Table of contents

A Word from the Director

The years follow each other all too rapidly, and it seems like only yesterday that I was writing a similar page for last year's report.

It has been a busy year at the CRM. The centre of our scientific programme for the year was our thematic programme in Mathematical Physics. The year began with a remarkable Summer School, held at the Banff Centre for Conferences. The theme was "Theoretical Physics at the end of the Twentieth Century", and it covered a remarkably wide variety of interesting areas of theoretical physics, with a range of topics going from quantum field theory to quantum computing and protein folding. The very breadth of the coverage brought an additional bonus, in that the lecturers could not assume that everybody had intimate knowledge of the material being presented, allowing relative amateurs like myself to take in the remarkable panorama being presented. The summer school also saw what I believe to be a first for a CRM activity, in that two of the participants got married during the event. The happy couple shared a cake with the participants, and took the rest of the day off. While the more prosaically minded might say that this is linked to the atmosphere of Banff, I prefer to think that the marriage is mostly due to the extraordinarily stimulating effect of a CRM summer school.

With such a beginning, the rest of the year could only go well, and indeed it did. My thanks are due to the organisers of the year: Philippe Di Francesco, Lisa Jeffrey, André LeClair, Yvan Saint-Aubin, and Luc Vinet. There were three series of Aisenstadt lectures, by R. Jackiw, J. Feldman, and D.H. Phong, as well as 14 workshops. The year closed with a remarkable two month concentration period on classical and quantum integrability, organised in a masterful fashion by André Leclair. There were two talks per day, and a lot of work and discussion during the rest of the day, to a point where I have never seen such a "research buzz" at the CRM.

In our general programme, we hosted 4 conferences, and contributed to 24 others, including 11 funded through the National Programme which is run jointly through the three Canadian Mathematics Institutes. One particularly successful CRM activity which will be reported on next year was the three week short programme on asymptotic series, differential algebra and finiteness problems in non-linear dynamical systems, run by Dana Schlomiuk and Luc Bélair. The activity had some courses for students, new interactions between mathematicians from different areas, and most importantly, time for that interaction to happen. A final thing to make a director happy is that a book will be coming out of the workshop, and will be published in a CRM series.

Speaking of which, our publication section saw a major change this year with the departure of Martin Goldstein as deputy director in charge of publications. Martin saw the programme develop almost from scratch and his diligence and careful encouragement of authors contributed greatly to its development. Fortunately, Jean Letourneux has agreed to take his place, and the programme continues to do well, with 6 monographs and conference proceedings appearing last year. One noteworthy feature was the purchase by Panjab University of 200 copies of our edition of Sarvadaman Chowla's collected works for distribution throughout India. My thanks also go to the other three deputy directors who helped me do the work: Jacques Bélair, Yoshua Bengio, and Steven Boyer.

On the industrial front, the Network for Computation and Mathematical Modelling (ncm_2) to which the CRM belongs, launched a major call for proposals, to which the membership has responded with enthusiasm. Twelve new projects are now being financed, and we are starting to see the true cross-disciplinary collaboration that is allowed by the network. One project that summarises much of the new interactions is one in "Nowcasting", which involves not only meteorologists but also experts in operations research and economists. The cross Canada MITACS network also finished its first year and a half of operation, and is progressing well, with the first annual general meeting held in Toronto last May. The CRM is the host centre for this year's meeting in Montréal.

One of the most striking features over the last year of all of these activities has been the arrival

of new faces. Considerable changes are awaiting us over the next few years, as a significant proportion of the Canadian mathematical professorate retires and is replaced by new faculty. In Montréal alone, the turnover will be of the order of fifty percent. My own department has hired six new faculty members in the last two years. I am pleased to say that one of them was hired after a postdoctoral fellowship during a theme year at the CRM; not being one to do things by halves, he will be publishing a book with the CRM next spring. I hope this will be repeated, and often.

Jacques Hurtubise

CRM's 30th Anniversary

The beginnings

The first steps to establish a research centre in mathematics at Université de Montréal were undertaken in 1968. As was previously done in many other countries, Canada was looking for a way to develop a research infrastructure that would allow researchers throughout Canada and the rest of the world to meet to create new mathematics. The visionary leadership of its founders, a start-up grant from the National Research Council (NRC), and the generosity of Université de Montréal led to the founding of CRM, the first research centre in mathematics in Canada.

CRM owes much of its success to the scientific and leadership qualities of its Directors. Maurice L'Abbé was the first Director. The Salon where most of the CRM receptions take place is named in his honour. Because of his numerous other responsibilities, he was soon followed by Jacques St-Pierre. Over the years, they were succeeded by Gert Sabidussi, Lucien Le Cam, Anatole Joffe, Carolyne van Vliet, David Sankoff, Francis Clarke, Luc Vinet, and Jacques Hurtubise.

Originally, the Centre had its own research personnel. It quickly became clear that it would not be financially viable to keep a research team without responsibilities in an academic unit. In 1982, the CRM researchers were integrated into the Department of Mathematics and Statistics (DMS) at Université de Montréal. In return, DMS offers teaching release to some professors to do research and organize activities at CRM.

National Centre

Under the leadership of Francis Clarke, CRM took on a national mandate in 1984 through a grant of NSERC's Programme of Special Collaborative Projects. Since then, CRM systematically organizes numerous scientific activities benefiting the Canadian community. Every year, concentrations of visitors, workshops, conferences, summer schools, etc., are organized around themes and many researchers from everywhere gather to participate in these activities.

It is also during his mandate that the *Institut de sciences mathématiques* (ISM) was created. Made up of the mathematics and statistics departments of the Montréal area, its purpose is to better coordinate graduate studies in mathematics and statistics and to facilitate student exchanges. Since then, many research and training activities, such as the funding of postdoctoral fellows, and a weekly colloquium, are jointly organized by CRM and ISM.

New Initiatives

Luc Vinet followed as director during a critical period when NSERC's programme funding CRM and Fields Institute was to be cancelled. Under his leadership, CRM not only survived, but it grew considerably. Along with the other research centres in mathematical sciences of the Montréal area, CRM created the Network for Computing and Mathematical Modelling (ncm_2). Also, CRM, Fields Institute, and PIms joined forces to create the MITACS Network of Centres of Excellence. All these initiatives offer tremendous new possibilities for all researchers in the mathematical sciences.

André Aisenstadt

As soon as he heard about a project to create a research centre in mathematics, Mr. André Aisenstadt showed interest. Since then, he has shown his great devotion to the Centre by investing, among other things, in an endowment fund which finances a Chair and a Prize under his name. Moreover, since 1994, CRM and DMS are housed in the André-Aisenstadt Pavilion. We are all indebted to him for his great generosity.

CRM in 2000

CRM is proud of its heritage and continues its activities with renewed vigour. Now under the leadership of Jacques Hurtubise, CRM continues to stimulate research in the mathematical sciences by organizing numerous activities, by publishing and distributing books and monographs through collaborations with AMS and Springer, by training young scientists, and by producing many research results through its researchers. CRM fulfills its mandate thanks to the indefatigable financial support of Université de Montréal, NSERC, FCAR, and various donors. CRM is now part of an international network of mathematical research centres, and along with its partners in ncm_2, Fields Institute, PIms, the MITACS network, ISM, and the other universities of the area, CRM is more than ever

before able to meet the challenges of research in mathematical sciences.

30th Anniversary Conference

To celebrate its heritage on this 30th anniversary, CRM organized a one-day conference on December 10, 1999. It was held just before the Winter Meeting of the Canadian Mathematical Society which was also in Montréal.

The first conference was presented by Peter Sarnak of Princeton University and it was on *Equidistribution on Arithmetic Surfaces.* He was followed by Nigel Higson of Pennsylvania State University. The title of his talk was *Asymptotic Geometry of Groups and Analysis in C* Algebras.* Dusa McDuff of SUNY-Stony Brook presented her latest results on *Symplectic Topology Today*. In the afternoon, Bong Lian of Brandeis University talked about *The Potential Function of a Calabi-Yau Threefold*. Currently a hot topic, *Probabilistic Aspects of Finance,* was presented by Ioannis Karatzas of Columbia University. Finally, Bill Miller of IMA gave us his perspective in a talk entitled *Mathematics in Industry : The IMA Experience.* This nice celebration concluded with a reception in the Main Pavilion of Université de Montréal.

From left to right: Jacques Hurtubise, CRM Director, Robert Lacroix, Rector of Université de Montréal, Danielle Ménard, NSERC Director of Research Grants in the Physical and Mathematical Sciences, Luc Vinet, Past-Director of CRM and Richard Kane, President of the Canadian Mathematical Society, during CRM'S 30th anniversary.

Many participants at the Canadian Mathematical Society's Winter Meeting also celebrated CRM's 30th anniversary.

Presenting the CRM

The Centre de recherches mathématiques (CRM) was created in 1969 by the Université de Montréal through a special grant from the NRC. 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 FCAR (Fonds pour la formation et l'aide à la recherche), the Université de Montréal, 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 accomplishes its mission in several ways. As part of its national mandate,

- it organizes a series of scientific events each year, around a given theme (distinguished lecture series, workshops, conferences, summer schools, visitor programmes, etc.);
- it has a general programme which helps to fund conferences and special events at CRM and across the country;
- each year it invites, through the Chair Aisenstadt, one or two prestigious mathematicians, to give advanced courses as part of its thematic programme;
- 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 some 150 technical reports and about half a dozen books per year. Some of its collections are published jointly with the AMS and with Springer Verlag;
- it has an extensive postdoctoral fellowship programme, with 39 postdoctoral fellows in place last year, funded either solely by the CRM or in partnership with other organisations;
- it informs the community of its activities through its web site at

  www.CRM.UMontreal.CA

- it participates, with the other two Canadian centres, in groundbreaking national initiatives such as the MITACS (Mathematics of Information Technology and Complex Systems) proposal. Another example is found in the National Programme Committee which provides funding for offsite research activities.

This national mandate is complemented by, and indeed supported by, a long-standing vocation of promoting research in the Montréal area. Indeed the CRM

- supports, through partnership agreements, a local group of researchers chosen mainly from departments of mathematics and statistics, but also from departments of computer science, physics, economics, engineering, etc.;
- organizes many series of regular seminars on different areas of mathematical sciences;
- sponsors joint activities with the ISM (Institut des sciences mathématiques) including the weekly CRM / ISM colloquium, graduate courses offered by distinguished visitors and a programme of postdoctoral fellowships.
- works actively at developing contacts with industry. Its joint activities with liaison and research centres (CERCA, CIRANO and CRIM) and research centres doing applied research (CRT, GERAD and INRS Télécom) led to the creation of the Network for Computing and Mathematical Modelling (ncm_2). This network is funded by NSERC and about 20 partners such as financial institutions, hightech companies and ministries.

The CRM fulfils its national mission by involving the largest possible number of Canadian mathematicians in its scientific programmes, 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 supported by two managerial structures: the Bureau and the Advisory Committee. The Advisory Committee is a prestigious group of internationally renowned mathematicians from Canada and the rest of the world, who approve scientific programmes and thematic years, choose recipients of the CRM-Fields and Aisenstadt prizes, and suggest new scientific ventures to explore. The president of the Canadian Mathematical Society is a member *ex officio.*

Personnel

The Director's Office

Jacques Hurtubise	***Director***
Martin Goldstein	***Deputy Director for Publications***
Jacques Bélair	***Deputy Director for Scientific Affairs***
Yoshua Bengio	***Deputy Director for MITACS***
Steven Boyer	***Deputy Director for Scientific Affairs***
Diane Poulin	***Secretary***

Administration

Béatrice Kowaliczko	***Head of Administration***
Vincent Masciotra	***Financial and Administrative Officer***
Michèle Gilbert	***Administrative Assistant***
Muriel Pasqualetti	***Administrative Assistant***
Josée Simard	***Secretary***

Scientific Activities

Louis Pelletier	***Coordinator***
Josée Laferrière	***Assistant Coordinator***
Diane Brulé-De-Filippis	***Secretary***

Publications

André Montpetit	***TeX Expert***
Louise Letendre	***Technician***

Computer Services

Daniel Ouimet	***UNIX Systems Manager***
Simon Mailhot	***Web expert***

MITACS/MaTISC

Marie Pineau	***Business Development Officer***

Scientific Personnel

Since its foundation in 1969, the CRM has supported a wide variety of research in mathematics by having various members attached to it, either as research staff, or through exchange agreements with neighbouring universities and industries, or as long-term visitors. These people perform their research at the CRM, and their presence has brought many benefits. In particular, the CRM's national programme is greatly facilitated by having on hand a large reserve of willing organisers, who have even contributed financially to the organisation of activities. The largest partnership is with the Université de Montréal, which gives annually the equivalent of 5 full-time teaching positions in release time to the CRM. The CRM has release agreements with the other Montréal area universities, providing for the equivalent of two more full time positions. Facilities are also provided to researchers attached to junior colleges. In addition, each year, a certain number of visiting researchers spend the year at the CRM and are given visiting member status. There are also members whose presence is due to industrial agreements with Atlantic Nuclear Services and Lockheed Martin.

Members

Ali, Syed Twareque
Math. & Stat., U. Concordia

Angers, Jean-François
Math. & Stat., UdeM

Arminjon, Paul
Math. & Stat., UdeM

Beaulieu, Liliane
Collège Rosemont

Bélair, Jacques
Math. & Stat., UdeM

Benali, Habib
INSERM, France

Bengio, Yoshua
DIRO, UdeM

Bergeron, François
Math., UQAM

Bergeron, Nantel
Math. & Stat., U. York

Bourlioux, Anne
Math. & Stat., UdeM

Boyer, Steven
Math., UQAM

Broer, Abraham
Math. & Stat., UdeM

Clarke, Francis
Univ. de Lyon

Darmon, Henri
Math. & Stat., U. McGill

Delfour, Michel
Math. & Stat., UdeM

Dssouli, Rachida
DIRO, UdeM

Durand, Stéphane
Collège Édouard-Montpetit

El-Mabrouk, Nadia
DIRO, UdeM

Fournier, Richard
Collège Dawson

Fleischer, Isidore
U. Windsor

Gagnon, Langis
Lockheed Martin Canada

Gander, Martin
Math. & Stat., U. McGill

Gauthier, Paul
Math. & Stat., UdeM

Goldstein, Martin
Math. & Stat., UdeM

Goulard, Bernard
Physique, UdeM

Goren, Eyal
Math. & Stat., U. McGill

Granas, Andrzej
Math. & Stat., UdeM

Grundland, Michel
Math., UQTR

Hall, Richard L.
Math. & Stat., U. Concordia

Harnad, John
Math. & Stat., U. Concordia

Hurtubise, Jacques
Math. & Stat., U. McGill

Hussin, Véronique
Math. & Stat., UdeM

Joffe, Anatole
Math. & Stat., UdeM

Joyal, André
Math., UQAM

Kamran, Niky
Math. & Stat., U. McGill.

