshop on Bayesian Inference and Functional Brain Mapping," the "Montreal Scientific Computing Days," and several others. Thanks to the laboratories and the devoted members of the Centre's Scientific Advisory Committee, more than ever the CRM's programs achieve world-class standing.

Publications The CRM has a vigorous publishing program with some fifteen new and forthcoming titles. Both the American Mathematical Society and Springer have a CRM series. Among the new titles of the year, of note are a monograph by V. Guillemin (MIT) and R. Sjamaar (Cornell) and another by A.J. Majda (Courant Institute), as well as proceedings edited by J. Hurtubise (McGill) and E. Markman (Massachusetts) on "Algebraic Structures and Moduli Spaces," by V. Apostolov (UQÀM), A. Dancer (Oxford), N. Hitchin (Oxford) and M. Wang (McMaster) on "Perspectives on Riemannian Geometry." See the complete list in this annual report. To which we should add the nice collection from the NATO ASI/Séminaire de Mathématiques Supérieures published by Springer but entirely edited by CRM.

Postdoctoral program Jointly with ISM, the CRM manages a world-renowned postdoctoral fellowship program. In addition, postdoctoral fellowships are offered in our thematic program as well as by the Centre's research laboratories. In all, 92 postdoctoral fellows were supervised by CRM members during at least part of the 2004 – 2005 year. Of these, 30 fellows were partly funded by the CRM and at least 6 came with their own fellowship funding; many of these were associated with the thematic year. To this number, we could add a dozen postdoctoral fellows funded in part by MITACS research teams.

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 2004–2005 the theme of Mathematics of Stochastic and Multiscale Modeling because of its importance, timeliness, and impact on the international scientific community. The thematic program included several workshops and conferences, two Aisenstadt Chair lecture series (Andrew J. Majda and Thomas Yizhao Hou), a number of visiting scientists in residence, and some postdoctoral fellowships. In coordination with Montréal universities, CRM offered an appropriate short course in order to help graduate students participate in the activities. *The reports are presented in the language in which they were submitted.*

Thematic Year 2004–2005: The Mathematics of Stochastic and Multiscale Modeling

Organizers: Anne Bourlioux (Montréal), Weinan E (Princeton), Jean-Pierre Fouque (NC State), Thomas Y. Hou (Caltech), Claude Le Bris (ENPC), Andrew J. Majda (Courant Inst.), Ronnie Sircar (Princeton), Panagiotis T. Souganidis (UT Austin), Andrew Stuart (Warwick), Paul F. Tupper (McGill), Eric Vanden-Eijnden (Courant Inst.)

The 2004–2005 thematic year was dedicated to the applied mathematical tools (modeling, analysis, computation) needed to study multiscale systems which arise in a variety of areas in science and engineering. These systems present many novel challenges for applied mathematicians. The central difficulty is how to account for the wide range of scales and the large number of degrees of freedom in such systems. In particular, it is necessary to find an appropriate coupling between the mathematically distinct models used for the different scales in such a system. The fields of application where these issues arise, and which were discussed during the theme year, include climate modeling, front propagation, molecular dynamics, materials science, financial engineering, and rheological fluids.

Despite the diversity of applications, the challenges in these areas have much in common. A fundamental question is: *How can one utilize knowledge about the dynamics of a system so as to design a useful mathematical model that accurately captures its global behaviour?* One particularly promising approach is based on stochastic models: this was the topic of the Summer School and was also a recurring theme throughout the various workshops. These offered opportunities for interaction between applied mathematicians specializing in modeling and numerical simulation and scientists and engineers in the various fields of applications.

Retrospective of the Thematic Year

« L'année thématique 2004-2005 sur la modélisation mathématique multiéchelle et stochastique est maintenant derrière nous, et c'est l'heure des bilans et remerciements. Une des missions essentielles du CRM est la formation à la recherche des étudiants et stagiaires postdoctoraux, et l'année thématique a foisonné d'occasions en ce sens, en particulier l'École d'été, pilotée par Eric Vanden-Eijnden, et le cours ISM avancé sous la houlette de Claude Le Bris – deux activités à but pédagogique, certes, mais sans compromis sur la qualité. Avec un contenu à un niveau d'excellence ils ont réussi à secouer et enthousiasmer les participants, novices ou non.

Ce bilan est donc une occasion très appropriée de donner la parole à l'un des participants juniors : ci-dessous, le compte-rendu scientifique des activités de l'année du point de vue très personnel de Tony Lelièvre, qui vient de réintégrer son laboratoire au CERMICS au terme de son année postdoctorale fort productive à Montréal.

L'heure est aussi aux remerciements : aux organisateurs d'ateliers C. Le Bris, P. Tupper, P. Souganidis, R. Sircar et J.-P. Fouque, Weinan E et E. Vanden-Eijnden, en particulier aux deux conférenciers Aisenstadt Andrew Majda et Tom Hou, très généreux dans leurs interactions avec les chercheurs locaux ; et, finalement, au personnel du CRM pour l'accueil attentif qu'il a réservé aux nombreux participants. Les commentaires enthousiastes ont abondé pour souligner à quel point l'organisation locale soignée a favorisé de façon essentielle la qualité des interactions scientifiques. »

Anne Bourlioux

Retrospective of the Year by Tony Lelièvre

« Les modèles multiéchelles s'attachent à décrire la réalité, en faisant appel à plusieurs échelles de descriptions : par exemple, dans le domaine de la mécanique des solides, on cherche à comprendre les liens entre les phénomènes à l'échelle de l'atome et les comportements de la matière à l'échelle macroscopique. Ces techniques d'intégration multiéchelle font appel à des technologies scientifiques récentes, dans des domaines très variés.

Les différents cours et ateliers tout au long de l'année ont mis en lumière un domaine où les mathématiciens appliqués jouent un rôle primordial entre les physiciens créateurs de modèle, les mathématiciens motivés par des questions plus théoriques et les numériciens soucieux de construire des algorithmes adaptés au modèle. Une des qualités de ces ateliers était d'ailleurs de réunir des chercheurs de tous ces horizons. Le travail du mathématicien appliqué, à l'interface de plusieurs communautés, prend toute son importance dans ces nouveaux types de modélisation où des connaissances pluri-disciplinaires sont nécessaires pour progresser.

La variété des techniques mathématiques nécessaires à l'étude de ces modèles (théorie de l'homogénéisation, théorie des larges déviations, théorie ergodique, schémas symplectiques,...) ainsi que des domaines de la physique concernés (mécanique statistique, modélisation de la turbulence, dynamique moléculaire, climatologie,...) constituait en soi un attrait majeur de cette année thématique pour un postdoctorant cherchant à ouvrir ses horizons. La conférence organisée par T.Y. Hou donnait un bon exemple de la variété des domaines où la modélisation multiéchelle est utilisée, et de la diversité des techniques mathématiques et numériques nécessaires à l'analyse de ces modèles.

Les modèles aléatoires jouent un rôle particulier dans ces modèles en plein développement, non pas tant par le fait que la meilleure description de la matière à l'échelle la plus microscopique (mécanique quantique) soit intrinsèquement aléatoire, mais plutôt parce que le passage d'une échelle microscopique à une échelle macroscopique consiste à éliminer des degrés de liberté ou à considérer des asymptotiques dans les échelles en temps ou en espace, d'où naît l'aléatoire. L'atelier organisé par A.J. Majda ainsi que ses cours de la Chaire Aisenstadt illustraient particulièrement ces aspects pour des applications à la modélisation climatique, où l'on cherche justement à bâtir, à partir de modèles précis et très complets mais en très grande dimension, des modèles approximés plus simples qui conservent des propriétés statistiques proches du modèle initial, avec pour objectif de comprendre les phénomènes déterminants pour le climat. Les étapes essentielles sont alors la détection des degrés de liberté les plus importants, puis la dérivation d'équations équivalentes sur ces degrés de liberté, en utilisant des relations de fermeture appropriées. Ceci requiert des outils liés à la théorie de l'homogénéisation ou encore à la mécanique statistique. Les modèles aléatoires étaient également au cœur de la conférence consacrée aux mathématiques financières, organisée par R. Sircar et J.-P. Fouque.

L'étude numérique et théorique des couplages de modèles est un autre aspect que ces modélisations multiéchelles ont en commun. En particulier, le couplage de modèles aléatoires et déterministes soulève des questions numériques intéressantes liées aux relations entre les différentes erreurs de discrétisation (en temps, en espace, erreur statistique pour les modèles Monte Carlo). La conférence organisée par A. Bourlioux et P. Souganidis sur les modèles de combustion illustrait particulièrement les questions soulevées par

les interactions entre modèles stochastiques (décrivant l'écoulement advectif aléatoire) et modèles déterministes (décrivant la chimie de la combustion). Le couplage de modèles peut aussi se faire à des interfaces, une zone étant décrite plus finement qu'une autre. C'est le problème du passage de l'information aux interfaces qui est alors soulevé. Ce thème était notamment au centre de la conférence organisée par Weinan E et E. Vanden-Eijnden sur la modélisation multiéchelle dans les solides, où une des questions récurrentes concernait le choix des conditions aux limites entre les modèles de dynamique moléculaire essentiellement discrets, et les modèles de mécanique des milieux continus. Ce domaine est un exemple où il reste encore beaucoup de questions théoriques pertinentes, sur des modèles simplifiés (comportement d'une chaîne de ressort unidimensionnel par exemple) : Quelle notion de minimum (local ou global) de l'énergie mécanique faut-il considérer ? Quelle est la bonne dynamique ?

Je voudrais terminer ce compte-rendu très informel et personnel en remerciant Anne Bourlioux pour l'organisation de cette année thématique et nos nombreuses randonnées, les membres de l'administration du CRM pour leur accueil, Michel Delfour pour son support financier, Stéphane Dellacherie pour nos longues discussions scientifiques ou autres, et Eric Vanden-Eijnden avec qui j'ai commencé une collaboration fructueuse au cours de cette année. »

Tony Lelièvre

Aisenstadt Chairholders in 2004 – 2005: T.Y. Hou and A.J. Majda

The CRM was honoured to have as Aisenstadt chairholders, during the 2004 – 2005 theme year Mathematics of Stochastic and Multiscale Modeling, Professors Thomas Yizhao Hou of California Institute of Technology et Andrew J. Majda of Courant Institute.

Thomas Yizhao Hou

Thomas Yizhao Hou is the Charles Lee Powell Professor of Applied and Computational Mathematics at Caltech, and one of the leading experts in applied and numerical analysis for vortex dynamics and multiscale problems. In his twenty-year research career his research interests have been centered around developing analytical tools and effective numerical methods for vortex dynamics, interfacial flows, and multiscale problems.

He was born in Guangzhou, China, and studied at the South China University of Technology before undertaking his Ph.D. at UCLA. Upon obtaining it in 1987, he joined the Courant Institute as a postdoctoral fellow and then became a faculty member in 1989. He moved to the applied mathematics department at Caltech in 1993, and is currently the executive officer in the department of applied and computational mathematics. He was awarded the Morningside Gold Medal in Applied Mathematics in 2004, the SIAM Wilkinson Prize in Numerical Analysis and Scientificc Computing in 2001, the François N. Frenkiel Award from the Division of Fluid Dynamics, American Physical Society in 1998, the Feng Kang Prize in Scientific Computing in 1997, and was a Sloan Foundation Research Fellow from 1990 to 1992. He was also an invited plenary speaker at the International Congress on Industrial and Applied Mathematics in Sydney in 2003, an invited speaker of the International Congress of Mathematicians in Berlin in 1998, and founding Editor-in-Chief of a SIAM interdisciplinary journal on *Multiscale Modeling and Simulation*.

Andrew J. Majda

Andrew J. Majda is the Morse Professor of Arts and Sciences at the Courant Institute of New York University. He was born in East Chicago, Indiana on January 30, 1949. He received a B.Sc. degree from Purdue University in 1970 and a Ph.D. degree from Stanford University in 1973.

Majda's primary research interests are modern applied mathematics in the broadest possible sense merging asymptotic methods, numerical methods, physical reasoning and rigorous mathematical analysis.

He is well known for both his theoretical contributions to partial differential equations and his applied contributions to diverse areas such as scattering theory, shock waves, combustion, in-

compressible flow, vortex motion, turbulent diffusion, and atmosphere ocean science.

Majda is a member of the National Academy of Sciences and has received numerous honours and awards including the National Academy of Science Prize in Applied Mathematics, the John von Neumann Prize of the Society of Industrial and Applied Mathematics, and the Gibbs Prize of the American Mathematical Society. He has been awarded the Medal of the Collège de France and is a Fellow of the Japan Society for the Promotion of Science. He received an honorary doctorate from his undergraduate *alma mater*, Purdue University in 2000.

He began his scientific career as a Courant Instructor at the Courant Institute from 1973 – 1975. Prior to returning to the Courant Institute in 1994, he held professorships at Princeton University (1984-1994), the University of California, Berkeley (1978 – 1984), and the University of California, Los Angeles (1976 – 1978). In the past several years at the Courant Institute, Majda has created the Center for Atmosphere Ocean Science with a multidisciplinary faculty to promote cross-disciplinary research with modern applied mathematics in climate modeling and prediction.

Majda has recently published with Andrea Bertozzi, *Vorticity and Incompressible Flow* (Cambridge University Press). Also, Majda's lecture notes, *Introduction to PDE's and Waves for the Atmosphere and Ocean*, was recently published in the Courant Lecture Note Series of the American Mathematical Society.

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 subject. They are also invited to prepare a monograph (see the Publications chapter in this report for a list of these publications). At the request of Dr. Aisenstadt, the first of their lectures 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. Tyrell 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, and Shing-Tung Yau.

Activities Held During the Thematic Year

Summer School
Stochastic Calculus for Applications: Theory and Numerics

August 9 – 20, 2004, CRM
organized jointly with MITACS

Organizers: Anne Bourlioux (Montréal), Eric Vanden-Eijnden (Courant Inst.)
Principal Lecturer: E. Vanden-Eijnden (Courant Inst.)
Supervisor of exercise sessions: I. Fatkullin (Caltech)
Invited Lecturers: P. Tupper (McGill), B. Khouider (Victoria), C. Le Bris (ENPC), I. Fatkullin (Caltech)
Number of participants: 51

The aim of the summer school was to cover the essentials of stochastic calculus, including fundamental concepts such as Markov chains, Wiener processes, stochastic differential equations, as well as more elaborate ideas such as the Girsanov transformation and path integrals. The material was presented at a semi-rigorous level by relying only on the standard tools of basic probability, linear algebra, and advanced calculus. Both theoretical and numerical aspects were covered and illustrated via examples.

The purpose of the summer school was to serve as an introduction for graduate students and postdoctoral fellows to one of the main mathematical tools at the centre of the thematic year organized by the CRM in 2004 – 2005 so that they could benefit to the maximum from the specialized workshops to be held subsequently. This mission was accomplished with success thanks to a combination of daily theoretical courses, four invited lectures on applications representative of some of the themes to be covered in

the workshops of the thematic program, and by daily, supervised exercise sessions. An interesting fact was the great diversity of participants: students, postdocs and researchers from mathematics, physics, pharmacy, chemistry, engineering, etc., not only from diverse Montreal universities and research centers, but also from elsewhere in Canada, from the United States and from Europe. Participation was assiduous throughout the two weeks — many participants commented on how positive the experience was from all points-of-view: i.e., excellence of the content and of the organization. The organizers received several queries asking if the activity would be repeated in the future.

Workshop
Multiscale Rheological Models for Fluids
November 14 – 17, 2004, CRM

Organizer: Claude Le Bris (ENPC)
Speakers: A. Bonito (EPFL), É. Cancès (ENPC), P. Constantin (Chicago), A. Debussche (ENS-Cachan Bretagne), M. Grmela (École Polytechnique Montréal), Z.-F. Huang (McGill), B. Jourdain (EPNC), C. Le Bris (EPNC), T. Lelièvre (Montréal), C. Liu (Penn State), A. Lozinski (EPFL), N. Masmoudi (Courant Inst.), F. Otto (Bonn), R.G. Owens (Montréal), J. Ramírez (Politécnica Madrid), P.T. Underhill (MIT), Q. Wang (Florida State), P. Zhang (Beijing)
Number of participants: 25

La modélisation multiéchelle du comportement non newtonien des fluides complexes peut être abordée par l'établissement de lois constitutives, mais de telles lois sont souvent difficiles à dériver et à valider. Une stratégie alternative est de faire appel à la théorie cinétique pour simuler le comportement des microstructures présentes dans le fluide (chaînes de polymères, particules en suspension, etc.) et de coupler cette description microscopique avec une description macroscopique du fluide par les équations de la mécanique du continuum.

Un large spectre de questions reliées à la rhéologie des fluides complexes a été abordé: les aspects de modélisation (Owens, Wang, Grmela, Underhill, Huang), les aspects de simulation numérique (Ramírez, Bonito, Lozinski), les aspects d'analyse mathématique et numérique (Constantin, Otto, Cancès, Liu, Masmoudi, Zhang). Certaines conférences ont été dédiées aux modèles faisant intervenir des équations de nature stochastique (Debussche, Jourdain, Lelièvre, Le Bris).

L'atelier a réuni environ 25 participants venus assister aux 18 conférences présentées et à une communication courte. La confrontation de compétences aussi diverses a été largement appréciée par les participants, et les longues plages de discussion ménagées dans l'emploi du temps ont rendu possibles de nombreux échanges dont certains seront certainement le germe d'interactions scientifiques à plus long terme.

Workshop
Front Propagation and Nonlinear Stochastic PDE's for Combustion and Other Applications
January 26 – 29, 2005, CRM
organized jointly with MITACS

Organizers: Anne Bourlioux (Montréal), Panagiotis T. Souganidis (UT Austin)
Speakers: J. Bell (Lawrence Berkeley National Lab.), K. Bushe (UBC), C. Devaud (Waterloo), Ö.L. Gülder (Toronto), F. Hamel (Aix-Marseille III), S. Heinze (MPI MIS), M. Herrmann (Stanford), D. Hillhorst (Paris XI), A. Kiselev (UW Madison), J. Nolen (UT Austin), A. Novikov (Penn State), J.-M. Roquejoffre (Toulouse III), A. Stevens (MPI MIS), V. Volpert (Lyon I), A. Zlatos (UW Madison)
Number of participants: 22

The development of efficient large-scale models for the numerical simulation of turbulent premixed flames requires a good understanding of the mathematical principles governing the dynamics of self-propagating fronts. One of the most challenging issues is the analysis of the complex interactions, at small scales, between advection, reaction and diffusion, including stochastic effects due to the media or the advective flow randomness.

This workshop, offered an opportunity for interactions between mathematicians at the forefront of this area and scientists involved in the design of models and numerical methods for various applications, in particular, turbulent combustion.

On the theoretical side, exchanges were quite intense with several speakers presenting very recent results on predictions of flame propagation and extinction in response to flows, notably those in a network of vortices; various estimators for PDEs, comparison principles for their solutions, and probabilistic methods were featured. Participants appreciated and found just as instructive presentations offering a different

but complementary perspective to theoretical efforts to understand flame fronts. For example, the presentation by A. Stevens highlighted the interesting and potentially very promising theoretical connection between models of combustion fronts and those in biology with a niche of, so far, little studied mathematical problems. Presentations of a more numerical and experimental nature also led to discussions going both ways: an improved awareness for mathematicians of the complexity and richness of the spectacular results obtained during physical and numerical experiments, but also very frank discussions, for instance on the mathematical validity of certain approximations widely used in numerical models.

Workshop
Representing Unresolved Degrees of Freedom for the Atmosphere and Ocean
March 2 – 5, 2005, CRM

Organizer: Andrew J. Majda (Courant Inst.)
Speakers: P. Bartello (McGill), J. Bowman (Alberta), G. Branstator (NCAR), O. Bühler (Courant Inst.), L. Campbell (Carleton), G. Craig (DLR Oberpfaffenhofen), T. DelSole (George Mason), C. Franzke (Courant Inst.), W. Grabowski (NCAR), D.M. Holland (Courant Inst.), M. Katsoulakis (UMass Amherst), B. Khouider (Victoria), P.J. Kushner (Toronto), A. Monahan (Victoria), T.G. Shepherd (Toronto), D. Straub (McGill), I. Timofeyev (Houston), B. Turkington (UMass Amherst), G.K. Vallis (GFDL)
Number of participants: 49

A central problem in attempts to understand and predict the evolution of atmospheric or oceanic flows is how best to represent the unresolved scales in these flows. In the jargon of dynamic meteorology or physical oceanography this is called the parameterization problem, while in the jargon of turbulence it is called the closure problem. The most pertinent areas of analysis and applied mathematics are homogenization theory, probability and non-linear stochastic PDEs. The purpose of this workshop was to explore two complementary issues that arise in the context of the parameterization problem:

1. the extent to which modern techniques in applied mathematics can be brought to bear on its formulation and partial solution; and
2. the extent to which problems in the representation of atmospheric and oceanic flows create fertile new areas of mathematical inquiry.

The workshop was genuinely interdisciplinary and new synergy between mathematics and these applications emerged throughout the meeting. One prominent example was the theme of multiscale cloud modeling where the mathematical talks by Khouider, Katsoulakis, and Majda had serendipity with the disciplinary lectures by Grabowski, Craig and Vallis. The young scientists in attendance were able to observe this vibrant scientific activity.

Another exciting development was the new mathematical theory for new types of breaking waves and their impact on mean flows developed by Bühler in his lecture after the general overview of Shepherd. Another interesting point of interaction was the mathematical techniques for stochastic mode reduction presented by Franzke and Timofeyev in contrast to the observational lecture of Branstator and the interesting lecture of Delsole on instantaneous optimal bases for turbulence. Finally, Turkington and Bowman gave interesting novel methods for parametrizing turbulent flow at large scales and in the integral range.

Workshop
Extracting Macroscopic Information from Molecular Dynamics
April 7 – 9, 2005, CRM

Organizer: Paul F. Tupper (McGill), Andrew Stuart (Warwick)
Speakers: G. Ciccotti (Roma "La Sapienza"), C. Dellago (Wien), A. Dinner (Chicago), W. Hoover, B. Leimkuhler (Leicester), J.H. Maddocks (ETH Zürich), C. Schuette (FU Berlin), R.D. Skeel (Purdue), M.E. Tuckerman (New York), E. Vanden-Eijnden (Courant Inst.), A.F. Voter (Los Alamos), S. Wiggins (Bristol)
Number of participants: 31

Models used in molecular dynamics are high-dimensional dynamical systems (or stochastic dynamical systems) with multiple time-scales. A major challenge for computational mathematics is the extraction of accurate macroscopic information at minimal cost. This workshop concentrated on two topics:

- the analysis and development of standard time-stepping algorithms in the context of molecular dynamics, with the purpose of the indirect calculation of macroscopic information;
- the design of new algorithms aimed at extracting macroscopic information directly.

During the workshop some particular areas of focus emerged: Transition path sampling (Blue moon, the string method), determining reaction coordinates (theory and practice), stochastic vs deterministic mechanics for molecular simulation (e.g., Langevin or dynamical thermostats), automatic extractions of information from huge, high-dimensional data sets and fast dynamics ("Voter" dynamics).

The workshop was widely considered a success. Because the talks were each an hour long, speakers were able to take their time to develop their material in a clear fashion. Because we limited the number of speakers to 12, there was ample time between the talks for discussion. Many participants explicitly thanked the organizers for this relaxed schedule, saying that it was a refreshing change from the usual format for such workshops.

Moreover, since the speakers included mathematicians, physicists, and chemists, there was a wide variety of perspectives on the different problems addressed. The most valuable outcome was probably the emergence of unforeseen parallels between different researchers' approaches to the analysis of molecular dynamics data.

Workshop
Multiscale Modeling of Solids
April 28 – 30, 2005, CRM

Organizer: Weinan E (Princeton), Eric Vanden-Eijnden (Courant Inst.)
Speakers: N. Bernstein (US Naval Research Lab.), W. Cai (Stanford), W.A. Curtin (Brown), E. Kaxiras (Harvard), A.J. Lew (Stanford), X. Li (IMA), W. K. Liu (Northwestern), G. Lu (California State), M. Marder (UT Austin), R. E. Miller (Carleton), A. Needleman (Brown), H. Park (Vanderbilt), M.G. Reznikoff (Bonn), R.E. Rudd (Lawrence Livermore National Lab.), M. Tang (Lawrence Livermore National Lab.), Y. Xiang (Hong Kong University of Science & Technology)
Number of participants: 33

This was a very successful workshop. It is quite different from most other workshops on multiscale modeling, since it was quite focused. This workshop concentrated on energetic and kinetic issues associated with defects, cross-slip, grain boundary migration, and phase boundary dynamics in solids. The objective was to develop mathematical models for complex multiscale phenomena such as crystal plasticity, nucleation and reconstruction of stepped surfaces, and the behaviour of nano-materials in general. Most participants were experts in the field. The workshop was run in such a way that it promoted in-depth, frank and sometimes heated discussions.

Several problems, such as issues of boundary conditions, dislocation dynamics and their role in plastic deformation, rare events, systematic coarse-graining procedures were discussed in depth. Most participants enjoyed this style of workshop and expressed interest to have more of such workshops in the future.

Workshop
Integrative Multiscale Modeling and Simulation in Materials Science, Fluids and Environmental Science
May 11 – 13, 2005, CRM

Organizer: Thomas Y. Hou (Caltech)
Speakers: J.E. Aarnes (SINTEF ICT), A. Bourlioux (Montréal), C.J. Budd (Bath), R.E. Caflisch (UCLA), S. Chen (Johns Hopkins), A.J. Chorin (UC Berkeley), P. Constantin (Chicago), L.J. Durlofsky (Stanford), Y. Efendiev (Texas A&M), B. Engquist (PSCI), A.C. Fannjiang (UC Davis), R. Ghanem (Southern California), J. Glimm (SUNY Stony Brook), Y.G. Kevrekidis (Princeton), R. Kuske (UBC), C. Liu (Penn State), W.K. Liu (Northwestern), M. Luskin (Minnesota), L.R. Petzold (UCSB), H. Tchelepi (Stanford), M.F. Wheeler (UT Austin), J. Xin (UT Austin), S. Yip (MIT), D. Zhang (Los Alamos)
Number of participants: 44

There were 22 invited speakers from various disciplines. They are all leading experts in their fields. The workshop also attracted participants from academia and industry. It generated very lively and stimulating discussions during the lectures, and the coffee breaks. People from different backgrounds found common research interests through the interactions of the workshop. We also identified a number of key challenges that remain to be resolved in the future. These challenges include the multiscale analysis and computational methods for problems without scale separation where global information becomes important, stochastic modeling and how to quantify the uncertainty effect due to the presence of random noise in modeling, bridging the gap between fundamental multiscale analysis for model problems and the engineering applications and the dynamic non-linear interaction across different length scales. Every in-

vited speaker gave a first-rate lecture. This includes both the senior established leaders in the field and the younger generation of rising stars. In many cases, the topic of one lecture complemented another lecture. As a result, the workshop generated a lot of interactions among the participants. We can see that mathematicians talked to engineers, and engineers learned from mathematicians. For example, the lecture by Wing-Kam Liu on applying the immersed boundary method to biological nanofilm deposition inspired discussion with Bjorn Engquist, who has done work on improving the accuracy of immersed boundary methods. The lecture of Shiyi Chen on multiscale simulation of fluid-solids interaction also inspired a lot of discussions on during the lecture regarding its potential applications to engineering problems and some of its limitations. The lectures by Durlofsky, Efendiev, and Arnes gave an admirable overview on the topic of upscaling of flow in porous media, covering both the state-of-the-art methodology and the frontier applications in the industry. Sidney Yip gave an outstanding talk on the dynamic aspect of multiscale modeling in materials science applications. Linda Petzold's lecture is an excellent example how an effective multiscale algorithm can make a difference in biological applications. Glimm's talk showed the importance of high resolution schemes in capturing the small scale interfacial instability while a less accurate method may completely miss these important fine scale details. Finally, Constantin's lecture provided the fundamental theory for some non-Newtonian models for complex fluids.

Many participants told the organizer how much they had enjoyed the workshop. In some sense, we have integrated successfully the different aspects of multiscale problems and started a very healthy and constructive dialogue among experts from different disciplines. If we continue this type of cross-disciplinary interactions, we will be able to make significant advances of the field.

Workshop
Stochastic Modeling in Financial Mathematics

June 1 – 5, 2005, CRM
organized jointly with SAMSI and partially funded by MITACS

Organizers: Ronnie Sircar (Princeton), Jean-Pierre Fouque (NC State)
Speakers: R. Almgren (Toronto), D. Becherer (Imperial College London), T. Bielecki (IIT), A. Cadenillas (Alberta), R. J. Elliott (Calgary), J. Fan (Princeton), P. Glasserman (Columbia), U. Haussmann (UBC), E. Hillebrand (LSU), U. Horst (UBC), S. Howison (Oxford), M. Jeanblanc (Évry-Val d'Essone), I. Karatzas (Columbia), S. Kou (Columbia), D. Kramkov (Carnegie Mellon), D. Pelletier (NC State), É. Renault (North Carolina), P. J. Schönbucher (ETH Zürich), K. Solna (UC Irvine), N. Touzi (CREST), L. Wu (Baruch College), T. Zariphopoulou (UT Austin)
Number of participants: 93

The theme of this workshop was emerging directions in financial mathematics, with emphasis on stochastic modeling of market uncertainties, theoretical and numerical approximations to pricing, hedging and portfolio optimization control problems, and data estimation issues. The goal was to bring together researchers in a variety of disciplines (mathematics, engineering, operations research and economics, for example) to emphasize different techniques and approaches.