Koosis, Paul
Math. & Stat., U. McGill

Korotkin, Dmitri
Math. & Stat., U. Concordia

Lalonde, François
Math., UQAM

Langlands, Robert
Institute for Advanced Study, Princeton

Léger, Christian
Math. & Stat., UdeM

Lessard, Sabin
Math. & Stat., UdeM

LeTourneux, Jean
Physique, UdeM

Lina, Jean-Marc
CRM, UdeM

McKay, John
Math. & Stat., U. Concordia

Nekka, Fahima
Faculté de Pharmacie, UdeM

Patera, Jiri
Math. & Stat., UdeM

Perron, François
Math. & Stat., UdeM

Rogers, Colins
U. New South Wales, Australia

Rosenberg, Ivo
Math. & Stat., UdeM

Rousseau, Christiane
Math. & Stat., UdeM

Roy, Roch
Math. & Stat., UdeM

Saint-Aubin, Yvan
Math. & Stat., UdeM

Sankoff, David
Math. & Stat., UdeM

Schlomiuk, Dana
Math. & Stat., UdeM

Shahbazian, Elisa
Lockheed Martin Canada

Sharp, Robert
Physique, U. McGill

Stern, Ron
Math. & Stat., U. Concordia

Toth, John
Math. & Stat., U. McGill

Valin, Pierre
Lockheed Martin Canada

Van Vliet, Carolyne
U. Florida

Vinet, Luc
Math./Phys., U. McGill

Winternitz, Pavel
Math. & Stat., UdeM

Worsley, Keith
Math. & Stat., U. McGill

Zolésio, Jean-Paul
CNRS, France

Postdoctoral Fellows

Each year the CRM receives several postdoctoral fellows. The source of their funding can be a national programme like the NSERC postdoctoral programme, the NATO international programme administered by NSERC, the CRM (alone or with the ISM or the Fields Institute), or personal grants from the members. Since 1993-1994 we have added to this list the CRM industrial programme which, in association with its ncm_2 partners, now offers postdoctoral fellowships. In the following list, the university refers to the one where the Ph. D. was obtained.

Aassila, Mohamed
Univ. de Strasbourg

Aguiar, Marcello
Cornell Univ.

Amblard, Cécile
Inst. Nat. Polytechnique

Bertola, Marco
S.I.S.S.A.

Bracken, Paul
Univ. of Waterloo

Brightwell, Mark
Univ. of Glasgow

Bryant, David
Univ. of Canterbury

Caprioglio, Myriam
Univ. de la Méditerranée
Aix-Marseille II

De Guise, Hubert
Univ. of Toronto

Deteix, Jean
Univ. de Montréal

Fowler, Thomas
The Georgia Inst. of Tech.

Guimond, Louis-Sébastien
Univ. de Montréal

Hagedorn, Thomas
Harvard Univ.

Klucznik, Michael
Brandeis Univ.

Lapointe, Luc
Univ. de Montréal

Loutsenko, Igor
Univ. de Montréal

Rajaei, Ali
Princeton Univ.

Spiteri, Raymond
Univ. of British
Columbia

Zaugg, Philippe
Univ. de Genève

Zabrocki, Michael
Univ. of California

Following is a list of postdoctoral fellows working on projects attatched to CRM's MITACS network. The affiliation listed indicates where the research is being done.

Chavez, Francisco
Univ. of Toronto

Deerakhchan, Katayoun
Institut de cardiologie
de Montréal

Farhat, Abdeljelil
CIRANO

Gu, Hong
Univ. of Waterloo

Hadjar, Ahmed
Polytechnique

Kagabo, Issa
Polytechnique

Langdell, Stephen
Univ. de Montréal

Mladenovic, Nenad

Nagai, Yoshihilo
Univ. McGill

Nagih, Anass
HEC

Rousseau, Guillaume
Univ. of Toronto

Schaefer, Carsten
Univ. McGill

Shinagawa, Kaori
Institut de cardiologie
de Montréal

Stojkovic, Goran
Polytechnique

Sun, Hui
Institut de cardiologie
de Montréal

Tateno, Katsumi
Univ. McGill

Villeneuve, Daniel
Polytechnique

Weisheng, Bao
Institut de cardiologie
de Montréal

Ziarati, Koorush
Iran

Visitors

Each year the CRM receives a large number of visitors. Most of these are here to participate in scientific activities: in the year 1999-2000, 804 participants registered for workshops run solely by the CRM. In addition, the CRM helped fund about 15 other scientific events. The following list does not include any of these, but only those who visited for longer periods, ranging from over a week to several months.

Abbondandolo, Alberto
Scuola Normale di Pisa

Aizenberg, Lev
Abromovich Bar-Ilan Univ.

Arnéodo, Alain
C.N.R.S.

Bahri, Chairul
Univ. of Toronto

Bégin, Luc
Univ. Laval

Berest, Yuri
Cornell Univ.

Bogoyavlenskij, Oleg I.
Queen's Univ.

Boivin, André
Univ. of Western Ontario

Buono, Pietro-Luciano
Univ. of Warwick

Butler, Leo
Queen's Univ.

Chavent, Guy
INRIA (France)

Cummins, Chris
Concordia Univ.

Daboul, Jamil
Ben Gurion Univ.

Daoud, Mohamed
Univ. Mohammed V

de Montigny, Marc
Univ. of Alberta

Derezinski, Jan
Univ. of Warsaw

Desrosiers, Patrick
Univ. Laval

Dorodnitsyn, Vlad, D.
Russian Academy of Sciences

Duval, Christian
Univ. d'Aix-Marseille II

Eynard, Bertrand
CEA Saclay

Fedorov, Yuri N.
Lomoosov Moscow State Univ.

Fehér, Laszlo
Jozsef Attila Univ.

Feldman, Joel S.
Univ. of British Columbia

Frenkel, Edward
Univ. of California

Gazeau, Jean-Pierre
Univ. de Paris VII

Ghoussoub, Nassif
Univ. of British Columbia

Grammaticos, Basile
Univ. de Paris VII

Güngör, Faruk
Istanbul Technical Univ.

Hansen, Wolfhard
Univ. Bielefeld

Jackiw, Roman W.
MIT

Jacob, Patrick
Univ. Laval

Jaksic, Vojkan
Univ. of Ottawa

Jeffrey, Lisa
Univ. of Toronto

Karrakchou, Jamila
Univ. Mohammed V

Kjiri, Mounia
Univ. de Montréal

Komori, Yasushi
Gunmaa College of Technology

Lemire, Frank
Univ. of Windsor

Leng, Xiaodan
Pasadena City College

Lesage, Frédéric
Lockheed Martin Canada

Levi, Decio
Univ. di Roma

Lohmus, Jaak
Univ. of Tartu

Long, Ling
Queen's Univ.

Loutsenko, Igor
Lockheed Martin Canada

Lupercio, Ernesto
Univ. of Michigan

Maréchal, Pierre
Univ. de Montpellier

Masakova, Zuzana
Faculty of Nuclear Sc. and Physics Eng. (Czech Republic)

Mathieu, Pierre
Univ. Laval

McLeod, Ian A.
Univ. of Western Ontario

Michel, Louis
IHES, France

Monastyrsky, Michael
ITEP

Moody, Robert V.
Univ. of Alberta

Nishino, Akinori
Gunmaa College of Technology

Ohyama, Yousuke
Osaka Univ.

Orlov, Aleksander
Landau, Moscow

Ouansafi, Abdellatif
Univ. Mohammed V

Paramonov, Petr
Steklov Institute, Moscow

Patera, Jan
Czech Technical Univ.

Phong, Duong H.
Columbia Univ.

Pleasants, Peter
Univ. of South Pacific

Pogosyan, Georges
Joint Institute for Nuclear Research (Dubna)

Posta, Severin C
Technical Univ. Czech Republic

Ragnisco, Orlando
Univ. Roma 3

Rowe, David
Univ. of Toronto

Runkel, Ingo
King's College London

Schmidt, Georg
McGill Univ.

Sheftel, Misha B.
North-Western Correspondence Polytechnical Inst. (Russia)

Sklyanin, Evgueni
ENS-Lyon

Stoll, Manfred
Univ. of South Carolina

Sweldens, Wim
Bell Lab., Lucent Techn.

Thiriet, Marc
INRIA

Thomova, Zora
SUNY-Institute of Techn.

Turbiner, Alexander
UNAM

Ujino, Hideaki
Gunmaa College of Technology

Vartanian, Arthur H.
Univ. of Alberta

Viallet, Claude
Univ. Pierre et Marie Curie

Vrana, Leopold
Faculty of Nuclear Sc. and Physics Eng. (Czech Republic)

Vulpe, Nicolae
Academy of Sciences of Moldova

Walton, Mark
Univ. of Lethbridge

Xudous, Yorgo
Univ. Laval

Yamilov, Ravil
Russian Academy of Sciences

Yau, Shing-Tung
Harvard Univ.

Yui, Noriko
Queen's Univ.

Zakrzewski, Wojciech
Univ. of Durham

Zhedanov, Alexei
Donetsk Univ.

Management

Bureau

The Bureau consists of members from the Université de Montréal (8 to 11 members) and from the outside (2 to 5 members). The rector of the Université and the dean of the Faculté des arts et des sciences are represented on the Bureau. Its role is to adopt the policies of the Centre, to recommend the nomination and the promotion of researchers and the appointment of regular members, to advise the director on the preparation of the budget and the Université on the choice of the director.

Bélair, Jacques
Dep. Dir. CRM,
Univ. de Montréal

Bengio, Yoshua
Dep. Dir. CRM,
Univ. de Montréal

Bergeron, François
UQAM

Boyer, Steven
Dep. Dir. CRM,
UQAM

Brassard, Gilles
Univ. de Montréal

Caillé, Alain
Vice-rector, Research
Univ. de Montréal

Cléroux, Robert
Univ. de Montréal

Goldstein, Martin
Dep. Dir. CRM,
Univ. de Montréal

Hubert, Joseph
Assoc. Dean,
Research, FAS
Univ. de Montréal

Hurtubise, Jacques
Director CRM,
Univ. McGill

Hussin, Véronique
Univ. de Montréal

Jeffrey, Lisa
Univ. of Toronto

Lessard, Sabin
Univ. de Montréal

Ransford, Thomas J.
Univ. Laval

Rousseau, Christiane
Univ. de Montréal

Vaillancourt, Jean
Univ. de Sherbrooke

Kowaliczko, Béatrice
Secretary

Advisory Committee

The 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 rector of the Université de Montréal or his representative and the director of the CRM also take part in the meetings. The Advisory Committee is informed periodically of the activities of the Centre, through the director, and transmits any advice that it deems relevant to the Bureau.

Bélair, Jacques
Dep. Dir. CRM,
Univ. de Montréal

Bengio, Yoshua
Dep. Dir. CRM,
Univ. de Montréal

Boyer, Steven
Dep. Dir. CRM,
UQAM

Goldstein, Martin
Dep. Dir. CRM,
Univ. de Montréal

Hambleton, Ian
McMaster Univ.

Hurtubise, Jacques
Director CRM,
Univ. McGill

Kane, Richard
Univ. of Western
Ontario

Lalonde, François
UQAM

Lawless, Jerry
Univ. of Waterloo

Melrose, Richard
MIT

Miller, Willard
IMA

Murty, Ram
Queen's Univ.

Odlyzko, Andrew
AT&T Labs

Pianzola, Arturo
Univ. of Alberta

Putnam, Ian
Univ. of Victoria

Treves, Francois
Rutgers Univ.

Ward, Michael
Univ. of British
Columbia

Kowaliczko, Béatrice
Secretary

Computer Facilities

The CRM offers its members and visitors a Unix environment based on a Sun Enterprise-450 equipped with four 400-MHz Ultra-Sparc processors and 2 Gb of memory as a main server, and a secondary server Sun Sparc-1000 with eight 40-MHz processors and 384 Mb of memory for lightweight CPU tasks. In 2000, the file server has grown by 18 Gigabytes (for the research group Physnum). This computing power is distributed through the offices and common rooms via 35 Sun workstations (from Sparc-4 to Ultra-10) and several X-terminals.

Note that the main server (Enterprise-450), 22 Sun Ultra-5 and Ultra-10 workstations and the Local Area Network installed in 1999 were obtained through a grant from the Canadian Foundation for Innovation with contributions from the Government of the Province of Québec, Sun Microsystems and Anixter.

The software libraries include compilers (SparcWorks environment for C, C++ and Fortran, GNU compilers, Java, etc.), symbolic manipulation programs (Mathematica, Maple, Macaulay), several text editors, web browsers, a web server, mail tools, and most utilities common to the mathematical world (SPLUS, etc.). Upgrades to TeX and its dialects are uploaded whenever they are released. Unix software to exchange with the PC and Mac platforms, such as SAMBA (PC file and printer server), StarOffice (Office suite), and AUFS (file server for Macintosh), are also installed. In 1999, security awareness has increased and new measures, such as the installation of surveillance software, were put in place with more to come in the future.

Since 1999, the CRM operates its own private local area network (LAN) : four BayNetworks Baystack-450 switches, providing 96 ports on twisted-pair at 10/100 Mb/s and 4 optic fiber links supporting Gigabit Ethernet. This private local network is linked to the network of Université de Montréal which maintains the connections with RISQ (Réseau interordinateurs scientifique québécois) and CA*net (the Canadian internet transit service). Members and guests can now connect their personal laptops (or computers) directly to the CRM private network, or if they are outside CRM offices, they can connect through phone links to our PPP server and its 4 modems.

The support staff works on Sun stations, X-terminals or on Macintoshes linked to the Sun server for all services, such as mail and backups. A 3-year plan for replacement of all support staff computers has started in 1999.

For printing, the CRM has acquired a new HP-8000DN workgroup printer (1200-dpi double-sided) and a jet-ink network printer Epson-900N for colour-printing.

The CRM has its servers installed in a room designed for this purpose, with an independently controlled environment and UPS (Uninterruptible Power Supply).

Scientific Activities

The core of each year's scientific programme at the CRM is its thematic programme. The topic is chosen by the Advisory Committee for its scientific importance, its timeliness, and its impact on the Canadian scientific community. Preceding years' topics include: Probability and Stochastic Control (1992-93); Dynamical Systems (1993-94); Geometry and Topology (1994-95); Applied and Numerical Analysis (1995-96); Combinatorics and Group Theory (1996-97), Statistics (1997-98), Number Theory and Arithmetic Geometry (1998-99). A year's activities can combine a good number of workshops and conferences, one or two Aisenstadt chairs, a certain number of visiting scientists in residence, and some post-doctoral fellowships. Typically, there is some coordination with Montréal universities to offer appropriate graduate courses in order to help graduate students participate in the activities. The reports are presented in the language in which they were submitted.

Theme Year 1999-2000: Mathematical Physics

Overview

Many sectors of mathematics and physics have been tightly interwoven in the last decades. The interactions have triggered some important developments that turned out to be fruitful for both disciplines: to name only a few, conformal field theory, vertex operators and representation theory; string theory, duality, non-commutative geometry and mirror symmetry; classical and quantum integrable systems and quantum groups.

These links make a theme year in mathematical physics particularly appealing. Several other reasons make it compelling. Canada can boast of an impressive number of first-class mathematical physicists, a number which is even larger if one includes theoretical physicists whose research interests have been influenced by mathematical developments. Through its various events and minicourses, it will also provide excellent opportunities for (pure) mathematicians to learn how recent developments in some of their disciplines are being used in physical theories. The summer school, the longer workshops, and the winter concentration period are designed to welcome advanced graduate students and postdoctoral fellows in both mathematics and physics and give them a chance to interact among themselves and with the leaders of these disciplines. Two of the workshops draw not only from mathematics and physics but from yet a third discipline (finance and computer science, respectively). Finally the theme year will enhance links between the mathematics and theoretical physics communities in Canada. It will have brought to CRM 804 participants including 89 postdoctoral fellows and 238 graduate students.

9th CRM Summer School: *Theoretical Physics at the End of the XXth Century*

June 27 – July 10, 1999, Banff, Alberta
Org. : Yvan Saint-Aubin and Luc Vinet (UdeM and CRM)

When organizing a summer school at the end of the most fruitful century in the history of physics one must carefully consider the question of topics. We decided to avoid a retrospective of problems solved during the last century and we shied away from a prediction of which ones might be settled during the next. We opted for a snapshot of what theoretical physics is at the end of this century (or, should we say, the last century), namely problems actively researched in the last few years of the nineteen nineties. This choice led to twelve courses that were timely, diverse and exciting. And the response from the participants was extremely positive.

Main Lectures

- Ian Affleck (UBC), *Boundary CFT Approach to Quantum Impurity Problems in Condensed Matter Physics.*
- Gilles Brassard (Montréal), *Quantum Information Processing.*
- Eric D'Hoker (UCLA), *Supersymmetric Yang-Mills Theory and Integrable Systems.**
- Michael Duff (Texas A&M), *Branes, Black Holes and anti-De Sitter Space*.*
- Krzysztof Gawedzki (IHES), *Easy Turbulence.**
- Brian R. Greene (Columbia), *Geometry and Quantum Gravity*.
- Allan Griffin (Toronto), *Bose-Einstein Condensation*.*

- Satoru Odake (Shinsu Univ.), *Integrability, Deformed Virasoro and Elliptic Algebras.**
- José Onuchic (UCSD), *Exploring the Protein Folding Funnel Landscape: Connection Between Theory and Experiments.**
- Marc Potters (Science & Finance, Paris) *Statistical Finance - New Problems for Physicists*,
- Ben Simons (Cambridge), *Mesoscopic Physics*.*
- Frank Wilczek (IAS, Princeton), *QCD in Extreme Conditions*.*

The courses with an asterisk will appear in the year 2001 in the collection Mathematical and Theoretical Physics published jointly by Springer and CRM.

Workshop on Theoretical Methods for Strongly Correlated Fermions

May 26 - 30, 1999
Org. : André-Marie Tremblay (Sherbrooke) and Andrei Ruckenstein (Rutgers)

Cet atelier a permis de confronter différentes approches théoriques pour les modèles d'électrons fortement corrélés, c'est-à-dire pour les systèmes d'électrons où les énergies cinétiques et potentielles sont comparables. On rencontre ces problèmes entre autre dans le contexte de la supraconductivité à haute température. Ces matériaux sont fortement anisotropes, plus spécifiquement quasi-bidimensionnels, et les électrons ne sont ni complètement localisés ni complètement délocalisés, ce qui implique encore une fois que les méthodes traditionnelles ne sont pas utilisables.

Parmi les méthodes théoriques développées récemment, on compte les développements autour de la dimension infinie, la bosonisation, l'invariance conforme, le groupe de renormalisation, les bosons esclaves et diverses autres méthodes non-perturbatives. Chacune de ces méthodes ayant ses limites et chacune d'elle étant suffisamment complexe, il est rare qu'une personne puisse en maîtriser plusieurs. Les approches numériques jouent un rôle essentiel puisqu'on ne peut pour le moment étudier que des Hamiltoniens qui sont des caricatures des systèmes accessibles expérimentalement. Ainsi, les approches numériques permettent de tester la validité des autres méthodes de nature plus analytique.

Malgré les nombreuses conférences et ateliers sur les fermions fortement corrélés, on ne retrouve pas d'atelier consacré uniquement aux aspects purement théoriques de ce problème. De l'avis des conférenciers, cet atelier a été une première. Il a mis en contact des experts de différentes approches, réunis autour d'un même problème, soit la solution de modèles de type Hubbard (contenant à la fois les aspects localisé et délocalisé) en basse dimension. Des présentations pédagogiques longues (une heure et demie) le matin ont permis à chacun d'apprécier les forces, les faiblesses ainsi que les problèmes ouverts pour chacune des méthodes théoriques importantes. Des présentations plus courtes l'après-midi ont permis de faire le point sur des problèmes d'actualité. Une heure et demie par jour a été réservée aux affiches, qui ont été exposées durant toute la durée de l'atelier, ce qui a permis plusieurs discussions informelles, entre autres durant les pauses café ou le matin à l'arrivée. L'atelier a attiré 57 participants dont 28 étudiants et boursiers postdoctoraux.

La première journée a été consacrée aux méthodes numériques. S. White a présenté une introduction à la méthode de renormalisation par la matrice densité alors que K. Hallberg nous a fait part des tous derniers développements. L'exposé de M. Imada a permis de faire le point sur les résultats pour un grand nombre de modèles. S. Zhang avait préparé un exposé très pédagogique sur les méthodes Monte Carlo quantique et sur une nouvelle méthode pour éliminer le problème du signe fermionique.

Ce sont les méthodes de bosonisation qui ont été au cœur de la deuxième journée. Après une introduction magistrale de D. Sénéchal, les conférenciers T. Giamarchi, I. Affleck et M.P.A. Fisher ont décrit comment ces méthodes permettent de comprendre, respectivement, l'effet du désordre sur les systèmes quasi-unidimensionnels désordonnés, la résonance de spin dans les chaînes de spin unidimensionnelles et les fermions fortement corrélés en deux dimensions. La présentation pédagogique de G. Kotliar sur la transition de Mott s'inscrivait dans un cadre méthodologique différent mais soulevait un problème de fond. En effet, des résultats récents sont venus contester le fait que la transition de Mott soit du premier ordre à température nulle, comme le suggère la méthode de développement en dimension infinie. Ce problème a été discuté en profondeur par les deux groupes impliqués lors d'une des deux séances de discussion de samedi après-midi et il

a été conclu que la méthode de calcul en dimension infinie devait pour le moment être considérée plus fiable.

La journée de vendredi a commencé par un tour d'horizon des applications de la méthode de renormalisation de Wilson aux fermions. C. Bourbonnais y a introduit le sujet et expliqué ses applications aux systèmes quasi-unidimensionnels. Il a exposé une nouvelle méthode qui donne de meilleurs résultats que la bosonisation lorsqu'elle est appliquée aux systèmes de spins avec interactions aux premiers et deuxième voisins. La plupart des experts du domaine étaient dans la salle. Des questions assez techniques sur l'applicabilité de la méthode de Wilson aux ordres supérieurs ont été débattues et éclaircies. Les unidimensionnels ont en général des lignes de points critiques à température nulle et S. Sachdev a enchaîné avec des explications très physiques sur les points critiques quantiques. L'effet du désordre près des points critiques quantiques a été discuté par A. Rosch. S. Zhang a présenté un nouveau développement de sa théorie de la supraconductivité de type SO(5). Il a en effet expliqué pourquoi les calculs numériques ne montrent qu'une partie du spectre des états en établissant une analogie avec l'effet chiral du champ magnétique. P. Wölfle, quant à lui, a montré comment on peut utiliser les méthodes conservatrices pour développer de nouveaux types d'approximation avec les bosons esclaves.

Samedi, N. Bickers a présenté une introduction très claire aux équations parquet et expliqué les nouvelles approches numériques qu'il a développées pour résoudre ces équations. Une nouvelle approche hamiltonienne à l'effet Hall quantique fractionnaire a ensuite été présentée par R. Shankar. Nous avons déjà parlé d'une des deux tables rondes de l'après-midi sur la transition de Mott avec G. Kotliar et S. Kehrein. Des discussions en petit groupe suite à l'autre table ronde menée par R. Frésard et B. Kyung sur de nouvelles méthodes non-perturbatives ont permis de faire le point sur les contradictions apparentes dans la littérature antérieure entre différentes approches au problème à N-corps. Les méthodes auto-cohérentes et les simulations Monte Carlo semblaient indiquer l'absence de pseudogap dans le poids spectral à une particule alors que de nouvelles méthodes et de nouvelles simulations indiquent plutôt qu'il y a un pseudogap à basse température lorsque la longueur de corrélation à une particule devient plus petite que la longueur de corrélation des modes collectifs.

V. Dobrosavljevic a montré le dimanche comment traiter l'effet combiné du désordre et des interactions grâce aux méthodes de dimension infinie. A. Chubukov a terminé l'atelier par un exposé plus spéculatif sur l'effet de l'antiferromagnétisme sur la supra-conductivité, terminant sur une note stimulante.

AARMS-CRM Workshop on Bäcklund & Darboux Transformations: *The Geometry of Soliton Theory*

June 5 - 9, 1999, Halifax, Nova Scotia
Org. : Mark J. Aablowitz (Colorado), Alan Coley (AARMS, Dalhousie), Athanassios S. Fokas (Imperial College), Decio Levi (Roma 3), Peter J. Olver (Minnesota), Colin Rogers (New South Wales), and Pavel Winternitz (CRM)

L'objectif de l'atelier était de regrouper un grand nombre de chercheurs actifs dans la théorie des solitons. Ce fut un succès puisque 62 chercheurs, dont 7 étudiants et chercheurs postdoctoraux, ont participé à l'atelier. L'accent a été mis sur le développement et les applications des transformations de Bäcklund et de Darboux. Il y a eu un total de 51 présentations de la part de conférenciers invités.

Astrophysics and Cosmology

June 6 - 12, 1999

This large conference will group two major workshops covering closely related subjects that are usually isolated.

Black Holes II: *Theory and Mathematical Aspects*

June 6 - 9, 1999, Fall Hills Inn, Val Morin
Co-sponsors : Canadian Institute for Advanced Research (CIAR) and Canadian Institute for Theoretical Astrophysics (CITA)
Org. : Valeri Frolov (Alberta), Werner Israel (Victoria), Robert Myers (McGill), Don Page (Alberta), and Eric Poisson (Guelph)

The focus of this workshop was the many recent developments in the statistical mechanical description of black holes. The workshop brought together some 66 researchers, including 37 graduate students and postdoctoral fellows, in general relativity and string theory who are interested in these developments. It was the second instalment in a series of similar workshops; the first one was held in Banff (Alberta) in June, 1997. Black Holes II was held in conjunction with the Eighth Canadian Conference on General Relativity and

Relativistic Astrophysics (McGill University, June 10-12), organized by Rob Myers and Cliff Burgess. The early nineteen seventies produced remarkable advances in our understanding of black holes. A set of four basic laws governing the evolution of classical black holes were formulated. While these laws bore a striking resemblance to the four laws of thermodynamics, such a comparison remained a formal analogy until 1974. At that time, Hawking made the astounding discovery that quantum processes occurring near the event horizon give rise to a thermal flux of radiation far from the black hole, with a temperature proportional to the surface gravity of the horizon. Thus Hawking's discovery showed that black holes do indeed behave as thermodynamic systems, and confirmed a suggestion by Bekenstein that they must possess an entropy proportional to the surface area of the event horizon. This realization revealed a profound connection between three different branches of physics: general relativity, quantum mechanics, and thermodynamics, and there is a widely held belief that this connection will provide insights into the elusive problem of quantizing gravity.

While the first law of black hole thermodynamics provides a formula for black hole entropy in terms of the area of the event horizon, it also presents us with a thermodynamic understanding of the entropy - namely, it is associated with energy unavailable for work, or energy that cannot be extracted from the black hole through classical processes. For ordinary thermal systems, statistical mechanics provides a complementary description of entropy in terms of our uncertainty about the precise state of the microscopic degrees of freedom. Constructing such a microphysical description of black holes has been an unresolved problem in gravitational physics which, despite numerous attempts, yielded no progress until very recently. The past few years have produced many breakthroughs in our understanding of the statistical origin of the black hole entropy. The main purpose of this workshop was to take stock of this progress, identify the remaining open issues, and map out future research directions. String theory, currently the favoured candidate for a theory of quantum gravity, is largely responsible for much of this recent progress. Certain black holes can be associated with configurations in string theory, which are amenable to examining and counting the underlying microscopic states. Hence a precise statistical mechanical account of the black hole entropy could be given in these particular cases. Motivated by the string theory results, complementary calculations were later made using spacetime loop variables, and also using an infinite conformal symmetry which apparently characterizes the spacetime geometry near an event horizon. The extent to which any of these calculations hold in general, and how the different approaches might be related, are important open questions that were discussed during the workshop.

There were 16 invited speakers at the workshop, and 15 additional speakers contributed talks. The invited lectures were held in the mornings and evenings, and the afternoons were devoted to the contributed lectures. We now present a brief overview of the invited lectures.

Sunday morning started out with reviews of the mostly classical aspects of black hole thermodynamics, presented by Robert Wald (Chicago), Abhay Ashtekar (Penn State), and Werner Israel (Victoria). The evening's lecture was given by Leonard Susskind (Stanford), who talked about the holographic principle, and the anti-de Sitter/conformal field theory correspondence. On Monday morning, the talks were mostly concerned with quantum-gravity aspects of black hole thermodynamics; these were given by Steve Carlip (UC Davis), Gabor Kunstatter (Winnipeg), and Emil Martinec (Chicago). In particular, Steve Carlip reviewed the calculations of black hole entropy using the conformal symmetry of the near-horizon geometry, and Emil Martinec gave an overview of the many different microscopic descriptions that string theory provides in various cases. The evening lecture was given by Don Page (Alberta), whose topic was the thermodynamics of very cold (near extreme) black holes. The discussion of quantum aspects continued on Tuesday morning, with talks by Ted Jacobson (Maryland), Valeri Frolov (Alberta), and Robert Mann (Waterloo). Bill Unruh (UBC) gave the evening lecture, and talked on his sonic analogue of black holes. Finally, Wednesday morning was devoted specifically to string theoretic aspects of black hole thermodynamics, with talks by Juan Maldacena (Harvard), Finn Larsen (Chicago), David Lowe (Brown), and Steve Gubser (Harvard).

Eighth Canadian Conference on General Relativity and Relativistic Astrophysics

June 10 - 12, 1999, McGill Univ, Montréal
Co-sponsor: Canadian Institute for Theoretical Astrophysics (CITA)
Org. : C.P. Burgess (McGill), J. Gegenberg (New Brunswick), D. Hobill (Calgary), G. Kunstatter (Winnipeg), R.G. McLenaghan (Waterloo), and R.C. Myers (McGill)

This conference was the eighth in an ongoing series of biannual meetings, which bring together Canadian researchers working on various aspects of gravitational physics, as well as experts in this field from around the world. At the present time, the study of general relativity and relativistic astrophysics is progressing rapidly in several different directions. Two prime examples are: the explosion of research activity in the statistical mechanical properties of black holes, stimulated by recent developments in superstring theory, and the intense study of gravitational waves, stimulated by the advent of large-scale experiments (*LIGO*) which should be able to detect these waves in the near future. Partly as a result of the sense of excitement which this activity has created, we were able to attract a hundred participants from nine different countries (Canada, England, France, Israel, Singapore, South Korea, Sweden, Switzerland and the United States), including 53 graduate students and postdoctoral fellows. Many of the participants came to McGill after attending the workshop, "Black Holes II: Theory and Mathematical Aspects", which was held in Val Morin (in the Laurentians, north of Montréal) on June 6-9, 1999.