The meeting was very successful in bringing together experts from the various fields of financial mathematics, statistics and econometrics. It gave an opportunity to graduate students to be exposed to a range of interesting and exciting research problems and also an opportunity to postdocs to show their work in twenty-minute talks. The format was extremely successful and most likely it will be adopted by others: we had fourty-five minute long talks (including questions) and fifteen-minute breaks during talks for coffee and further discussions.

The workshop brought forward exciting new developments in (among others): utility-indifference pricing, numerical solution of nonlinear partial differential equations, credit risk, multiscale techniques for volatility modeling (in credit, equity and fixed income), estimation of volatility and its time-scales and even the occurrence of the Riemann-Zeta function in finance!

The organizers are delighted to have had the opportunity to put together such a workshop at CRM, and many of the participants have contacted us afterwards to express their gratitude also.

Advanced Course
Multiscale Systems: Modeling and Simulation

Fall 2004, CRM

Professor: Claude Le Bris (ENPC)

This course was an introduction to the study of multiscale problems from the applied mathematician's point of view. Various strategies were described and analyzed, each of them explained in the framework of a specific application.

Examples of applications::

- Solid Mechanics
- Laminated Materials;
- Molecular Chemistry;
- Polymeric Fluids Dynamics;
- Chemical Reactions Kinetics.

Scientific point-of-views:

- Physics
- Mathematical Analysis;
- Numerical Analysis;
- Programming.

This is a very active research area. The course aimed at establishing the mathematical basis of this discipline so that the student will be equipped to explore various multiscale research areas.

Past Thematic Programs

The Centre de recherches mathématiques has organized thematic activities every year since 1993. Before that, starting in 1987, special semesters and concentration periods were combined with thematic years.

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

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 PDE's 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-site and elsewhere in Canada. Whether it be for specialized workshops for a small number of researchers or large meetings for 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 Riemannian Geometry

June 28 – July 16, 2004, CRM

Organizers: Vestislav Apostolov (UQÀM), Andrew Dancer (Oxford), Nigel Hitchin (Oxford), McKenzie Wang (Hamilton)
Short courses instructors: Michael Anderson (SUNY Stony Brook), Karsten Grove (Maryland), Nigel Hitchin (Oxford)
Invited speakers: M. Anderson (SUNY Stony Brook), O. Biquard (Strasbourg), R. Bielawski (Glasgow), C. Boyer (New Mexico), R. Bryant (Duke), D. Calderbank (Edinburgh), J. Chen (UBC), X. Chen (UW Madison), A. Dancer (Oxford), M. Dunajski (Cambridge), P. Gauduchon (École Polytechnique Palaiseau), A. Fraser (UBC), K. Grove (Maryland), M. Herzlich (Montpellier II), N. Hitchin (Oxford), C. LeBrun (SUNY Stony Brook), N.C. Leung (Minnesota), J. Lohkamp (Augsburg), C. Margerin (École Polytechnique Palaiseau), M. Min-Oo (Hamilton), A. Nabutovsky (Toronto), D. Page (Alberta), G. Papadopulos (Cambridge), H. Pedersen (Odense), P. Petersen (UCLA), C. Pope (Texas A&M), R. Rotman (Toronto), K. Shankar (Oklahoma), X. Wang (MIT), B. Wilking (Münster), W. Ziller (Pennsylvania)
Number of participants: 90

This three-week program, held during the summer of 2004 at the Centre de recherches mathématiques, focused on the study of Riemannian metrics whose curvature satisfies constraints (the so-called special geometries). The relation between curvature and topology has been of interest since the beginning of differential geometry and, more recently, metrics with special curvature properties have come to the fore in physical problems related to string theory. These subjects were the leitmotivs of the program that was attended by over 90 participants.

The program opened with a week of introductory short courses designed for graduate students and postdoctoral fellows.

Michael Anderson gave a comprehensive survey on Einstein metrics on open manifolds, which have a certain structure at infinity. Asymptotically, the simplest structures are those of constant curvature, and his five lectures covered both the asymptotically flat and the hyperbolic (or conformally-compact) cases. He described a large class of examples of such metrics, and then focused on general questions of existence and uniqueness. He explained through his talks the so-called Anti-de Sitter/Conformal Field Theory correspondence in physics, and gave a number of results on the structure of the map from the space of Einstein conformally-compact metrics to the conformal structures on the boundary. These lectures were masterful in their grasp of both the physical theories and the rigorous mathematical results related to them.

Karsten Grove gave a four-lecture mini-course on comparison geometry, from a fairly new and original point of view. The comparison geometry has its roots in global Riemannian geometry, where it took off in the 1930s through the works of Hopf, Morse, Schoenberg, Myers and Synge. The real breakthrough came in the 1950s with the pioneering works of Rauch, Alexandrov, Toponogov and Bishop. Since then, the simple idea of comparing the geometry of an arbitrary Riemannian manifold with the geometry of constant curvature spaces has had a tremendous evolution. First in conjunction with Morse theory and convexity, then with Gromov-Hausdorff topology on spaces of Riemannian manifolds, and the geometry of singular spaces, and most recently in the presence of symmetries. All these aspects were beautifully presented through the lectures which had a great success.

What is special about 6, 7 and 8 dimensions? Why do we study Calabi-Yau threefolds, G_2 and Spin(7) manifolds? These were the questions addressed in Nigel Hitchin's introductory lectures to these special geometries of great interest in string theory. Based on the fundamental principle to look at the geometry of open orbits of Lie groups, he presented a truly elegant and original approach to the subject. The orthogonal groups $\mathrm{SO}(n,n)$ also appear in this setting through their spin representations, and this provided an entrance into the exciting world of generalized geometry. His lectures were beautifully

orchestrated with many examples and constructions on moduli spaces.

The audience during this first week was quite eclectic, ranging from physicists to geometers to topologists. All three lecturers did wonderful tutorial work during the office hours they kindly provided to the participants. There were many fruitful discussions across boundaries, and these led in particular to an informal lecture by Michael Anderson on the celebrated recent work of Perelman, aiming at a complete resolution of Thurston's geometrisation conjecture.

The last two weeks of the program included 43 one-hour specialized talks, elaborating in particular on the subjects introduced during the first week.

Einstein metrics, positive sectional curvature, obstruction theory for positive scalar curvature were the main topics during the second week of the program.

Michael Anderson presented his new construction of compact Einstein metrics, by using a generalization of Thurston's theory of hyperbolic Dehn surgery and gluing techniques. His construction provides the first known families of 4-dimensional compact Einstein manifolds which are neither Kählerian nor locally symmetric. Christoph Böhm gave a comprehensive overview of general existence results for homogeneous Einstein metrics, including many new examples. Charles Boyer lectured on his recent works with K. Galicki and J. Kollár that produce an abundance of new Einstein metrics on compact manifolds of dimension $2n+1$, including exotic spheres. Don Page explained how an Euclidean version of the general Kerr-de Sitter metric leads to the construction of amazingly explicit Einstein metrics on S^{n-2}-bundles over S^2. David Calderbank lectured on his recent works with H. Pedersen and M. Singer that classify both locally and globally self-dual Einstein manifolds and orbifolds that admit an isometric action of a 2-torus. Andrew Dancer presented a classification for superpotentials that have been used to reduce the Einstein equations to subsystems. Olivier Biquard explained the relation between 3-dimensional CR geometry and Einstein geometry, and defined a new eta invariant for CR manifolds coming from this correspondence. David Duchemin presented his work on quaternionic-Kähler fillings of quaternionic-contact structures in dimension 7. Gordon Craig explained his gluing construction of Einstein fillings of infinitely many topological types of certain 3-dimensional hyperbolic manifolds.

Wolfgang Ziller related the existence of positive sectional curvature metrics on the total space of fiber bundles with the recent constructions of Einstein self-dual orbifolds, due to N. Hitchin, D. Calderbank and M. Singer. Burkhard Wilking then presented a classification of the positively curved compact manifolds of cohomogeneity one, a result that he, K. Grove and W. Ziller have recently obtained, and he discussed in detail the still open case of a smooth 3-Sasakian 7-manifold constructed out of Hitchin's Einstein self-dual orbifolds. Ingi Petursson and Ailana Fraser talked about their exciting results on compact Riemannian manifolds of (almost) positive isotropic curvature.

Joachim Lohkamp presented the complete proof of the positive mass theorem that he and U. Christ have recently found. Marc Herzlich then defined an analogous asymptotic invariant in the case of asymptotically hyperbolic metrics, called "hyperbolic mass," and proved the "positive mass property" in this case. Margarita Kraus talked about inequalities which bound the Riemannian curvature tensor with the asymptotic "mass invariant" of an asymptotically flat Lorentzian manifold. Hélène Davaux found a new upper estimate of the scalar curvature of a compact spin manifold in terms of the spectrum of the Laplacian of the universal covering, thus providing a new obstruction to the existence of a positive constant scalar curvature metrics.

There were also two talks on upper curvature bounds during this second week, given by Regina Rotman and Krishnan Shankar. Alexandre Nabutovsky gave an excellent overview of variational methods in Riemannian Geometry, and Niky Kamran surveyed some long time behaviour results for solutions of geometric hyperbolic equations arising in the Lorenzian Kerr space-time.

The third week of the program was mostly focused around the geometry of metrics with special holonomy, Kähler and Hermitian metrics with special curvature, and holomorphic methods in Riemannian geometry.

Roger Bielawski lectured on his recent works on invariant Kähler metrics with prescribed Ricci curvature, on the complexification of a symmetric space of compact type. Paul Gauduchon gave a new description of all Kähler metrics with vanishing Bochner curvature, thus providing an alternative approach to R. Bryant's classification

of these manifolds. Gideon Maschler presented his recent works with A. Derdzinski that classify, both locally and globally, all Einstein manifolds which are conformally Kähler. Christina Tønnesen-Friedman presented an abundance of new explicit examples of extremal Kähler metrics on toric bundles. Yann Rollin talked about his very important recent work with M. Singer that relates existence of scalar-flat Kähler metrics and stability of parabolic vector bundles. Maurizio Parton and Ruxandra Moraru talked about reduction and instanton moduli spaces over certain hyper-Hermitian manifolds.

Gueo Grantcharov, Ana Fino and Helge Joergensen explained their classification results of certain homogeneous spaces with special holonomy properties. Bogdan Alexandrov discussed some fuzzy threads in the literature concerning the notion of weak holonomy. Stefan Ivanov presented a proof of a Goldberg-type conjecture concerning Einstein G_2-manifolds. Georges Papadopoulos introduced the notion of spinorial cohomology and explained how it can be applied to study manifolds with special holonomy. Min-Oo talked about calibrated geometry in spaces with special holonomy G_2 and Spin(7), and its relevance to string theory. He discussed various explicit constructions recently found by physicists. His lecture was later followed by a talk by his collaborator, Spiro Karigiannis, on calibrated cycles in certain bundle constructions of metrics with holonomy G_2. There were two other talks on calibration theory associated to special Lagrangian manifolds, given by Marianty Ionel and Adrian Butscher. Wei-Dong Ruan discussed convergence and degeneration of complete Kähler – Einstein hypersurfaces in complex tori.

Robert Bryant lectured on complete Riemannian metrics for which the Ricci tensor is a Hessian of a function. This class of manifolds naturally appears in the study of Ricci flow on manifolds.

Claude LeBrun gave a very beautiful new proof of all the classical results concerning compact surfaces with closed geodesics, by using a twistor-theoretic approach to reduce these problems to certain rigidity properties of complex-analytic surfaces. Maciej Dunajski demonstrated how the twistor-approach can be applied to various nonlinear integrable equations arising in mathematical physics to find solutions via simple algebro-geometric operations on families of rational curves.

Following Hitchin's ideas, Marco Gualtieri introduced the notion of generalized Kähler geometry and explained how these structures naturally appear on 4-manifolds and in connection with twisted K-theory classes of even dimensional Lie groups.

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

The lecture notes of the short courses given during the first week of the program, as well as a number of other contributions will be published as a joint CRM – AMS volume. We wish to acknowledge the National Science Foundation (NSF) for their contribution.

Séminaire de mathématiques supérieures – NATO ASI 2004

Morse Theoretic Methods in Non-Linear Analysis and Symplectic Topology

June 21-July 2, 2004, Université de Montréal

This Seminar was held with financial support from the NATO, the CRM, the Vice-rectorat à la recherche, the Faculté des Sciences and the Département de mathématiques et de statistique of Université de Montréal

Organizers: Octavian Cornea (Montréal), Paul I. Biran (Tel Aviv)
Speakers: A. Abbondandolo (Scuola Normale Superiore di Pisa), P. Biran (Tel Aviv), R. Cohen (Stanford), O. Cornea (Montréal), M. Farber (Durham), K. Fukaya (Kyoto), H. Hofer (Courant Inst.), M. Izydorek (Politechnika Gdańska), Y.-G. Oh (UW Madison), L. Polterovich (Tel Aviv), M. Schwarz (Leipzig), C. Vitebo (École Polytechnique Palaiseau)
Number of participants : 65

The talks at this meeting centered on Morse theoretical techniques which can be used to solve difficult analytic problems as well as problems in symplectic topology and in robotics. The key tool in modern symplectic topology is Floer homology techniques, and this has constituted a recurring theme for the lectures given at the SMS.

In the first week Helmut Hofer talked about the foundations of symplectic field theory, one of the major new "machines" in symplectic topology whose development has been pursued by Hofer, Eliashberg and Givental for a number of years now. The origins of symplectic field theory lie in Floer's machinery but it goes much be-

yond that, and both in applications in complexity. Hofer's lectures were therefore extremely timely. Matthias Schwarz presented his recent proof for a result of Viterbo relating the Floer homology of the cotangent bundle and the string topology of the zero section of this bundle. This notion of string topology has been recently introduced by Chas and Sullivan with a purely topological motivation, and the fact that it fits perfectly with the quantum product in Floer's theory is quite remakable. Michael Farber discussed applications to robotics. Paul Biran described efficient methods to use Floer homology in the monotone case to prove results concerning the topological structure of Lagrangian submanifolds. Leonid Polterovich showed how to relate this symplectic topology to dynamics and geometric group theory methods. Octav Cornea presented higher order Floer type invariants and applications.

This was an intense first week with lectures of the highest order of interest for specialists as well as for beginners in the field. Some of the topics discussed (in particular by Hofer, Schwarz, Cornea and Polterovich) were presented publicly for the first time at the SMS–NATO ASI. The second week continued as strongly: Claude Viterbo talked about generating functions techniques, Alberto Abbondandolo discussed Morse theory in Hilbert spaces, Kenji Fukaya talked about a new version of his A^∞ machinery (developed with Oh and Ono) and applications, some of which overlapped with applications obtained by different methods by Cornea jointly with Lalonde and mentioned in the first week. Marek Izydorek lectured on his approach to the infinite dimensional Conley index and Yong-Geun Oh presented his recent spectral invariant techniques and chain level Floer methods. Finally, Ralph Cohen described his topological approach to string topology and its potential implications for symplectic topology.

Obviously, as it follows from the description above, many of the talks of different speakers were strongly interrelated (for example, Hofer's talks and those of Cornea, those of Schwarz with those of Cohen, those of Oh and those of Viterbo). This contributed to the overall quality and strength of the SMS–NATO ASI itself.

Mini-Workshop on Computational Aspects of Dynamical Systems

July 19, 2004, Concordia University
organized by the Applied Mathematics Laboratory

Organizer: Eusebius Doedel (Concordia)
Speakers: A. Vanderbauwhede (Gand), B. Krauskopf (Bristol), H. Osinga (Bristol), P. Tupper (McGill).

The aim of this mini-workshop was to bring together theory and application of numerical techniques for dynamical systems. New developments were demonstrated with case studies of dynamical systems arising in applications. Problems considered included the continuation and bifurcation of periodic orbits in symmetric Hamiltonian systems, and the computation of invariant manifolds, including unstable manifolds in delay equations with application to a laser with optical delay, and computation of one-dimensional unstable manifolds when the equilibrium loses its hyperbolicity or the manifold is a strong unstable manifold. The problem of justifying long-time large-scale simulations of molecular systems was also considered through a concept of weak ergodicity.

Conference on Fixed Point Theory and its Applications in Honour of Andrzej Granas

August 16 – 20, 2004, CRM
organized by the Mathematical Analysis Laboratory, a collaboration with the Département de mathématiques et de statistique of Université de Montréal

Organizer: Marlène Frigon (Montréal)
Principal speakers: V. Benci (Pisa), B. Bojarski (Polish Academy of Sciences), H. Brezis (Rutgers), R. Brown (UCLA), B. Cornet (Paris I), E. Fadell (Wisconsin), J. Jaworowski (Indiana), J.W. Lee (Oregon State), F.-C. Liu (Inst. Sinica, Taiwan), A. Marino (Pisa), J. Mawhin (Louvain), S.B. Nadler Jr. (West Virginia), R. Nussbaum (Rutgers), H. Steinlein Munich)
Number of participants: 50

La Conférence sur la théorie des points fixes et ses applications a réuni à Montréal du 16 au 20 août 2004 une cinquantaine de participants venus célébrer, dans une atmosphère de collégialité et de fraternité, le 75^e anniversaire du Professeur Andrzej Granas. Les thèmes principaux de la Conférence étaient la théorie des points fixes et ses applications à l'analyse non linéaire, aux équations différentielles et aux systèmes dy-

namiques. Notamment, les sujets suivants ont été traités : la théorie du degré topologique sur des espaces de Banach ou sur des variétés et la théorie du degré équivariant, les théorèmes de point fixe et de point périodique, la théorie de Nielsen et celle de Perron-Frobenius, les applications KKM et les théorèmes de type minimax, les méthodes variationnelles appliquées à des problèmes d'équations aux dérivées partielles.

Workshop on Algebraic K-Theory
October 2 – 6, 2004, CRM

Organizers: Eric Friedlander (Northwestern), Dan Grayson (Urbana-Champaign), Rick Jardine (Western Ontario), Manfred Kolster (McMaster)
Speakers: P. Balmer (ETH Zürich), G. Carlsson (Stanford), J.-L. Colliot-Thélène (Paris-Sud 11), T. Geisser (USC), A. Goncharov (Brown), J. Hornbostel (Regensburg), M. Karoubi (Paris VII), M. Levine (Northeastern), I. Madsen (Aarhus), F. Morel (Munich LMU), O. Röndigs (Bielefeld), M. Schlichting (LSU), R. Sujatha (Tata Institute), A. Suslin (Northwestern), B. Totaro (Cambridge), M. Walker (Nebraska), K. Zainoulline (Bielefeld)
Number of participants : 49

The meeting reflected some of the major developments of the past year in the subject, particularly in motivic homotopy theory. These include Levine's proof of the Voevodsky slice conjecture, Morel's proof of the unstable connectivity theorem for motivic homotopy types (which was described in his talk as a type of Hurewicz theorem), and the identification by Röndigs and Ostvaer of Voevodsky's triangulated category of motives with the stable category of modules over the cycle-theoretic Eilenberg–MacLane spectrum. Levine's theorem uses a homotopy theoretic approach to the Chow moving lemma, which was discussed during his talk. The Levine and the Röndigs–Ostvaer results together substantially demystify the relation between the motivic stable category and motivic cohomology, while Morel's work points the way to explicit calculations of motivic homotopy groups. Suslin displayed a spectral sequence for the motivic cohomology of an arbitrary Severi-Brauer variety which is built from a decomposition of the motive associated to its Čech resolution.

It had been expected that the proof of the Bloch-Kato conjecture relating Galois cohomology to the Milnor K-theory of a field would be completely written up by the time of this conference, but this was not to be. Suslin predicts, however, that this proof will be properly written up within a year. The Bloch–Kato conjecture has sensational calculational consequences; these include the Lichtenbaum–Quillen conjecture which says that K-theory can be computed from étale cohomology.

Informal Semester on Symplectic Topology
Fall 2004, CRM

Organizers: Octav Cornea (Montréal), François Lalonde (Montréal)
Speakers: M. Entov (Haifa), J.-Y. Welschinger (ENS Lyon), F. Bourgeois (Université Libre de Bruxelles), J.-Y. Welschinger (ENS Lyon), M. Pinsonnault (Toronto), P. Seidel (Chicago), S. Anjos (IST Lisbonne), D. McDuff (SUNY Stony Brook), A.-L. Biolley (Toronto), Y. Ruan (UW Madison), C. Liu (Harvard), K. Wehrheim (Princeton), R. Hind (Notre Dame), V. Ginzburg (UC Santa Cruz),Y. Eliashberg (Stanford), E. Kerman (U of I Urbana-Champaign), Y. Karshon (Toronto), C. Abbas (Michigan State), A. Teleman (Aix-Marseille 1).

This was an informal thematic semester, held in addition to the official theme year on Multi-scale Stochastic Modelling. With two major thematic programs going on at the same time in Fall 2004 at the CRM, one can easily imagine the intensity of activities and febrility during that period. The informal Semester on Symplectic Topology was a Canadian Leadership Initiative funded by NSERC; it was the natural sequel to the events in symplectic topology that had started with the NATO Advanced Study Institute in the Summer of 2004. Our purpose was to invite a number of researchers in the field who have made recent remarkable contributions to the subject and we asked them to discuss their work in an informal, flexible, workshop setting. We encouraged them to be present at the CRM for periods from a week up to a month and, in particular, during a concentration period in the first two weeks of November. This created to an excellent working atmosphere and it was very useful to post-docs, students and established researchers alike.

Some of the lecturers have given one lecture of one hour and some others two or more sometimes longer talks. The maximum has been attained by Welschinger who gave three lectures of an average length of two hours each.

Also present and active in the discussions were Jean-Claude Sikorav (ENS Lyon) as well as Shengda Hu (Montréal), Alex Ivrii (Montréal)

and the two organizers. A number of students also participated sporadically: Clement Hyvrier, Remi Leclercq as well as Baptiste Chantraine. Eliashberg's, Kharshon's and Seidel's talks were organized jointly with CIRGET's seminar.

Scientific description

A number of talks focused on "hot" topics in symplectic topology: examples are the work on real Gromov-Witten invariants in the presence of symmetry with the two different points of view of Welschinger and ChiuChu Liu. In Welschinger's case, the symmetry is the real involution on complex manifolds with fixed locus equal to a Lagrangian submanifold. Really, what Welschinger is doing is to construct enumerative invariants similar to the Gromow – Witten ones, in a way that requires careful gluing of moduliu spaces according to rules that are dictated by a new concept, the "mass." In Liu's case, the symmetry was given by a S^1-action whose effect was to collapse the boundary of a moduli space so that new invariants could be defined.

The emerging theory of polyfolds, a whole new theory that would give the right framework to deal with lots of elliptic moduli spaces (i.e., spaces of solutions to certain underdetermined partial differential equations on curved spaces of arbitrary dimensions), due to Hofer – Wisocky – Zehnder were patiently explained by Katrin Wehrheim. Applications of symplectic field theory and contact homology were discussed in the talks of Bourgeois, Hind, Eliashberg as well as in those of Kerman and Ginzburg who described their novel way to detect periodic orbits of Hamiltonian flows by using a Floer theoretic construction which takes into account periodic orbits belonging to distinct homotopy classes (the so-called "Floer Branched Homology"). We also heard about more topological points of view concerning the space of Hamiltonian diffeomorphisms as in the talks of Anjos, McDuff, and Pinsonnault. Andrei Teleman and Paul Seidel both discussed topics closer to algebro-geometric problems relevant in symplectic topology.

The main support for this semester was provided by a LSI NSERC grant (whose coordinator is Steven Boyer). The CRM provided office spaces and computer capabilities as well as a seminar room and other administrative assistance. We were also helped by Ms. Diane Bélanger, the administrative assistant to the Mathematics Canada Research Chairs at Université de Montréal who kindly took care of the hotel reservations.

Montreal Scientific Computing Days

February 26 – 27, 2005, CRM
organized by the Applied Mathematics Laboratory

Organizers: Tony Humphries (McGill), Nilima Nigam (McGill), Robert Owens (Montréal)
Invited speakers: J. Gopalakrishnan (Florida), J. S. Hesthaven (Brown)
Number of participants: 101

The second edition of this annual event, was once again a great success, this year attracting 101 participants, mostly from Québec and Ontario, up from 78 participants last year. The objective of this conference is to encourage scientific exchange within the scientific computing community in Québec and further afield. The two-day program included two short courses offered by international experts, at a level accessible to advanced graduate students.

Jay Gopalakrishnan gave two long lectures on Multigrid methods, a class of numerical techniques to solve linear systems arising from discretization of PDEs using a hierarchy of discretization grids. These methods can often compute an approximate solution up to a given precision at asymptotically optimal computational cost. The optimal complexity of multigrid has brought within the reach of simulation many scientific problems previously thought to be of intractable size. The first lecture covered the fundamental theory and mechanics of multigrid methods, showing how it leads to optimal algorithms, and illustrating it on simple examples. The second lecture considered more complicated applications, highlighting examples from electromagnetics, and investigated the modifications needed to successfully apply the multigrid paradigm. The interplay between convergence theory of discretizations and convergence analysis of multigrid was emphasized, especially how one has led to improvements in the other.

Jan Hesthaven gave two long lectures on Discontinuous Galerkin methods for solving time-dependent PDEs. These discontinuous finite element methods, although proposed first more than three decades ago, have recently received considerable attention due to a number of very attractive properties, e.g., solid theoretical foundation, ability to work with high-order and adaptive grids, support for unstructured grids and very high performance on parallel computers. The first lecture covered the fundamental theory of these methods, discussing some key theoretical results, illustrated by illuminating ex-

amples. The second lecture focused on more applied aspects and how to develop and implement these methods for a variety of problems and applications.

Both lecturers gave superb and well appreciated presentations, and also made comprehensive notes available, Hesthaven even supplied a suite of software routines for implementing the Discontinuous Galerkin method. There were also 15 twenty-minute contributed talks, many by postdoctoral fellows and graduate students, who were especially encouraged to participate, and a pizza and poster session on Saturday evening.

Workshop on Bayesian Inference and Functional Brain Mapping

March 31 – April 2, 2005, CRM
organized by PhysNum and the Statistics Laboratory

Organizers: J.-F. Angers (Montréal), J.-M. Lina (ETS)
Speakers: A. Mohammad-Djafari (Supélec), C. Bouman (Purdue), C. Phillips (Liège), K. Worsley. (McGill), C. Grova (McGill), J. Daunizeau (Montréal)
Number of participants: 30

En choisissant d'ancrer l'analyse bayésienne dans le contexte de l'imagerie en neuroscience, les organisateurs avaient comme objectif de susciter l'intérêt des jeunes chercheurs quant aux avenues de recherche qui s'offrent aujourd'hui dans ce domaine extrêmement dynamique des biosciences. Les thèmes suivants ont été abordés :

- reconstruction d'images selon une approche bayésienne ;
- application des modèles de chaînes de Markov cachées à la modélisation des couleurs ;
- aspect calculatoire des problèmes inverses en imagerie biomédicale ;
- comparaison entre différentes méthodes de fusion d'information ;
- comparaison entre différents paradigmes d'estimation ;
- sélection de modèles pour les données en imagerie par résonance magnétique fonctionnelle ;
- estimation à la source pour les électroencéphalogrammes.

Ces sujets couvraient différents aspects des problèmes souvent rencontrés lors de la reconstruction d'images. Plusieurs méthodes d'estimation et de calculs ont été présentées.

Charles Bouman (Purdue) a fait le point sur les nouveaux imageurs optiques qui soulèvent aujourd'hui autant d'intérêt sur le plan des possibilités de « voir » l'activité cérébrale que de défis au niveau des méthodologies de reconstruction tomographique. La tomographie bayésienne a fait l'objet de l'exposé d'Ali Mohammad-Djafari (Supélec), spécialiste reconnu des questions de reconstruction à partir de données partielles et incomplètes. L'exposé de Keith Worsley (McGill) donnait un point de vue critique sur l'approche bayésienne en la remettant dans une perspective d'étude de groupe pour l'inférence robuste de l'activation cérébrale. Cet exposé complétait fort bien les deux présentations fouillées de Christophe Phillips (Liège) qui a su remettre en perspective les outils méthodologiques dans le contexte appliqué de l'imagerie cérébrale qui peut, aujourd'hui, profiter de la fusion de plusieurs types d'information. L'atelier a également donné l'occasion à de jeunes chercheurs de présenter leurs propres travaux. Christophe Grova (McGill) a ainsi présenté une méthodologie d'évaluation pour comparer les performances des estimateurs. Jean Daunizeau (Montréal) a donné une solution au problème de fusion multimodale qui permet de prendre en compte différentes sources d'information et François Destrempes (Montréal) a présenté un estimateur bayésien pour les modèles de champs de Markov cachés qui sont largement utilisés en imagerie mathématique.

Le format de cet atelier a permis d'établir un bon échange entre les différents conférenciers et les participants. Plusieurs étudiants ont pu aussi présenter leurs travaux et en discuter avec les chercheurs plus expérimentés dans ce domaine.

Workshop on Analysis and Computation of Lattice, Delay and Functional Differential Equations

April 25, 2005, McGill University
organized by the Applied Mathematics Laboratory

Organizer: Tony Humphries (McGill)
Invited speakers: D. Breda (Universita degli Studi di Udine), D. Pelinovsky (McMaster), P.-L. Buono (UOIT), B. Moore (McGill), T. Humphries (McGill), R. Wilds (McGill)
Number of participants: 18

This workshop focused on recent developments in the analysis and computation of lattice, de-

lay and functional differential equations, with particular emphasis on advanced-retarded differential delay equations which define travelling wave solutions to lattice differential equations, and related problems. It brought together researchers with theoretical, computational and applications interests. Topics covered included determining stability of solutions via pseudospectral approximation of characteristic values, bifurcations of travelling wave solutions in discrete NLS lattices, and unfolding of local bifurcations in equations modelling biological phenomena. Also covered were travelling waves and propagation failure in problems with inhomogeneous diffusion, as well as numerical computation of travelling waves in lattice differential equations including model problems and problem truncation.

Analysis Day

April 29, 2005, CRM
organized by the Mathematical Analysis Laboratory

Organizers: Thomas Ransford (Laval), Christiane Rousseau (Montréal), Alina Stancu (Montréal), Galia Dafni (Concordia), Dmitry Jakobson (McGill)
Speakers: T. Kaczynski (Sherbrooke), A. Kokotov (Concordia), F. Nazarov (Michigan State)
Number of participants: 27

Le laboratoire a commencé ses activités seulement en 2003-2004. Le programme scientifique de l'année 2003-2004 a été remarquable tant par sa qualité que par les rapprochements qu'il a permis entre des membres qui se connaissaient peu. Ce laboratoire est celui qui a le plus de membres. Ses membres sont dispersés dans toutes les universités québécoises, ce qui force différents sous-groupes à travailler en parallèle. Pour remédier à ce problème, nous avons commencé en 2004-2005 la tradition d'une journée d'analyse à laquelle seront conviés tous les membres. À court terme il n'y a pas lieu de faire venir beaucoup de conférenciers de l'extérieur mais plutôt de laisser la parole aux membres. Le format incluait des conférences d'une heure et des conférences d'une demi-heure, en évitant les conférences en parallèle.

Topics in Low-Dimensional Topology

May 16 – 17, 2005, UQÀM
organized by CIRGET

Organizers: Steven Boyer (UQÀM), Olivier Collin (UQÀM)
Number of participants: 15

Fifteen mathematicians and students participated in this two-day workshop held at UQÀM. Five of the six talks focused on the topology and geometry of 3-manifolds and one other on 4-dimensional topology. The two main themes were applications of geometric methods in 3-manifolds and the contact topology in dimension 3.

The speakers and their titles were:

- Joseph Masters (SUNY Buffalo), *Quasi-Fuchsian surfaces in hyperbolic knot-manifolds*
- Baptiste Chantraine, (UQÀM), *Isotopies lengendriennes et cobordismes lagrangiens*
- Xingru Zhang, (SUNY Buffalo), *Virtual fibring of Montesinos link complements*
- David Gay, (UQÀM), *Constructing singular Lefschetz pencils and fibrations*
- Olga Plamenevskaya, (MIT), *Khovanov homology, Heegaard Floer invariants, and contact structures*
- Michel Boileau, (Toulouse 3), *Finiteness of 3-manifolds and non-zero degree mappings*.

Analytic Number Theory Conference

May 19 – 21, Université Laval
organized by CICMA

Organizers: Jean-Marie De Koninck (Laval), Claude Levesque (Laval)
Speakers: C. Ballot (Caen), W. Banks (Missouri), J. Friedlander (Toronto), V. Garcia (Puerto Rico), A. Granville (Montréal), H. Kadiri (Montréal) , S. Louboutin (Luminy), F. Luca (Morelia), R. Murty (Kingston), C. Pomerance (Dartmouth), L. Szalay (Ouest-Hongrie)
Number of participants: 43

La conférence portait sur une grande variété de thèmes en théorie analytique des nombres, dont les fonctions arithmétiques, les séries de Dirichlet, les courbes elliptiques, la méthode du crible, les sommes de diviseurs, les problèmes du type Waring, les fonctions zêta de Dedekind, les équations de Pell simultanées, le théorème de Polya-Vinogradov, les petits intervalles contenant des premiers en progression arithmétique. Le principal objectif de cette rencontre

était la mise en commun de différents résultats d'actualité en théorie analytique des nombres.

Quatrième colloque francophone sur les sondages

May 24 – 27, 2005, Université Laval
Official Meeting of the Société Française de Statistique (SFdS), supported by the Statistics Laboratory

Chair of the scientific committee: Louis-Paul Rivest (Laval)
Chair of the organizing committee: Louise Bourque (ISQ)
Speakers: J. Domingo-Ferrer (Rovira i Cirgili de Tarragone, Catalogne), J. Baulne (ISQ), L. Des Groseillers (ISQ), E. Gagnon (ISQ), P. St-Cyr (Statistics Canada), R. Orok (Statistics Canada), P. Collomb (INED), M.-C. Tremblay (Environment Canada), S. Cotter (Office fédéral de la statistique, Suisse), P. Gauthier (Statistics Canada), F. Dupont (INSEE), E. Graf (Office fédéral de la statistique, Suisse), E. Rancourt (Statistics Canada), M. Thompson (Waterloo), A. Saïdi (Statistics Canada), C. Boudreau (Medical College of Wisconsin), N. Lavigne (Statistics Canada), R. Morrison (Statistics Canada), S. Giroux (Statistics Canada), M.-E. Tremblay (ISQ), N. Plante (ISQ) R. Courtemanche (ISQ), D. Joye (SIDOS), R. Silberman (LASMAS-CNRS), L. Bourque (ISQ), R. Barnabé (Statistics Canada), A. Davison (EPFL), C. Sårndal, J.-D. Opsomer (Iowa State), J.-F. Beaumont (Statistics Canada), P. Bernard (Montréal), D. Lievesley (UNESCO)
Number of participants: 240

L'organisation du Colloque de Québec a été assurée par l'Institut de la statistique du Québec (ISQ) et l'Université Laval, en collaboration avec Statistique Canada, l'Association des statisticiennes et statisticiens du Québec (ASSQ), la Société statistique du Canada (SSC), le Centre de recherches mathématiques et l'Association internationale des statisticiens d'enquête (de l'Institut international de statistique).

Plus de 240 participants, venant de l'Europe et des Amériques, ont participé à ce colloque qui a duré quatre jours. Deux ateliers portant sur des méthodes statistiques spécifiques à l'analyse de données d'enquête complexes ont été présentés le mardi 24 mai. Environ 75 participants ont pris part à ces ateliers. Le premier était animé par François Brisebois de Statistique Canada et portait sur l'analyse de données sur la santé, recueillies à l'aide d'enquêtes à plans complexes alors que le deuxième, était animé par Olivier Sautory de INSEE-CEPE et portait sur les procédures SAS d'échantillonnage et d'analyse de données d'enquête. Le colloque comme tel a débuté le mercredi 25 mai au matin par un exposé sur le rôle des méthodologistes dans la gestion de la qualité par Gordon Brackstone, président de l'association internationale des statisticiens d'enquêtes, une section de l'Institut international de la statistique. Une centaine de communications y ont été présentées, 70 libres et 30 sur invitation. La plénière de clôture, où M. et Mme Mizrahi de l'ARgSES dressaient un historique des enquêtes de santé en France, s'est terminée le vendredi 27 mai à 17h00.

Plusieurs séances ont porté sur des développements de statistique théoriques motivés par l'analyse de données d'enquête. Le bootstrap, le lissage et l'utilisation de modèles statistiques pour les données d'enquête y ont été abordés. Les enquêtes de santé ont également fait l'objet de nombreuses communications ; on y a traité du choix du mode de collecte, et de la pondération des données, entre autres. La plénière de clôture présentait un historique des enquêtes de santé en France. Des thèmes propres à la statistique officielle tels la gestion de la qualité, le recensement, l'utilisation de données administratives et le respect de la confidentialité des informations fournies par les répondants ont été traités dans de nombreuses sessions. Une séance sur l'accès, par les chercheurs, aux micros données confidentielles dans les pays francophones s'est terminée par une visite du laboratoire CIQSS-Laval où les chercheurs de l'université Laval ont accès aux données d'enquête de l'Institut de la statistique du Québec et de Statistique Canada.

Les organisateurs ont reçu de nombreux témoignages d'appréciation tant pour les aspects scientifiques qu'organisationnels du colloque. En effet, le programme scientifique chargé et fort relevé était accompagné d'un programme social fort intéressant. Quant aux conférences présentées dans le cadre du colloque, elles se retrouveront dans les actes qui seront publiés chez Dunod en 2006, assurant ainsi une pérennité à la recherche qui y a été présentée.

CRM-ISM Colloquium Series

The CRM, together with the Institut des sciences mathématiques (the Québec university graduate mathematics consortium), runs two Montréal colloquium series, one in mathematics and another in statistics (the latter jointly with GERAD). These series offer during the academic year survey talks by distinguished mathematicians and statisticians on topics of current interest.

CRM – ISM Mathematics Colloquium

Coordinators: Octavian Cornea (Montréal), Dmitry Jakobson (McGill).

April 22, 2005: Isadore Singer (MIT)
The Geometry of Twisted K-Theory

April 15, 2005: Kaleem Siddiqi (McGill)
Medial Integrals for Shape Analysis

April 8, 2005: Fabio Bagarello (Palermo)
Relations between Multi-Resolution Analysis and Quantum Mechanics: Applications to the Fractional Quantum Hall Effect

April 1, 2005: Mark Haiman (UC Berkeley)
Macdonald Polynomials

March 18, 2005: Alexander Its (IUPUI, Indianopolis)
On the Asymptotic Analysis of Toeplitz Determinants via the Riemann – Hilbert Method

March 11, 2005: Krystyna Kuperberg (Auburn)
Wild and 2-Wild Trajectories

March 4, 2005: Matt Gursky (Notre Dame)
Some Fully Nonlinear Equations in Geometry

February 18, 2005: Askold Khovanskii (Toronto)
Insolvability of Equations in Finite Terms

February 11, 2005: Steven Lu (UQÀM)
Positivity Theorems and the Structure of Compact Complex Manifolds

February 4, 2005: Stephan De Bièvre (Lille I)
Chaos quantique: au-delà du théorème de Schnirelman

January 28, 2005: David Bryant (McGill)
How can a Mathematician Cope with Phylogenetic Uncertainty?

January 21, 2005: Jozef Dodziuk (CUNY)
Elliptic Difference Operators on Graphs

January 14, 2005: Haynes Miller (MIT)
Elliptic Moduli in Algebraic Topology

January 7, 2005: Vladimir Remeslennikov (UQÀM) et Ilya Kazatchkov (Omsk)
Free Partially Commutative Groups

December 10, 2004: Vladimir Korepin (SUNY Stony Brook)
Quantum Correlations and Number Theory

December 3, 2004: Yuri Gurevich (Microsoft)
What is an Algorithm?

November 26, 2004: Bruce Reed (McGill)
Routed Routing and Graph Minors

November 19, 2004: Alejandro Adem (UBC)
Periodic Complexes and Group Actions

November 5, 2004: Claude Le Bris (ENPC)
Flots généralisés de solutions pour des équations différentielles déterministes et stochastiques à coefficients irréguliers

October 22, 2004: Jean-Pierre Gazeau (Paris VII)
États cohérents et quantification de systèmes simples

October 15, 2004: Stephanos Venakides (Duke)
The Nonlinear Analogues of the Fourier Transform, Steepest Descent and Eikonal Analysis

October 8, 2004: Ronald Fintushel (Michigan State)
Lagrangian Tori in 4-Manifolds

October 1, 2004: John Harnad (Concordia)
Random Matrices, Orthogonal Polynomials and Integrable Systems

September 24, 2004: Paul Schupp (Illinois, Urbana Champaign)
The Uniform Membership Problem, Foldings and Polynomial Time

September 17, 2004: Pengfei Guan (McGill)
Convexity of Solutions of Geometric Nonlinear Partial Differential Equations

CRM – ISM – GERAD Statistics Colloquium

Coordinators: Christian Léger (Montréal) *main-coordinator*, Pierre Duchesne (Montréal), Brenda MacGibbon (UQÀM), Arush Sen (Concordia), Russ Steele (McGill).

April 8, 2005: Hira Koul (Michigan State)
Goodness-of-Fit Testing in Interval Censoring Case 1

March 18, 2005: Jeffrey S. Rosenthal (Toronto)
Adaptive MCMC: A Java Applet's Perspective

March 11, 2005: Ricardas Zitikis, (Western Ontario)
Comparing Points in Multi-Dimensional Spaces, Even When They Are Random

March 4, 2005: Debbie Dupuis (HEC)
Ozone Concentrations: a Robust Analysis of Multivariate Extremes

February 25, 2005: Changbao Wu (Waterloo)
Empirical Likelihood Approach to Calibration with Survey Data

February 18, 2005: Edward L. Ionides (Michigan)
Infectious Diseases: Data Analysis via Continuous Time Population Models

February 11, 2005: Angelo J. Canty (Toronto)
Finding Differentially Expressed Genes from Affymetrix Microarray Data

February 4, 2005: Richard Cook (Waterloo)
Some Robust Methods for Studies Involving Recurrent Events

January 25, 2005: Hao Yu (Western Ontario)
Residual Processes of GARCH Models and Their Applications

December 3, 2004: Subhash Kochar (ISI)
Dependence Orderings for Order Statistics and Records

November 26, 2004: Weidong Tian (Waterloo)
Stochastic Volatility Models: A Large Deviation Approach

November 19, 2004: Linyuan Li (New Hampshire)
On the Minimax Optimality of Block Thresholded Wavelet Estimators with Long Memory Data

Novembere 12, 2004: Donald Dawson (Carleton et McGill)
2004 CRM-Fields Prize
Stochastic Dynamics of Evolving Populations

November 5, 2004: Christopher Field (Dalhousie)
Robustness Issues in Models for Molecular Evolution

October 29, 2004: Corinne Berzin (Grenoble II)
Théorèmes centraux limites pour des fonctionnelles non linéaires de processus gaussiens et applications

October 22, 2004: Randy Sitter (Simon Fraser)
2004 CRM-SSC Prize
Resampling in Complex Surveys

October 15, 2004: Qihe Tang (Concordia)
Asymptotic Ruin Probabilities in the Presence of Stochastic Returns on Investments

October 8, 2004: Adrian Raftery (Washington)
La prévision météorologique probabiliste

October 1, 2004: Xin Gao (York)
A Unified Nonparametric Approach for Unbalanced Factorial Design

September 24, 2004: David Haziza (Statistique Canada)
Approche par modèle de non-réponse pour l'inférence en présence de données imputées

September 17, 2004: Steven X. Wang (York)
Weighted Likelihood Estimation

Multidisciplinary and Industrial Program

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

Activities of the Multidisciplinary and Industrial Program

Workshop on Stochastic Networks
July 16 – 26, 2004, CRM

Organizers: Peter Glynn (Stanford), George Kesidis (Penn State), Donald A. Dawson (McGill), Raj Srinivasan (Saskatchewan)
Number of participants: 90

In July 2004, within the framework of its Multidisciplinary and Industrial Program, the CRM hosted a workshop on Stochastic Networks with three different activities. The Madison-style Stochastic Network Conference (SNC) included two satellite workshops. The two-day workshop on Economics of Communication Networks preceded the SNC, while the three-day Call Centre Workshop (CCW), partially funded by the Wharton Financial Institutions Center, was at the tail end of the SNC.

Workshop on Economics of Communication Networks
Organizer: George Kesidis (Penn State)

This workshop attracted some of the major figures who are working on increasingly important economic issues related to the theory of communication networking. In particular, two very interesting talks on the role of economic incentives for emerging peer-to-peer networks drew a great deal of discussion during the breaks. Lively discussions also broke out during several talks and participants expressed the value of the clarification of issues that was achieved in this sometimes confusing area where a diversity of issues need to be considered simultaneously. For example,

- the roles and mathematical definitions of "fairness" and how they might be interpreted as regulation in a communication network that is run more according to free market dynamics than in current practice;
- how security, pricing & billing, and quality-of-service may be interrelated.

Stochastic Networks Conference
Organizer: Peter Glynn (Stanford)

This meeting attracted the major figures who are contributing to the development of a mathematical theory for stochastic networks. A large portion of the talks related to various challenges that are arising in the wireless networks setting, where key issues include the spatial variation, bandwidth limitations, and the need to generate distributed control policies. The format of the conference, in which only four one hour talks were scheduled over each of the six days (with the exception of the Wednesday session, in which only three talks were scheduled), lent itself to an environment in which participants were able to pursue significant technical interactions. In spite of the lack of opportunity to give full contributed talks, the meeting attracted a significant number of attendees, in large part because it provided an opportunity for unhurried technical exchanges amongst all participants.

It should be noted that Alcatel provided financial support to the meeting, in recognition of the relevance of the research agenda to its core mission. A number of industrial participants attended the meeting. In addition, one of the major journals in the area, *Queuing systems: Theory and applications*, contacted the organizer subsequent to the meeting to request that a special invited issue, consisting of papers based on the talks given at the meeting, be put together. This special issue is being pursued, and publication is expected late in 2005. This journal's interest in pursuing such a special issue is a clear testimony to the quality of the talks offered as part of the Stochastic Networks Conference.

Call Center Workshop
Organizer: Raj Srinivasan (Saskastchewan)

To recognize the recent flurry of research activities in the call center area, the last day of the SNC was designated as a joint activity with the CCW. There were four talks on that day of the SNC, most of them being concentrated on staffing large call centres using fluid models. This joint activity was very well received by the eighty-two people in attendance. The CCW continued for another two days with twelve talks. There were twenty-eight to forty-two people in attendance for the two-day activity. The talks covered a wide range of topics including queu-

ing network with time varying rates, statistical analysis of call centres, workforce planning and profit maximization, revenue management through cross-selling and managing learning and turnover in employee staffing. The workshop also included a tutorial on call centers.

One of the highlight of the talks was the presentation from Chantal Gagné, the General Manager of Bell Canada Holdings, who discussed several challenges involved in the management of call centers at Bell Canada. In particular, she emphasized the difficulties facing the industry in forecasting call volume over the eighteen months planning horizon and training work force during that period. Active participation from the audience resulted in lively and productive discussions. Besides the annual two-day Call Center Forum run by the Wharton Financial Institutions Centre for their industrial participants, the CCW hosted by CRM is the first major workshop on call centres. Based on the feedback we have received from the participants, this workshop was a very successful one.

MITACS Biomedical Workshop

January 19 – 20, 2005, CRM
organised by MITACS

Organizers: Leon Glass (McGill), Michael Mackey (McGill), Jack Tuszynski (Alberta), David Ritscher (Medtronic), Jeffrey Saltzman (Merck), Colin Hill (Gene Network Sciences), Alain Vinet (Montréal), Gerda de Vries (Alberta), Kevin Hall (National Institutes of Health), Jianhong Wu (York), Thomas Hillen (Alberta)
Speakers: R. McInnes (Institute of Genetics), S. Bull (Toronto), A. Atoyan (Montréal), L. Greller (Biosystemix), M. Weiner (Biophan Technologies), J. Tuszynski (Alberta), J. Saltzman (Merck), C. Hill (Gene Network Sciences), K. Worsley (McGill)
Number of participants: 47

A number of MITACS research projects are currently involved in biomedical research with scientists and partners drawn from across Canada. Our experience from both research projects and networking activities demonstrates that there is considerable interest in this area among both industry and government organizations.

The main objectives of the workshop were: to bring together individuals from industry, government and academia who are interested in biomedical research; to share experiences from industry and government participants on key issues relating to medical devices and drug development, design, and testing; to establish future biomedical research priorities; and finally, to create new opportunities for research collaborations between industry, government and academia.

During this workshop, industrial, academic and governmental organizations discussed and identified keys research areas in the field of (but not limited to):

Drug development/design/testing

- design issues;
- use of signaling networks to aid in intelligent drug design;
- in vitro drug testing;
- diabetes drug design;
- analysis, interpretation and integration of biomedical data.

Medical devices

- techniques/devices for arrhythmia detection and treatment;
- analysis of medical imaging (mri, cat scan, pet, etc.);
- devices for the treatment of diabetes, e.g., programmable implanted pumps;
- analysis of gene chip data;
- analysis, interpretation and integration of biomedical data.

Furthermore, issues concerning public health were raised. For instance: device manufacturers, drug companies, large data collections from huge sets, lack of incentive from drug or device manufacturers to develop studies addressing issues.

Participants had the opportunity to share their academic interests and propose new collaborations. Also, various biomedical internship possibilities were proposed.

Launching of Aeronautics Cooperation CRM – CRIAQ – MITACS

January 20, 2005, Dorval

On January 2005, at the initiative of CRM and with the help of CIRANO's Director, the first exploratory day between mathematicians and the Canadian Aeronautical Industry was held at the Bombardier offices in Dorval. Presentations were given by the Advanced Research Director at Bombardier, Bombardier researchers, Pratt & Whitney representatives, MITACS Director and CEO, CRIAQ's president, and CRM director. Also present were Michel Delfour from CRM and Neil Stewart from DIRO (Montréal).

This event was held in preparation to the Toronto MITACS meeting on Aeronautics.

Workshop on Computational Biology in the Post-Genomics Era

March 19 – 20, 2005, CRM

Scientific committee: Sandrine Dudoit (UC Berkeley), Avner Friedman (Ohio State), Michael Hallet, (McGill), Leah Keshet (UBC), Mark Lewis (Alberta), Normand Mousseau (Montréal), John Nash (CNRC-ISB), Enrico Purisima (CNRC-IRB), Jamie Stafford (Toronto) and Rajmund L. Somorjai (CNRC-IBD)
Steering committee: Barbara Lee Keyfitz (director, Fields), Ivar Ekeland (director, PIMS), François Lalonde, (director, CRM), William Cowley (Senior Program Officer, NRC), Isabelle Blain (Vice-President, CRSNG)
Number of participants: 64

The origin of the workshop is the result of long-term discussions between NRC and the mathematics institutes, CRM, Fields and PIMS.

Firstly, the workshop was intended to explore possible joint research activities between the NRC labs and industry on the one hand and researchers in the Canadian universities, especially those who have developed specific mathematical expertise, on the other hand, on the general subject of computational biology (taken in a broad sense). Thus the workshop provided an opportunity to seek possible common research interests and complementary methods or points of view between the two milieux. The ultimate goal was to see whether or not there is a genuine interest in interacting at a scientific level The workshop provided an opportunity to learn about foreign experiences, especially in the US and in France, where there have been efforts to launch initiatives that have led to the emergence of a genuine "computational community."

A further purpose of the workshop was to broaden the scientific interaction between biologists and mathematicians, to address biologists' concern that their models are so simplistic that they will not be challenging to mathematics; whether mathematics can provide approaches to seemingly intractable problems of biology, and to provide direction to mathematicians about new domains that will need study.

The main scientific themes of the workshop were: biomedical data analysis, computational structural biology, proteomics and protein modeling and genomics analysis.

The topics discussed in the plenary session were: funding agencies, universities and the challenges of interdisciplinary research and the scientific collaborations between mathematicians and biologists. During the first session, the main themes were: the challenge of interdisciplinary research, what NSERC is doing and should do, the MITACS model and the US model.

Workshop on Latent Variable Models and Survey Data for Social and Health Sciences Research

May 4 – 6, 2005, CRM
NPCDS activity
sponsored by the CRM, the NPCDS, the SAMSI and Statistics Canada

Organizers: Mary Thompson (Waterloo), Chris Skinner (Southampton), Paul Biemer (UNC Chapel Hill), Jamie Stafford (Toronto), Milorad Kovacevic (Statistics Canada), Randy Sitter (Simon Fraser), David Bellhouse (Western Ontario), Roland Thomas (Carleton)
Speakers: H.Ariizumi (Wilfrid Laurier), T. Asparouhov (Muthen & Muthen), K.A. Bollen (UNC Chapel Hill), Brault, A. Carle (U.S. Census Bureau), K. Chantala (UNC Chapel Hill), S. Christ (UNC Chapel Hill), A. Cyr (Statistics Canada), A. Davies (Statistics Canada), M. Kovacevic (Statistics Canada), B. Meekins (Bureau of Labor Statistics), B. Muthén (UCLA), J. Olsen (Brigham Young), M. Paterson (Sherbrooke), S. Rabe-Hesketh (UC Berkeley), J.N.K. Rao (Carleton), G. Roberts (Statistics Canada), A. Sacker (University College London), C. Skinner (Southampton), A. Skrondal (London School of Economics), R.D. Wiggins (City University London)
Number of participants: 65

This workshop was part of the contribution of the National Program on Complex Data Structures (NPCDS) to the theme year on Latent Variable Models in the Social Sciences (LVMSS) of the Statistical and Applied Mathematical Sciences Institute (SAMSI) in North Carolina.

The program began with a tutorial by Anders Skrondal and Sophia Rabe-Hesketh based on their recent book, *Generalized latent variable modelling* (Chapman and Hall/CRC). The tutorial covered a great deal of ground, including a thorough introduction to the author's framework for latent variable models, and a variety of interesting applications. It was very valuable for both experts and novices.

The difficulties in adapting latent variable methods to complex survey data are perhaps best appreciated in the context of multi-level models, and Chris Skinner provided an excellent overview of progress to date in this area. Papers by Chantala and Suchindran and by Kovacevic and Huang provided further insights into the performance of currently available techniques.

Bengt Muthén and Tihomir Asparouhov introduced Mplus and demonstrated its efficiency and flexibility for latent variable models. The software is being developed in conjunction with leading edge research in social science methodology, and the complex survey project will make it even more useful. The discussions of the application papers were also greatly enhanced by the contributions of the Mplus team.

The workshop provided an opportunity for a review of the accomplishments of the SAMSI theme year on latent variable models, by its leader, Ken Bollen.

One gratifying feature of the workshop was the high quality of the presentations, and of the analyses put forward. It is very good for statisticians and social scientists each to see something of the best of what the other has to offer.

Spring School and Workshop on Mini-invasive Procedures in Medicine and Surgery: Mathematical and Numerical Challenges

May 16 – 27, 2005, CRM
sponsored by CRM, MITACS and INRIA

Scientific committee and organizers: Michel Delfour (Montréal), André Fortin (Laval), André Garon (École Polytechnique Montréal), Charles Peskin (Courant Inst.), Marc Thiriet (INRIA Rocquencourt)
Main speakers of the School: Charles Peskin (Courant Inst.), Marc Thiriet (INRIA Rocquencourt)
Speakers and animators of mini-workshops of the School: Miguel Fernandez (INRIA Rocquencourt), Julie Grant (École Polytechnique Montréal), Gérard Plante (Institut de Pharmacologie de Sherbrooke), Grégoire Malandain (INRIA Sophia-Antipolis), Catalin Fetita (Institut National des Télécommunications)
Invited speakers: Y. Bourgault (Ottawa), G.W. Burgreen (Mississippi State), L. Cohen (Paris-Dauphine), M. Delfour (Montréal), C.R. Ethier (Toronto Western Research Institute), C. Fetita (Institut National des Télécommunications), A. Fogelson (Utah), A. Fortin (Laval), A. Garon (École Polytechnique), R. Lohner (George Mason), G. Malandain (INRIA Sophia Antipolis), M. S. Olufsen (NC State), R. Owens (Montréal), J. Peirò (Imperial College London), M. Sorine (INRIA Rocquencourt), D. Steinman (Robarts Research Institute, London, ON), M. Thiriet (INRIA Rocquencourt), J. Urquiza (Montréal), K. Worsley (McGill), J.-P. Zolésio (INRIA, Sophia-Antipolis)
Number of participants: 58, including 18 students.

The object of this combined Spring School and Workshop was to bring together experts of international stature on several facets of mini-invasive procedures in medicine and surgery and to identify the underlying mathematical and computing challenges. The main themes of the workshop were:

- Biology and mechanics of blood flows;
- brain imaging and functions;
- cardiac pump;
- fluid-structure interactions;
- image-based computations;
- imaging, meshing and computing;
- image processing;
- immersed boundaries;
- medical devices;
- mathematical modeling and computer simulation of the circulation and the hearth;
- particle flows;
- wall transport.

This ambitious project resulted from a sustained and productive collaboration between Marc Thiriet (INRIA, France), André Garon (École Polytechnique, Canada) and Michel Delfour (CRM and DMS, Canada). The importance of such exchanges between France and Canada was recognized two years ago by INRIA which conferred the status of associated group to the researchers.

The initiative of holding a Spring School in the days preceding the Workshop proved to be a great success; student participation was excellent and exchanges were useful and animated. We had the privilege to have two exceptional principal speakers whose 12 talks were complementary. Charles Peskin (Courant Institute, New York) is one of the pioneers in the field of mathematical modeling and in the simulation of flows and the heart. He his also the father of "immersed boundaries" and of the first valve simulations. Marc Thiriet (member of CNRS, Laboratoire Jacques-Louis Lions, Université Pierre et Marie Curie), and principal investigator respon-

sible for the REO project at INRIA, Rocquencourt, France), is a pneumologist by training as well as a mechanical engineer specializing in fluids. He was a tremendous driving force during the school, thanks to, in particular, an extraordinarily encyclopedic book of more than 300 pages titled "Biology and mechanics of blood flows" which was given in pre-publication to all participants. This work will be published by Springer. The theme of his lectures was "From input data (biologic, medical, physical, rheological) to blood flow numerical simulations."

These two series of principal lectures of the school were completed by three afternoons of thematic mini-workshops. Miguel Fernandez (INRIA, Rocquencourt, Projet REO) animated the one on "Numerical simulations of the fluid-structure coupling in physiological vessels." Dr. Gérard Plante (Institut de Pharmacologie de Sherbrooke) and Julie Grant (École Polytechnique, Montréal) conducted the second one on "Molecule transport in vessel walls and blood flows." Finally, Grégoire Malandain (INRIA Sophia-Antipolis, Projet Epidaure) and Catalin Fetita (Institut National des Télécommunications, Projets Artemis) lead the one on "Medical image processing: from vessel wall extration to surface mesh production."