The list of invited talks included: Abhay Ashtekar, *Quantum Geometry and Black Hole Entropy;* Gilles Fontaine, *White Dwarf Stars as Potential Contributors to Baryonic Dark Matter;* Ted Jacobson, *Entropy and Gravity: Horizons, Entanglement and the Holographic Bound;* Vicky Kaspi, *Binary Radio Pulsar Timing and General Relativity;* Lev Kofman, *Preheating After Inflation;* Sharon Morsink, *Surprises from Rotating Neutron Stars;* Don Page, *Can Quantum Cosmology Give Observational Consequences of Many-Worlds Quantum Theory?;* Peter Saulson, *What Will We Learn from Gravitational Wave Detection?;* Lennie Susskind,*The Holographic Principle;* Bill Unruh, *The Effect of Second Order Perturbations on the Expansion of the Universe*; Jeff Winicour: *The Characteristics of Colliding Black Holes.*

There were also thirty-four contributed talks (including eleven by graduate students) and fourteen poster presentations. A brief sampling of the wide variety of topics covered in these contributions is: the dynamics of Brill-wave spacetimes, algebraic computing in general relativity, detection of gravitational waves from coalescing binaries, the Hamiltonian description of isolated black holes, topological censorship, and the scattering cosmic strings from black holes.

Frontiers of Mathematical Physics: *Summer Workshop on Particles, Fields and Strings 99*

August 2 - 20 1999, Univ. of British Columbia, Vancouver, British Columbia
Co-sponsors : Pacific Institute for Mathematical Sciences (PIms) and Asia Pacific Center for Theoretical Physics (APCTP)
Org. : Taejin Lee (Kangwon National Univ.), Yuri Makeenko (ITEP, Moscow & NBI, Copenhagen), John Ng (TRIUMF), Soonkeon Nam (APCTP, Seoul), Chaiho Rim (APCTP, Seoul), Alexander Rutherford (PIms), Gordon Semenoff (UBC), K.S. Viswanathan (Simon Fraser), and Ariel Zhitnitsky (UBC)

The main scientific topic of this workshop, which took place at the Pacific Institute for Mathematical Sciences site at the University of British Columbia, was recent developments in superstring theory. The two main themes were the IKKT matrix model of type IIB strings and the AdS/CFT correspondence. Other topics, such as the role of K-theory in string theory, the structure of supersymmetric Yang-Mills theory and some general questions about the solutions of supergravity were also discussed. Igor Klebanov (Princeton University) presented a series of three review lectures on the AdS/CFT correspondence. Joe Polchinski (ITP Santa Barbara) gave a series of two lectures discussing some more advanced issues in that subject.

There were 68 participants. Of these, 16 were postdoctoral fellows, 14 were graduate students and the remainder were more senior scientists. Most were theoretical and mathematical physicists. Three were mathematicians. Participants came from Russia, Korea, Japan, Taiwan, USA, Canada, Italy, France, England, Spain, Denmark, and Ireland.

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

invited speakers provided a scientific focus to the workshop and strengthened the quality of the seminars.

The invited speakers were Peter Horava (Caltech), Seungjoon Hyun (Seoul), Hikaru Kawai (Kyoto), Igor Klebanov (Princeton), Kimyeong Lee (Seoul National U.), Amanda Peet (Santa Barbara), Joe Polchinski (Santa Barbara), and S. Rajeev (Rochester).

Workshop on Non-linear Dynamics and the Renormalization Group

August 22 - 27, 1999
Org. : Israel Michael Sigal (Toronto) and Catherine Sulem (Toronto)

This workshop was devoted to two relatively young and fast developing areas of mathematical physics - non-linear dynamics and the renormalization group, the former being understood as a qualitative theory of non-linear evolution partial differential equations. Some of the questions addressed were: the dynamics of particle-like structures (e.g. solitons and vortices) and interface boundaries, blow-up profiles, universal features of large-time behaviour, and the application of renormalization group methods to quantum field theory, statistical mechanics and in non-linear partial differential equations (in particular, in general relativity).

The workshop had review talks summarizing recent advances, talks on current progress and discussions on promising directions. We describe in more detail the subject matter of the workshop. Non-linear dynamics and renormalization group theory, which are among the most active areas of research in physics in the last 25 years, have rather disparate origins, at least at first sight. The non-linear evolution equations describe usually macroscopic objects whose characteristics undergo changes in space and time. The renormalization group theory, on the other hand, was invented to investigate the microscopic systems of enormous number, say 10^{23}, of degrees of freedom, which are in a state of equilibrium. However, these areas are closely related. It has been known for a long time that states of macro-objects, whose evolution is given through non-linear evolution equations, describe large scale, collective characteristics of microsystems of a large number of degrees of freedom. However, the interaction of these two areas, of interest to us, was discovered only recently. To begin with, it is mathematical rather than physical. On one hand, a renormalization group can be considered as an infinite dimensional dynamical system and the methods of non-linear differential equations play an essential role here. On the other hand, the method of renormalization group turned out to be very effective in understanding long time behaviour of rather complicated evolution equations.

Though the development described above first appeared in physics, the problems addressed there are of key interest in other fields, such as biology, economics, chemistry, and engineering. So far these problems have been attacked mostly with heuristic arguments, justified by computer simulations and costly experiments. Developing mathematical techniques, as well as introducing logical clarity in these areas, is one of the main challenges facing mathematicians. This workshop has brought together mathematicians and physicists working on non-linear differential equations and renormalization group methods. It has contributed to the exchange of ideas in these fields.

The workshop attracted 56 participants, including 9 graduate students and postdoctoral fellows, from Canada, USA, France, Switzerland, Germany, Japan, Taiwan, and Greece. The list of speakers included: S. Alama (McMaster), N. Alikakos (Athens), F. Bethuel (Paris VI), P. Bizon (Warsaw), O. Bogoyavlenski (Queen's), L. Bronsard (McMaster), P. Deift (Courant), J.P. Eckmann (Geneva), J. Feldman (UBC), J.M. Graf (Zurich), S. Gustafson (Toronto), T. Hurd (McMaster), V. Jaksic (Ottawa), R. Jerrard (Illinois), L. Kapitansky (Kansas), N. Kevlahan (McMaster), M. Kiessling (Rutgers), J. Lebowitz (Rutgers), R. McCann (Toronto), M. Merkli (Toronto), H. Nawa (Nagoya), D. Pelinowsky (Toronto), G. Perelman (EP, Paris), R. Pyke (Ryerson), Y. Saint-Aubin (Montréal), S. Serfaty (ENS, Paris), J. Shatah (Courant), T. Spencer (IAS, Princeton), A. Soffer (Rutgers), B. Vasiljevic (Toronto).

The general feeling among participants was that the workshop was a great success, that it made a valuable contribution to the fields in question and that it helped to ease the entry of new researchers, and most importantly graduate students and postdoctoral fellows, into these fascinating fields. The participants were

impressed by CRM facilities, the helpfulness of the staff and the lively atmosphere of the city.

Workshop on Aspects of Quantization

September 23 - 29, 1999
Org. : Lisa Jeffrey (Toronto)

Quantization originates in theoretical physics (in the passage from the classical phase space which parametrizes the position and momentum of a classical particle, to the Hilbert space of wave functions whose norm squared describes the probability distribution of the particle). It has been incorporated into various disciplines in pure mathematics including algebraic and symplectic geometry. This workshop brought together researchers with interests in three different areas of mathematics related to the theory of quantization:

- quantization by coherent states;
- geometric quantization;
- the behaviour of quantization under symplectic reduction, in particular the conjecture of Guillemin and Sternberg that "quantization commutes with reduction".

The portion of the conference devoted to coherent state quantization was organized by Prof. S.T. Ali (Concordia Univ.).

The workshop brought together 46 participants including 18 postdoctoral fellows and graduate students. The list of invited speakers included researchers from Canada, France, Mexico and the USA. To the best of the organizer's knowledge, this was the first time a meeting devoted exclusively to the theme of quantization had been held in Canada.

The list of invited talks included:
E. Meinrenken, *A Fixed Point Formula for Loop Group Actions;* R. Sjamaar, *Imploded Cross Sections;* C. Woodward, *Quantization of the Moduli Space of Flat Connections for non Simply-Connected Groups*; B. Kostant, *A Cubic Dirac Operator and a Generalization of Bott-Borel-Weil*; J. Weitsman, M. Vergne, *The Duflo Isomorphism and the Campbell-Hausdorff Formula*; M. Brion, *The General Faces of the Moment Polytope*; A. Szenes, *Deformation Quantization of Moduli Spaces of Vector Bundles*; E. Lerman, *A Non-Abelian Duistermaat-Heckman Formula*; J. Hurtubise, *Framed Parabolic Bundles and Representations with Weighted Frames*; C. Teleman, *Quantization of the Hitchin System;* Y.-H. Kiem, *Equivariant and Intersection Cohomology of Moduli Spaces of Vector Bundles;* C. Villegas Blas, *The Segal-Bargmann Transform and Canonical Transformations for Spheres*; P. Paradan, *Localisation of the Riemann-Roch Character*; A. Uribe, *Semiclassical Properties of Almost-Kaehlerr and Spin-c Quantizations*; L. Jeffrey, *The Verlinde Formula for Moduli Spaces of Parabolic Bundles*; J. Sniatycki, *Commutativity of Quantization and Reduction and Decomposition of Representations*; M. Gotay, *On Quantizing Nilpotent and Solvable Basic Algebras*; B. Hall, *Unitarity in Quantization Commutes with Reduction*; S. Berceanu, *Symplectic Area of Geodesic Triangles and Coherent states*; C. Duval, *Equivariant Quantization*; H. Fuehr, *Coherent States from Cyclic Representations*; S.T. Ali, *Coherent State Quantization and a Generalized Wigner Function*.

QIP 2000 : Workshop on Quantum Information Processing

December 5 - 11, 1999
Org. : Gilles Brassard (Montréal) and Richard Cleve (Calgary)

L'informatique quantique est un domaine de recherches en pleine ébullition qui étudie les nouvelles avenues pour le traitement de l'information que rend possibles la mécanique quantique. Nous nous intéressons en particulier au calcul quantique, à la cryptographie quantique, à la téléportation quantique et aux autres formes de communication quantique qui mettent en oeuvre le phénomène de l'intrication quantique.

QIP 2000 était le troisième d'une série d'ateliers internationaux dont le but est de réunir une fois l'an les chercheurs qui s'intéressent particulièrement aux aspect informatiques du traitement quantique de l'information. Les conférenciers invités provenaient du Canada, du Danemark, des États-Unis, d'Israël, de la Lettonie, des Pays-Bas et du Royaume-Uni.

Une centaine de participants, dont 47 étudiants et boursiers postdoctoraux, ont rendu cet événement particulièrement enrichissant. Afin de favoriser les discussions informelles, le programme contenait des conférences le matin et en fin d'après-midi, mais trois heures de temps libre étaient prévues chaque jour en début d'après-midi. Une photo de groupe est disponible à l'URL suivant:
http://www.crm.umontreal.ca/act/theme/1999/QIP2KNS.jpg
Un cahier des résumés des conférences a été distribué lors de l'inscription.

La journée initiale de l'atelier a été consacrée à une série de mini-cours (tutorials) dont le but était de permettre à des chercheurs n'ayant pas déjà les connaissances préalables dans le domaine de pouvoir suivre les conférences des jours suivants. Au programme de cette journée du 6 décembre 1999, les cours suivants ont été donnés:
Gilles Brassard, *Introduction to Quantum Information Processing;* Richard Cleve, *Fundamental Quantum Algorithms*; Isaac Chuang, *Quantum Computers: Physical Implementation;* Daniel Gottesman, *Introduction to Quantum Error Correction and Fault-Tolerance* et Charles H. Bennett, *Quantum Information Theory Tutorial* .

La seconde journée, 7 décembre 1999, a été consacrée au stockage et à l'extraction de l'information quantique, ainsi qu'à l'autotest: Lov K. Grover, *Amplitude Amplification with Multiple Targets;* John P. Preskill, *Topological Storage of Quantum Information*; Michele Mosca, *Self-Testing of Universal Sets of Quantum Gates* et Dominic Mayers, *Violation of Locality and Self-Testing Quantum Apparatus.*

La troisième journée, 8 décembre 1999, a été consacrée à la théorie de l'information quantique et des algorithmes quantiques: Peter W. Shor, *EPR Assisted Capacity of a Quantum Channel;* David DiVincenzo, *Algebraic and Graph Theoretic Aspects of Unextendible Product Bases and Bound Entanglement;* Umesh Vazirani, *Quantum Computation with Highly Mixed States* et Tal Mor, *Algorithmic Cooling for Ensemble Computers*.

Le matin de la quatrième journée, 9 décembre 1999, a été consacrée à la cryptographie quantique: Claude Crépeau, *Bit Commitment and Zero-Knowledge*: *Classical vs Quantum*; Louis Salvail, *Perfectly Concealing Quantum bit Commitment from any Quantum One-Way Permutation* et Vwani Roychowdhury, *A Proof of Security of Quantum key Distribution*. L'après-midi de cette journée était libre afin de favoriser encore davantage les discussions informelles et de démontrer l'adage de Erdos selon lequel le mathématicien est une machine destinée à transformer la caféine en théorèmes.

La cinquième journée, 10 décembre 1999, a été consacrée aux algorithmes quantiques (derechef) et à la théorie de la complexité quantique: Dorit Aharonov, *A Quantum to Classical Phase Transition in Noisy Quantum Computers;* Eli Biham, *Exact Solution of Grover's Search Algorithm Using any Unitary Transformations;* Ronald de Wolf, *Log-Rank Lower Bound for Entanglement-Assisted Quantum Communication Complexity*; Harry Buhrman, *Quantum Communication Complexity Bounds by Polynomials*; *Classical Communication Cost in Quantum Information Processing;* Hoi-Kwong Lo, *A Generalization of Quantum Communication Complexity*.

La sixième et dernière journée, 11 décembre 1999, a été consacrée à la théorie de la complexité quantique (derechef) et à la théorie de l'information quantique (derechef): John Watrous, *Space-Efficient Simulation of Quantum Processes*; Raymond Laflamme, *Quantum Computation, the Power of one bit of Quantum Information and Quadratically Signed Weight Enumerators*; Andris Ambainis, *Quantum Lower Bounds by Quantum Adversaries*; Michael Nielsen, *The Structure of the Entangled States;* Christopher A. Fuchs, *On Unknown Quantum States* et Richard Jozsa, *Distinguishability of States and von Neumann Entropy*.

Workshop on Strings, Duality and Geometry

March 22 - 25, 2000
Org. : Eric D'Hoker (UCLA) and Duong H. Phong (Columbia)

The workshop on "Strings, Duality, and Geometry" was centered on recent advances in this fast evolving area of interface between geometry and physics. Particular attention was devoted to mirror symmetry and Calabi-Yau manifolds, construction of Lagrangian fibrations of tori and symplectic geometry, Seiberg-Witten theory and integrable models, holographic duals, Eisenstein series and exact thresholds, non-commutative geometry and non-commutative quantum field theory, and differential geometric problems related to the AdS / CFT correspondence.