The main workshop of the second week brought together world-renowned specialists around nine of the major themes of the activity. It was a privileged meeting ground for the American, Canadian and French team, in a very casual *Québécois* ambiance. The participation was sustained until the very last session on Friday. Students interested to give a talk gave their presentations on Wednesday afternoon and at the end of the other days.

Finally, the organizers would like to tank CRM, INRIA and MITACS for their financial assistance.

CRM Prizes

CRM – Fields Prize 2005 awarded to David W. Boyd

David Boyd, this year's recipient, is one of Canada's leading number theorists. He has made seminal contributions to analytic number theory, noteworthy among which are his explorations of the deep connections between the Mahler measure of polynomials and special values of their associated L-functions.

Professor Boyd received his B.Sc. from Carleton University in 1963, and his M.A. and Ph.D. from the University of Toronto in 1964 and 1966. He has taught at the University of Alberta and the California Institute of Technology, and has been at UBC since 1971 where he is currently Full Professor. He is a winner of the E.W.R. Steacie Prize, a Fellow of the Royal Society of Canada, and has won both the Canadian Mathematical Society's Coxeter – James and Jeffery – Williams Prize lectures. His service to the Canadian mathematical community includes terms as vice-president of the Canadian Mathematical Society, chair of the NSERC Mathematics grant selection committee, and Acting Director of the Pacific Institute for the Mathematical Sciences. The recipient outlines the main themes of his research in *Le Bulletin du CRM*, vol. 11, n^o 1, pp. 14 – 15.

The CRM – Fields Prize

The Centre de recherches mathématiques and The Fields Institute established the CRM-Fields prize in 1994 to recognize exceptional research in the mathematical sciences. The recipient is chosen by a selection committee made up of members of the Advisory Committee of the CRM and the Scientific Advisory Panel of the Fields Institute.

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), Edwin Perkins (2003), John McKay (2003), and Donald A. Dawson (2004).

André Aisenstadt Prize 2005 awarded to Ravi Vakil

The 2005 André-Aisenstadt Prize was awarded to Ravi Vakil of Stanford University. After completing his B.Sc. and M.Sc. at the University of Toronto in 1992, Dr. Vakil obtained his Ph.D. from Harvard University in 1997 under the supervision of Joe Harris. Dr. Vakil then spent a year as a postdoctoral fellow at Princeton University, and three years at MIT as a C.L.E. Moore Instructor, before becoming an Assistant Professor at Stanford in 2001.

Dr. Vakil works in algebraic geometry, investigating the enumerative geometry of projective algebraic curves. His most spectacular work has been done in the last years, in his study of degenerations in a Grassmannian, to solve several old problems in Schubert calculus. One of his conclusions is that all Schubert problems are enumerative over the real numbers. This has been a major goal in the area of real enumerative geometry for at least two decades, and Dr. Vakil has given a complete solution.

The exceptional work of Ravi Vakil was recognized by several prizes and honors, including a NSF Career Fellowship, a Sloan Research Fellowship, a Centennial Fellowship and a G. de B. Robinson Prize. The Prize was awarded to Dr. Ravi Vakil at a ceremony held on April 29, 2005 at the CRM. The recipient's research description can be found in *Le Bulletin du CRM*, vol. 11, no 1, pp. 2 – 3.

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 CRM's advisory committee. At the time of considera-

tion, 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-Aisensadt 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), and Vinayak Vatsal (2004).

CAP – CRM Prize 2005 awarded to Robert C. Myers

The Canadian Association of Physicists (CAP) and the Centre de recherches mathématiques (CRM) were very pleased to announce that the 2005 CAP – CRM Prize in Theoretical and Mathematical Physics was awarded to Professor Robert C. Myers of the Perimeter Institute in Waterloo for his outstanding contributions to theoretical physics, ranging from aspects in gravitational physics to foundational aspects of string theory.

After a B.Sc. in Applied Physics in Waterloo in 1982, Robert Myers went to Princeton University where he completed a M.Sc. (1983) and a Ph.D. (1986) under the supervision of Professor M.J. Perry. He then held a postdoctoral position at the Institute for Theoretical Physics of the University of Santa Barbara, and he joined McGill University in 1989, where he became a Full Professor in 2000. Since 2001, he is a Long-Term Researcher at the new Perimeter Institute for Theoretical Physics, and also holds a cross-appointment as a Full Professor in the Physics Department at the University of Waterloo.

Robert Myers has played a pivotal role in the development of string theory and is one of its most broad and creative researchers. We highlight here some of his contributions, which have had a tremendous impact in theoretical physics.

His work in the 1980s (some in collaboration with M. Perry) generalized the standard four-dimensional rotating black hole solution in general relativity to higher dimensions. These metrics have been the starting point for a number of recent constructions of brane solutions in string theory. His work on non-critical string theory shed profound new insights into the dimensionality of space-time in string theory, by showing that the string theory made sense in dimensions other than the critical dimension originally envisioned.

His 1999 paper on the dielectric effect for branes, known in the community as the Myers effect, has been highly influential. Guided by duality, he constructed a consistent action for branes moving in a background field, and thereby discovered the Myers effect which describes how in the presence of background fields, a stack of branes will become polarized and spread out. This deep insight has in turn inspired a number of important contributions by some of the leading researchers in string theory and quantum gravity.

His very recent work also include significant and exciting contributions in a number of different areas. With his collaborators, Robert Myers has found new constructions of cosmic strings that can have a profound consequences in finding experimental support for string theory. This work is one of the few genuine "stringy" predictions that have come out of string theory, and opens up the exciting possibility of testing string theory by making astronomical observations.

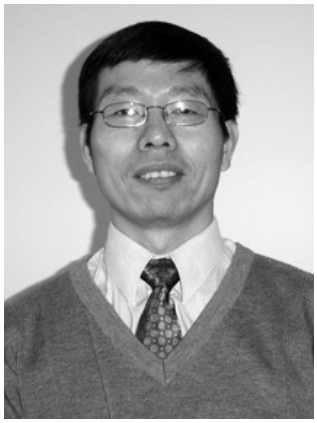
The high quality of the research of Professor Myers has been recognized by several prestigious research awards, such as the CAP's Herzberg Medal, and the first award in the Gravity Research Foundation Essay Contest (that he won twice). The 2005 CAP – CRM Prize was awarded to Professor Myers at the Annual Congress of the CAP held in June 2005 at Vancouver.

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 in recognition of exceptional achievements in theoretical and mathematical physics. The prize consists of a $2,000 award and a medal.

Previous winners were 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) and Jiří Patera (2004).

CRM – SSC Prize 2005 awarded to Jiahua Chen



The CRM – SSC Prize in Statistics has been awarded this year to Dr. Jiahua Chen (Professor, Department of Statistics and Actuarial Science, University of Waterloo) for his outstanding contributions to the statistical sciences. Within 15 years of his Ph.D. he has made major sustained contributions to three areas: design of experiments, inference for mixtures and survey methodology. Professor Chen blends powerful mathematical ability with keen insight into what is important statistically. His work combines deep theory and practical methodology for dealing with difficult issues.

Apart from his three main research areas, Jiahua Chen has made notable contributions to many other areas including fish surveys, empirical likelihood, fractal images, genetics and robust estimation. Professor Chen applies strong technical and mathematical skill with a remarkable aptitude for handling important and practical problems. He has published extensively in the *Journal of the Royal Statistical Society*, *Biometrika*, the *Journal of the American Statistical Association*, the *Annals of Statistics*, *Biometrics*, *Statistica Sinica*, the *Canadian Journal of Statistics* and other influential journals.

Jiahua Chen has also made important professional contributions as Associate Editor of the *Canadian Journal of Statistics* and of *Quality Technology and Quantitative Management*, and as a member of the Statistical Sciences Grant Selection Committee of the Natural Sciences and Engineering Research Council. He has been dedicated in his service to his department, in particular as Associate Chair for Graduate Studies. He was elected President of the International Chinese Statistical Association in 2005. This prize announcement was made at University of Saskatchewan in Saskatoon, site of this year's Annual SSC Meeting. The recipient outlines the main themes of his research in *Le Bulletin du CRM*, vol. 11 no 1, pp. 12 – 13.

The CRM – SSC Prize

The Statistical Society of Canada, 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. Jiahau Chen is the seventh recipient of the CRM – SSC Prize.

Previous winners of the award were Christian Genest (1999), Robert J. Tibshirani (2000), Colleen D. Cutler (2001), Larry A. Wasserman (2002), Charmaine B. Dean (2003) and Randy Sitter (2004).

CRM Partnership

THE CRM is strongly committed to its national mission and takes measures to ensure that the largest possible number of scientists across Canada benefits 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 at all important forums where the future directions of the Canadian mathematical sciences are discussed; it urges its organizers to make efforts to ensure the participation of the Canadian specialists 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), and other societies as well with other institute 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 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 has been the Mathematics of Information Technology and Complex Systems (MITACS).

Other initiatives involved these institutes, such as the CRM–Fields prize awarded in recognition of outstanding accomplishments in the mathematical sciences in Canada. It was created in 1994 and starting in 2006 will become the CRM–Fields–PIMS prize. The administrative responsibility for this prize will alternate each year between the three institutes.

International Collaboration

In 2004–2005, on the international scene, the CRM collaborated or received financial assistance from the National Science Foundation (NSF), the Banff International Research Station (BIRS), INSERM in Paris, the Statistical and Applied Mathematical Sciences Institute (SAMSI), the Institute of Electrical and Electronics Engineers (IEEE), Alcatel, and the Institute for Mathematics and its Application (IMA).

In its publishing activities, the CRM is continuing its partnership with the American Mathematical Society (AMS), in particular with its two series of joint publications, the *CRM Monograph Series* and the *CRM Proceedings and Lecture Notes*. It also has two series with Springer, in statistics and in mathematical physics. The CRM has exchange agreements with the Fields Institute, PIMS, MSRI (Mathematical Sciences Research Institute), the Institute for Mathematics and its Applications, École Normale Supérieure (France), the Isaac Newton Institute, the Institut des Hautes Études Scientifiques (IHÉS, France), and the Banff International Research Station.

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. CRM also financially supports a number of initiatives of the CMS, such as the mathematical camps, the Canadian Mathematics Education Forum, as well as the travel grant program for students who attended the joint Canada-France meeting in Toulouse in 2004. 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, with CAP, it awards a prize each year in mathematical and theoretical physics. Moreover, the CRM hosted the 2004 Annual Meeting of the SSC.

The Mathematics of Information Technology and Complex systems (MITACS)

MITACS began as a vision of the three Canadian mathematical sciences institutes. They envisioned a pan-Canadian network of projects each focused on using sophisticated mathematical tools for modeling 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 underway.

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 highly mathematically skilled personnel that is vital to Canada's future social and economic well being.

MITACS networks 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 and communication;
- networks and security.

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

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 analysis of complex data sets, and to establish a framework for 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

NPCDS/SAMSI Workshop on the Design and Analysis of Computer Experiments for Complex Systems
Banff, Alberta, July 13–17, 2004
Organizers: Jim Berger (Duke, SAMSI), Derek Bingham (Simon Fraser), Randy Sitter (Simon Fraser), Jamie Stafford (Toronto, NPCDS), Will Welch (UBC)

Workshop on Missing Data Problems
Fields Institute, Toronto, August 5-6, 2004
Organizers: Richard Cook, Don McLeish (Waterloo)

Workshop on Data Mining Methodology and Applications
Fields Institute, Toronto, October 28-30, 2004
Organizers: Hugh Chipman (Acadia), Antonio Ciampi (McGill), Michael Vainder (Generation 5)

Workshop on Latent Variable Models and Survey Data for Social and Health Sciences Research
CRM, May 4–6, 2005
Organizers: Mary Thompson (Waterloo), Chris Skinner (Southampton), Paul Biemer (UNC Chapel Hill), Jamie Stafford (Toronto), Milorad Kovacevic (Statistics Canada), Randy Sitter (Simon Fraser), David Bellhouse (Western Ontario), Roland Thomas (Carleton). A description of this activity can be found in page 33

Workshop on Forest Fires and Point Processes
Fields Institute, Toronto, May 24–28, 2005
Organizers: W. John Braun (UWO), David Martel (Toronto), Rick Schoenberg (UCLA)

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 Research in the Mathematical Sciences as well as Acadia University, Dalhousie University, Memorial University, and the University of New Brunswick (Fredericton) for providing funding for its activities.

AARMS Scientific activities

CMS/CAIMS Summer 2004 Meeting
Dalhousie University, June 13–15, 2004
Sessions organized by AARMS:

- Algebraic Topology
  Organizers: Keith Johnson (Dalhousie), Renzo Piccinini (Milano)
- Graphs, Games and the Web
  Organizer: Richard Nowakowski (Dalhousie)
- Nonlinear Dynamics in Biology and Medicine
  Organizer: Shigui Ruan (Dalhousie and Miami)
- Hopf Algebras and Related Topics
  Organizers: Yuri Bahturin (Memorial), Margaret Beattie (Mount Allison), Luzius Grunenfelder (Dalhousie), Susan Montgomery (Southern California), Earl Taft (Rutgers)
- 16th Canadian Symposium on Fluid
  Organizers: Richard Karsten (Acadia), Serpil Kocabiyik (Memorial)

AARMS Workshop on Symbolic Computation
Dalhousie, June 16, 2004
Organizers: Alan Coley (Dalhousie), Robert Milson (Dalhousie), Mark Fels (Utah State)

International Conference on Nielsen Theory and Related Topics
Memorial University of Newfoundland, June 28–July 2, 2004
Organizers: Philip Heath (Memorial), Edward Keppelmann (Nevada)

International Conference on Nonlinear Dynamics and Evolution Equations
Memorial University of Newfoundland, July 6–10, 2004.
Organizers: Andy Foster (Memorial), Brian Sleeman (Leeds), Jianhong Wu (York), Yuan Yuan (Memorial), Xiaoqiang Zhao (Memorial), Xingfu Zou (Memorial)

2004 AARMS Summer School
Memorial University of Newfoundland, July 12–August 16, 2004
Director: Edgar Goodaire (Memorial)

APICS 2004: AARMS Symposium on Functional Analysis and Operator Algebra
University of New Brunswick, Saint John, October 17, 2004
Organizers: Dan Kucerovsky (UNB Fredericton), Andrew Toms (UNB Fredericton)

East Coast Combinatorics Conference 2005
Lord Beaverbrook Hotel, Fredericton, January 22, 2005
Organizers: David Bremner (UNB Fredericton), Hugh Tomas (UNB Fredericton)

Quantum Gravity Workshop
University of New Brunswick, Fredericton, April 28–30, 2005
Organisateurs: Arundhati Dasgupta (UNB Fredericton), Jack Gegenberg (UNB Fredericton), Viqar Husain (UNB Fredericton)

Academic Partners

All this activity rests on a solid base 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 release 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 theme program, the CRM has also been arranging 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, Université de Québec à Montréal, Concordia University, and Université Laval as well as grants from Fonds de recherche québécois sur la nature et les technologies (FQRNT) of Québec and of NSERC, CRM finances the activities of the eight laboratories representing the most active branches of the mathematical sciences. These laboratories are the scene of scientific vitality par excellence and serve to feed the national and international scientific programs of the CRM. Please refer to the chapter "Research Laboratories" for reports describing the activities of each of these laboratory.

Association with University of Ottawa

In 2003, the Department of Mathematics and Statistics became a member of the Centre de recherches mathématiques (CRM). In partnership with the University of Ottawa, the CRM co-finances postdoctoral fellowships, a series of CRM–University of Ottawa conferences and teaching releases so that University of Ottawa faculty members can undertake research collaborations with colleagues in the CRM's laboratories or to participate in CRM scientific activities.

The following research conferences, workshops, and mini conferences were made possible through sponsorship by 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.
September 10, 2004: Barbara Lee Keyfitz (Houston)
Why Are Multidimensional Conservation Laws So Difficult?

Lie Theory Workshop
March 5–6, 2005,
Organizers: Erhard Neher (Ottawa), Wulf Rossmann (Ottawa)

Network for Computing and Mathematical Modeling (ncm_2)

The CRM is one of founding members the the Network for Computing and Mathematical Modeling, ncm_2, a collaboration which allows the network to respond to the needs of industry in a large number of fields related to a common area of computing and mathematical modeling, mostly around five major themes: risk management, information processing, imaging and parallel computing, transport and telecommunications, health and electronic commerce.

The five centres that established the network were the CRM, the Centre de recherche en calcul appliqué (CERCA), the Center for Interuniversity Research and Analysis on Organizations (CIRANO), the Center for Research on Transportation (CRT), and the Group for Research in Decision Analysis (GERAD). Since then, three new members 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 the ncm_2's Laboratoires universitaires Bell, part of a joint project between the ncm_2 and Bell. The laboratories aim at creating innovations in the field of multimedia research and applications (mainly interactive applications aimed at the general public, electronic commerce applications and new generations of evolved networks) as well as

at promoting the training of a highly qualified, international calibre workforce in these areas.

Neuro-imaging initiative in Québec (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 was formalized with the constitution 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 through a very large grant ($11M). One of the strongest alliances of CRM within that network is its association with the INSERM laboratory for brain-imaging at Jussieu–La Salpêtrière, Paris (director: Habib Benali).

Joint Initiatives

The annual meetings of the CMS, SSC and CAIMS, together with some of their training and promotion activities, are jointly sponsored by the CRM, the Fields Institute, the PIMS and MITACS. *The reports of these activities are presented in the language in which they were submitted*.

Annual Meeting of the Statistical Society of Canada

May 30 to June 2, 2004, CRM, Université de Montréal
Organizers: Program Committee Chair, Christian Genest (Laval); Local Arrangements Chair, Christian Léger (Montréal)

The thirty-second annual meeting of the Statistical Society of Canada was hosted by the Université de Montréal and the Centre de recherches mathématiques. Over 550 registrants participated in the meeting, which featured a wide range of sessions, including workshops of three SSC sections: biostatistics, survey methods, and business and industrial statistics.

The meeting was sponsored by the Centre de recherches mathématiques, the Fields Institute, PIMS, MITACS, Hydro Québec, the Université de Montréal, Pfizer, Bell University Laboratories, and the Institut de la statistique du Québec.

The scientific program was extremely rich with 109 invited papers and 142 contributed papers. Among the invited papers, the following addresses are especially noteworthy.

Presidential Invited Address
Kathryn Roeder (Carnegie Mellon)
Discovering haplotype blocks in the human genome

Gold Medal Address
Mary Thompson (Waterloo)
Understanding associations: implications for the design and analysis of longitudinal surveys

Special Invited Addresses of the Sections

- Raymond Chambers (Southampton)
  Informative sampling and sampling information.
- Daryl Pregibon (Google, Inc.)
  Graph Mining
- Richard Simon (US National Cancer Institute)
  Key features in the design and analysis of DNA microarray studies

Pierre Robillard Award Address (Best Thesis):
Rachel MacKay Altman (Washington)
Hidden Markov Models: Multiple Processes and Model Selection

Canadian Journal of Statistics Award Address:
Belkacem Abdous (Laval), Kilani Ghoudi (United Arab Emirates), Bruno Rémillard (HEC Montréal)
Nonparametric Weighted Symmetry Tests

CMS/CAIMS Summer 2004 Meeting

June 13–15, 2004, Dalhousie University
Meeting Directors: Richard Wood (Dalhousie), Raymond Spiteri (Dalhousie)

The CMS/CAIMS Summer 2004 Meeting was held at Dalhousie University on June 13–15, 2004, and welcomed 432 participants. The Public Lecture, entitled "Getting at the truth," was given by Ed Barbeau on June 14 and was very well attended.

Other special events included plenary talks delivered by: Peter Cameron (Queen Mary), Craig Fraser (Toronto), Mark Lewis (Alberta), Alan C. Newell (Arizona/Warwick), Peter Olver (Minnesota), Frank T. Smith (University College London), Mikhail Zaicev (Moscow State)

The Canadian Mathematical Society was pleased to present lectures from their research

prize winners, specifically the CMS Jeffery-Williams Lecture, given by Joel Feldman (UBC), and Leo Jonker (Queen's), who received the first CMS Excellence in Teaching Award. The CAIMS Research Prize Lecture was given by Robert D. Russell (Simon Fraser) and the CAIMS Cecil Graham Doctoral Dissertation Award Lecture was given by Ramadan Akila (Guelph).

A wide variety of fields of interest were represented in the symposia topics detailed below. Most of these are fields that are well represented by researchers in Atlantic Canada:

16th Canadian Symposium on Fluid Dynamics
Organizers: Richard Karsten (Acadia), Serpil Kocabiyik (Memorial)

Applications of Invariant Theory to Differential Geometry
Organizers: Robert Milson (Dalhousie), Mark Fels (Utah State)

Classical Analysis in honour of David Borwein's 80th Birthday
Organizers: Jonathan Borwein (Dalhousie), Mike Overton (Courant Inst.)

Dynamical Systems
Organizer: Michael A. Radin (Rochester Institute of Technology)

Financial Mathematics
Organizers: Joe Campolieti (Wilfrid Laurier), David Vaughan (Wilfrid Laurier), Yongzeng Lai, (Wilfrid Laurier)

General Topology and Topological Algebra
Organizers: Ilijas Farah (York), Vladimir Pestov (Ottawa)

Graphs, Games and the Web
Organizers: Anthony Bonato (Wilfrid Laurier), Jeannette Janssen (Dalhousie), Richard Nowakowski (Dalhousie)

History of Mathematics
Organizer: Thomas Archibald (Acadia)

Hopf Algebras and Related Topics
Organizers: Yuri Bahturin (Memorial), Margaret Beattie (Mount Allison), Luzius Grunenfelder (Dalhousie), Susan Montgomery (Southern California), Earl Taft (Rutgers)

Mathematical Education
Organizers: Richard Hoshino (Dalhousie), John Grant McLoughlin (UNB Frederecton)

Nonlinear Dynamics in Biology and Medicine
Organizer: Shigui Ruan (Dalhousie)

Numerical Algorithms for Differential Equations and Dynamical Systems
Organizer: Tony Humphries (McGill)

Qualitative Behaviour and Controllability of Partial Differential Equations
Organizer: Holger Teismann (Acadia)

Topology
Organizers: Keith Johnson (Dalhousie), Renzo Piccinini (Milano)

Topos Theory
Organizer: Myles Tierney (Rutgers and UQÀM)

The NExTMAC Workshop was organized separately from the meeting and took place on June 12, 2004.

The Meeting Committee would like to acknowledge with much thanks the financial support of the following: Atlantic Association for Research in the Mathematical Sciences, le Centre de Recherches Mathématiques, the Fields Institute for Research in Mathematical Sciences, Mathematics of Information Technology and Complex Systems, Pacific Institute for the Mathematical Sciences, Acadia University, Dalhousie University, Memorial University of Newfoundland, Mount Allison University, Saint Mary's University, Maplesoft, Springer, Unisys Canada Inc.

Toulouse 2004 : First Joint Canada-France Meeting of the Mathematical Sciences

July 12–15, 2004, Centre de congrès Pierre Baudis, Toulouse
Scientific Director: Francis Clarke (Lyon I)

The first Canada-France congress involved the three Canadian societies: CMS, CAIMS, SSC, and their French counterparts: SMF, SMAI and SFdS. Four hundred and thirty delegates registered with a significant number of students and postdoctoral fellows. Several lectures were given in French.

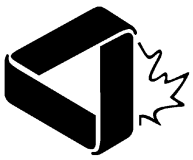
The plenary lectures were given by Laurent Lafforgue (IHES), Grégoire Allaire (École Polytechnique Palaiseau), Maïtine Bergounioux (Orléans), Jonathan Borwein (Dalhousie), David Brillinger (UC Berkeley), Walter Craig (McMaster), Henri Darmon (McGill), Emmanuel Giroux (ENS-Lyon), Gabor Lugosi (Pompeu Fabra), Mikhail Lyubich (Toronto), Christophe Reutenauer (UQÀM), Alain-Sol Sznitman (ETH

Zürich), Murad Taqqu (Boston) and Henry Wolkowicz (Waterloo). Michèle Artigue (Paris VII) gave the education lecture.

There were 16 special sessions: Operator algebras, Symplectic topology and geometry, Number theory, Spectral and geometric analysis, Partial differential equations, Dynamical systems, Differential Equations and Control, Variational Analysis and optimization, Stochastic Analysis, Multifractals and long memory processes, the Probability/Statistics interface, Statistical analysis of functional data, Numerical analysis, Low dimensional topology and geometrical group theory, Mathematical biology, Complex dynamical systems. Eric Muller (Brock) organized a panel on the popularization of mathematics. Discussions are under way for a second Canada-France meeting to be held in the summer of 2008 in Montreal.

CMS Winter 2004 Meeting

December 11–13, 2004, McGill University
Meeting Director: Olga Kharlampovich (McGill)



The Meeting welcomed 450 participants. Following the usual format of the CMS Winter Meeting, the program included a wide variety of sessions, a contributed paper session, plenary and prize lectures, and a public lecture. Most activities and all scientific talks were held at the Hilton Bonaventure Hotel. The meeting began with Alexei G. Myasnikov (McGill) delivering a public lecture entitled, "Complexity of Computations and Cryptography." The event, held at the Best Western Hotel Europa, drew a large audience and was followed by a welcoming reception.

Plenary talks were delivered by: Michael Bennett (UBC), Persi Diaconis (Stanford), Rostislav Grigorchuk (Texas A&M), François Lalonde (Montréal) and Rainer Steinwandt (Karlsruhe).

The Canadian Mathematical Society was pleased to present lectures from their research prize winners, namely, the CMS Coxeter-James Prize Lecture, given by Izabella Laba (UBC), the CMS Doctoral Prize Lecture, given by Nicolaas Spronk (Waterloo) and the CMS Adrien Pouliot Prize lecture, given by Jean-Marie De Koninck (Laval).

A wide variety of fields of interest were represented in the symposia topics detailed below.

Algebraic Combinatorics
Organizers: François Bergeron (UQÀM), Riccardo Biagioli (UQÀM), Peter McNamara (UQÀM), Christophe Reutenauer (UQÀM)

Approximation Theory
Organizers: Richard Fournier (Dawson), Paul Gauthier (Montréal)

Arithmetic Geometry
Organizers: Eyal Goren (McGill), Adrian Iovita (Concordia)

Combinatorial and Geometric Group Theory
Organizers: Inna Bumagin (Carleton), Dani Wise, (McGill)

Commutative Algebra
Organizers: Sara Faridi (Ottawa), Sindi Sabourin (York), Will Traves (US Naval Academy), Adam van Tuyl (Lakehead)

Discrete Geometry
Organizers: Karoly Bezdek (Calgary), Rob Calderbank (Princeton), Robert Connelly (Cornell), Bob Erdahl (Queen's)

Dynamical Systems and Applications
Organizer: Michael A. Radin (Rochester Institute of Technology)

Groups, Equations, Non-commutative Algebraic Geometry
Organizers: Olga Kharlampovich (McGill), Alexei G. Myasnikov (McGill)

Harmonic Analysis
Organizer: Galia Dafni (Concordia)

History of Mathematics
Organizers: Thomas Archibald (Acadia), Rich O'Lander (St. John's), Ron Sklar (St. John's), Alexei Volkov (UQÀM)

Interactions between Algebra and Computer Science
Organizers: Olga Kharlampovich (McGill), Alexei G. Myasnikov (McGill), Vladimir Shpilrain (CUNY-City College)

Mathematical Methods in Statistics
Organizers: Russell Steele (McGill), Alain Vandal (McGill), David Wolfson (McGill)

Mathematics for Future Teachers
Organizer: Leo Jonker (Queen's)

Number Theory
Organizers: Chantal David (Concordia), Andrew Granville (Montréal)

Special Structures in Differential Geometry
Organizers: Gordon Craig (Bishop's), Spiro Karigiannis (McMaster)

Universal Algebra and Complexity
Organizers: Jennifer Hyndman (UNBC), Benoit Larose (Concordia), Denis Therien (McGill)

Contributed papers session was organized by William G. Brown (McGill)

The Meeting Committee would like to acknowledge with much thanks the financial support of the following: McGill University Provost, McGill University Dean of Science, McGill University Department of Mathematics and Statistics, Centre de recherches mathématiques (CRM), CRM Analysis Laboratory, Fields Institute, MITACS and Pacific Institute for the Mathematical Sciences.

Mathematical Education

IN its mission to promote and stimulate research in the mathematical sciences, at all levels, the CRM provides funding and support for many activities and programs related to mathematical education and researcher training. Many of these activities and programs are coordinated jointly with the ISM (Institut des sciences mathématiques). *The ISM text that follows was only available in French.*

Institut des sciences mathématiques (ISM)

Fondé en 1991 par les départements de mathématiques et de statistique des quatre universités montréalaises, l'Institut des sciences mathématiques est un consortium des six universités québécoises (Concordia, Laval, McGill, l'Université de Montréal, l'UQÀMet l'Université de Sherbrooke) qui offrent un programme de doctorat en mathématiques. S'appuyant sur l'ensemble des chercheurs universitaires québécois travaillant en sciences mathématiques, il coordonne un grand nombre de ressources, aussi bien matérielles qu'intellectuelles, pour atteindre la masse critique qui fait de Montréal et du Québec un pôle nord-américain de formation et de recherche en sciences mathématiques. L'Institut est financé par le ministère de l'Éducation du Québec et par les six universités membres.