The workshop attracted 58 participants including 19 graduate students and postdoctoral fellows. There was an ideally balanced group of mathematicians and physicists, and the workshop led to many fruitful exchanges. The workshop also benefited from the presence of Roman Jackiw, Aisenstadt Chair, whose lectures were included in the programme.

The list of invited speakers included: Brian Greene, Boris Pioline, Shing-Tung Yau, Eric Zaslow, Samir Mathur, Rob Myers, Dan Freed, Mark Gross, Albrecht Klemm, Michael Faux, Bong Lian, Kefeng Liu, Bernard Julia, Dan

Kabat, Steve Naculich, Howard Schnitzer, François Lalonde, Wei-Dong Ruan, Massimo Porratti, Philippe Pouliot, Jean-Loup Gervais, Frederik Denef, Anatoly Libgober, Konstantin Savvidy, and Andrei Todorov.

Workshop on Mathematical Physicists in Finance and Industry

June 12 - 17, 2000
Org. : Luis Seco (Toronto) and Stathis Tompaidis (Texas)

The workshop consisted of two distinct parts. The first part was a series of mini-courses given by the organizers and John Chadam (Pittsburgh). Participants in the course consisted mainly of graduate students, with a small number of professional scientists who had an interest in a quick introduction to the subject. The format of the courses was that of case studies, mixed with the fundamental elements of the theory. They were very well attended, and the audience participated eagerly.

Part II was a traditional conference, that hosted visitors from North America and Europe mainly. Of special interest was a joint talk given by Fields Medalist Charles Fefferman and Allan Ho, from Princeton University, a talk with the format of a "duet" rarely seen in mathematical talks. The topics covered were very varied, from stochastic volatility to transactions costs, from pricing of American options to risk management in non-gaussian markets. Of special interest was the fact that several talks were given by students and young scientists, as well as by noted scientists established in their fields. Altogether, there were 40 participants including 11 graduate students and postdoctoral fellows.

Part II ended with an "Industry Day", which included the participation of CIRANO and Banque Nationale. Personnel from Hydro Québec also participated in the workshop.

Concentration Period Quantum Integrability 2000

April 2 - June 11, 2000
Org. : Philippe Di Francesco (North Carolina), André LeClair (Cornell), Nicolai Reshetikhin (Berkeley) and Hubert Saleur (USC)

D'avril à juin, le CRM a été l'hôte d'un trimestre de concentration lors de l'hiver 2000 avec plusieurs chercheurs en résidence. Le programme fut constitué de deux périodes de quatre semaines et d'un atelier. La première période a porté sur les Algèbres quantiques et l'intégrabilité et la seconde sur les Modèles intégrables en matière de l'état solide et la physique hors-équilibre. Tous les participants, dont certains reconnus internationalement, furent en résidence pour des périodes d'au moins deux semaines et allant parfois jusqu'à deux mois et demi. Onze personnes ont participé à toutes les activités du trimestre, incluant sept étudiants et boursiers postdoctoraux dont cinq provenant d'institutions de l'extérieur. Le sentiment général est celui d'un événement excitant et extrêmement productif.

Quantum Algebras and Integrability

April 2 - 30, 2000
Org. : André LeClair (Cornell) and Nicolai Reshetikhin (Berkeley)

Cette première période de concentration était consacrée aux aspects plus mathématiques sous-jacents aux modèles intégrables quantiques. Des résultats récents y ont été présentés sur les sujets suivants: algèbres affines quantiques pour les modèles sur réseau et en théorie des champs quantiques; opérateurs vertex et facteurs de forme; équations de Kniznick-Zamolodchikov déformées et autres équations aux différences; facteurs elliptiques; algèbres de Virasoro déformées; résultats exacts sur les fonctions de corrélation; température finie; théorie des champs avec frontière; perturbations intégrables des théories des champs conformes; algèbres affines quantiques et matrices S exactes.
Les activités de ce premier mois du Trimestre sur l'intégrabilité quantique ont attiré 62 chercheurs dont 26 étudiants et boursiers postdoctoraux.

Workshop on Isomonodromic Deformations and Applications in Physics

May 1 - 6, 2000
Org. : John Harnad (Concordia, CRM) and Alexander Its (IUPUI, Indianapolis)

This was the first international workshop organized solely on the theme of Isomonodromic Deformations and Applications in Physics. The study of isomonodromic deformation equations is currently in very active development, motivated in part by the central role of such equations in a number of areas of quantum and statistical physics. The main domains in physics to which this approach is applicable are:

- Computation of correlation functions in quantum integrable systems and lattice models of statistical physics;

- The spectral theory of random matrices, with applications to quantum gravity;
- Topological field theory, with applications to solution of the DVVW equations through the theory of Frobenius manifolds;
- Scaling reductions of classical integrable systems.

There was a certain overlap in participation with the preceding CRM period of concentration on Quantum Algebras and Integrability. Also, during the first three days of the six-day workshop, the Aisenstadt Chair lectures by Prof. Joel Feldman, on Fermi Surfaces and Infinite Genus Riemann Surfaces, were integrated into the schedule.

The speakers at the workshop included some of the foremost experts in the field, together with a number of active younger researchers. There were a total of about 40 participants, including 11 graduate students and postdoctoral fellows, coming from the U.S., Canada, Japan, Russia, Ukraine, Germany, Spain, United Kingdom, Belgium, Italy, and Australia. The programme consisted of a total of 24 one hour talks, mainly by invited speakers. The specific topics covered included: Inverse monodromy problems for differential operators with meromorphic coefficients, and monodromy preserving deformations; isomonodromic tau functions as Fredholm determinants; matrix Riemann-Hilbert problems, non-linear WKB and applications to asymptotics; vertex operators, Darboux and Backlund transformations; applications to computation of correlation functions in quantum integrable systems and lattice models of statistical mechanics; applications to the spectral theory of random matrices, random word and random permutation problems, and zeros of random polynomials; Frobenius manifolds; relations to classical integrable systems; perturbations of infinite dimensional integrable systems.

The list of speakers and further details may be found at the workshop web site:
http://www.crm.umontreal.ca/~harnad/home.dir/ISOMON.dir/isomon-workshop.html and at
http://www.crm.umontreal.ca/~harnad/home.dir/ISOMON.dir/isomon-sched.html.

The proceedings will be published by the AMS in the CRM Proceedings and Lecture Notes series.

Integrable Models in Condensed Matter and Non-Equilibrium Physics

May 14 - June 11, 2000
Org. : Philippe Di Francesco (North Carolina), André LeClair (Cornell) and Hubert Saleur (USC)

Le second mois du Trimestre sur l'intégrabilité quantique se concentrait sur la matière condensée, avec une emphase sur le désordre. Ceci était particulièrement heureux puisque plusieurs résultats importants apparaissaient à ce moment-là et plusieurs furent présentés et discutés au CRM. Parmi les sujets traités se trouvent : les systèmes désordonnés; les matrices aléatoires; les problèmes d'impureté; les systèmes de Hall quantiques; les matériaux tubulaires et les plateaux de magnétisation; les théories conformes des champs avec frontière; l'intégrabilité des processus stochastiques; le scaling dans les systèmes loin de l'équilibre; la turbulence; la criticalité auto-organisée. Cette activité a réuni 63 chercheurs dont 18 étudiants et boursiers postdoctoraux.

Aisenstadt Chair

The Aisenstadt Chair was endowed by Montréal philanthropist Dr. André Aisenstadt. Under its auspices, one or two 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 courses on a specialized subject. They are also invited to prepare a monograph. 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, and Frans Oort.

The CRM was honoured to have as Aisenstadt chairholder, during the 1999-2000 theme year in Mathematical Physics, Professors Joel Feldman of the University of British Columbia, Roman Jackiw of the Massachusetts Institute of Technology, and Duong H. Phong of Colombia University.

Professor Joel S. Feldman
University of British Columbia

Joel S. Feldman, Professor of Mathematics at the University of British Columbia obtained his B.Sc. in Mathematics and Physics at the University of Toronto, and went on to obtain his A.M. and his Ph.D. in Physics at Harvard University. He became a research Fellow at the same university in 1974 and proceeded to become a CLE Moore Instructor at the Massachusetts Institute of Technology from 1975 to 1977. He has been professor of mathematics at the University of British Columbia since 1977.

He has since widely participated in organizing mathematical workshops and has been a keynote speaker at several international meetings including Canadian Mathematical Society meetings in St.John's (1986), Vancouver (1993) and Toronto (1995), the International Association of Mathematical Physicists Congress (Swansea, 1988) and the International Congress of Mathematicians (Kyoto, 1990). His honours and distinctions include the James Loudon Gold Medal in Mathematics and Physics, The Woodrow Wilson Fellowship, the Charles Bayne Aiken Fellowship and the UBC Killam Research Prize.

Dr. Feldman is recognized as one of the leading mathematical physicist in the world. He has always worked on hard problems in modern physics involving deep mathematics. His early work led to the first example of the Wightman axioms in 3-dimensional spacetime, a tour de force. His accomplishments in the areas of constructive quantum field theory, renormalization theory, Schroedinger operators, many body theory, and the theory of Riemann surfaces have been characterized by great technical power and clarity of thought. He has had fruitful collaborations with various co-workers such as V. Rivasseau, H. Knörrer, E. Trubowitz, J. Magnen, D. Lehmann, M. Salmhofer, J. Feldman, etc. in some 30 papers, studying systems of interacting electrons, in particular Fermi liquids and superconductivity.

During his visit to the CRM in the summer of 1999, Professor Feldman gave a series of lectures on the Renormalization Group and Fermionic Functional Integrals. The Renormalization Group is the name given to a technique for analyzing the qualitative behaviour of a class of physical systems by iterating a map on the vector space of interactions for the class. In a typical non-rigorous application of this technique one assumes, based on one's physical intuition, that only a certain finite-dimensional subspace (usually of dimension three or less) is important.

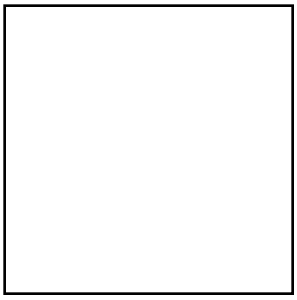
From August 22 to 25, 1999, Professor Feldman gave a series of lectures that covered the definition of Grassmann algebras, the definition and basic algebraic properties of Gaussian integrals over these algebras, a statement of how one formulates Fermionic models of quantum field theory and many-body physics in terms of integrals over Grassmann algebras, some basic bounds on Gaussian integrals over a Grassmann algebra, an expansion for non-Gaussian Grassmann integrals that converges

when a covariance for the Gaussian part of the measure is really nice, and finally, the use of the renormalization group to prove convergence of non-Gaussian Grassmann integrals when the covariance for the Gaussian part of the measure is not so nice.

During a second visit from April 28 to May 3, 2000, Professor Feldman presented a series of lectures on Fermi Surfaces and Infinite Genus Riemann Surfaces. He introduced a class of infinite genus Riemann surfaces to which much of the classical theory extends. He concentrated on a family of examples that arise in the study of the spectrum of Schoedinger operators, which are differential operators that play a central role in modeling crystals.

Professor Roman Jackiw

Massachusetts Institute of Technology



Roman Jackiw obtained his B.A. in 1961 from the Swarthmore College and continued his studies at Cornell University where he received his Ph.D. in 1966. From 1966 to 1969, he was at Harvard University as a Junior Fellow. He joined MIT in 1969. He was an invited professor at several prominent institutions among them, the Institute for Theoretical Physics, the University of California and Columbia University.

He is a fellow of the American Academy of Arts and Sciences, the American Physical Society and the National Academy of Sciences. He is also a recipient of the Alfred P. Sloan Research Fellowship as well as the John Simon Guggenheim Memorial Fellowship. His career has extended into scientific publications such as the Annals of Physics where he became an assistant editor in 1973. He also is a correspondent for Comments on Nuclear and Particle Physics since 1984 and has remained on the editorial board of the Ukrainian Journal of Physics since 1991. He has published over 30 books, book reviews and non-technical papers in his field.

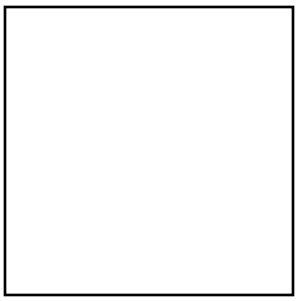
Professor Jackiw has made major contributions to field theories relevant to condensed matter physics, notably with his discovery of fractional charge and spin in these theories. He is recognized for his imaginative use of quantum field theory which throws light on physical problems, including his work on topological solitons, field theory at high temperatures, and the existence of anomalies and their role in particle physics.

He gave a first series of lectures at the CRM on March 22 through 24, 2000 on Non-linear (Fluid Dynamical) Equations and d-Branes. He explored relationships among various non-linear differential equations on the basis of their relation to the Nambu-Goto action for extended objects. Some of these equations describe fluid motion and they are generalized by the inclusion of Grassmann variables to build models of supersymmetric fluid dynamics.

From June 7 through 9, 2000, he gave a second series of lectures on Non-linear (Fluid Dynamical) Equations, Complete Integrability and Non-Abelian Generalization. Non-linear equations suggested by fluid mechanics were described and their complete integrability was demonstrated. Ordinary fluid dynamical models were generalized to accommodate invariance against global non-Abelian transformation groups.

Professor Duong H. Phong

Columbia University



Professor Duong H. Phong obtained his B.A. (1973) and Ph.D. in mathematics (1977) from Princeton University. He went on to become L.E. Dickson Instructor of Mathematics at the University of Chicago, and was a member of the Institute for Advanced Study in 1977. In 1978 he became a Ritt Assistant Professor of Mathematics at Columbia University. Now full professor, he has also served as chair of the Department of Mathematics.

His awards include the Alfred P. Sloan Fellowship (1982-84). He is also Fellow of the American Mathematical Society. In 1994, he was an invited speaker at the Zürich International Congress of Mathematicians. Throughout his career Professor Phong has been involved in a variety of scientific activities. He became a

member of the Editorial Board of the Mathematical Physics Series of World Scientific, the Asian Journal of Mathematics and a member of the Scientific Committee of the International Congress of the Chinese Mathematicians in Beijing in 1998. In 1986 and 1991, he was a visiting professor at the Université de Paris-Sud and at Princeton University, respectively. Furthermore from 1993 to 1996, he was part of the scientific advisory committee of CRM where he jointly organized two workshops, *Strings, Duality and Geometry* and *Mirror Symmetry and Complex Geometry*.

In the past 10 years, he has been a major speaker in numerous scientific meetings in Europe, the United States, and China. He also has supervised numerous Ph.D. theses. He has contributed to over 76 scientific publications and was involved as an editor in two books: *Mirror Symmetry III*, proceedings of a conference on *Complex Geometry* and *Mirror Symmetry* and *Mirror Symmetry IV*, proceedings of a Conference on *String, Duality and Geometry*, both held at the University of Montréal.

During his stay at CRM from May 17 to May 26, 2000, Professor Phong delivered a series of lectures entitled *Symplectic Forms, Soliton Equations, and Supersymmetric Gauge Theories*. He provided a self-contained introduction to symplectic forms in soliton theory and supersymmetric gauge theories. He discussed constructions of symplectic forms in terms of Lax pairs, new integrable models of Calogero-Moser and spin chain types, and their relations with Seiberg-Witten solutions of supersymmetric gauge theories. Finally, he discussed methods for extracting the prepotential from the Seiberg-Witten spectral curves.

General Programme

The CRM's general programme funds a wide variety of scientific events, both on-site and around the world. Whether it be for specialized workshops for a small number of researchers, large meetings for hundreds of participants or activities for high school or undergraduate students, the general programme promotes research in mathematical sciences at all levels. The programme is quite flexible, to allow for opportunities as they arise.

AARMS Combinatorics Workshop

May 24 - 28, 1999, Memorial Univ., Saint-John's, Newfoundland
Org.: Jason Brown (Dalhousie), Richard Nowakowski (Dalhousie), Abraham Punnen (New Brunswick), and Nabil Shalaby (Memorial)

The scope of the workshop was combinatorics with emphasis on combinatorial designs, their constructions, and related open problems. The programme started with a short introduction of the concepts and constructions of combinatorial designs by Nabil Shalaby (Memorial). The topics presented by the main speakers included a survey of colouring problems in combinatorial designs (Alexander Rosa, McMaster), decomposing complete graphs of cycles of fixed length (Brian Alspach, Simon Fraser), and edge colourings and their uses (Chris Rodger, Auburn). The other invited speakers included Anthony Bonato (Mount Allison), Hadi Kharaghani (Lethbridge), David Pike (Memorial), Rolf Reese (Memorial), and Ruizhong Wei (Waterloo). Attendance was 36, including 10 senior researchers and 23 graduate students. This workshop was well appreciated by all participants.

Canadian Undergraduate Mathematics Conference

May 26 - 30, 1999, Memorial Univ., Saint-John's, Newfoundland

The Canadian Undergraduate Mathematics Conference is organized by and for undergraduate mathematics students. CRM subsidized the participation of a group of students from McGill University. The following students gave talks: Shabnam Beheshti, *Some Basics of Hyperbolic Geometry*; Madeline Pool, *Modeling Infectious Disease*; Alexandru Ghitza, *Counting Lattice Points*; Patrick Lam, *The Prime Number Theorem*; Gabriel Holmes, *Nets and Filters*; Brian Kudlow, *Equivalences of Automata and Monoids*, Jean-Sabin McEwen, *A Possible Explanation of the Solar Neutrino Problem*; Peter Green, *Locale Theory*; Pierre-Alexandre Tremblay, *The Cartan Equivalence Method*, and Michael Wong *Singular Plane Curves and ODEs*.

CMS Summer Meeting: *Special Session in Harmonic Analysis*

May 29- June 1, 1999
Memorial Univ., Saint-John's, Newfoundland
Org.: Kathryn Hare (Waterloo)

This special session brought together 15 invited speakers: J. Benedetto (Maryland) *The Role of Tiling in Sampling and Wavelet Theory*, T. Chen (UWO) *Generalized Hardy Operators and Normalizing Measures*, C. Finet (Belgium) *Transfer Principles in Orlicz Spaces*, B. Forrest (Waterloo) *Operator Spaces in Noncommutative Harmonic Analysis*, Jean-Paul Gabardo (McMaster) *Determinacy in Truncated Trigonometric Moment Problems and the Extension Property*, E. Granirer (UBC) *Some Functional Analytic Properties of Quotients of the Fourier Algebra as Reflected by Some Subsets of the Real Line*, H. Heinig (McMaster) *Modular Inequalities for the Calderón Operator*, Z. Hu (Windsor) *Isomorphism and Homomorphism Results on the von Neumann Algebra VN(G)*, R. Kerman (Brock) *Weighted Inequalities for Semigroups of Operators and the Norm Convergence of the Abel Means of Certain Eigenfunction Expansions*, T. Lau (Alberta) *On the Centre of Some Banach Algebras Associated to a Locally Compact Group*, D. Oberlin (Florida) *Convolution With Affine Arclength Measures in the Plane*, J.-O. Ronning (Skovde) *Generalized Perron Trees – What and why*, G. Sinnamon (UWO) *From Nörlund Matrices to Laplace Representations*, Nicolaas Spronk (Waterloo) *Diagonal Type Conditions on Group C*-Algebras*, and S. Wainger (Wisconsin) *Some Discrete Problems in Harmonic Analysis*.

1999 Math Camp

May 31 - June 9, 1999, Université du Québec à Trois-Rivières, Trois-Rivières
Org. : Harry White (Université du Québec à Trois-Rivières)

Le camp mathématique est une activité parrainée par l'Association mathématique du Québec (AMQ) dans le but de mettre en contact des étudiants doués pour les mathématiques avec des mathématiciens professionnels. Les campeurs sont sélectionnés parmi ceux qui ont le mieux réussi au concours de l'AMQ (niveau collégial). En 1999, il y a eu 23 participants. Le premier prix du Concours est allé à Sol Moreno du Collège Brébeuf. Les deuxième et troisième prix sont allés à Pierre Levan du Petit Séminaire de Québec, campus de l'Outaouais et à Pascal Turbis du Cégep de Baie-Comeau.

Annual Meeting of the Statistical Society of Canada: *Special Session on Directional Statistics*

June 3 - 6, 1999, Univ. of Regina, Regina, Saskatchewan
Org.: Louis-Paul Rivest (Laval)

Le CRM a commandité une session spéciale sur la statistique directionnelle dans le cadre du congrès annuel de la Société statistique du Canada. Les conférenciers invités de la session étaient Nick Fisher du CSIRO en Australie, un chercheur établi dans le domaine, de même que deux chercheurs canadiens, Peter Kim de l'Université Guelph et Duncan Murdoch de l'Université Western Ontario. Environ 40 personnes ont assisté à la session.

La session a débuté par la présentation de N. Fisher qui a traité de la détection des modes dans un échantillon d'angles. L'auteur a présenté plusieurs façons de traiter ce problème tout en soulignant la nécessité de poursuivre la recherche dans ce domaine car il ne possède pas encore de solution satisfaisante. La deuxième présentation, par Peter Kim, a traité de la modélisation statistique d'un échantillon de vecteurs-unités en trois dimensions. L'auteur a mis de l'avant une méthode générale d'estimation qu'il a ensuite utilisée pour modéliser les directions orthogonales aux plans de rotation des comètes dans le système solaire. Il a terminé son exposé en faisant une brève interprétation physique des résultats de l'analyse statistique. M. Murdoch a ensuite traité d'un modèle de régression pour des matrices de rotations 3x3. Il a ensuite appliqué sa méthode pour calibrer les orientations fournies par un système de caméra pour l'étude de la cinématique humaine.

20th Annual Meeting of the Canadian Applied and Industrial Mathematics Society

June 11 - 13, 1999, Univ. Laval, Québec
Org.: Michel Fortin (Laval)

Le département de mathématiques et de statistique de l'Université Laval et le GIREF (Groupe interdisciplinaire de recherche en éléments finis) ont été les hôtes de la rencontre annuelle de la SSCMAI, tenue conjointement avec la dixième Journée de Éléments Finis (JEF). Le but de cette rencontre étant de faire le point sur les activités de recherche en mathématiques appliquées au Canada, le programme se devait d'être vaste et de fournir au plus grand nombre possible de chercheurs la possibilité de présenter leurs travaux.

Les sujets suivants ont été approfondis dans un minisymposium et couvert par une conférence plénière donnée par un éminent chercheur. Suivant chaque titre, vous trouverez entre parenthèses le nom de l'organisateur et celui du conférencier invité : *Cryptographie quantique* (C. Crépeau, McGill et R. Cleve, Alberta), *Dynamique des populations* (S. Rhuan, Dalhousie et O. Diekmann, Utrecht), *Interfaces en sciences des matériaux* (L. Bronsard, McMaster et G. Milton, Utah), *Méthodes numériques pour les EDP non linéaires* (M. Gunzberger, SIAM et Iowa), *Arithmétique par intervalles* (G. Alefeld, GAMM et Karlsruhe), *Théorie de la bifurcation* (B. Dionne, Ottawa et M. Golubitsky, Houston), *Biomécanique numérique* (H. Manouzi, Laval et M. Thiriet, INRIA) et *Mathématiques et physiologie* (J. Bélair, Montréal et L. Glass, McGill).

En plus de ces minisymposia, il y eut neuf séances de communications d'une vingtaine de minutes pour un total de plus de 80 présentations. La rencontre a été un franc succès attirant pas moins de 132 personnes parmi lesquels on retrouvait une trentaine d'étudiants et 35 chercheurs en provenance de l'extérieur du pays.

13th High Performance Computing Symposium, HPCS'99

June 13 – 16, 1999, Queen's Univ., Kingston, Ontario
Org. : Andrew Pollard (Queen's)

The symposium brought together over 125 leading researchers from academic and government research laboratories in nine countries. The Symposium included all-day tutorials (on HPC Java, Tools for IBM SP, Cluster Computing, and Open MP) and three days filled with papers that expounded exciting advances in HPC from the medical, pharmaceutical and engineering industries, as well as novel contributions from researchers in HPC systems and architectures. The proceedings from this conference were published by Kluwer Academic Publishers.

Posters that highlight recent work were set up during the symposium. A Jobs Fair was held and a number of graduate students had the opportunity to interview and be interviewed by the many agencies present. Ample time was made available for discussion, either around the extended lunchtime periods or during the many social events.

SDL FORUM'99: The next Millenium

June 21 - 25, 1999
Org.: Rachida Dssouli (Montréal), Gregor von Bochmann (Ottawa), Yair Lahav (SDL Forum Society, ECI Telecom LDT) and Nortel Networks

Le Forum'99 LDS porte sur le SDL, soit *Specification and Description Language*. Ce forum se tient à tous les deux ans et celui-ci était le 9e de la série. Le langage normalisé LDS permet la spécification et la description des systèmes communicants. Il a évolué sur une vingtaine d'années à travers des versions successives du standard émanant de l'organisation de normalisation ITU-T. LDS est connu sous le nom "norme Z.100". La première version, apparue en 1980, contenait déjà une représentation graphique en plus de représentation textuelle. La dernière version est appelée SDL 2000.

Une particularité importante du forum est qu'il réunit des participants de l'industrie et des universités dans des proportions de 2/3 et 1/3, respectivement. Les thèmes du forum étaient : les applications du langage LDS, la dérivation systématique de LDS et la génération de code, les extensions au langage, la convergence avec UML et, finalement, test, performance et simulations fondés sur LDS.

Le Forum a attiré environ 120 participants. La première journée a été consacrée à des tutoriaux. La seconde journée a débuté avec la présentation du conférencier principal, Ahmed Jerraya (CNRS, Grenoble), intitulée *Hardware Software Co-design from SDL*. Le reste de la conférence a été consacrée aux résultats des conférenciers dont les articles avaient été acceptés. Les principaux conférenciers invités étaient Yair Lahav, Oystein Haugen, Rick Reed, Uwe Glässer, Reinhard Gotzhein, A. Prinz et Claudine Simson. Les comptes-rendus de la conférence ont été publiés chez Elsevier.

CNTA'99

June 20 – 24, 1999, Univ. of Manitoba, Winnipeg, Manitoba
Org.: J. Borwein (SFU), D. Boyd (UBC), C. David (Concordia), R. Murty (Queen's), C. Stewart (Waterloo), local organizer; H. Williams (Manitoba)

The purpose of the Canadian Number Theory Association (CNTA) is to enhance and promote learning and research in Number Theory, particularly in Canada where we already have a great deal of strength in this area. To advance these goals the CNTA organizes major international conferences. The focus of CNTA is mainly on the following areas: combinatorial/computational number theory, analytic number theory, diophantine problems and arithmetic geometry. All of these areas have seen rapid development in recent years, both in Canada and internationally. They are also well represented among the interests of the members of the scientific committee for this conference.

For CNTA'99 there were 8 plenary one-hour talks and 17 invited 40-minute talks. The plenary speakers were: H. Darmon (McGill), J. Friedlander (Toronto), E. Goren (McGill) A. Granville (Georgia), P. Sarnak (Princeton), W. Schmidt (Colorado), C. Skinner (Princeton), and T. Wooley (Michigan). These were chosen on the basis of the importance of their recent and past work and their stature as internationally recognized number theorists. They presented knowledgeable survey lectures concerning recent progress in their respective fields. The 17 invited speakers were selected to represent the themes of the conference and did so very effectively. To mention just a few of these talks, A. Odlyzko gave a very nice survey of his recent work in computing the zeros of the Riemann zeta function, D. Bressoud gave a very nice account of the alternating sign matrix conjecture, A. Bremner gave a beautiful presentation of his

work on magic squares and elliptic curves, C. Greither provided a lovely account of his work on generalizing the Redei-Reichardt theorem and M. Harper gave the first proof of a very important result: $Z[\sqrt{14}]$ is Euclidean. There were also 40 contributed talks organized in 8 sessions each representing a particular theme of the conference. These talks were very strong and, in some cases, outstanding. In particular, the talk of K. Williams on bounding the size of the least solutions of diagonal quadratic equations and the talk of Chan on new approximations to π come to mind, but there were many others. The talks were all very well attended.

Andrew Granville, a former Ph.D. student of P. Ribenboim from 1984-87, received the first Ribenboim medal. He also presented the Ribenboim Lecture. This was an account of his joint work with Soundararajan on how large or small character sums can be, both conjecturally and unconditionally, and how their values are distributed in the complex plane.

Séminaire de mathématiques supérieures: *Integrable Systems: From Classical to Quantum*

July 26 - August 6, 1999, Université de Montréal, Montréal
Org. : A. Daigneault (Montréal), J. Harnad (Concordia and CRM), P. Winternitz (Montréal and CRM), S. Lessard (Montréal), W. Miller (Minnesota-Minneapolis), A. Polychronakos (Ioannina, Greece and Uppsala, Sweden), and G. Sabidussi (Montréal)

The topic of the 1999 SMS was quantum integrable systems, with special emphasis on the passage from classical to quantum integrability, as well as the relation to exactly solvable models in statistical mechanics. Although this area has seen much progress in recent years, there have been few occasions where young researchers are given a systematic overview that would permit them to enter the field. This was one of the main objectives of this activity. Other than the main speakers, there were 40 participants.

The main lectures were given by J. Harnad, *Loop Groups, R-Matrices, and Separation of Variables*; J. Hurtubise, *Hitchin Systems, Spectral Curves, and Surfaces*; A. Its, *A Riemann-Hilbert Approach in the Exactly Solvable Quantum Field and Statistical Physics Models*; V. Korepin, *Determinant Representations for Quantum Correlation Functions for Exactly Solvable Models*; W. Miller, *Multiseparability and Superintegrability for Classical and Quantum Systems*; T. Miwa, *Algebraic Analysis of Solvable Lattice Models*; A. Polychronakis, *Calogero-like Systems: Physics and Mathematics*; N. Reshetikhin, *Quantization of Integrable Systems*; S. Ruijsenaars, *Special Functions Associated With Integrable Quantum Systems*; E. Sklyanin, *Bäcklund Transformations, Baxter's Q-Operators and Separation of Variables*; C.A. Tracy, *Random Matrix Models and Integrable Systems*; P. Winternitz, *Integrable Systems, Symmetries, and Lie Algebra Contractions.*

International Conference and Workshop on Valuation Theory

July 26 - August 11, 1999
Univ. of Saskatchewan, Saskatoon, Saskatchewan
Org.: Andrew Carson (Saskatchewan), Murray Marshall (Saskatchewan), Franz-Viktor Kuhlmann (Saskatchewan), Deirdre Haskell (College of the Holy Cross), Salma Kuhlmann (Saskatchewan), Hans Schoutens (Wesleyan Univ.).
Co-sponsors : Fields Institute and PIms

This conference is dedicated to Paulo Ribenboim, in recognition of his extensive contributions to the subject. Tutorials were given on July 26 and 27. The conference was held from July 28 through August 4. A special session in honor of Paulo Ribenboim was held on July 31, while the informal workshop was held from August 5 through August 11.