Voici un aperçu des activités et programmes de l'ISM :

- **Coordination et harmonisation des programmes d'étude de 2^{e} et 3^{e} cycles**
  C'est la principale raison d'être de l'ISM, qui vise à réunir les forces de ses départements membres pour en faire une grande école de mathématiques. Ainsi, l'Institut coordonne les programmes d'étude de 2^{e} et 3^{e} cycles des universités membres et favorise la mise en commun des expertises des chercheurs ainsi que la circulation interuniversitaire des étudiants.
- **Bourses d'excellence et soutien financier**
  L'ISM offre aux étudiants et jeunes chercheurs divers moyens matériels de poursuivre leurs recherches dans les meilleures conditions possibles.
- **Activités scientifiques**
  L'ISM a depuis sa création mis en place plusieurs événements qui font désormais partie du paysage scientifique québécois.
- **Promotion des sciences mathématiques**

Le CRM a plusieurs activités communes avec l'ISM, en particulier un programme conjoint de bourses postdoctorales, deux colloques CRM-ISM, un en mathématiques et un en statistique et l'organisation de cours avancés liés à la programmation thématique. Depuis l'été 2003, le CRM participe également au programme de bourses d'été pour les étudiants de premier cycle qui permet aux stagiaires postdoctoraux de superviser ces étudiants.

CRM-ISM Postdoctoral Fellowships

Les bourses postdoctorales CRM-ISM offrent à des jeunes chercheurs prometteurs la chance de consacrer la majeure partie de leur temps à leurs travaux de recherche. Le processus de sélection de ces boursiers est très rigoureux : en organisant un seul concours pour les six universités membres de l'ISM, l'institut reçoit un grand nombre de candidatures qui sont ensuite évaluées par les 150 professeurs membres de l'Institut. Il s'agit d'un concours extrêmement compétitif où environ un candidat sur quarante est choisi. De plus, le CRM et l'ISM ont débuté l'informatisation du processus de demande de bourse. Dès la prochaine année, les dossiers seront acheminés électroniquement, facilitant ainsi la gestion de ces nombreuses candidatures et réduisant considérablement la quantité de ressources utilisées dans le processus.

Nous ne pouvons surestimer l'importance de ces stagiaires postdoctoraux dans nos universités : ils stimulent et collaborent avec les chercheurs bien établis, ils sont une source d'idées nouvelles provenant d'autres grands centres, et ils créent un lien essentiel entre les professeurs et les étudiants, organisant souvent de leur propre gré des groupes de travail sur des sujets de pointe.

2004-2005 Postdoctoral Fellows :

Mostafa Gabbouhy (Ph.D. 2000, Université Ibn Tofaïl, Maroc) travaille avec Daniel Leroux (GIREF, Laval), et Jean-Loup Robert (GIREF, Laval) sur l'étude d'un modèle de Saint Venant 3-D avec couplage de la convection thermique et adaptation de maillage.

David Gay (Ph.D. 1999, UC Berkeley) a travaillé avec Vestislav Apostolov (UQÀM), Olivier Collin (UQÀM) et François Lalonde (Montréal) sur la topologie symplectique et de contact de basse dimension. David Gay a pris un poste de professeur à l'University of Cape Town en Afrique du Sud, débutant en juillet 2005.

Harald Helfgott (Ph.D. 2003, Princeton) a travaillé avec Andrew Granville (Université de Montréal) en théorie des nombres, courbes elliptiques, formes automorphes et combinatoire. Harald Helfgott a accepté un poste de professeur à l'University of Bristol en Angleterre.

Alexander Ivrii (Ph.D. 2003, Stanford) travaille sur la topologie symplectique et les courbes holomorphes-J avec Octav Cornea (Montréal), François Lalonde (Montréal) et Iosif Polterovich (Montréal).

Shannon Starr (Ph.D. 2001, UC Davis) a travaillé en physique mathématique et mécanique statistique avec Vojkan Jaksic (McGill) et John Toth (McGill). Shannon Starr est maintenant professeur à l'University of California à Los Angeles.

Ye Tian (Ph.D. 2003, Columbia) travaille avec Henri Darmon (McGill) sur la théorie des nombres.

Stephan Tillmann (Ph.D. 2002, Melbourne) travaille sur la topologie de basse dimension et les dégénérescences des structures hyperboliques avec Steven Boyer (UQÀM).

Michèle Titcombe (Ph.D. 1999, UBC) travaille avec Jacques Bélair (Montréal) sur l'analyse appliquée (analyse asymptotique, méthodes de perturbation), l'analyse numérique, la modélisation mathématique, la biologie mathématique, la dynamique des fluides et la dynamique non linéaire.

Undergraduate Summer Scholarships

En collaboration avec le CRM et les professeurs membres de l'ISM, la bourse d'été de premier cycle est offerte par l'ISM aux étudiants de premier cycle prometteurs qui désirent faire un stage de recherche en mathématiques et éventuellement poursuivre des études aux cycles supérieurs. La supervision des boursiers d'été est assurée par des stagiaires postdoctoraux pour lesquels il s'agit généralement d'une première expérience en supervision de recherche. Les boursiers cette année étaient :

Lory Ajamain (McGill)
Responsable de stage : Brian E. Moore

Dominique Brunet (Laval)
Responsable de stage : Mario Roy

François Charette (Montréal)
Responsables de stage : Alina Stancu et Octav Cornea

Maria Dorokhina (McGill)
Responsable de stage : Pete Clark

Wai Chit Lam (McGill)
Responsable de stage : Emily Dryden

Yuedan Liu (McGill)
Responsable de stage : Pete Clark

Clarence Simard (Montréal)
Responsable de stage : Harald Helfgott

"Sur la route" ISM Colloquium

October 1–3, 2004, Université de Sherbrooke
Organizing committee: Jennifer Bélanger, Sylvain Bérubé, Julie Dionne, Jean-Philippe Morin, Charles Paquette, Jean-Simon Sénécal, David Smith, Anik Trahan.
Plenary speakers: Michael Barot (UNAM), Joël Foisy (SUNY Potsdam), Jean Goulet (Sherbrooke), Claude Le Bris (ENPC)
Speakers: M. Valley (Laval), G. Chênevert (McGill), P. Poulin (McGill), A. Rémillard (Montréal), J.-P. Morin (Sherbrooke), D. Smith (Sherbrooke), H. Bac (UQÀM), G. Paquin (UQÀM), X. Provençal (UQÀM).
Number of participants: 38

Inspiré par le colloque pan-québécois des étudiants, un groupe d'étudiants de l'Université de Sherbrooke a décidé de lancer cette année le « Colloque ISM sur la route », un « mini » colloque pan-québécois qui s'est déroulé du 1 au 3 octobre 2004 à l'Université de Sherbrooke. Dans la tradition des colloques ISM, cette rencontre était organisée par des étudiants et était destinée à l'ensemble de la communauté étudiante aux cycles supérieurs. En plus de pouvoir présenter leurs plus récents travaux, les participants ont eu le plaisir d'assister à quelques conférences plénières. Le Colloque a attiré une quarantaine d'étudiants des universités de l'ISM.

Others Joint Initiatives

ESSO/CMS Math Camps 2004

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 Mathematic Society to ensure these camps are accessible to students from across Canada who demonstrate en excellence and interest in mathematics.

In 2004, there were thirteen regional math camps in ten provinces, as well as a national camp, in which 350 students participates

Organized by Thomas Griffiths (Waterloo), the national camp was held at University of Western Ontario from June 5 to 12, 2004. 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. Students are invited based upon their results in various mathematics competitions. Presentations on particular topics and the various problem solving sessions are runs by local area teachers and faculty member 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 competition as well as recommendations from teachers. The 2004 regional camps took place at the University of Regina, Sir Wilfred Grenfell College, the University of New Brunswick, the University of Prince Edward Island, Université du Québec à Rimouski, Simon Fraser University, Dalhousie University, the University of Ottawa, the University of Western Ontario, Brock University, the University of Alberta, and the University of Manitoba.

The sponsors of the 2004 math camp program were: Imperial Oil Foundation, Canadian Mathematical Society, NSERC PromoScience, the Fields Institute, the Centre de recherches mathématiques, the Pacific Institute for the Mathematical Sciences, the Association Mathématique du Québec, the host universities, the governments of New Brunswick, Alberta, Northwest Territories, Newfoundland and Labrador, Nova Scotia, Québec, Ontario, and Saskatchewan.

2004 AMQ Mathematics Camp

May 23 – June 4, UQÀM

Organizer: Pierre Bouchard (UQÀM)

For the fourth year in a row, the Camp was held at UQÀM. Participants are primarily prizewinners of the Quebec Mathematics Contest, on the CEGEP level. For about twelve days, they had the chance to meet with mathematicians and people who use mathematics in their work. Every day, one or more lecturers presented a topic that would be of interest to the students. Participants shared in an unforgettable experience with more than twenty other mathematics enthusiasts. They also had access at all times to UQÀM's computers.

2004 IMO Training Seminar

June 25 – July 4, UQÀM
Organizer: Matthieu Dufour (UQÀM)

The International Mathematical Olympiad (IMO) is the World Championship Mathematics Competition for High School students and is held annually in a different country. The CMS has been sending a team of Canadian students to the annual IMO since 1981. Canadian students have always done extremely well, obtaining a total of 93 medals (14 Gold, 27 Silver and 52 Bronze). In 2004 the Olympiad was held at Athens and the Canadian team obtained 4 medals, 1 Gold and 3 Bronze.

As with all competition, training is vital for success. The Canadian Team of six high school students chosen from more than 200,000 students who have participate in various local, provincial, national and international contests. Team members and their coaches attended a training seminar at UQÀMfor two weeks prior to their departure to Athens. A few select students from Québec, who have excelled in mathematics competitions, also attended the IMO training seminar as observers for the first few days.

The 2004 Canadian Olympiad "mathletes" were: Oleg Ivrii (Toronto), János Kramár (Toronto), Dong Uk Rhee (Edmonton), Peng Shi (Toronto), Jacob Tsimerman (Toronto) et Yufei Zhao (Toronto).

Canadian Mathematics Education Forum

May 6–8, 2005, University of Toronto

Co-chairs: Florence Glanfield (Saskatchewan), Frédéric Gourdeau (Laval), Bradd Hart (McMaster)

The 2005 Canadian Mathematics Education Forum (CMEF2005) was organized by the Canadian Mathematics Society (CMS). The Forum was held at the University of Toronto with some activities at the nearby Fields Institute. This Forum follows the one held in 2003 in Montréal. The 2005 Forum is the third organized by the CMS, the first national forum in mathematical education being held in Québec in May 1995.

The purpose of the 2005 invitational forum was to develop a national on-going conversation, among educators at all levels of schooling, about important issues and concerns in the development and future of mathematics education in Canada. The overall theme of the 2005 Forum was *Why teach Mathematics?* The Forum was thought of as a working meeting and included plenary panel sessions and talks as well eleven working groups.

The Forum brought together some 200 participants coming from all sectors connected to education in mathematics and from all the provinces and territories of Canada: teachers and instructors of mathematics at all the levels, researchers in mathematics and mathematics education, consultants and education advisers, representatives of associations of teaching and teachers of mathematics, representatives of the provincial ministries for education, representatives of other groups having a particular interest for the teaching of mathematics: industry representatives, parents, administrators, editors, textbook writers, etc.

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

Working groups

- Mathematics education in the aboriginal community,
- Early numeracy: developing mathematical literacy in the early years,
- Why is mathematics relevant in our society,
- Supporting student success — Helping students reach their potential,
- Creating a curriculum that affords learners opportunity to develop powerful mathematics,
- Learning in the presence of technology,
- Mathematics through the eyes of a child,
- Classroom practice and mathematics education research,
- Developing a national mathematics teaching community,
- Supporting teacher success.

Partners

- Canadian Mathematical Society
- Alberta Education
- Fields Institute
- Ministère de L'Éducation, du Loisir et du Sport du Québec
- University of Saskatchewan
- Nova Scotia Department of Education
- Pacific Institute for the Mathematical Sciences
- Yukon Department of Education
- McMaster University
- Centre de recherches mathématiques
- Institut des sciences mathématiques
- Toronto District School Board
- Ontario Ministry of Education
- Saskatchewan Learning
- Nunavut Department of Education
- Canadian Applied and Industrial Mathematics Society
- Statistical Society of Canada
- Université Laval
- Nova Scotia Mathematics Teachers' Association
- Ontario Association for Mathematics Education
- BC Association of Mathematics Teachers
- Saskatchewan Mathematics Teacher Society
- Association Mathématique du Québec
- Groupe des responsables en mathématiques au secondaire

Research Laboratories

THE CRM now encompasses eight research laboratories at the heart of the Québec mathematical community. These research groups act as focal points for local scientific activity and participate actively in the scientific programs of the CRM.

Applied Mathematics

Description

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 which one was only able to dream of 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 further encourage 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 annual 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 bi-weekly computational science and engineering seminar. It also supports postdoctoral fellows and summer students as well as Canadian and international visitors.

Activities of the laboratory in 2004–2005

Seminars

The regular core activity of the laboratory is the weekly applied mathematics seminar which usually takes place on Mondays at McGill. This year it was organized by Paul Tupper, who lined up 32 speakers covering a very wide range of interesting topics in applied mathematics. Though most seminars were at McGill, there were also seminars at Université de Montréal and one at Concordia. The series included joint seminars with the Analysis laboratory and with the McGill departement of Atmospheric and Oceanic Sciences and Computational Science and Engineering. The seminar series was well attended not just by laboratory members along with their students and postdoctoral fellows, but with significant participation of the Montréal-wide applied mathematics community.

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 bi-weekly Computational Science and Engineering (CSE) Seminar at McGill, organized this year by Dennis Giannacopoulos (Electrical and Computer Engineering, McGill), which included 13 speakers, in addition to the three joint "Applied Mathematics/CSE" seminars.

Workshops, special sessions and others

Besides its regular activities, the laboratory organized the second Montréal Scientific Computing Days in February. The objective of this conference is to encourage scientific exchange within the scientific computing community in Québec and further afield. The two-day program included two short courses offered by international experts, at a level accessible to advanced graduate students, as well as oral and poster contributed sessions. Students and postdoctoral researchers were especially encouraged to participate. The event was once again a great success, this year attracting over 100 participants, mostly from Québec and Ontario.

Two one-day workshops were also organized by the laboratory on "Computational Aspects of Dynamical Systems" and "Analysis and Computation of Lattice, Delay and Functional Differential Equations." Michel Delfour was a member of the organizing committee for the Spring School and Workshop "Mini-invasive procedures in medicine and surgery: mathematical and numerical challenges." Details on these three workshops as well as on the Montreal Scientific Computing Days can be found in the sections "General Program" and "Multidisciplinary Program."

In addition to these laboratory events, the laboratory members were very active in the organization of activities related to the Theme Year.

- Anne Bourlioux was the principal organizer for the CRM Thematic Year on "The Mathematics of Stochastic and Multiscale Modeling," and also organized the workshop "Front Propagation and Nonlinear Stochastic PDEs for Combustion and other Applications" and the Summer School "Stochastic Calculus for Applications: Theory and Numerics."
- Paul Tupper organized another workshop, "Extracting Macroscopic Information from Molecular Dynamics."

Details about all these activities can be found in the chapter "Thematic program" of this report.

With over 30 seminar speakers from outside Quebec, the laboratory members were also hosts to a number of scientific visitors including Dimitri Breda (Udine), Chris Elmer (NJIT), McKay Hyde (Rice), Olivier Lafitte (Paris 13), Peter Monk (Delaware) et David Nicholls (Notre Dame).

Members of the laboratory

Highlights of its members

During the year we welcomed three new members; Jacques Bélair (Montréal), Robert Owens (Montréal) and Paul Tupper (McGill).

The laboratory members were visible at the national and international levels in applied and industrial mathematics.

- Anne Bourlioux served on the board of directors of CAIMS, and several members of the laboratory were involved in organizing and participating in various symposia during the Joint 2004 CAIMS/CMS meeting including Peter Bartello, Jacques Bélair, Tony Humphries, Sebius Doedel, Martin Gander and Sherwin Maslowe.
- Eusebius Doedel organized workshops on "Analysis and Continuation of Bifurcations," at University of Seville in May 2004, and "Qualitative numerical analysis of high-dimensional nonlinear systems," at University of Bristol in March 2005.
- Martin Gander organized two minisymposia at 16th International Conference on "Domain Decomposition Methods," New York, January 2005 on "Optimized Schwarz Methods" and "Space-Time Parallel Methods for PDE's."
- Robert Owens organized a minisymposium on "High Order Methods for Complex Fluids" at the International Conference on ""Spectral and High-Order Methods," Brown, June 2004.
- Paul Tupper has been chosen as finalist for the 2005 Fox Prize in Numerical Analysis.

During the year 2004–2005, 17 master's students, 20 Ph.D. students and 8 postdoctoral fellows were supervised by laboratory members.

Regular members

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

Paul Arminjon (Montréal)
Numerical methods in fluid mechanics.

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

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

Martin Gander (Geneva and McGill)
Domain decomposition, preconditioning.

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

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

Robert G. Owens (Université de Montréal)
Mechanic and numerical simulation of complex fluids.

Georg Schmidt (McGill)
Control of partial differential equations.

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

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

Jean-Paul Zolésio (INRIA)
Control, optimization.

CICMA

CICMA Centre Interuniversitaire en Calcul Mathématique Algébrique

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. The center is particularly well represented in this regard 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.

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

Activities of the laboratory in 2004–2005

Seminars

The main scientific activity of the CICMA laboratory is the Québec–Vermont Number Theory Seminar, which is held every second Thursday for a full day, with about 30 regular participants from Montréal, Vermont, Québec and Ottawa.

One can see from that list that the invited speakers to the QVNTS are among the most prominent researchers in number theory, arithmetic geometry and related topics. In the academic year 2004–2005, the invited speakers to the QVNTS included: Haruzo Hida (UCLA) who gave a series of lectures on his fundamental work on p-adic families of modular forms, which has profoundly infuenced the development of the subject and plays a key role in the work of Iovita and Darmon (in collaboration with Bertolini); and Akshay Venkatesh (Clay Fellow, NYU), one of the young leaders in number theory today, who came to talk about his new and outstanding work on equidistribution, subconvexity and spectral theory.

The complete list of invited speakers for 2004–2005 is: Dino Lorenzini (Georgia), Kartik Prasanna (UCLA), Haruzo Hida (UCLA), Jean-Louis Colliot-Thélène (Paris-Sud), Marvin Knopp (Temple), Akshay Venkatesh (Clay Fellow, NYU), Mark Kisin (Chicago), Jordan Ellenberg (Wisconsin), Gabor Kun (Eotvos University, Budapest), Romyar Shari (McMaster), Wenzhi Luo (Ohio State), David McKinnon (Waterloo), Denis Thérien (McGill), Farshid Hajir (Amherst), Jason Lucier (Waterloo), Alexandru Popa (Princeton), Jorge Devoto (Buenos Aires), Nora Ganter (Urbana-Champaign), Ali Ozluk (Maine), Pierre Charollois (Bordeaux), John Cremona (Nottingham), Gergely Harcos (Texas), Nyandwi Servat (University Tunis El Manar), R. Sujatha (Tata Institute), John Coates (Cambridge), Gregory Freiman (Tel Aviv) et Manfred Einsiedler (Wien and Princeton).

A number of talks were also given by the local participants, and an important facet of QVNTS is to give to CICMA members an occasion to present to each other their latest research. The QVNTS are also important for the postdoctoral fellows, allowing them to present their research to the number theory community, and to share their expertise. One of the QVNTS day was entirely dedicated to the recent spectacular work of C. Khare proving Serre's conjecture. The talks were given by David Savitt, a CICMA postdoctoral fellow whose work was important in the proof of Khare.

In addition to the main scientific event, the QVNTS, the members of CICMA are also involved in more informal and specialized seminars, or working seminars, among smaller groups of postdoctoral fellows, graduate students and faculty members. Those include:

- The "Séminaire de Théorie analytique des nombres," organized since 2003–2004 by a group of postdocs and graduate students. The topics covered in the seminars are influenced by the research interests of the participants.
- A Working Seminar organized by Adrian Iovita on the p-adic Banach spaces, and the L-invariants associated to modular forms. The participants included some faculty members, and several postdocs and graduate students.

Workshops, special sessions and others

Organized by CICMA members, the following activities took place in the province:

A conference on Analytic number theory, organized by Jean-Marie De Koninck at Université Laval
May 19–21, 2005

One of the goals of the conference was to encourage scientific exchanges between researchers in Québec and Mexico, following the collaboration of Florian Luca (UNAM, Mexico) and Jean-Marie De Koninck. This conference was funded in part by the Ministère des relations internationales (division Amérique latine) and the corresponding institution in Mexico. More details can be found in page 26.

The annual "Québec–Maine Number Theory" Conference which was held in Québec City in October 2004, was organized by Claude Levesque.

In addition to (and including some of) the invited speakers of the QVNTS mentioned above, a number of long-term visitors, involved in research projects with the CICMA members, were in Montreal during the year 2004–2005.

We mention a few here: Nora Ganter (Urbana-Champaign), Jorge de Voto (Buenos Aires), Haruzo Hida (UCLA), Alina Cojocaru (Princeton), Samit Dasgupta (Harvard), Pierre Charollois (Bordeaux) et Kristin Lauter (Microsoft).

Members of the laboratory

Highlights of its members

Other conferences and workshops organized by CICMA members include:

- A 5-day Workshop at BIRS entitled "Diophantine Approximation and Analytic Number Theory" which was held on November 20–25, 2004, and whose organizers included Andrew Granville. Several faculty member and postdoctoral fellows from Montréal participated to the event.
- Two special sessions at the CMS Winter Meeting held at McGill University in December 2004. A session on Arithmetic geometry was organized by Eyal Goren and Adrian Iovita, and a session on Number theory was organized by Chantal David and Andrew Granville. Both sessions were funded by the CMS.

C. David, A. Iovita, H. Darmon (principal applicant), and E. Goren obtained a NSERC Leadership Support Initiative Grant.

C. David, H. Kisilevsky, F. Thaine, H. Darmon (director), and E. Goren obtained a FQRNT Team Grant.

During the year 2004–2005, 21 master's students, 23 Ph.D. students and 12 postdoctoral fellows were supervised by laboratory members.

Regular members

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

Chris J. Cummins (Concordia)
Group theory, modular functions, Moonshine.

Chantal David (Concordia)
Analytical number theory, L-functions

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

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

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

Eyal Goren (McGill)
Arithmetic geometry, algebraic number theory, moduli spaces of abelian verieties, 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.

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 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 at a crucial crossing 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, a group of researchers of international calibre in geometry and topology has been hired by Québec universities. The research centre, based at UQÀM, now comprises seventeen professors-researchers 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 geometric Langlands program; classification of special Kähler metrics; the study of symplectic invariants, especially in dimension 4; Hamiltonian dynamical systems.

Activities of the laboratory in 2004–2005

Workshops, special sessions and others

CIRGET members have organized various events in the Montreal area this year funded by CIRGET, the CRM and other sources. A complete description of all these activities can be found in the chapter "General Program ."

- **Short Program on Riemannian Geometry**
  June 28 to July 16, CRM
  Organizers: Vestislav Apostolov (UQÀM), Andrew Dancer (Oxford), Nigel Hitchin (Oxford), McKenzie Wang (McMaster)

  The theme of this program was the study of special geometries (metrics whose curvature satisfies constraints), as well as the relation between curvature and topology.

- **Special Semester on Symplectic Geometry and Topology**
  Fall 2004, CRM
  Organizers: Octavian Cornea (Montréal), François Lalonde (Montréal)

  This began with the Séminaire de Mathématiques Supérieures (SMS), the annual NATO sponsored summer school held at the Université de Montréal. This year's topic was "Morse theoretic methods in non-linear analysis and symplectic topology." The School was held from June 21 to July 2 with 91 students participating. In the framework of this informal semester, between October 14 and December 7, 17 invited lectures were given, with an intensive two-week workshop held November 2 to November 12.

- **Topics in Low-Dimensional Topology**
  May 16–17, 2005, UQÀM
  Organizers: Steven Boyer (UQÀM), Olivier Collin (UQÀM)

  The two main themes of the Workshop were applications of geometric methods in 3-manifolds and the contact topology in dimension 3.

Niky Kamran invited Stephan De Bièvre (Lille) to give a full-term course this winter on quantum field theory in curved space-time at McGill to provide students and postdoctoral fellows with the background for a workshop he is planning in 2005-2006. The course was a rigorous constructive quantum field theory course that covered the classical theorems on CCR algebras and concluded with a discussion of the Unruh effect for accelerated observers near black holes. This was the first time that a course on this important topic has been given in Montreal. The lectures will be published as a book.

Added to the many seminar and conference visitors listed above, CIRGET also welcomed : Daryl Cooper (UCSB), Xingru Zhang (SUNY), Michel Boileau (Toulouse), Felix Finster (Regensburg), Alexander Its (IUPUI), Gabriele Vezzosi (Florence), Michael Batanin (Sidney), Marie-Françoise Ouedraougo (Ouagadougou), Viktor Enolskii (Heriot-Watt) and Michael Gekhtman (Notre-Dame).

The CIRGET Summer Scholarship program, that encourages promising undergraduate students to continue in graduate studies, began to bear fruit. Indeed, Apostolov's two summer fellows started a master's in geometry in 2004. Furthermore, each year, we receive many applications from French students from the ENS, which is a good indication of the international spread of the CIRGET.

One can see how well the CIRGET is known internationally by looking how many postdoctoral CRM-ISM applications it received: the third of all the applications were send to CIRGET members (110 to 330). Four of these candidate will joint the CIRGET next year. The presence of postdoctoral fellows enhance CIRGET dynamism, they participate in organizing event, they invite many collaborators whom presence is benefic for all CIRGET members, they work with graduate students and collaborate with regular members. Two publications resulted from these collaborations: Hu and Lalonde published a paper in symplectic geometry and Tillmann and Boyer will publish soon a paper in low-dimensional topology.

Seminars

The three weekly CIRGET Seminars have been quite active.

- The Geometry-Topology Seminar is the main regular activity of the laboratory, attended by all CIRGET members. Organized by Olivier Collin, the seminar hosted 24 speakers of whom 17 were from outside Montreal.
- The Geometric Group Theory Seminar, a more specialized seminar organized by Dani Wise, met 17 times over this period with 11 talks given by speakers from outside Montreal.
- Finally, the CIRGET Junior Seminar, organized by Baptiste Chantraine for CIRGET student members, met 23 times.

Members of the laboratory

New members of the laboratory

CIRGET welcomed two new members this year. Steven Lu (Ph.D. Harvard 1990) accepted a position at UQÀM after spending four years in Germany at the Max Plank Institute and two years at the University of Essen. Pengfei Guan (Ph.D. Princeton 1989) came to McGill as a senior CRC after spending many years at McMaster University.

Both have integrated smoothly into the Montreal mathematical scene and have played an active role in CIRGET. Their presence will reinforce the geometrical analysis domain, in which Apostolov and Kamran already work. With now four researchers working in the area, geometrical analysis will become an important CIRGET research nucleus.

During the year 2004–2005, 22 master's students, 15 Ph.D. students and 10 postdoctoral fellows were supervised by laboratory members.

Regular Members

Steven Boyer (UQÀM) *Director*
Topology of manifolds, low-dimensional geometry and topology.

Syed Twareque Ali (Concordia)
Coherent states, wavelets, quantization techniques, harmonic analysis, Wigner functions.

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.

Octavian 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.

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 applications of spectral geometry.

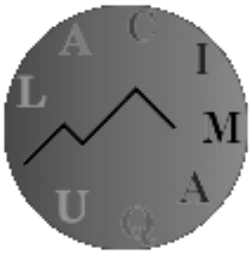
Peter Russell (McGill)
Algebraic geometry.

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

Daniel T. Wise (McGill)
Geometric group theory, low-dimensional topology.

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. Since 2002, LaCIM is one of the eight research laboratories of the CRM.

Research areas

Discrete mathematics has lately become an important field of practical research, witness the new heading in Mathematical Reviews 05E of algebraic combinatorics with subheadings indicating interactions with the newest areas of mathematics, such as group representations, quantum groups, discrete algebraic geometry, 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, highlighting constructive geometric methods. Moreover, combinatorics applies to computer science (theory of automata, analysis of algorithms), to statistical physics (computation of configuration spaces and of critical exponents, discrete models), bio-informatics (combinatorics of words applied to genomic sequences). The youth, dynamism, utility and applicability of this research domain are highlighted in the modern world, where discrete structures (trees, graphs, permutations) are more and more present in communications, networks and research engines, of which the use is growing exponentially in this 21st century.

The researchers

The laboratory is comprised of thirteen principal researchers, ten of them professors at UQÀM, one at McGill, one at Université de Montréal

and one at École Polytechnique de Montréal; of twelve collaborator and five associated members in North America, one in Chile and two in Europe. Notably, Christophe Reutenauer (regular member) and Nantel Bergeron (associate member) hold Canadian research chairs. A team of four LaCIM members is supported by a grant from FQRNT. André Joyal, past member of LaCIM and current member of CIRGET, is involved in several activities at LaCIM, both formal and informal. LaCIM is the largest research group in combinatorics in Canada and is known worldwide in its field. The UQÀM team has contributed to the emergence and establishment of combinatorics as a mathematical discipline. For example, several LaCIM members have played and continue to play an important role in the organization of the international colloquium "Formal Power Series and Algebraic Combinatorics," which is bilingual and is held yearly, alternately in Europe and North America. Its success is without question.