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

The main topics of the Workshop were: Local uniformization and resolution of singularities, model theory of valued fields in positive characteristic and its connections with resolution of singularities, the theory of valued function fields, approximate roots and related subjects, o-minimal expansions of the reals and Hardy fields. In addition to these subjects, the workshop offered an opportunity to discuss other recent developments and open problems which are connected to the scientific programme of the conference.

The list of invited speakers included: Shreeram Abhyankar (Purdue), Francois Loeser (Paris), Carlos Andradas (Madrid), James Madden

(Baton Rouge), Ron Brown (Hawaii), Jan Minac (Western Ontario), Alexandru Buium (Urbana), Freddy van Oystayen (Antwerpen), Gilles Christol (Paris), Olivier Piltant (Paris), Vincent Cossart (Versailles), Florian Pop (Bonn), Michel Coste (Rennes), Patrick Popescu-Pampu (Paris), Tom Craven (Hawaii), Victoria Powers (Emory), Dale Cutkosky (Missouri), Ana Reguera (Valladolid), Nikolai Dubrovin (Vladimir), Paulo Ribenboim (Kingston), Yuri Ershov (Novosibirsk), Peter Roquette (Heidelberg), Jose Engler (Campinas), Mohamed Saidi (Bonn), Joachim Graeter (Potsdam), Thomas Scanlon (Berkeley), Urs Hartl (Ulm), Claus Scheiderer (Regensburg / Duisburg), Roland Huber (Wuppertal), Erwin Schoerner (Munich), Sudesh Khanduja (Chandigarh), Niels Schwartz (Passau), Hagen Knaf (Heidelberg), John Shackell (Canterbury), Jochen Koenigsmann (Konstanz), Patrick Speissegger (Toronto), Leung Ka Hin (Singapore), Michel Vaquie (Paris), Quing Liu (Bordeaux), Adrian Wadsworth (San Diego).

First Canada-China Math Congress

August 23 - 28, 1999, Tsinghua University, China
Org. : N. Ghoussoub (PIMS), K.C. Chang (Chinese Math Society), L. Peng (Beijing), D. Cai (Tsinghua), X.-W. Zhou (Nankai), S. Halperin (MITACS), D. Dawson (Fields), R. Kane (Canadian Math Society), and L. Vinet (CRM)

This was the first joint mathematical congress with China. Organized jointly by the three mathematical institutes, it provided an important opportunity to establish future scientific projects with Chinese mathematicians. It was an unqualified success with more than sixty Canadian participants.

First Meeting of Chairs of Mathematics/Statistics Departments in Canada

November 20 - 21, 1999, CRM

This activity brought together 25 Chairs of Mathematics / Statistics Departments from Canada, as well as six representatives from the mathematical institutes, MITACS, the ISM, and the CMS, to discuss common problems. Among the items of the agenda that were discussed, were the recruitment of students at all levels, links with the mathematical institutes, data and resources, and outreach to schools. The meeting was such a success that a new meeting is being planned for 2000.

The Future of Mathematical Communication

December 1 - 5, 1999, MSRI, Berkeley, California
Org. : François Bergeron (UQAM), Jonathan Borwein (Simon Fraser), Joe Buhler (MSRI, Berkeley), Bradd Hart (Fields), Martin Groetschel (IMU), Peter Michor (EMS), and Andrew Odlyzko.

This workshop explored the probable evolution of mathematical communication in coming years and follows a similar workshop held five years earlier, also at MSRI. The conference had several disparate associated events, including a half-day training workshop on the use of streaming video, a one-day workshop on electronic publishing in the sciences aimed at attracting a broader audience, and a session of talks and discussion sponsored by the IMU's Committee on Electronic Information and Communication. Among the major issues covered by the workshop, we note preprint servers, journals, books, intellectual property, protocols and languages for scientific communication, metadata and search mechanisms, multi-media and interactive tools.

Canadian Mathematical Society Winter Meeting 1999: *Special Sessions on Algebraic and Geometric Methods in Differential Equations and Algebraic Combinatorics, Group Representations, and Macdonald Polynomials*

December 11 – 13, 1999, Montréal
Org.: Michel Delfour (Montréal)
Local org.: Véronique Hussin (Montréal)

The Département de mathématiques et de statistique of Université de Montréal was the host of the CMS Winter Meeting 1999. The Winter Meeting and the First CMS Job Fair attracted a record number of 439 registered participants. CRM sponsored two symposia.

The first, entitled Algebraic and Geometric Methods in Differential Equations: The 20th Century in Celestial Mechanics and one Century of Work on Hilbert's 16th Problem, was organized by Angelo Mingarelli (Carleton) and Christiane Rousseau (Montréal). The themes of the session cover major developments in the mathematics of the 20th century. It brought together people using algebraic, geometric, algebro-geometric and bifurcation methods in differential equations (mostly ordinary differential equations, but also differential delay equations) in the spirit of Poincaré's work. The

invited speakers were Kenneth Meyer (Cincinnati), Florin Diacu (Victoria), Dan Offin (Queen's) Tadashi Tokieda (UQAM), J. Chalmers (Carleton), Ernesto Perez-Chavela (UNAM – Mexico), Philip Holmes (Princeton), John Guckenheimer (Cornell), Sue Campbell (Waterloo), Jacques Bélair (Montréal), Freddy Dumortier (Limburgs Universitair Centrum – Diepenbeek, Belgium), Yulij Il'yashenko (Moscou and Cornell), Sergey Yakovenko (Weizmann Institute, Israel), Jean-Pierre Françoise (Paris VI), Dana Schlomiuk (Montréal), Robert Roussarie (Bourgogne, France), Christiane Rousseau (Montréal), and Pietro-Luciano Buono (Warwick, United Kingdom).

The second symposium was called Algebraic Combinatorics, Group Representations, and Macdonald Polynomials. It was organized by François Bergeron (UQAM), Nantel Bergeron (York), and Mike Zabrocki (UQAM and CRM). The invited speakers were Adriano Garsia (UC San Diego), François Bergeron (UQAM), Victor Ginzburg (Chicago), Siddhartha Sahi (Rutgers), Ed Allen (Wake Forest), Carol Chang (Northeastern), Mark Haiman (UC San Diego), Mike Zabrocki (UQAM), Jean-Christophe Aval (Bordeaux I), Alain Lascoux (Marne La Vallée), Jennifer Morse (UC San Diego), Tudose Geanina (York), and Luc Vinet (McGill).

5th International Seminar on Relational Methods in Computer Science

January 9 - 14, 2000, Valcartier, Québec
Org. : Jules Desharnais (Laval), Marc Frappier (Sherbrooke), and Wendy MacCaull (St.Francis Xavier)

Depuis le milieu des années 70, il est devenu clair que le calcul des relations est un outil conceptuel fondamental en informatique tout autant qu'en logique. Alors que les applications informatiques évoluent rapidement, la nécessité de faire appel aux sciences exactes pour comprendre les méthodes existantes se fait sentir. Il est de plus en plus approprié d'utiliser les approches formelles pour faire face à la complexité de l'information, des algorithmes et des designs. En effet, on considère maintenant que les approches formelles sont nécessaires au développement futur de plusieurs zones de l'informatique, comme par exemple la spécification et la vérification des systèmes distribués. Parmi les approches formelles, on retrouve celles qui sont basées sur l'algèbre des relations. Celle-ci a été utilisée pour l'analyse, la modélisation et la résolution de plusieurs problèmes informatiques tels ceux qui sont posés par la spécification et la dérivation de programmes, la production de démonstrateurs de théorèmes, la conception de bases de données, la tolérance aux fautes et le codage de l'information. Malgré sa base axiomatique simple, l'algèbre des relations a montré qu'elle peut être appliquée à une grande variété de structures d'information.

Le but de ce séminaire et de toute la série RelMiCS est de regrouper des chercheurs venant de différentes sous-disciplines des mathématiques et de l'informatique, qui utilisent le calcul des relations comme outil conceptuel et méthodologique dans leur travail. Nous cherchons à mieux comprendre les problèmes informatiques tels que la spécification et la conception de programmes, la vérification du logiciel et du matériel, la décomposition des bases de données relationnelles, etc. À travers un outil commun, plusieurs domaines de l'informatique sont touchés. Les articles présentés dans ces séminaires contribuent à la fois au développement de la théorie et des applications.

Des comptes rendus des présentations ont été publiés. Les principales conférences invitées étaient *Security by Typing* de Mourad Debbabi (Laval), *Certification of Compiler Optimizations using Kleene Algebra with Tests* de Dexetr Kozen (Cornell) et *A Retrospective View on RelMiCS and some Promising Directions* de Gunther Schmidt (Universität des Bundeswehr München).

Workshop CRM - MITACS - IRIS
Data Mining and Machine Learning : Selecting and Combining Models with Machine Learning Algorithms

April 11 -14, 2000
Org.: Yoshua Bengio (Montréal) and Dale Schuurmans (Waterloo)

The workshop was held April 11-14, 2000, at the CRM. Its objective was to bring together experts and neophytes, senior researchers, students and practitioners in the field of model selection and model combination for machine learning algorithms.

A central objective of machine learning research is to develop algorithms that learn predictive relationships from data. This is a central component of data mining and knowledge discovery tasks, which are becoming commonplace applications in the realm of e-commerce. This is a difficult task, however,

because inferring a predictive function from data is in fact an "ill-posed" problem; that is, many functions can often "fit" a given finite data set, and yet these functions might generalize very differently on new data drawn from the same distribution.

More than 130 participants (from 4 continents) have contributed to make this workshop a success and a noted international event. The workshop started with a tutorial on data-mining by Hugh Chipman on the 11th. In the following three days, leaders in the field, along with promising graduate students, presented some thought-provoking contributions, some of which sparked animated arguments in the audience. Although most of the presentations were focused on algorithms and mathematical analyses, several speakers presented important applications (e.g. in handwriting recognition and in bio-informatics). The speakers contributed papers or slides, in electronic form, and these have been posted on the workshop web page **(www.iro.umontreal.ca/~bengioy/crmworkshop2000)** Furthermore, the organizers are putting together a special issue of the Machine Learning Journal (on model selection and model combination) in which the best papers of the workshop will be published.

But what is model selection? To make the learning problem well-posed, one needs to somehow "calibrate" the complexity of the proposed function class to the amount and quality of available sample data. A classical approach is to perform "model selection" where one imposes a preference structure over function classes and then optimizes a combined objective of class preference and data fit. In doing so, however, it would be useful to have an accurate estimate of the expected generalization performance at each preference level; one could then pick the function class that obtained the lowest expected error, or combine functions from the functions classes with the lowest expected error, and so on. Many approaches have been proposed in the past for this purpose, both in the statistics and the machine learning research communities.

Recently in machine learning there has been significant interest in new techniques for evaluating generalization error, for optimizing generalization error, and for combining and selecting models. This is exemplified, for example, by recent work on Structural Risk Minimization, Support Vector Machines, various Boosting algorithms, and the Bagging algorithm. These new approaches suggest that better generalization performance can be obtained using new, broadly applicable procedures. Progress in this area has not only been important for improving our understanding of how machine learning algorithms generalize; it has already been demonstrated to be very useful for practical applications of machine learning and data analysis.

The workshop brought together several key researchers in the fields of machine learning and statistics to present their recent results and debate the controversial issues that have been dividing them in recent machine learning and neural network conferences.

The list of invited speakers includes Peter Bartlett (Australia National Univ.), Leo Breiman (Berkeley), Huch Chipman (Waterloo), Tom Dietterich (Oregon State Univ.), Yoav Freund (AT&T Labs-Research), Christian Léger (Montréal), Michael Perrone (IBM T.J. Watson Research Center), Robert Schapire (AT&T Labs-Research), Dale Schuurmans (Waterloo), Peter Sollich (King's College, Univ. of London), and Grace Wahba (Wisconsin at Madison).

Special Functions 2000 : *Current Perspective and Future Directions*

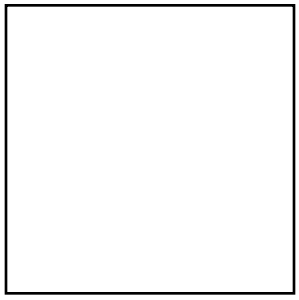
May 29–June 9, 2000, Arizona State University, Tempe, Arizona
Org. : Sergei Suslov (Arizona State), Vyacheslav Spiridonov (Joint Institute for Nuclear Research, Dubna, Russia), Tom Koornwinder (Amsterdam), and Luc Vinet (CRM)

Special function theory and its applications is currently enjoying enormous interest, due in part to meetings organized in the last few years by the Canadian mathematical institutes. The topics of the workshop included orthogonal polynomials and special functions in one and several variables, asymptotics, continued fractions, applications to number theory, combinatorics and mathematical physics, integrable systems, harmonic analysis and quantum groups, Painlevé classification. Among the Canadian participants, M. Rahman (Carleton) and L. Vinet (CRM) were lecturers. This workshop was part of the NATO Science Programme.

CRM Prizes

CRM/Fields Prizes

In 1994 the Centre de recherches mathématiques (CRM) and the Fields Institute announced the creation of a new prize to be awarded for exceptional contributions to the mathematical sciences. The recipient of the prize is chosen by the Comité consultatif of the CRM and the Scientific Advisory Committee of the Fields Institute according to the criterion of excellence in research. The prize consists of both a $5 000 award and a medal, and the winner is required to give a lecture at the CRM and the Fields Institute. The past recipients are: H.S.M. Coxeter, G.A. Elliot, J. Arthur, R.V. Moody, and Stephen A. Cook.

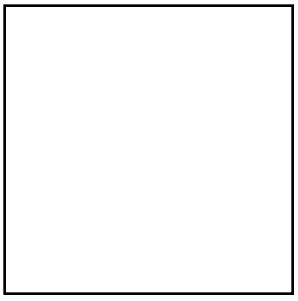


The CRM-Fields Institute 2000 Prize is awarded to *Israel Michael Sigal.* One of the outstanding mathematical physicists active in Canada today, Professor Israel Michael Sigal was born in Russia. He obtained his bachelor's degree at Gorky University in 1968 and his Ph.D. at Tel-Aviv University (1976). He is currently Professor at the University of Toronto.