Research activities at LaCIM

André Joyal enriched the counting theory of Polya by including the theories of group representations and symmetric functions. Under the name of theory of species, this theory marked the emergence of the UQÀM combinatorics group about twenty years ago. From that time research has diversified greatly at LaCIM:

- classical enumerative combinatorics and its applications (counting of discrete configurations and planar maps);
- algebraic combinatorics;
- theoretical computer science;
- bio-informatics.

Seminars and others

The LaCIM Combinatorics and Theoretical Informatics Seminar is an important and successful integrating element. Cédric Chauve and Christophe Reutenauer are the organizers. These seminars were held on Fridays 25 times during the year and about 25 people attended the talks.

During 2004 – 2005, the LaCIM hosted several visitors: David Barrington (Amherst), Jean-Pierre Borel (Limoges), Ricard Gavalda (UPC Barcelona), Mark Haiman (Berkeley), Cristoffer Hansen (Århus), Christian Kassel (Strasbourg), Michal Koucky (Prague), Clemens Lautemann (Mainz), Francois Lemieux (UQÀC), Julia Mitacki (Bielefeld), Mathieu Raffinot (Paris), Klaus Reinhardt (Tübingen)and Jens Stoye (Bielefeld).

Members of the laboratory

Highlights of its members

Denis Thérien is a James McGill Professor at McGill University (2002–2009) and Christophe Reutenauer has a Canada Research Chair in "Combinatorial Algebra and Mathematical Computing " (2001–2008).

Two former members of the LaCIM, Marni Mishna (Ph.D.) and Sara Faridi (postdoctoral fellow) received this year a NSERC Faculty Support Programs (Each year, only 25 candidate are chosen). Also, Marni Mishna received in 2004 the Governor General's Academic Medal for her Ph.D. Thesis.

LaCIM integrated a new regular member: John Mullins, Professor at the Computer Engineering Department of the École Polytechnique de Montréal; he is director of CRAC (Conception et réalisation des applications complexes). He already collaborates with Srecko Brlek.

During the year 2004–2005, LaCIM members were active in the organization of many large-scale events:

• François Bergeron, in collaboration with Sara Faridi (former LaCIM postdoctoral fellow), Riccardo Biagioli (LaCIM postdoctoral fellow) and Tony Geramita, organized, in January 2005, the *Second Invariants and Combinatoric Workshop*, held in Ottawa (the first took place in Kingston in January 2004).

The main achievement of this event has been the establishment of an on-going dialogue between two separate research communities that had been using similar techniques to study different mathematical problems. The two groups are algebraic combinatorialists working on the representation theory of symmetric groups, and commutative algebraists studying resolutions and inverse systems. The connections between these topics were highlighted in a successful meeting that took place in January 2004 at Queen's University in Kingston. In this meeting, through a series of expository lectures by Tony Geramita and François Bergeron, among others, it was

made evident that interesting special cases of the notion of Macaulay's inverse systems of commutative algebra are essentially the same objects as coinvariants spaces studied in algebraic combinatorics and representation theory. This year's meeting will continue in the same tradition.

• Vladimir Makarenkov was president of the Scientific Committee (which also include Anne Bergeron and Cédric Chauve) of the *Société francophone de Classification Colloquium*, which took place at UQÀM in May 2005.

Beside the usual classification thematic, the following themes were privileged in Montréal: Bioinformatics, evolution and phylogenic analysis, consensus methods, data search and symbolic data analysis.

Invited speakers: Francisco De Carvalho (Universidade Federal de Pernambucol), Pierre Hansen (HÉC), Melvin F. Janowitz (DIMACS Center, Rutgers University), Sabine Krolak-Schwerdt (Universität des Saarlandes), Bruno Leclerc (École des Hautes Études en Sciences Sociales), Maurizio Vichi (Universitá "La Sapienza" di Roma).

• A special session on "Algebraic Combinatorics" of the *CMS Meeting*, held at McGill in December 2005, was organized by François Bergeron and Christophe Reutenauer, together with the two postdoctoral fellows Peter MacNamara and Riccardo Biagioli. Topics included all aspects of algebraic combinatorics and their relations with other parts of mathematics. One particular focus was on recent work concerning relations among symmetric functions.

Invited speakers: Nantel Bergeron (York), Francesco Brenti (Tor Vergata), Sergey Fomin (Michigan), Adriano Garsia (UC San Diego), Ian Goulden (Waterloo), David Jackson (Waterloo), Mercedes Rosas (York), Mark Skandera (Dartmouth), Richard Stanley (MIT), John Stembridge (Michigan), Stephanie van Willigenburg (UBC) et Mike Zabrocki (York).

• The 2004 International *JOBIM* Conference (Journées Ouvertes en Biologie, Informatique et Mathématiques) included in its program committee Anne Bergeron, Sylvie Hamel, Cédric Chauve and Vladimir Makarenkov.

JOBIM is a multidisciplinary event that brings together experts in biology, computer science, mathematics and physics. In 2004, the program was divided in six sessions on: repetitions, patterns, gene expression and regulation networks; comparative genomic, predictions, models; data bases, exploration, classification and visualization; phylogeny, evolution and population; structure and families of ARN or proteins; and metabolism classification, biological systems.

The program included 20 long presentations, 33 "flash" presentations and 6 invited talks. This year the invited speakers were Tom Hudson (McGill), Bernard Dujon (Institut Pasteur), Hervé Philippe (Montréal), Mathieu Blanchette (McGill), David Sankoff (Ottawa) and Shoshana Wodak (Hospital for Sick Children, Toronto). JOBIM also held a poster session: around 40 posters were presented.

• An Invited Minisymposia on "Genome Rearrangements" was organized by Anne Bergeron in June 2004 during the SIAM conference *Discrete Mathematics* held at Nashville, Tennessee.

The recent spectacular growth of genome sequencing projects provides a fertile ground for new problems that are both relevant to biologists, and challenging to mathematicians and computer scientists. In an unexpected way, chromosomes happen to be ordering devices for the various genes that encode information about species. The content and order of these genes varies from species to species, and different genomes are modeled as permutations and words. This symposium will focus on the issues raised by whole genome comparisons: These range from central applied problems such as gene function prediction or phylogeny reconstruction, to hard combinatorial problems whose solution requires the development of new theoretical tools.

During the year 2004–2005, 34 master's students, 22 Ph.D. students and 7 postdoctoral fellows were supervised by laboratory members.

Regular members

Christophe Reutenauer (UQÀM) *Director*
Algebraic combinatorics, non-commutative algebra, automata, codes, free algebras.

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

Anne Bergeron (UQÀM)
Bio-informatics.

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

Srecko Brlek (UQÀM)
Combinatorics of words, algorithmics.

Cedric Chauve (UQÀM)
Enumerative combinatorics, trees, bioinformatics.

Sylvie Hamel (Montréal)
Bio-informatics and algorithms, language and automaton theory, 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) Logic and Algebra applications to modelization, concurrent systems analysis, in particular, safety systems analysis.

Denis Thérien (McGill)
Theory of complexity of computation, logic, combinatorics, probability.

Timothy Walsh (UQÀM)
Algorithmics, enumerative combinatorics, graphs.

Associate members

Michel Bousquet (Cegep du Vieux-Montréal)

Alain Goupil (Cegep du Vieux-Montréal)
Combinatorics, algebra, finite group representations, symmetrical groups and extensions.

Pierre Lalonde (Cegep Maisonneuve)
Enumerative and bijective combinatorics, sign alternating matrices, involution enumeration related to divers parameters, use of pfaffiens and determinants in enumeration.

Cédric Lamathe (UQÀM)

Luc Lapointe (University of Talca, Chili)
Algebraic Combinatorics, symmetrical functions, integrable systems, supersymmetries.

Collaborating members

Marcello Aguiar (Texas A&M University)
Algebraic Combinatorics, non-commutative algebra, Hopf algebras and quantum groups, category theory.

Luc Bélair (UQÀM)
Mathematical logic, model theory.

Nantel Bergeron (York Univ.)
Applied algebra.

Pierre Bouchard (UQÀM)
Commutative algebra, algebraic geometry and combinatorics.

Yves Chiricota (UQÀC)

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

Adriano Garcia (University of California at San Diego)
Algebraic combinatorics, symmetrical functions, Harmonic and co-invariant spaces, quasi-harmonic and quasi-invariant functions.

André Joyal (UQÀM)
Algebraic topology, Category theory.

Jacques Labelle (UQÀM)
Combinatorics, topology.

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

Simon Plouffe

Xavier G. Viennot (Université Bordeaux I)
Enumerative, algebraic and bijective combinatorics, interaction 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 formed three years ago. Currently the laboratory has 36 (regular and associate) members working at eight different universities in Quebec, the USA and France. The research areas of the members of the laboratory are 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.

Activities of the laboratory in 2004–2005

Workshops, special sessions and others

Workshop on Spectral Theory of Schrödinger Operators
July 26-30, 2004, CRM
Organizers: Vojkan Jaksic (McGill), Yoram Last (Hebrew)

This workshop, organized in the framework of the 2003 – 2004 CRM theme year, focused on the spectral theory of random and quasiperiodic Schrödinger operators. In solid state physics random and almost periodic Schrödinger operators serve as models of disordered systems, such as alloys, glasses and amorphous materials. The disorder of the system is reflected by the dependence of the potential on some random parameters.

This workshop brought together the world leaders in spectral theory of random and quasiperiodic Schrödinger operators. Its goal was to review the state of the art of the field and to map new directions of the research. The programme included short courses given by M. Aizenman (Princeton), B. Simon (Caltech), and S. Jitomirskaya (Irvine). The workshop was held in conjunction with the following one.

Workshop on Dynamics in Statistical Mechanics
August 2-6, 2004, CRM
Organizers: Vojkan Jaksic (McGill), Claude-Alain Pillet (Toulon)

This workshop, also organized in the framework of the 2003 – 2004 CRM theme year, was devoted to the study of dynamical properties of (classical and quantum) open systems. In particular, through the study of noisy or forced dissipative systems, or Hamiltonian systems with a large number of degrees of freedom, our understanding of the mathematical structure of nonequilibrium statistical mechanics has greatly improved.

The aim of this meeting was to present the latest results and discuss the possible future directions of research in this area. The program included short courses to be given by H. Araki (Kyoto), B. Derrida (École Normale), J. Froehlich (ETH), J.-P. Eckmann (Geneva). The workshop was held in conjunction with the preceding one.

Conference on Fixed Point Theory and its Applications in Honour of Andrzej Granas
August 16-20, 2004, CRM
Organizer: Marlène Frigon (Montréal)

The Centre de Recherches Mathematiques (CRM), in collaboration with the Department of Mathematics and Statistic of the Université de Montréal, organized this conference in honour of Andrzej Granas on the occasion of his 75th birthday. The main themes of the conference were fixed point theory and its applications to problems arising in non-linear analysis, differential equations and dynamical systems. Details

about this activity can be found in page of this report.

Analysis Day
29 April 2005, CRM
Organizers: Thomas Ransford (Laval), Christiane Rousseau (Montréal), Alina Stancu (Montréal), Galia Dafni (Concordia), Dmitry Jakobson (McGill).

This laboratory is one of the most numerous and is present in all the universities of the province. This forces sub-groups of the laboratory to work in parallel. To remedy the problem, and since a lot of the members do not know each other, we started in 2004–2005 a tradition of organizing each year an Analysis Day, to which all the members will be invited. For the moment, there is no need to invite many speakers from abroad, but to let the members give the talks, so they will know each other's research areas.

During 2004–2005, the Mathematical Analysis Laboratory hosted several visitors: H. Araki (Kyoto), J. Artes (Barcelona), L. Bruneau (Warsaw), M. Cojocaru (Queen's), S. De Bievre (Lille), J. Derezinski (Warsaw), F. Dumortier (Limburgs Universitair Centrum), A. Fedotov (Physics Institute, St-Petersbourg), B. Helffer (Paris Sud), V. Ivrii (Toronto), F. Klopp (Paris Nord), Y. Last, (Hebrew), J. Llibre (Barcelona) M. Mrozek (Jagellon), N. Nadirashvili (CNRS, Marseille), C.-A. Pillet (Toulon), L. Rey-Bellet (UMass Amherst), N. Vulpe, (Moldavian Academy), A. Sobolev (Sussex), S. Zelditch (Johns Hopkins) et E.S. Zeron (Cinvestav-IPN).

Seminars

Several Analysis Seminars take place in Québec universities. The following were organized by the members of the laboratory in 2004–2005.

Analysis (Laval): 20 talks in the regular seminar and 18 in the working group.

Analysis (McGill/Concordia)
Organizers: Galia Dafni, Dmitry Jakobson, 22 talks.

Analysis (Montréal)
Organizers: Paul Gauthier, Richard Fournier.
This weekly seminar focused on complex analysis, organized mainly for students, 20 talks.

Seminar in Nonlinear Analysis and Dynamical Systems (Montréal)
Organizers: Christiane Rousseau, Alina Stancu, 25 talks.

Analysis and Related Topics (Sherbrooke/Bishop's)
Organizers: Madjid Allili, Tilak Bhattacharya, François Dubeau, Tomasz Kaczynski, 15 conférences.

Student Analysis Seminar (McGill)
Organizer: Eugene Kritchevski

Members of the laboratory

Highlight of the members

- P. Guan (McGill), A. Kokotov (Concordia) have recently become associate members of the laboratory and A. Shnirelman (Concordia) has become regular member.
- P. Guan (McGill) and A. Shnirelman (Concordia) have recently been awarded Senior Canada Research Chair Positions.
- Christiane Rousseau (Montréal) organized, in collaboration with Pavao Mardesic, a Conference for the 60th anniversary of Robert Roussarie in June 2004 at Luminy.
- Christiane Rousseau (Montréal) organized, in collaboration with Robert Roussarie, the session "Dynamical systems " during the first France-Canada Colloquium in July 2004 at Toulouse. She was also member of the Meeting Organization Committee, together with the presidents of the Canadian and French mathematical societies.
- Paul Gauthier (Montréal) and Richard Fournier (Dawson) organized a sessions in Approximation theory and Galia Dafni (Concordia) organized a session in Harmonic analysis at the 2004 CMS Winter Meeting in Montreal.
- Pengfei Guan (McGill) organized a Geometric analysis session at AMS Meeting in Newark, Delaware, April 2005.

During the year 2004–2005, 30 master's students, 26 Ph.D. students and 6 postdoctoral fellows were supervised by laboratory members.

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 Clarke (Lyon I)
Nonlinear and dynamic analysis, control theory, calculus of variations.

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

Donald Dawson (Carleton)
Probability, stochastic process.

Stephen Drury (McGill)
Harmonic analysis, matrix theory.

Richard Fournier (Collège Dawson)
Probability, stochastic processes.

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

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

Pawel Góra (Concordia)
Ergodic theory, dynamic systems, fractal geometry.

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

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

Vojkan Jaksic (McGill)
Quantum mechanics, statistics, random Schrödinger operators.

Tomasz Kaczynski (Sherbrooke)
Topological methods, Conley index, applications to dynamical systems.

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

Ivo Klemes (McGill)
Harmonic analysis, trigonometric series.

Paul Koosis (McGill)
Analyse harmonique.Harmonic analysis.

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

Javad Mashreghi (Laval)
Complex analysis, harmonic analysis, Hardy spaces.

Iosif Polterovich (Montréal)
Geometric applications of spectral geometry.

Thomas Ransford (Laval)
Complex and harmonic analysis, functional analysis and theory of operators, spectral analysis, potential theory.

Dominic Rochon (UQTR)
Numbers, analysis, dynamic complexes.

Jérémie Rostand (Laval)
Complex analysis, experimental mathematics.

Christiane Rousseau (Montréal)
Dynamical systems, bifurcations, qualitative theory, polynomial systems, analytic invariants, integrable systems.

Dana Schlomiuk (Montréal)
Global analysis, dynamical systems, singularities, bifurcations, algebraic curves, primary integral.

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

Ron Stern (Concordia)
AFunctional analysis and theory of operators, linear and non-linear systems, non-smooth analysis, stability, optimal order.

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

Associate members

Richard Duncan (Montréal)
Ergodic theory, probability.

Kohur GowriSankaran (McGill)
Potential theory.

Pengfei Guan (McGill)
Geometric analysis.

Alexei Kokotov (Concordia)

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

Yiannis Petridis (CUNY, Lehman College)
Automorphic forms and spectral theory. L-Functions, quantum chaos.

Samuel Zaidman (Montréal)

Mathematical Physics

Description

The mathematical physics group is one of the oldest and most active at the CRM. It consists of nineteen regular members, all full-time faculty at five Quebec Universities, and four associate members. A new associate member was added this year: Alexander Shnirelman, who was named to a Canada Research Chair in Applied Mathematics at Concordia University. The Laboratory also includes two attachés de recherches, fourteen postdoctoral fellows (some, jointly with the Analysis and CIRGET Laboratories), and lab members supervise, or co-supervise the thesis work of about forty masters and doctoral students.

The group carries out research in many of the currently most active areas in 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.

Activities of the laboratory in 2004–2005

Workshops, special sessions and others

Much of the year was spent in preparation for the CRM "Short Program on Random Matrices, Random Processes and Integrable systems," organized by two Lab members: John Harnad and Jacques Hurtubise, which took place as part of the CRM General Program on June 20 – July 8, 2005. Details about this activity will be found in the 2005 – 2006 CRM annual report.

The members of the laboratory maintain active ties and ongoing collaborations with other researchers from centers in mathematical physics around the world. The list of scientific visitors to the laboratory this academic year included: A. Arefijamaal (Meshhed), H. Braden (Edinburgh), L. Chekhov (Moscow), S. De Bièvre (Lille), R. Conte (Paris), C. Eilbeck (Edinburgh), A. El Gradechi (Artois), V. Enolskii (Heriot-Watt), B. Eynard (Saclay), M. Fels (Utah State), F. Finster (Regensburg), R. Floreanini (IFIN Trieste), M. Gekhtman (Notre Dame), A. Its (IUPUI), C. Klein (Bonn), M. Knopp (Temple), A. Kokotov (St. Petersburg), D. Levi (Rome), D. Majard (Aix-Marseille), N. Nadirashvili (Chicago), S. Norton (Cambridge), E. Previato (Boston), I. Rivin (Temple), Nasser Saad (UPEI), A. Safapour (Meshhed), A. Sergyeyev (Silésie), M.K. Tavassoly (Ispahan), P. Tempesta (SISSA Trieste), Z. Thomova

(SUNY Syracuse), S. Venakides (Duke), N. Witte (Melbourne) and Ismet Yurdusen (Middle East Technical).

In addition, within the framework of ISM sponsored doctoral level courses, two special series of lectures were given by visiting researchers who were at the CRM for the Fall and Winter semesters, while on sabbatical leave from their home institutions: Professors Michael Gekhtman (Notre Dame) and Stefan De Bièvre (Lille). The titles of these courses were:

Integrable systems, exactly solvable lattices and Lie groups
Concordia, Michael Gekhtman.
September to December 2004.

Topics in Analysis V : An Introduction to free Bose fields
McGill, Stephan De Bièvre.
January to April 2005.

Seminars

- The regular CRM Mathematical Physics seminar series was continued throughout the academic year, with weekly talks given both by invited visitors and local members of the Lab, including postdoctoral fellows and some graduate students near to completion of their doctorates.
- From January until April, 2005, a second "Working Seminar in Mathematical Physics" was organized by V. Jaksic at McGill.

Members of the laboratory

Highlights of the members

- Jacques Hurtubise was elected a Fellow of the Royal Society of Canada.
- Alexander Shnirelman, our new Associate Member, was named a Tier I Canada Research Chair at Concordia University.

In addition the following conferences/workshops were organized by members of the laboratory:
Special Session "In the Wake of Hamilton and Jacobi 200 Years Later"
AMS Joint Mathematics Meeting
January 5–8, 2005, Atlanta, Georgia
Organizers: Maria Clara Nucci (Perugia), Pavel Winternitz (Montréal).

"Wavelets 2005," VIIth International Workshop on Wavelets, Differential Equations, and Quantization
February 21–25, 2005, University of Havana
Organizer: Syed Twareque Ali (Concordia).

Research in teams program "Random Matrices, Multi-orthogonal Polynomials and Riemann–Hilbert Problems"
April 30–May 14, 2005, BIRS
Organizer: John Harnad (Concordia).

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.

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

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 ode's and boundary-value problems.

Jacques Hurtubise (McGill)
Algebraic geometry, integrable systems, gauge theory, moduli spaces.

Véronique Hussin (Montréal)
Group theory, Lie algebra and application in physics, supersymmetries in classic and quantum mechanics.

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

Vojkan Jaksic (McGill)
Mathematical physics, quantum statistical mechanics, random Schrödinger operators.

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

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

Jean LeTourneux (Montréal)
Symmetry properties of systems, special functions.

Pierre Mathieu (Laval)
Conformal field theory, classical and quantum integrable systems, affine Lie algebras.

Jiří Patera (Montréal)
Applications of group theory, quasi-crystals, Lie algebras.

Yvan Saint-Aubin (Montréal)
Conformal field theory, statistical mechanics, 2-dimensionalphase transition model.

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

Luc Vinet (McGill)
Symmetric properties of systems, special functions.

Pavel Winternitz (Montréal)
Methods of group theory in physics, nonlinear phenomena, symmetries of difference equations, superintegrability.

Associate members

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

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

Carolyne Van Vliet (Miami)
Non-equilibrium statistical mechanics, fluctuations and stochastic processes, quantum transport in condensed matter, electronic behavior in submicron quantum devices.

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

PhysNum

PhysNum 

Description du laboratoire

En tant que laboratoire propre au CRM, PhysNum est un laboratoire dont une grande part des activités de recherche est hébergée par le CRM. Cette particularité, qui contribue à la visibilité du Centre dans le champ des mathématiques appliquées, explique sa taille relativement réduite par rapport à l'étendue de ses collaborations dans les milieux de la neuro-imagerie à Montréal et ailleurs : le Regroupement Neuroimagerie Québec (piloté par Yves Joanette et Julien Doyon), le GRENE (dirigé par Franco Lepore, Département de psychologie, Montréal) et le groupe d'Imagerie Quantitative de l'Unité 494 de l'INSERM (Paris), (dirigé par Habib Benali). La plupart des ressources financières sont consacrées à des étudiants qui poursuivent leur recherche au CRM. Notre recherche avec ces groupes porte sur l'imagerie mathématique, essentiellement dans le domaine médical, avec les thèmes suivants :

- l'analyse et la modélisation en ondelettes (formalisme thermodynamique, modèles graphiques),

- l'analyse fractale et multifractale (analyse des matériaux, angiogénèse, signaux turbulents),
- l'approche probabiliste pour la résolution de problèmes inverses (inférence par Maximum d'Entropie, graphes d'indépendance).

Ces outils sont utilisés dans plusieurs domaines cliniques et cognitifs. Les différentes équipes, mentionnées plus haut, centrées sur la neurologie, sont intéressées à voir se développer de la "méthodologie fine" dans leur problématique et donc, une interaction à long terme avec notre équipe est envisagée.

Principaux thèmes de recherche du laboratoire pour l'année 2004–2005

Maximum d'entropie et inférence en Magnéto-EncéphaloGraphie (MEG)

Le travail a porté sur la version "bayésien empirique" du MEM qui permet de mieux contrôler la loi de référence présente dans le formalisme du MEM. Des algorithmes itératifs, proches d'algorithmes d'apprentissage de type EM (Expectation-Maximisation), ont été évalués sur des simulations en MEG à temps fixe et sur des données EEG en épilepsie. Le formalisme du maximum d'entropie continue de démontrer sa stabilité et sa robustesse dans l'estimation des sources dipolaires distribuées (10 000 sources) sur le cortex (Erwig Lapalme, Jean-Marc Lina, Jérémie Mattout, 2005). Dernière étape dans ce volet de recherche, l'estimation des séries temporelles en MEG et l'évaluation des performances du MEM sur des données réelles sont actuellement en cours et font l'objet de la rédaction d'un article (Erwig Lapalme, Jean-Marc Lina, Bernard Goulard, 2005). Les travaux ont fait l'objet de la thèse de doctorat d'Erwig Laplame (directeurs : Jean-Marc Lina, Bernard Goulard).

Estimateur du signal EEG en présence d'artefacts oculaires

Ce volet de recherche est une collaboration entre PhysNum (Lina, Goulard, Basile-Bellavance) et le département de Pédo-psychiatrie de l'Hôpital Sainte-Justine (Robey, Liang, Basile-Bellavance). Le problème consiste à réduire le nombre de répétitions de stimuli dans les expériences EEG en neuropsychiatrie chez les enfants, en proposant une méthode robuste de détection et d'élimination des artefacts oculaires dans les signaux. Ces artefacts sont la principale source de difficulté d'interprétation des signaux, voire du rejet des mesures. Le contrôle oculaire chez les jeunes enfants demeurant difficile a obtenir, la solution proposée par la collaboration consiste a détecter les mouvements oculaires dans les signaux bruts projetés dans le plan temps-échelle par une analyse en ondelettes continues. Les évaluations de la méthode sur des signaux cliniques démontrent que celle-ci permet de mieux interpréter les expériences, avec beaucoup moins de signaux collectés.

Localisation de sources en MEG/EEG

La détection des activités cérébrales en IRMf et EEG/MEG reste un problème ouvert. En effet, en IRMf, les modèles linéaires multidimensionnels, actuellement utilisés, ne prennent pas en compte les corrélations spatio-temporelles du bruit présent dans les données. Souvent, ces corrélations ne peuvent être négligées car elles risquent d'engendrer une mauvaise estimation de la carte d'activité fonctionnelle. Pour en tenir compte, nous avons récemment proposé des modèles non séparables de covariance spatio-temporelle du bruit et calculé des cartes statistiques d'activation plus robustes. En MEG, pour extraire les distributions spatio-temporelles des activités neurales, nous avons montré, au travers de la thèse de Jérémie Mattout (directeurs : Habib Benali, Line Garnero), l'intérêt de combiner les informations spatiales issues de l'IRMf et les informations temporelles issues du signal MEG. Ce travail se poursuit actuellement à partir d'acquisitions simultanées IRMf/EEG et fait l'objet de la thèse de doctorat de Jean Daunizeau (Thèse en cotutelle avec l'Université de Montréal ; directeurs : Habib Benali, Jean-Mark Lina et Bernard Goulard). L'intégration des informations IRMf (imagerie de Résonance Magnétique Nucléaire fonctionnelle) dans la détection de sources en MEG/EEG (Magnéto-Electro-Encéphalographie) est l'objectif de ce volet de recherche. L'étude d'une méthodologie d'inférence sur le décours temporel des sources d'un modèle dipolaire distribué, capable de prendre en compte des connaissances a priori multimodales, est actuellement dans sa phase d'évaluation de performance. Le modèle retenu par Jean Daunizeau (doctorant en cotutelle entre Montréal et Paris 11, codirection Benali, Goulard, Lina) s'apparente à celui développé dans le cadre du Maximum d'entropie en exprimant la dépendance temporelle à l'échelle de « par-

celles » (construites à partir des données) qui contiennent des sources élémentaires qui sont contrastées localement par la méthode d'inférence (Daunizeau, Mattout, Goulard, Lina, Benali, 2004). Soulignons que ces méthodes ont fait l'objet d'une évaluation de performance dans un cas clinique bien défini (Grova, Daunizeau, Lina, Benali, Gotman, 2004, 2005).

Activité 2005 liée à ce thème :

Atelier (deux journées) **Inférence bayésienne et Imagerie cérébrale** (en collaboration avec Jean-François Angers)
Conférenciers : Ali Mohammad-Djafari (SupElec, France), Charles A. Bouman (Purdue, USA), Christophe Phillips (Liège, Belgique), Keith Worsley (McGill), Christophe Grova (McGill), Jean Daunizeau (Montréal).

Atelier qui mit l'accent sur la modélisation de l'activité cérébrale et les aspects liés à la connectivité. Aspects méthodologiques et implémentation numérique. Les détails de l'activité peuvent être trouvés au chapitre « Programme général ».

Études de la connectivité fonctionnelle en IRMf

Les modèles pour l'étude des connectivités entre populations de neurones à partir du signal IRMf et MEG/EEG sont en plein essor. La connectivité fonctionnelle est définie comme étant la corrélation entre deux régions du cerveau. Afin de mesurer les connectivités directes entre régions, nous avons introduit une nouvelle définition de la connectivité qui donne un rôle central à la notion de corrélation partielle. Nous avons proposé un modèle théorique original, auto-adaptatif aux données et guidé par des connaissances a priori sur le réseau fonctionnel étudié. Ce modèle repose sur les modèles graphiques d'association et le principe de l'échantillonnage bayésien. Il permet une évaluation statistique rapide et robuste des différents graphes de connectivité possibles. Cette méthode a été validée sur des données de simulation et des données réelles issues de protocoles cognitifs. Nous la validons actuellement sur des données cliniques (chirurgie de tumeurs cérébrale). Ce travail a fait l'objet de la thèse de G. Marrelec (directeur : H. Benali). Le modèle de connectivité développé nécessite l'identification préalable du réseau de régions fonctionnellement connectées. Pour ce faire, nous avons développé une méthode de détection du réseau spatial basée sur le calcul des corrélations entre les fluctuations lentes du signal IRMf (< 0.1 Hz) et le signal d'une région « cible » préalablement identifiée. Ainsi, nous avons pu construire un réseau de régions plus étendu que celui de la carte d'activation, et indépendant de la tâche sensori-motrice considérée. Seul, le niveau de corrélation entre les noeuds du réseau identifié semble varier d'une tâche à l'autre. Ce travail fait l'objet de la thèse de Pierre Bellec (directeur : Habib Benali).

Membres du laboratoire

Durant l'année 2004–2005, 2 étudiants à la maîtrise et 4 étudiants au doctorat ont été encadrés par les membres québécois du laboratoire.

Membres réguliers

Jean-Marc Lina (ETS) *responsable*
Ondelettes, modélisation statistique et imagerie cérébrale, algorithmes d'apprentisage.

Alain Arnéodo (CNRS)
Fractales et ondelettes.

Habib Benali (CHU Pitié-Salpêtrière)
Analyse quantitative en imagerie cérébrale, imagerie médicale et systèmes multi-modaux

Line Garnero (CHU Pitié-Salpêtrière)
Magnéto-Encéphalo-Graphie (MEG)

Bernard Goulard (Montréal)
Imagerie cérébrale

Fahima Nekka (Montréal)
Analyse fractale, systèmes poreux, ondelettes

Frédéric Lesage (Montréal)
Théorie conforme, systèmes intégrables, problèmes inverses imagerie optique.

Membre associé

Keith J. Worsley (McGill)
Géométrie et analyse d'images aléatoires en médecine et en astrophysique

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 been undergoing a revolution in its techniques and its approaches. This revolution has been driven by the need to analyze very large data sets, data with more complex structure, and by the advent of powerful computers. For example, statistical methodology is now addressing problems whose structure is more complex, such as brain images or genome data and new methodology is developed for large data sets. Data-mining is one of the tools used. The laboratory aims at structuring the Québec community to engage with this revolution at a time of an important renewal of academic personnel. This structure allows the Québec community to benefit from a new pan-Canadian program in analysis of complex data organized by the three Canadian mathematics institutes. The laboratory is composed of the leaders of the Québec school of statistics who work on subjects 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, as well as resampling methods.

Activities of the laboratory in 2004–2005

Workshops, special sessions and others

Many activities organized by the Statistic Laboratory were held in Montréal and in Québec in 2004–2005. A detailed description of these activities can be found in the "General Program" and the "Joint Initiatives" sections of this report.

The annual meeting of the Statistical Society of Canada took place at the CRM in June 2004. The Program Committee was chaired by Christian Genest; Local Arrangements were coordinated by Christian Léger. Many commented on the highquality of several aspects of the meeting organized by "the two Christian" Meeting. Notably, with more than 550 participants, it was financially the most profitable.

The Laboratory is proud of its association with the PhysNum Laboratory in the organization of the joint Workshop "Bayesian Inference and Functional Brain mapping." Organized by Jean-François Angers and Jean-Marc Lina, this two-day workshop attended by 30 participants, aimed to promote interaction between the specialists and researchers in functional brain imagery.

The Laboratory organizes NPCDS workshops in collaboration with the Fields and PIMS and is involved in its research projects. The Workshop on "Latent Variable Models and Survey Data for Social and Health Sciences Research" organized by the NPCDS, in collaboration with SAMSI, took place at the CRM in May 2005. With more than 80 participants coming from the Netherlands, the United Kingdom, the United States and the Canada, the workshop was a success, notably considering the diversity of the participants. Beside the experienced researchers participation, the workshop was also attended by scientists working in statistical agencies, for instance: Statistique Canada, US Census Bureau, Bureau of Labor Statistics, together with research groups such as the Research Unit on Children's Psychosocial Maladjustment (GRIP) and la Direction de santé publique (Québec).

The major scientific activity of the laboratory this year was the Quatrième Colloque francophone sur les sondages held in Québec City in May. With more than 225 participants, this international Congress welcomed world-renowed specialists in survey methods. The Scientific Committee was chaired by Louis-Paul Rivest; Thierry Duchesne and Christian Léger were members of the Organizing Committee. Proceedings will be published.

Seminars

The scientific life of the laboratory is fed, on a weekly basis, with the CRM–ISM–GERAD Statistics Colloquium in Montréal and the Statistics Seminar at Université Laval. As one can see, GERAD joined CRM and ISM in the financial support and the organization of the Statistics Colloquium. This collaboration between CRM and GERAD is mutually beneficial for the two centres and their members. The complete list of the talks is given in page 28 of this report.

Members of the laboratory

Highlights of its members

- This year, ten new members joined the laboratory: Belkacem Abdous (Laval), Masoud Asgharian (McGill), Pierre Duchesne (Montréal), Thierry Duchesne (Laval), Charles Dugas (UdeM), Debbie Dupuis (HEC), Sorana Froda (UQÀM), Arush Sen (Concordia), Russ Steele (McGill) and Alain Vandal (McGill).
- During its annual meeting in June, the Statistical Society of Canada (SSC) granted a Gold Medal to Keith Worsley. This Medal is awarded to a Canadian mathematician in recognition of his exceptional achievement and work in Statistics. He gave a lecture at the SSC meeting.
- In December, Russ Steele, Alain Vandal and David Wolfson organized a session on "Mathematical Methods in Statistics" during the Winter 2004 Meeting of the Canadian Mathematic Society. There was a strong participation from the members of the laboratory.

During the year 2004–2005, 63 master's students, 44 Ph.D. students and 4 postdoctoral fellows were supervised by laboratory members.

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, change-point Problems, simulated annealing and its variants, optimization.

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

Martin Bilodeau (Montréal)
Multivariate analysis, decision theory, asymptotic methods.

Yogendra 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 Dupuis (HEC)
Extreme values, robustness.

René Ferland (UQÀM)
Probability, statistic processes, applications to mathematical finance.

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 (HEC Montréal)
Probability, 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.

Arush Sen (Concordia)
Statistical inference of truncated data, nonparametric function estimation.

Russ Steele (McGill)
Bayesian approaches to mixing modeling, multiple imputation.

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

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.

AMS
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.

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.

AMS
CRM Proceedings & Lecture Notes

Vestislav Apostolov, Andrew Dancer, Nigel Hitchin & McKenzie Wang (eds.), *Perspectives in Comparison, Generalized and Special Geometry* (to appear).

Pavel Winternitz, David Gomez-Ullate, Arieh Iserles, Decio Levi, Peter J. Olver, Reinout Quispel, & Piergiulio Tempesta, *Group Theory and Numerical Analysis*, vol. 39, 2005.

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

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

Hershy Kisilevsky & Eyal Z. Goren, *Number Theory*, vol. 36, 2004.

H. E. A. Eddy Campbell & David L. Wehlau, *Invariant Theory in All Characteristics*, vol. 35, 2004.

Pavel Winternitz, John Harnad, C.S. Lam & Jirí Patera, *Symmetry in Physics*, vol. 34, 2004.

Previous Titles

AMS
CRM Monograph Series

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.

AMS
CRM Proceedings & Lecture Notes

André D. Bandrauk, Michel C. Delfour & Claude Le Bris (eds.), *Quantum Control*: *Mathematical and Numerical Challenges*, vol. 33, 2003.

Vadim B. Kuznetsov (ed.), *The Kowalevski Property*, vol. 32, 2002.

John Harnad & Alexander R. Its (eds.), *Isomonodromic Deformations and Applications in Physics*, vol. 31, 2002

John McKay & Abdellah Sebbar (eds.), *Proceedings on Moonshine and Related Topics*, vol. 30, 2001.

Alan Coley, Decio Levi, Robert Milson, Colin Rogers & Pavel Winternitz (eds.), *Bäcklund and Darboux Transformations*, vol. 29, 2001.

John C. Taylor (ed.), *Topics in Probability and Lie Groups*: *Boundary Theory*, vol. 28, 2001.

Israel M. Sigal & Catherine Sulem (eds.), *Nonlinear Dynamics and Renormalization Group*, vol. 27, 2001.

John Harnad, Gert Sabidussi & Pavel Winternitz (eds.), *Integrable Systems*: *From Classical to Quantum*, vol. 26, 2000.

Decio Levi & Orlando Ragnisco (eds.), *SIDE* III — *Symmetry and Integrability of Difference Equations*, vol. 25, 2000.

B. Brent Gordon, James D. Lewis, Stefan Müller-Stach, Shuji Saito & Noriko Yui (eds.), *The Arithmetic and Geometry of Algebraic Cycles*, vol. 24, 2000.

Pierre Hansen & Odile Marcotte (eds.), *Graph Colouring and Applications*, vol. 23, 1999.

Jan Felipe van Diejen & Luc Vinet (eds.), *Algebraic Methods and q-Special Functions*, vol. 22, 1999.

Michel Fortin (ed.), *Plates and Shells*, vol. 21, 1999.

Katie Coughlin (ed.), *Semi-Analytic Methods for the Navier – Stokes Equations*, vol. 20, 1999.

Rajiv Gupta & Kenneth S. Williams (eds.), *Number Theory*, vol. 19, 1999.

Serge Dubuc & Gilles Deslauriers (eds.), *Spline Functions and the Theory of Wavelets*, vol. 18, 1999

Olga Karlampovich (ed.), *Summer School in Group Theory in Banff*, 1996, vol. 17, 1998.

Alain Vincent (ed.), *Numerical Methods in Fluid Mechanics*, vol.16, 1998.

François Lalonde (ed.), *Geometry, Topology and Dynamics*, vol. 15, 1998.

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

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

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

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

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

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

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

Joel S. Feldman, Richard Froese, & Lon M. Rosen (eds.), *Mathematical Quantum Theory* I: *Field Theory and Many-Body Theory*, vol. 7, 1994.

Guido Mislin (ed.), *The Hilton Symposium* 1993, vol. 6, 1994.

Donald A. Dawson (ed.), *Measure-Valued Processes, Stochastic Partial Differential Equations and Interacting Systems*, vol. 5, 1994.

Hershy Kisilevsky & M. Ram Murty (eds.), *Elliptic Curves and Related Topics*, vol. 4, 1994.

Andrei L. Smirnov & Rémi Vaillancourt (eds.), *Asymptotic Methods in Mechanics*, vol. 3, 1993.

Philip D. Loewen, *Optimal Control via Nonsmooth Analysis*, vol. 2, 1993.

M. Ram Murty (ed.), *Theta Functions*, vol. 1, 1993.

Springer
CRM Series in Mathematical Physics

David Sénéchal, André-Marie Tremblay & Claude Bourbonnais, *Theoretical Methods for Strongly Correlated Electrons*, 2003.

*Roman Jackiw, *Lectures on Fluid Dynamics*, 2002.

Yvan Saint-Aubin & Luc Vinet (eds.), *Theoretical Physics at the End of the Twentieth Century*, 2001.

Yvan Saint-Aubin & Luc Vinet (eds.), *Algebraic Methods in Physics*, 2000.

Jan Felipe van Diejen & Luc Vinet (eds.), *Calogero – Moser – Sutherland Models*, 1999.

Robert Conte (ed.), *The Painlevé Property*, 1999.

Richard MacKenzie, Manu B. Paranjape & Wojciech J. M. Zakrzewski (eds.), *Solitons*, 1999.

Luc Vinet & Gordon Semenoff (eds.), *Particles and Fields* (Banff, 1994), 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.

Maximilian Ya. Antimirov, Andrei A. Kolyshkin & Rémi Vaillancourt, *Mathematical Models for Eddy Current Testing*, 1998.

Xavier Fernique, *Fonctions aléatoires gaussiennes, vecteurs aléatoires gaussiens*, Montréal, 1997.

Faqir Khanna & Luc Vinet (eds.), *Field Theory, Integrable Systems and Symmetries*, Montréal, 1997.

Paul Koosis, *Leçons sur le théorème de Beurling at Malliavin*, 1996.

David W. Rand, *Concorder Version Three*, 1996 (software and user guide).

Jacques Gauvin, *Theory of Nonconvex Programming*, 1994.

Decio Levi, Curtis R. Menyuk & Pavel Winternitz (eds.), *Self-Similarity in Stimulated Raman Scattering*, 1994.

Rémi Vaillancourt, *Compléments de mathématiques pour ingénieurs Montréal*, 1993.

Robert P. Langlands & Dinakar Ramakrishnan (eds.), *The Zeta Functions of Picard Modular Surfaces*, 1992.

Florin N. Diacu, *Singularities of the N-Body Problem*, 1992.

Jacques Gauvin, *Théorie de la programmation mathématique non convexe*, 1992.

Pierre Ferland, Claude Tricot, & Axel van de Walle, *Analyse fractale*, 1992 (software and user guide).

Stéphane Baldo, *Introduction à la topologie des ensembles fractals*, 1991.

Robert Bédard, *Groupes linéaires algébriques*, 1991.

Rudolf Beran & Gilles R. Ducharme, *Asymptotic Theory for Bootstrap Methods in Statistics*, 1991.

James D. Lewis, *A Survey of the Hodge Conjecture*, 1991.

David W. Rand & Tatiana Patera, *Concorder*, 1991 (software and user guide).

David W. Rand & Tatiana Patera, *Le Concordeur*, 1991 (software and user guide).

Véronique Hussin (ed.), *Lie Theory, Differential Equations and Representation Theory*, 1990.

John Harnad & Jerrold E. Marsden (eds.), *Hamiltonian Systems, Transformation Groups and Spectral Transform Methods*, 1990.

M. Ram Murty (ed.), *Automorphic Forms and Analytic Number Theory*, 1990.

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

Anthony W. Knapp, *Representations of Real Reductive Groups*, 1990.

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

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

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

*Yuri I. Manin, *Quantum Groups and Noncommutative Geometry*, 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* 20*th Century*, 1997.

Serge Lang, *Les grands courants*, 1991

Robert Bédard, *Brouiller les cartes*, 1991.

Serge Lang, *Les équations diophantiennes*, 1991.

Laurent Schwartz, *Le mouvement brownien*,1990.

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

CRM Preprints

Bertola, M., Eynard, B., Harnad, J., *Semiclassical orthogonal polynomials, matrix models and isomonodromic tau functions*, Centre de recherches mathématiques, CRM-3169, October 2004; arXiv:nlin.SI/0410043.

Bertola, M., Gekhtman, M., *Biorthogonal Laurent polynomials, Töplitz determinants, minimal Toda orbits and isomonodromic tau functions*, Centre de recherches mathématiques, CRM-3182, March 2005.

Cornea, O., Lalonde, F., *A universal Floer theory, localization and applications*, Centre de recherches mathématiques, CRM-3172, 2004.

Dryanov, D., Fournier, R., *On a discrete variant of Bernstein's polynomial inequality*, Centre de recherches mathématiques, CRM-3178, January 2005.

El Boukili, A., Madrane, A., Vaillancourt, R., *Multifrontal solution of sparse unsymmetric matrices arising from semiconductor equations*, Centre

de recherches mathématiques, CRM-3125, June 2004.

Ghidaoui, M. S., Kolyshkin, A. A., Vaillancourt, R., *Transient turbulent flow in a pipe*, Centre de recherches mathématiques, CRM-3176, January 2005.

Grundland, A. M., Strasburger, A., Zakrzewski, W. J. M., *Surfaces immersed in* $\mathrm{su}(N+1)$ *Lie algebras obtained from the* CP^N *sigma models*, Centre de recherches mathématiques, CRM-3180, February 2005.

Mélard, G., Roy, R., Saidi, A., *Exact maximum likelihood estimation of structured or unit root multivariate time series models*, Centre de recherches mathématiques, CRM-3129, June 2004.

Nguyen-Ba, T., Kolyshkin, A. A., Vaillancourt, R., *Hermite–Birkhoff differential equation solvers*, Centre de recherches mathématiques, CRM-3175, December 2004.

Ratnarajah, T., Vaillancourt, R., *Quadratic forms on complex random matrices and channel capacity*, Centre de recherches mathématiques, CRM-3126, June 2004.

Ratnarajah, T., Vaillancourt, R., Alvo, M., *Complex random matrices and Rician channel capacity*, Centre de recherches mathématiques, CRM-3174, October 2004.

Rousseau, C., Christopher, C., *Modulus of analytic classification for the generic unfolding of a codimension one resonant diffeomorphism or resonant saddle*, Centre de recherches mathématiques, CRM-3167, September 2004.

Saidi, A., *Consistent testing for independence of two partially nonstationary vector ARMA time series*, Centre de recherches mathématiques, CRM-3173, November 2004.

Schlomiuk, D., Vulpe, N., *Integrals and phase portraits of planar quadratic differential systems of invariant lines of at least five total multiplicity*, Centre de recherches mathématiques, CRM-3181, March 2005.

Schlomiuk, D., Vulpe, N., *The full study of planar quadratic differential systems possessing exactly one line of singularities, finite or infinite*, Centre de recherches mathématiques, CRM-3183, April 2005.

Yoshikawa, M., Gong, Y., Ashino, R., Vaillancourt, R., *Case study on SVD multiresolution analysis*, Centre de recherches mathématiques, CRM-3179, January 2005.

Zhao, M., Ghidaoui, M. S., Kolyshkin, A. A., Vaillancourt, R., *On the stability of oscillatory pipe flows*, Centre de recherches mathématiques, CRM-3168, October 2004.

For other preprints by CRM members see page 90.

Scientific Personnel

CRM Members in 2004-2005

IN contrast with most other mathematics institutes around the world, the CRM can count on the solid foundation of regular, associate and invited members. Regular members are all professors at partner institutions: Université de Montréal, Concordia University, McGill University, UQÀM, Université Laval, Université de Sherbrooke and the University of Ottawa. Other members are researchers attached to the CRM in 2004–2005 as part of exchange agreements with neighbouring universities and industry or are long-term visitors from Canadian and foreign institutions. The presence at the CRM of such an active group of researchers has brought many benefits to the Centre. In particular, the CRM's national program is greatly facilitated by having on hand a large reserve of willing organizers, who have even contributed financially to the organization of activities. The largest partnership is with the Université de Montréal, which gives the equivalent of five fulltime teaching positions in release time to the CRM. Release agreements with the other Montréal area universities provide for the equivalent of two more full-time positions. Facilities are also provided to researchers attached to junior colleges. Several members are attached to the CRM through industrial agreements.

Regular Members

Syed Twareque Ali, Concordia
Vestislav Apostolov, UQÀM
Paul Arminjon, Montréal
André D. Bandrauk, Sherbrooke
Line Baribeau, Laval
Peter Bartello, McGill
Robert Bédard, UQÀM
Jacques Bélair, Montréal
Habib Benali, INSERM
Yoshua Bengio, Montréal
Anne Bergeron, UQÀM
François Bergeron, UQÀM
Marco Bertola, Concordia
Yves Bourgault, Ottawa
Anne Bourlioux, Montréal
Steven Boyer, UQÀM
Gilles Brassard, Montréal
Abraham Broer, Montréal
Robert C. Brunet, Montréal
David Bryant, McGill
Vašek Chvátal, Concordia
Francis H. Clarke, Lyon I
Olivier Collin, UQÀM
Claude Crépeau, McGill
Miklós Csűrös, Montréal
Chris Cummins, Concordia
Galia Dafni, Concordia
Henri Darmon, McGill
Chantal David, Concordia
Michel C. Delfour, Montréal
Eusebius J. Doedel, Concordia
Rachida Dssouli, Concordia
Nadia El-Mabrouk, Montréal
Marlène Frigon, Montréal
Martin J. Gander, Gèneve and McGill
Paul M. Gauthier, Montréal
Eyal Z. Goren, McGill
Bernard Goulard, Montréal
Andrew Granville, Montréal
Alfred Michel Grundland, UQTR
Gena Hahn, Montréal
Richard L. Hall, Concordia
Michael Hallett, McGill
John Harnad, Montréal
Antony R. Humphries, McGill
Jacques Hurtubise, McGill
Véronique Hussin, Montréal
Adrian Iovita, Concordia
Dmitry Jakobson, McGill
Vojkan Jaksic, McGill
Niky Kamran, McGill
Olga Kharlampovich, McGill
Hershy Kisilevsky, Concordia
Paul Koosis, McGill
Dmitry Korotkin, Concordia
Gilbert Labelle, UQÀM
Jacques Labelle, UQÀM
François Lalonde, Montréal

Robert P. Langlands, Institute for Advanced Study
Christian Léger, Montréal
Pierre Leroux, UQÀM
Frédéric Lesage, Polytechnique Montréal
Sabin Lessard, Montréal
Jean LeTourneux, Montréal
Claude Levesque, Laval
Jean-Marc Lina, ETS
Brenda MacGibbon, UQÀM
François Major, Montréal
Vladimir Makarenkov, UQÀM
Michael Makkai, McGill
Patrice Marcotte, Montréal
Javad Mashreghi, Laval
Sherwin A. Maslowe, McGill
Pierre Mathieu, Laval
John McKay, Concordia
Alexei G. Miasnikov, McGill
Nilima Nigam, McGill
Jiří Patera, Montréal
Iosif Polterovich, Montréal
Thomas J. Ransford, Laval
Christophe Reutenauer, UQÀM
Ivo G. Rosenberg, Montréal
Christiane Rousseau, Montréal
Roch Roy, Montréal
Peter Russell, McGill
Gert Sabidussi, Montréal
Yvan Saint-Aubin, Montréal
David Sankoff, Ottawa
Dana Schlomiuk, Montréal
E.J.P. Georg Schmidt, McGill
Alexander Shnirelman, Concordia
Ron J. Stern, Concordia
John A. Toth, McGill
Luc Vinet, McGill
Pavel Winternitz, Montréal
Daniel T. Wise, McGill
Keith J. Worsley, McGill

Associate Members

Liliane Beaulieu, Vieux-Montréal
Nantel Bergeron, York
Robert Conte, CEA Saclay
Stéphane Durand, Édouard-Montpetit
Richard Fournier, Dawson and Montréal
Decio Levi, Roma Tre
Fahima Nekka, Montréal
Yannis N. Petridis, CUNY-Lehman College
Elisa Shahbazian, Lockheed Martin
Francisco Thaine, Concordia
Pierre Valin, Défense Canada-Valcartier
Carolyne M. Van Vliet, Miami
Jean-Paul Zolésio, INRIA Sophia-Antipolis

Invited Members

Jean-François Angers, Montréal
Octav Cornea, Montréal
Louis G. Doray, Montréal
Pierre Duchesne, Montréal
Charles Dugas, Montréal
Jun Li, Montréal
François Perron, Montréal
Damien Roy, Ottawa
Abdellah Sebbar, Ottawa

Postdoctoral Fellows

Each year the CRM plays host to a great number of postdoctoral fellows. The sources for their funding include the NSERC and FQRNT postdoctoral programs, the NATO international program administered by NSERC, the CRM (usually 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 is that where their doctoral degree was obtained.

Alain Bourget, McMaster University

Abdellatif Bourhim, Université Mohammed V

Guillaume Bourque, University of Southern California

Peter S. Campbell, University of Alberta

Raquel Casesnoves, Université de Montréal

Stéphane Dellacherie, Université de Paris VII

Mostafa Gabbouhy, Université Ibn Tofaïl

David T. Gay, University of California at Berkeley

Yoshitaka Hachimori, University of Tokyo

Harald Andres Helfgott, Princeton University

Alexander Ivrii, Stanford University

Sergei Krutelevich, Yale University

Marcelo Lanzilotta Mernies, Stanford University

Tony Lelièvre, École nationale des ponts et chaussées

Jun Li, Université de Montréal

Peter McNamara, Massachusetts Institute of Technology

Marco Merkli, University of Toronto

Man Yue Mo, Oxford University

Ramin Mohammadalikhani, University of Toronto

Chadi Nour, Université de Lyon I

Ambrus Pal, Columbia University

Yan Pautrat, Université de Grenoble I

Bélà Gabor Pusztai, University of Szeged

Mario Roy, Universität Göttingen

Anupam Saikia, University of Cambridge

Mohamed Noureddine Senhadji, Université d'Oran

Libor Snobl, Czech Technical Institute

Shannon Lee Starr, University of California at Davis

Phi Long Thanh (Nguyen), Columbia University

Ye Tian, Columbia University

Stephan Tillmann, University of Melbourne

Michèle Suzanne Titcombe, University of British Columbia

José Manuel Urquiza, Université de Paris VI

Dimiter Vassilev, Purdue University

Ismet Yurdusen, Middle East Technical University

Alexander Zhalij, Institute of Mathematics, Kiev

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 2004-2005, 348 such participants registered for workshops of the thematic program, 728 in activities of the general program and 324 in those of the industrial and multidisciplinary program. The following list includes only visitors who were in residence for at least four weeks:

Huzihiro Araki, Kyoto

Harry W. Braden, Edinburgh

Laurent Bruneau, Warsaw

Pierre Charollois, Bordeaux I

Monica-Gabriela Cojocaru, Queen's

Robert Conte, CEA Saclay

Stephan De Bièvre, Lille I

Jan Derezinski, Warsaw

Alain Desgagné, Drake

Amine El Gradechi, Artois

Ibrahim Fatkullin, Caltech

Alexander Fedotov, ITEP Moscou

Mark Fels, Utah State

André Garon, Polytechnique Montréal

Michael Gekhtman, Notre Dame

Rajendra Gurjar, Tata Institute

Bernard Helffer, Paris Sud

Thomas Yizhao Hou, Caltech

Alexander Its, IUPU Indianapolis

Yael Karshon, Toronto

Ely Kerman, Illinois at Urbana-Champaign
Boualem Khouider, Victoria
Frédéric Klopp, Paris XIII
Alexey Kokotov, Concordia (LTA)
Pierre Lafaye de Micheaux, Grenoble II
Yoram Last, Hebrew
Claude Le Bris, ENPC
Claude LeBrun, SUNY Stony Brook
Decio Levi, Roma Tre
Michael Levitin, Heriot-Watt
Andrew J. Majda, Courant Inst.
Kayo Masuda, Himeji Institute of Technology
Masayoshi Miyanishi, Kwansei Gakuin
Nikolai Nadirashvili, Chicago
Soghra Nobakhtian, Isfahan
Renata Otahalova, Silesia
Lubomir Pekar, Faculty Hospital Motol
Claude-Alain Pillet, Toulon
Mohamad Reza Pouryayevali, Isfahan
Igor Rivin, Temple
Stephan Ruscheweyh, Würzburg
Pavle Saksida, Ljubljana
Gerald Schmieder, Oldenburg
Artur Sergyeyev, Silesia
Jean-Claude Sikorav, ENS Lyon
Panagiotis Souganidis, Texas A&M
Piergiulio Tempesta, SISSA Trieste
Loïc Teyssier, Strasbourg
Marc Thiriet, INRIA Rocquencourt
Zora Thomova, SUNY Syracuse
Jiri Tolar, Czech Technical Institute
Eric Vanden-Eijnden, Courant Inst.
Nicolae Vulpe, Academy of Sciences, Moldova
Eduardo Santillan Zeron, Cinvestav-IPN
Jean-Paul Zolésio, INRIA Sophia-Antipolis

Short-term Visitors

Visitors who were in residence for less than four weeks:

Casim Abbas, Michigan State
Michael T. Anderson, SUNY Stony Brook
Silvia Anjos, Instituto Superior Technico
Meenaxi Bhattacharjee, Würzburg
Michel Bernadou, Pôle universitaire Léonard de Vinci
Anne-Laure Biolley, Toronto
Olivier Biquard, Strasbourg
Frédéric Bourgeois, UL Bruxelles
Charles P. Boyer, New Mexico
Robert Bryant, Duke
Leonid Chekhov, Steklov Mathematical Institute
Andrew Dancer, Oxford
Hassan Doosti, Mashhad
C. Eilbeck, Celera Genomics
Yakov Eliashberg, Stanford
Misha Entov, Institut Weizmann
Alexandre Ern, ENPC
Catalin Fetita, Institut National des Télécommunications
Felix Finster, Regensburg
Eric Friedlander, Northwerstern
Line Garnero, Hôpital de la Salpêtrière
Paul Gauduchon, École Polytechnique Palaiseau
Jean-Pierre Gazeau, Paris VII
Peter Gibson, Toronto
Victor Ginzburg, UC Santa Cruz
Peter Glynn, Stanford
Daniel R. Grayson, Illinois at Urbana-Champaign
Karsten Grove, Maryland
Alexander Gutfraind, Waterloo
Gergely Harcos, UT Austin
Kevin Hare, Waterloo
Samvel Haroutiunian, Yerevan State University
Richard Hind, Notre Dame
Nigel J. Hitchin, Oxford
Rick Jardine, Western Ontario
George Kesidis, Penn State
Manfred Kolster, McMaster
Vladimir E. Korepin, SUNY Stony Brook
Olivier Lafitte, Paris XIII

Michael Lamoureux, Calgary
Jibin Li, Kunning University of Science and Technology
Chiu-Chu Liu, Harvard
Joachim Lohkamp, Augsburg
Grégoire Malandain, INRIA
Gary Margrave, Calgary
Dusa McDuff, SUNY Stony Brook
Arian Novruzi, Ottawa
Tom Osborn, Manitoba
Charles Peskin, Courant Inst.
Martin Pinsonnault, Fields Inst.
Alexandru-Anton Popa, Princeton
Emma Previato, Boston
Sophia Rabe-Hesketh, UC Berkeley
Yongbin Ruan, UW Madison
Simon Salamon, Imperial College London
Paul Seidel, Chicago
Anders Skrondal, London School of Economics
Raj Srinivasan, Saskatchewan
Andrei Teleman, Aix-Marseille I
Mary E. Thompson, Waterloo
Alexander Turbiner, UNAM
Ravi Vakil, Stanford
Stephanos Venakides, Duke
McKenzie Y. Wang, McMaster
Katrin Wehrheim, ETH Zürich
Jean-Yves Welschinger, ENS Lyon
Hongmei Zhu, York

Preprints and Research Reports

THE quality of the CRM members' research can be measured by the abundance of their scientific publications. Here follows a list of research reports, preprints and articles submitted during 2004–2005.

Aberkane, A., Brlek, S., *Sequences with complexity given by that of Thue-Morse*, Discrete Mathematics, submitted.

Ali, S. T., Bagarello, F., *Some physical appearances of vector coherent states and CS related to degenerate Hamiltonians*, Journal of Mathematical Physics, 46 (May 2005), 053518.

Anjos, S., Lalonde, F., *The homotopy type of the space of symplectic balls in S^2XS^2 above the critical value*, arXiv:math.SG/0406129, July 2004.

Apostolov, V., Calderbank, M. J., Gauduchon, P.,Tonnesen-Friedman, C. W., *Hamiltonian 2-forms in Kaehler geometry* III: *Compact examples*, math.DG/0501516, January 2005.

Apostolov, V., Tonnesen-Friedman, C. W., *A remark on Kähler metrics of constant scalar curvature on ruled complex surfaces*, The Bulletin of the London Mathematical Society, to appear.

Arminjon, P., Touma, R., *Central finite volume methods with constrained transport divergence for ideal MHD*, Journal of Computational Physics, 204:2 (May 2005), 737–759.

Arminjon, P., Touma, R., *Central schemes with constrained transport divergence treatment for two-dimensional ideal MHD*, SIAM Journal on Scientific Computing, submitted.

Asgharian, M., Wolfson, D. B., Zhang, X., *Checking stationarity of incidence rate using prevalent cohort survival data*, Statistics in Medicine, submitted.

Asgharian, M., Wolfson, D. B., Zhang, X., *A simple criterion for the stationarity of the incidence rate from prevalent cohort studies*, Statistics in Medicine, submitted.

Aval, J., Bergeron, F., Bergeron, N., *Diagonal Temperley-Lieb invariants and harmonics*, arXiv:math.CO/0411568, November 2004.

Azambre, D., Bergeron, M., Mullins, J., *SOCLE project : UML to UCFG compilation : Composability and source code generation*, National Defense of Canada, 2004.

Bandrauk, A., Chelkowski, S., Nguyen, H. S., *Attosecond control of electrons in molecules*, International Journal of Quantum Chemistry, submitted.

Bandrauk, A., Nguyen, H. S., *Attosecond molecular spectroscopy*, Canadian Journal of Chemistry, submitted.

Baron, M., Bell, M. G., Bookman, A., Jerome, D., Kamiska, E., Lupton, T., Pope, J., Steele, R., *Reliability and validity of ophthalmoscopic capillaroscopy in systemic sclerosis*, Journal of Experimental Rheumatology (2005), submitted.

Bengio, Y., Delalleau, O., Le Roux, N., *The curse of dimensionality for local kernel machines*, Département d'informatique et recherche opérationnelle, Technical Report no. 1258, March 2005.

Bengio, Y., Larochelle, H., *Implantation et analyse d'un modèle graphique à entraînement supervisé, semi-supervisé et non supervisé pour la désambiguïsation sémantique*, Département d'informatique et recherche opérationnelle, Technical Report no. 1252, 2004.

Bengio, Y., Monperrus, M., *Discovering shared structure in manifold learning*, Département d'informatique et recherche opérationnelle, Technical Report no. 1250, July 2004.

Bergeron, A., Stoye, J., *On the similarity of sets of permutations and its applications to genome comparison*, Journal of Computational Biology, submitted.

Bergeron, F., Biagioli, R., *Tensorial square of the hyperoctahedral group coinvariant space*, submitted.

Bergeron, F., McNamara, P., *Some positive differences of products of Schur functions*, arXiv:math.CO/0412289, December 2004.

Bergeron, M., Mullins, J., *SOCLE project : UML and OCL Semantics in ASM*, National Defense of Canada, 2004.

Bergeron, N., Gao, Y., Hu, N., *Drinfel'd doubles and Lusztig's symmetries of two-parameter quantum groups*, arXiv:math.RT/0505614, May 2005.

Bergeron, N., Hohlweg, C., *Coloured peak algebras and Hopf algebras*, arXiv:math.AC/0505612, May 2005.

Bergeron, N., Reutenauer, C., Rosas, M. H., Zabrocki, M., *Invariants and coinvariants of the symmetric group in noncommuting variables*, arXiv:math.CO/0502082, February 2005.

Bergeron-Brlek, A., Brlek, S., Labelle, J., *Irrationality of $\sqrt{3}$ — A geometric proof*, Mathematics Magazine, submitted.

Bertola, M., Eynard, B., Harnad, J., *Semi-classical orthogonal polynomials, matrix models and isomonodromic tau functions*, Centre de recherches mathématiques, CRM-3169, October 2004,; arXiv:nlin.SI/0410043.

Bertola, M., Gekhtman, M., *Biorthogonal Laurent polynomials, Töplitz determinants, minimal Toda orbits and isomonodromic tau functions*, Centre de recherches mathématiques, CRM-3182, March 2005.

Bertolini, M., Darmon, H., *The rationality of Stark-Heegner points over genus fields of real quadratic fields*, submitted.

Beuter, A., Lambert, B., MacGibbon, B., *Quantifying postural tremor changes in workers exposed to low levels of manganese*, Journal of Neuroscience Methods, submitted.

Blomer, V., Granville, A., *Estimates for the representation numbers of binary quadratic forms*, Duke Mathematical Journal, submitted.

Bouchard, M., Carrier, G., Brunet, R. C., Noisel, N., Labarre, G., Dumas, P., Weber, J. P., *Biological monitoring of exposure to organophosphorus insecticides in horticultural greenhouse workers*, Science of Total Environment, submitted.

Bourlioux, A., Khouider, B., *A rigorous asymptotic perspective on the large scale simulations of turbulent premixed flame fronts*, Multiscale Modelling and Simulations, submitted.

Brassard, G., Broadbent, A., Tapp, A., *Quantum pseudo-telepathy*, Foundations of Physics, to appear.

Brassard, G., Broadbent, A., Tapp, A., *Recasting Mermin's multi-player game into the framework of pseudo-telepathy*, Quantum Information and Computation, to appear.

Brassard, G., Méthot, A. A., Tapp, A., *Minimum entangled state dimension required for pseudo-telepathy*, Quantum Information and Computation, to appear.

Brlek, S., Melançon, G., Paquin, G., *Properties of the extremal intinite smooth words*, Journal of Automata, Languages and Combinatorics, submitted.

Brlek, S., Pergola, E., Roques, O., *Non Uniform Random Generation of Generalized Motzkin Paths*, Acta Informatica, submitted.

Bumagin, I., Kharlampovich, O., Miasnikov, A. G., *Isomorphism problem for finitely generated fully residually free groups*, arXiv:math.GR/0502496, February 2005.

Caffarelli, L. A., Guan, P., Ma, X.-N., *A general convexity principle for fully nonlinear elliptic equations* .

Chelkowski, S., Bandrauk, A., Apolonski, A., *Phase-dependent asymmetries in strong-field ionization*, Physical Reviews A, submitted.

Chelkowski, S., Bandrauk, A., Corkum, P., *Control of nuclear processes with super intense laser fields*, Physics Reviews Letters, submitted.

Chen, Y., Dinwoodie, I. H., MacGibbon, B., *Sampling for conditional inference on case/control data*, Journal of the Royal Statistical Society B, submitted.

Clarke, F. H., *Continuity of solutions to a basic problem in the calculus of variations*, Annali della Scuola Normale Superiore de Pisa, submitted.

Coleman, R., Iovita, A., *Hidden structures on curves*, submitted.

Colin, F., Frigon, M., *Systems of singular Poisson equations in unbounded domains*, Advances in Differential Equations, 2005:9 (September 2005), 1035–1052.

Cornea, O., Lalonde, F., *A universal Floer theory, localization and applications*, Centre de recherches mathématiques, CRM-3172, 2004.

David, C., Fearnley, J., Kisilevsky, H., *Vanishing of L-functions of elliptic curves over number fields*, arXiv:math.NT/0406012, June 2004.

De Koninck, J.-M., Doyon, N., *Esthetic numbers and game theory*, submitted.

De Koninck, J.-M., Doyon, N., Kátai, I., *Counting the number of twin Niven numbers*, submitted.

De Koninck, J.-M., Kátai, I., Subbarao, M. V., *A consequence of a theorem of Filaseta*, submitted.

Desrosiers, P., Lapointe, L., Mathieu, P., *Symmetric functions in superspace*, Advances in Mathematics, to appear.

Doray, L. G., Luong, A., Najem, E. H., *Efficiency of some estimators for a generalized Poisson autoregressive process of order* 1, Journal of Statistical Computation and Simulation, submitted.

Dryanov, D., Fournier, R., *On a discrete variant of Bernstein's polynomial inequality*, Centre de recherches mathématiques, CRM-3178, January 2005.

Duchesne, P., *Testing for serial correlation for unknown form in cointegrated time series models*, GERAD, G-2004-76, October 2004.

El Boukili, A., Madrane, A., Vaillancourt, R., *Multifrontal solution of sparse unsymmetric matrices arising from semiconductor equations*, Centre de recherches mathématiques, CRM-3125, June 2004.

Fortin, J.-F., Jacob, P., Mathieu, P., *SM(2,4κ;) fermionic characters and restricted jagged partitions*, Journal of Physics A, 38 (February 2005), 1699–1709.

Fortin, M., Reutenauer, C., *A note on compression spaces*, submitted.

Frenette-Charron, J.-B., Pelletier, M., Danyluk, J., Chauve, C., Sarhan, F., *The plant Lipocalin gene family*, submitted.

Frigon, M., Montoki, E., *Multiplicity results for systems of second order differential equations*, Nonlinear Studies, submitted.

Gagarin, A., Labelle, G., Leroux, P., *Characterization and enumeration of toroidal $K_{3,3}$-subdivision-free graphs*, arXiv:math.CO/0411356, November 2004.

Gauthier, G., Rémillard, B., Turcotte, D., *Pricing variance options in a GARCH setting*, GERAD, G-2004-57, July 2004.

Ghidaoui, M. S., Kolyshkin, A. A., Vaillancourt, R., *Transient turbulent flow in a pipe*, Centre de recherches mathématiques, CRM-3176, January 2005.

Goulard, B., Lina, J.-M., St-Jean, P., *Stationary multiscale graphical models*, Applied Probability, to appear.

Goupil, A., Chauve, C., *Combinatorial operators for Kronecker powers of representations of $\mathfrak{S}_n$*, arXiv:math.RT/0503307, March 2005.

Gouyou-Beauchamp, D., Leroux, P., *Enumeration of symmetry classes of convex polyominoes on the honeycomb lattice*, Theoretical Computer Science, to appear.

Granville, A., *Cycle lengths in a permutation are typically Poisson distributed*, submitted.

Granville, A., *Prime divisors are Poisson distributed*, submitted.

Granville, A., Kurlberg, P., *Poisson statistics via the Chinese remainder theorem*, Journal für die Reine und Angewandte Mathematik, submitted.

Granville, A., Martin, G., *Prime number races*, American Mathematical Monthly, accepted.

Granville, A., Soundararajan, K., *Large character sums: Pretentious characters and the Polya–Vinogradov theorem*, Journal of the American Mathematical Society, submitted.

Granville, A., Soundararajan, K., *Extreme values of $|\zeta(1+it)|$*, Journal of the Ramanujan Mathematical Society, submitted.

Granville, A., Soundararajan, K., *An uncertainty principle for arithmetic sequences*, Annals of Mathematics, submitted.

Grundland, A. M., Snobl, L., *Description of surfaces associated with Grassmannian sigma models on Minkowski space*, Journal of Mathematical Physics, 46:8 (2005), 3508–3520.

Grundland, A. M., Snobl, L., *Description of surfaces associated with CP^{N-1} sigma models on Minkowski space*, arXiv:math.DG/0405513.

Grundland, A. M., Snobl, L., *Description of surfaces associated with Grassmannian sigma models on Minkowski space*, Journal of Mathematical Physics, 46:8 (2005), 3508–3520.

Grundland, A. M., Strasburger, A., Zakrzewski, W. J. M., *Surfaces immersed in su(N+1) Lie algebras obtained from the CPN sigma models*, Centre de recherches mathématiques, CRM-3180, February 2005.

Guan, P., Lin, C.-S., Ma, X.-N., *The Christoffel–Minkowski problem.* II. *Weingarten curvature equations*, submitted.

Guan, P., Lin, C.-S., Ma, X.-N., *The existence problem for curvature measures* .

Guan, P., Lin, C.-S., Wang, G., *On quotient equations in conformal geometry*, submitted.

Guan, P., Ma, X.-N., Zhou, F., *The Christoffel–Minkowski problem.* III. *Existence and convexity of admissible solutions*, submitted.

Guan, P., Wang, G., *Conformal deformations of the smallest eigenvalue of the Ricci tensor*, Max Planck Institute for Mathematics in the Sciences, 43/2005, May 2005.

Guignon, V., Chauve, C., Hamel, S., *Distance d'édition entre "tige-boucles"*, submitted.

Gurjar, R., Masuda, K., Miyanishi, M., Russell, P., *Affine lines on affine surfaces and the Makar–Limanov Invariant*, submitted.

Hahn, G., *Composing directed hypergraphs*, Journal of Combinatorial Theory. Series B, submitted.

Hanley, J. A., MacGibbon, B., *Creating non-parametric bootstrap samples using Poisson frequencies*, Computer Methods and Programs in Biomedicine, submitted.

Iovita, A., Pollack, R., *On Iwasawa theory of elliptic curves over $\mathbb{Q}$ at primes of supersingular reduction over $\mathbb{Z}_p$-extensions of number fields*, Journal für die Reine und Angewandte Mathematik accepted.

Iovita, A., Stevens, G., *On p-adic families of modular forms*, submitted.

Jakobson, D., Levitin, M., Nadirashvili, N., Polterovich, I., *Spectral problems with mixed Dirichlet–Neumann boundary conditions: Isospectrality and beyond*, Journal of Computational and Applied Mathematics, to appear.

Jakobson, D., Polterovich, I., *Estimates from below for the spectral function and for the remainder in local Weyl's law*, submitted.

Jaksic, V., Last, Y., *Simplicity of singular spectrum in Anderson type Hamiltonians*, submitted.

Kokotov, A., Korotkin, D., *Tau-functions on spaces of Abelian and quadratic differentials and determinants of Laplacians in Strebel metrics of finite volume*, Journal of Differential Geometry, submitted.

Kokotov, A., Korotkin, D., *Isomonodromic tau-function of Hurwitz Frobenius manifolds and its applications*, International Mathematics Research Notices, submitted.

Korotkin, D., *On some integrable system arising in differential geometry and general relativity*, Annales des sciences mathématiques du Québec, submitted.

Labelle, G., Leroux, P., Gagarin, A., *Structure and labelled enumeration of $K_{3,3}$-subdivision-free projective-planar graphs*, arXiv:math.CO/0406140, June 2004.

Labute, J., Lemire, N., Minac, J., Swallow, J., *Cohomological Dimension and Schreier's formula in Galois cohomology*, Bulletin of the London Mathematical Society, submitted.

Labute, J., Lemire, N., Minac, J., Swallow, J., *Demuskin groups, Galois Modules, and the elementary type conjecture*, to appear.

Lapalme, E., Lina, J.-M., Mattout, J., *Sources clustering and entropic inference in MEG*, IEEE Transactions on Biomedical Engineering, submitted.

Léger, C., MacGibbon, B., *On the bootstrap in cube root asymptotics*, Canadian Journal of Statistics, accepted.

Lepage, T., Lawi, S., Tupper, P., Bryant, D., *Continuous and tractable models for the variation of evolutionary rates*, Mathematical Biosciences, 199:2 (February 2006), 216–233.

Lu, S., Dethloff, G., *Logarithmic surfaces an hyperbolicity*, arXiv:math.AG/0406287, June 2004.

Mélard, G., Roy, R., Saidi, A., *Exact maximum likelihood estimation of structured or unit root multivariate time series models*, Centre de recherches mathématiques, CRM-3129, June 2004.

M'Lan, C.-E., Joseph, L., Wolfson, D. B., *Bayesian sample size determination for case control studies*, Journal of American Statistical Association, submitted.

Ngan, K., Straub, D. N., Bartello, P., *Aspect ratio effects in quasi-2D turbulence*, Physics of Fluids, submitted.

Nguyen-Ba, T., Kolyshkin, A. A., Vaillancourt, R., *Hermite-Birkhoff differential equa-*

tion solvers, Centre de recherches mathématiques, CRM-3175, Décember 2004.

Ollivier, Y., Wise, D. T., *Kazhdan groups with infinite outer automorphism group*, arXiv:math.GR/0409203, September 2004.

Ratnarajah, T., Vaillancourt, R., *Quadratic forms on complex random matrices and channel capacity*, Centre de recherches mathématiques, CRM-3126, June 2004.

Ratnarajah, T., Vaillancourt, R., Alvo, M., *Complex random matrices and Rician channel capacity*, Centre de recherches mathématiques, CRM-3174, October 2004.

Rochon, D., *A bicomplex Riemann zeta function*, Tokyo Jounal of Mathematics, submitted.

Rousseau, C., *Divergent series: past, present, future...*, American Mathematical Monthly, submitted.

Rousseau, C., Christopher, C., *Modulus of analytic classification for the generic unfolding of a codimension one resonant diffeomorphism or resonant saddle*, Centre de recherches mathématiques, CRM-3167, September 2004.

Russell, P., Koras, M., *Contractible surfaces with a quotient singularity*, submitted.

Saidi, A., *Consistent testing for independence of two partially nonstationary vector ARMA time series*, Centre de recherches mathématiques, CRM-3173, November 2004.

Sauer, N. W., Rosenberg, I. G., *Interval cardinality in the lattice of clones*, submitted.

Schlomiuk, D., Vulpe, N., *Planar quadratic vector fields with invariant lines of total multiplicity at least five*, submitted.

Schlomiuk, D., Vulpe, N., *Integrals and phase portraits of planar quadratic differential systems of invariant lines of at least five total multiplicity*, Centre de recherches mathématiques, CRM-3181, March 2005.

Schlomiuk, D., Vulpe, N., *The full study of planar quadratic differential systems possessing exactly one line of singularities, finite or infinite*, Centre de recherches mathématiques, CRM-3183, April 2005.

Waite, M. L., Bartello, P., *Stratified turbulence generated by internal gravity waves*, Journal of Fluid Mechanics, submitted.

Waite, M. L., Bartello, P., *The transition from geostrophic to stratified turbulence*, Journal of Fluid Mechanics, submitted.

Walsh, T. R. S., *Enumeration of unrooted maps in the plane, Technical report*, UQÀM, Technical Report no. 2005-01, February 2005.

Winternitz, P., Levi, D., *Continuous symmetries of difference equations*, arXiv:nlinSI/0502004, to appear.

Yoshikawa, M., Gong, Y., Ashino, R., Vaillancourt, R., *Case study on SVD multiresolution analysis*, Centre de recherches mathématiques, CRM-3179, January 2005.

Zhao, M., Ghidaoui, M. S., Kolyshkin, A. A., Vaillancourt, R., *On the stability of oscillatory pipe flows*, Centre de recherches mathématiques, CRM-3168, October 2004.

Zlobec, I., Steele, R., Nigam, N., Compton, C., *A predictive model of rectal tumor response to pre-operative radiotherapy using classification and regression tree (CART) methods*, Clinical Cancer Research (2005), submitted.

Committees Heading the CRM

Bureau de direction

THE Bureau consists of members from the Université de Montréal (eight to eleven members) and from the outside (two to five members). The rector of the Université de Montréal and the Dean of its Arts and Sciences faculty are represented on the Bureau. The Bureau adopts the policies of the Centre, recommends the nomination and the promotion of researchers and the appointment of regular and associate members, advises the Director on the preparation of the budget and the Université de Montréal on the choice of the Director.

Yoshua Bengio
Université de Montréal

François Bergeron
Université du Québec à Montréal

Alain Caillé, Vice-Rector, Research
Université de Montréal

Joseph Hubert, Dean
Arts and Sciences Faculty
Université de Montréal

Hershy Kisilevsky
Concordia University

François Lalonde
Université de Montréal

Christian Léger
Université de Montréal

Christiane Rousseau
Université de Montréal

Peter Russell
McGill University

Yvan Saint-Aubin
Université de Montréal

Chantal David (Concordia University) and **Jean LeTourneux** (Université de Montréal), both Deputy Directors of the CRM, were invited members.

Scientific Advisory Committee

THE Scientific Advisory Committee is constituted of distinguished researchers from Canada and abroad. Its members are either mathematicians or scientists with close ties to the mathematical sciences. The Advisory Committee is informed periodically of the activities of the Centre through the Director. The Committee transmits recommendations about the general scientific orientation of the CRM and gives advice about proposeded scientific activities.

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 recently, Finslerian geometry. Jean-Pierre Bourguignon directs advanced

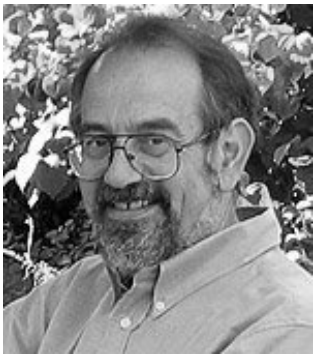
research classes at CNRS. He is the Director of Institut des hautes études scientifiques (IHES) at Bures-sur-Yvette and Professor of Mathematics at École Polytechnique. From 1990 to 1992, he served as President of the Société mathématique de France and from 1995 to 1998 of the European Mathematical Society. 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.

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.

Peter Glynn is Thomas W. Ford Professor in the School of Engineering at Stanford University. He received his Ph.D in Operations Research from Stanford University in 1982. He is a Fellow of the Institute of Mathematical Statistics and his research interests focus on computational probability, queueing theory, statistical inference for stochastic processes, and stochastic modeling.

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*.

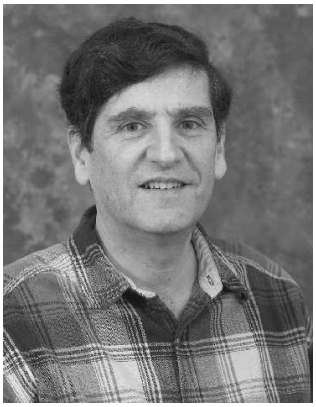


Nigel Hitchin is Savilian Professor of Geometry at New College, Oxford University. He holds a Ph.D. degree in Mathematics (1972) from Wolfson College of Oxford University. He is principally interested in differential and algebraic geometry and its relationship with the equations of mathematical physics. Current projects include the areas of hyperkähler geometry, special Lagrangian geometry and mirror symmetry, geometric solutions of Painlevé equations, magnetic monopoles, vector bundles on algebraic curves, and the theory of gerbes.

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 1996-1997. 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*.

M. Ram Murty is a Professor of Mathematics and Queen's Research Chair at Queen's University. He holds a Ph.D. degree in Mathematics (1980) from MIT. A specialist in algebraic and analytic number theory, his researches focus on Artin's conjecture, elliptic curves, modular forms, automorphic forms, Langland's program, Selberg's conjectures, and cryptography.



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.

Alain Caillé, Vice-Principal (Research), Université de Montréal, **François Lalonde**, CRM Director and **Eddy Campbell**, President of the Canadian Mathematical Society were ex-officio members of the Advisory Committee. **François Bergeron** (Université du Québec à Montréa), **Chantal David** (Concordia University) and **Jean LeTourneux** (Université de Montréal), all Deputy Directors of the CRM, were invited members of the Committee.

CRM Administrative and Support Staff

The Director's Office

François Lalonde
Director

François Bergeron
Acting Director (Summer 2004), Deputy Director

Chantal David
Deputy Director, Theme Years

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

Computer Services

Daniel Ouimet
Systems Administrator

André Montpetit
Office Systems Manager (half time)

François Cassistat
Technical Assistant

Frédéric Loisier
Technical Assistant

Publications

André Montpetit
TeX Expert (half time)

Louise Letendre
Technician

Communications

Suzette Paradis
Communications Officer and Webmaster

Statement of Revenue and Expenditures for the Fiscal Year Ending on May 31, 2005

	NSERC-Centre	NSERC-NPCDS	FQRNT-Centre	CÉDAR UdeM	Other universities	Endowments	Matching funds	Other sources	TOTAL
REVENUE									
Operating grants	966,000	57,100	455,000	—	—	—	—	—	1,478,100
Equipment grant	—	—	42,695	—	—	—	—	—	42,695
Univ. de Montréal grant (Professors)	—	—	—	510,000	—	—	—	—	510,000
Univ. de Montréal,grant (Operations)	—	—	—	356,000	—	—	—	—	356,000
UQÀM grant	—	—	—	—	120,000	—	—	—	120,000
McGill U. grant	—	—	—	—	100,000	—	—	—	100,000
Concordia U. grant	—	—	—	—	50,000	—	—	—	50,000
U. Laval grant	—	—	—	—	29,865	—	—	—	29,865
U. of Ottawa,grant	—	—	—	—	30,000	—	—	—	30,000
Contributions from researchers (PDFs, workshops)	—	—	—	—	—	—	210,447	—	210,447
Contributions from MITACS & SAMSI	—	—	—	—	—	—	—	38,355	38,355
Contributions from ISM & GERAD,for Colloquium	—	—	—	—	—	—	—	16,557	16,557
Other contributions for activities	—	—	—	—	—	—	—	36,514	36,514
Publications (royalties, sales, etc.)	—	—	—	—	—	—	—	34,278	34,278
Endowments (Aisenstadt & Bissonnette)	—	—	—	—	—	37,967	—	—	37,967
Registration fees	—	—	—	—	—	—	—	64,777	64,777
Service contracts and other revenue	—	—	—	—	—	—	—	28,117	28,117
TOTAL REVENUE	**966,000**	**57,100**	**497,695**	**866,000**	**329,865**	**37,967**	**210,447**	**218,597**	**3,183,671**
EXPENDITURES									
SCIENTIFIC PROGRAMS — CENTRE									
Thematic program									
Aisenstadt Chairs	1,740	—	4,548	—	—	4,000	—	4,683	14,971
Visitors	7,285	—	1,330	—	—	—	6,000	527	15,142
Postdoctoral fellows (PDF)	47,000	—	—	—	—	—	35,485	—	82,485
Summer school 2004	7,513	—	—	—	—	—	—	8,418	15,931
Workshops	122,336	—	—	252	—	—	9,251	18,506	150,345
Total — Thematic program	185,874	—	5,878	252	—	4,000	50,736	32,134	278,874
General program	106,852	—	7,030	200	—	25,455	23,210	81,718	244,465
Industrial and multidisciplinary program	44,393	—	—	—	—	—	—	28,800	73,193
National Program on Complex Data Structures (NPCDS)		13,378	—	—	—	—	—	4,175	17,553

(continued on the next page)

	NSERC-Centre	NSERC-NPCDS	FQRNT-Centre	CÉDAR UdeM	Other universities	Endowments	Matching funds	Other sources	TOTAL
EXPENDITURES (continued)									
Other Postdoctoral fellows									
CRM-ISM fellows	66,911	—	—	—	—	—	136,500	(200)	203,211
University of Ottawa	10,000	—	—	—	30,000	—	—	—	40,000
Total — Other PDF	76,911	—	—	—	30,000	—	136,500	(200)	243,211
SCIENTIFIC PROGRAM — RESEARCH LABORATORIES									
Course releases	—	—	15,000	7,500	52,700	—	—	—	75,200
Admin. and research support	—	—	23,500	—	61,085	—	—	—	84,585
Postdoctoral fellows	116,097	—	—	24,000	76,667	—	—	—	216,764
Students	22,025	—	—	22,185	33,865	—	—	—	78,075
Visitors	—	—	4,688	—	17,342	—	—	(184)	21,846
Workshops and seminars	2,395	—	30,018	1,089	29,846	—	—	(386)	62,962
Other	—	—	—	—	2,800	—	—	—	2,800
Total — Research Laboratories	140,517	—	73,206	54,774	274,304	—	—	(570)	542,231
Other scientific expenditures									
College researchers' projects	—	—	19,524	—	—	—	—	—	19,524
UdeM professors	—	—	—	508,237	—	—	—	—	508,237
Course releases	—	—	—	—	—	22,500	—	—	22,500
Scientific advisory committee and representation exp.	1,202	—	5,786	3,774	—	—	—	1,798	12,560
Publicity, Bulletin, Annual Report	12,722	—	—	13,518	—	—	—	490	26,730
Total — Other scientific expenditures	13,924	—	25,311	525,530	—	22,500	—	2,288	589,552
Personnel	299,941	—	212,153	190,898	—	—	97	31,955	735,044
Executive	—	—	15,000	52,538	—	—	—	—	67,538
Operating and computing expenditures	21,323	—	96,685	38,415	—	—	—	12,212	168,635
TOTAL EXPENDITURES	**889,734**	**13,378**	**435,263**	**862,607**	**304,304**	**51,955**	**210,544**	**192,512**	**2,960,297**
YEAR-END BALANCE	76,266	43,722	62,432	3,393	25,561	(13,988)	(97)	26,085	223,374

Mission 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 do 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 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). They sponsor the Annual Meetings of the Mathematical Sciences Societies (SMC, SSC, SCMAI), the development of the mathematical sciences in the Atlantic provinces through AARMS, and other activities organized outside the three institute. 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 previous 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.