Apart from being a worldwide leader in his area of quantum theory, he is the leading expert on the analysis of the Schroedinger equation, which is at the heart of mathematical models of atoms and molecules. He also made groundbreaking contributions to the theory of interaction between light and matter, known as Quantum Electrodynamics. He has been rewarded with many honors. He is a Fellow of the Royal Society of Canada and received, in 1993, the John L. Synge Award for being an outstanding Canadian mathematician. These honours include several invited lectures at the International Congress of Mathematical Physics and the International Congress of Mathematics, and editorships of the following journals: Reviews in Mathematical Physics and the Duke Mathematical Journal. He received his prize on November 10, 1999 in Montréal.

André-Aisenstadt Prize

Created in 1991, the André-Aisenstadt Mathematics Prize is intended to recognize and reward talented young Canadian mathematicians. The Prize, which is given for research achievement in pure and applied mathematics, consists of a $3000 award. The recipient is chosen by the CRM Advisory Committee. At the time of nomination, candidates must be Canadian citizens or permanent residents of Canada, and no more than seven years from their Ph.D. The previous winners of the André-Aisenstadt Prize were: Niky Kamran (1991); Ian Putnam (1992); Michael Ward and Nigel Higson (1994); Adrian S. Lewis (1995); Henri Darmon and Lisa Jeffrey (1996); Boris Khesin (1997); John Toth (1998).

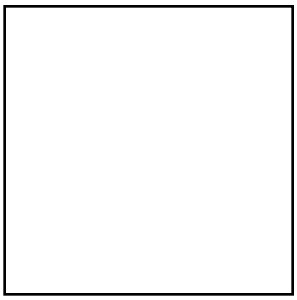


CRM was delighted to award the André-Aisenstadt Prize to *Professor Changgeng Gui* of the University of British Columbia and the University of Connecticut. Dr. Gui completed his undergraduate studies at the University of Beijing and obtained his Ph.D. at the University of Minnesota in 1991. From 1993 to 1995, he was a Postdoctoral Fellow at McMaster University and became Assistant Professor at the University of British Columbia in 1997. His main research interests are in qualitative properties of solutions to non-linear partial differential equations, such as existence, multiplicities, symmetry, and stability.

When Professor Gui came to receive his prize, he gave a lecture entitled *Some Mathematical Problems Related to Phase Transitions.* Gradient theory of phase transitions has been studied extensively in the last thirty years, particularly in connection with minimal surfaces and motions, by mean curvature. In this talk, he discussed some progress in answering some fundamental questions related to this theory, including solutions to the Gibbons conjecture and the De Giorgi conjecture. These conjectures concern the basic configurations of states near plane interfaces.

CRM-CAP Prize

Awarded for the first time in 1995, the CRM-CAP Prize is given for outstanding contributions to theoretical and mathematical physics. It consists of a $2000 award and a medal. Previous winners were Werner Israel of the University of Alberta (1995), William G. Unruh of the University of British Columbia (1996), Ian Affleck of the University of British Columbia (1997), J. Richard Bond of CITA of the University of Toronto (1998), and David J. Rowe of the University of Toronto (1999). The 2000 CRM-CAP prize has been awarded to Dr. *Gordon Semenoff*.



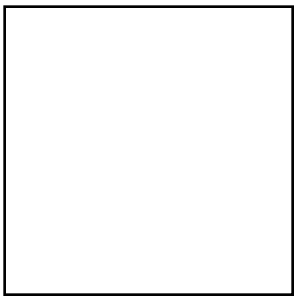
Dr. Semenoff attended the University of Alberta where he received his B.Sc. with first class honors in Physics in 1976 and a Ph.D. in theoretical physics in 1981. After a Postdoctoral Fellowship at MIT, he joined the faculty of the University of British Columbia where he has been Professor of Physics since. He was a member of the Institute for Advanced Study in Princeton in the years 1985 and 2000 and a visiting professor at the Niels Bohr Institute in Copenhagen in 1999. Dr. Semenoff has received a number of honors including a Killam Research Prize (1989), the MacDowell Medal for Achievement in Physics (1991), and the National Bank of Denmark Award (1999).

Dr. Semenoff is a theoretical physicist who has made contributions to quantum field theory, statistical mechanics and string theory. He is best known for his the first use of index theorems to compute the quantum numbers of topological solitons in field theory. He published this work in 1982 and 1983, and an authoritative review of the subject in 1984.

Dr. Semenoff is also an authority on quantum field theory in unusual environments such as high temperature and density. He has made many subsequent contributions to theoretical and mathematical physics and he has done well known work in the field-theoretical realization of particles with exotic spin and statistics called anyons. He also obtained one of the first solutions of the unitary matrix model in a background field. He discovered an important extra-local gauge symmetry in the Kazakov-Migdal model which is a lattice gauge theory of induced quantum chromo-dynamics. Finally he obtained an exact solution of a variety of matrix models that resemble Coulomb gas models of quarks.

CRM-SSC Prize

In 1999, the Centre de recherches mathématiques (CRM) and the Statistical Society of Canada created the CRM-SSC Prize in statistics in recognition of outstanding contributions to the Statistical Sciences during the recipient's first 15 years after earning a doctorate. The CRM-SSC Prize in Statistics consists of a $3000 award and a medal. The recipient is chosen by a joint CRM/SSC advisory committee, consisting of three members named by the SSC and two, including a president, by the CRM. In 1999, the Prize went to Christian Genest of Université Laval.



This year, the Centre de recherches mathématiques and the Statistical Society of Canada have awarded the CRM-SSC 2000 Prize in Statistics to Dr. Robert Tibshirani of Stanford University.

Rob Tibshirani grew up in the Niagara Falls area. He completed his Bachelor's degree in statistics and computer science at the University of Waterloo in 1979 and a Master's degree in Statistics at the University of Toronto in 1980. He obtained his Ph.D. in 1984 from Stanford University. He then joined the Department of Biostatistics and Preventive Medicine and the Department of Statistics of the University of Toronto in 1985. In 1998, he accepted a joint position in the Department of Health Research and Policy and the Department of Statistics at Stanford University. He has received numerous awards, including the COPSS award given to the best statistician under 40 years of age in the world (1996), the E.W.R. Steacie Memorial Fellowship of NSERC (1997), as well as a fellowship of the J. Guggenheim Foundation (1994). He is a fellow of the American Statistical

Association and of the Institute of Mathematical Statistics. He has served as Associate Editor of the *Annals of Statistics, Statistical Science, Journal of the American Statistical Association*, and of the *Canadian Journal of Statistics*. He gives numerous conferences and has supervised many Ph.D. students. He is particularly well known for his books on generalized additive models and on the bootstrap.

Professor Tibshirani is a world leader in the development of computer-intensive statistical modeling and analysis for applications in genetics, medicine and public health. One of his papers which has had a large impact was published in the *New England Journal of Medicine* and studied the risks of car accidents when using a cellular phone.

Members' Seminars & Special Events

The members of the CRM are encouraged to organize seminars and other scientific activities during their stay at the CRM. These activities take the form of courses, workshops and research seminars

Seminar of the Physnum Group

January 13, 2000
Cécile Amblard, CRM
Résolution de problèmes inverses mal posés par la méthode du maximum d'entropie sur la moyenne

February 10, 2000
Alin Andrei Carsteanu, INRS-EAU
Statistique bivariées dans les cascades multiplicatives et génératrices de mesures multifractales

Special Lectures

June 8, 1999
Marc Thiriet, INRIA
Modèles numériqiues en mécaniques des fluides. Illustration à l'aide de quelques exemples

April 14, 2000
Adi Ben-Israel, Rutgers Univ.
The Matrix Volume and its Applications in Analysis

Seminar in Non-linear Analysis

Org.: Andrej Granas (CRM & Univ. de Montréal)

November 22, 1999
Alberto Abbondandolo, **Scuola Normale di Pisa**
Morse Theory for Strongly Indefinite Functionals

November 23, 1999
Alberto Abbondandolo, **Scuola Normale di Pisa**
Applications to Hamiltonian Systems

November 29, 1999
Andrej Granas, CRM & Univ. de Montréal
Extension of Compact Homotopies and the Leray-Schauder Principle

November 30, 1999
Donald O'Regan, National Univ. of Ireland
Multiplicity Results in Fixed Point Theory and Applications

Analysis Seminar CRM-ISM

Org.: Paul Gauthier (CRM & Univ. de Montréal)

June 3, 1999
Richard Duncan, Univ. de Montréal
Théorème ergodique et groupes unitaires

June 10, 1999
Galia Dafni, Concordia Univ.
H^1 and CMOs

June 17, 1999
André Boivin, Univ. of Western Ontario
Théorème(s) de Muntz dans C

July 8, 1999
Edouardo Santillan Zeron, CRM
Low Dimensional Singularities and Polynomial Convexity

July 15, 1999
Paul Gauthier, CRM & Univ. de Montréal
Transformations quasirégulières et régulières

July 29, 1999
Yacine Rebahi
Irrégularité des D-modules algébriques holonomes

October 1, 1999
Thomas Ransford, Univ. Laval
Théorème de Bloch pour les multifonctions algébroides

January 14, 2000
Mohamad Pouryayevali, Univ. de Montréal
Injective Holomorphic Mappings

January 28, 2000
Lev Abramovich Aizenberg, Univ. Bar-Ilan
Duality in Complex Analysis

February 4, 2000
Petr Paramonov, Univ. de Moskva
Uniform Approximation of and by Gravitational Fields

February 18, 2000
Wolhfard Hansen, Univ. Bielefeld
Harnack Inequalities for Schrödinger Operators

February 25, 2000
Richard Fournier, CRM
Un principe de continuation analytique hyperbolique

March 10, 2000
Richard Fournier, CRM
Un principe de continuation analytique hyperbolique II

March 17, 2000
Alexandre Erëmenko, Purdue Univ.
Meromorphic Functions, Negative Curvature and Spherical Geometry

March 24, 2000
Fabian Todor
Intération des polynômes complexes et l'équation fractale avec applications

April 28, 2000
André Boivin, Univ. of Western Ontario
Sur les séries de Fourier non-harmoniques

May 12, 2000
Sebastien Manka, Univ. de Montréal
Le problème de Dirichlet dans le demi-plan

May 19, 2000
Pierre-Olivier Rathé, Univ. de Montréal
Le problème de Dirichlet dans le disque

Study Workshop: Inverse Monodromy Problems

Org.: John Harnad (Concordia)

November 4, 1999
Yousuke Ohyama, CRM & Osaka Univ.
Special Solutions of Schlesinger Equations

November 18, 1999
John McKay, CRM & Concordia Univ.
Moonshine - What it is about

November 25, 1999
Marco Bertola, CRM
Frobenius Manifolds I: Introduction

December 2, 1999
Yousuke Ohyama, CRM & Osaka Univ.
Special Solutions of Schlesinger Equations (Part II)

December 9, 1999
Yousuke Ohyama, CRM & Osaka Univ.
Special Solutions of Schlesinger Equations (Part III)

December 16, 1999
Marco Bertola, CRM
Frobenius Structures on Hurwitz Spaces of Functions

January 20, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications I

January 27, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications II

February 3, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications III

February 10, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications IV

March 2, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications, V

March 2, 2000
Dmitri Korotkin, CRM & Concordia Univ.
Theta Functions, Isomonodromic Deformations and Applications, VI

The Langlands Geometric Programme

Org.: Jacques Hurtubise (McGill)

January 13, 2000
Eyal Z. Goren, CRM & McGill Univ.
Vector Bundles

January 27, 2000
Eyal Z. Goren, CRM & McGill Univ.
Moduli of Vector Bundles

February 10, 2000
Jacques Hurtubise, CRM & McGill Univ.
Hitchin's Integrable Systems on the Moduli of Stable Pairs

March 9, 2000
Jacques Hurtubise, CRM & McGill Univ.
Quantification des systèmes de Hitchin

March 28, 2000
Henri Darmon, CRM & McGill Univ.
Correspondance Fonctions-faisceaux

April 20, 2000
Edward Frenkel, Univ. of California
Introduction to the Geometric Langlands Programme

Seminar in Mathematical Physics

Org.: Jiri Patera & Pavel Winternitz (CRM & Univ. de Montréal)

September 21, 1999
Hubert de Guise, CRM
Des représentations indécomposables de dimension finie du groupe E(2)

September 28, 1999
Louis-Sébastien Guimond, CRM
Les quasicrystaux utilisés pour éliminer la périodicité des générateurs de nombres pseudo-aléatoires

October 19, 1999
Pierre Valin, CRM & Lockheed Martin Canada
DND / LM Canada / University Collaborations Developing Technologies for Airbone Mission Management Systems

October 26, 1999
Marco Bertola, CRM
Jacobi Groups, Jacobi Forms and their Applications

November 9, 1999
Faruk Güngör , Istantul Technical Univ.
Symmetries and Solutions of the Generalized Boussinesq Equation

Louis Michel, Institut des hautes études scientifiques (IHES)
La symétrie d'un crystal impose la connexité de l'ensemble des branches d'une bande d'énergie élémentaire

November 23, 1999
Alexei Zhedanov, Donetsk Institute for Physics and Technology, Ukraine
Orthogonal Polynomials and Krall-Sheffer Duality

November 30, 1999
Stéphane Lafortune, CRM
Point Symmetries of Generalized Toda Field Theories

December 7, 1999
Jean-Pierre Gazeau, Univ. Paris 7
États cohérents pour le puit infini de potentiel

December 14, 1999
Decio Levi, Univ. di Roma Tre
Lie Algebras, Contractions and Symmetries of the Toda Hierarchy

December 21, 1999
Yuriy Korenyak , Kharkiv Univ., Ukraine
A new Point of View to the Modeling of Fields on Surfaces

January 11, 2000
Jamil Daboul, Ben Gurion Univ.
Kac-Moody Algebras and the Hydrogen Atom

January 18, 2000
Igor Loutsenko, CRM & Princeton Univ.
Soliton Solutions of Integrable Hierarchies and Coulomb Plasma

January 25, 2000
Richard L. Hall, CRM & Concordia Univ.
Geometric Spectral Inversion

February 4, 2000
Jan Derezinsk, Univ. of Warsaw
Hypergeometric Type Functions and Lie Algebras

February 8, 2000
Oleg I. Bogoyavlenskÿ, CRM & Queen's Univ.
Exact Global Plasma Equilibria

February 15, 2000
George Pogosyan, Joint Institute for Nuclear Research, Dubna, Russia
Superintegrability on Spaces wth Constant Curvature

CRM Statistics Seminar

Org.: Christian Léger (CRM & Univ. de Montréal)

June 17, 1999
Ian McLeod, Univ. of Western Ontario
Time Series Forecasting with Feed-Forward Neural Nets

September 16, 1999
Gilles Ducharme, Univ. Montpellier II & Univ. de Montréal
1900-2000, cent ans de tests d'adéquation

September 23, 1999
David Tyler, Univ. Rutgers
On the Uniqueness of the Multivariate S-functionals and M-functionals under Non-Elliptical Distributions

September 30, 1999
Jean-Michel Zakoian, CREST, Paris & Univ. de Lille 1
Least-Squares and Autocorrelation Based Estimators of Weak ARMA Model

October 14, 1999
Jack Kalbfleisch, Univ. of Waterloo, President of the Statistical Society of Canada
Methods for Response-Selective and Missing Data Problems

October 25, 1999
Roger Lafosse, Univ. Paul-Sabatier
Proposition de SVD généralisée : application en sélection de variables et reconnaissance de structure

January 27, 2000
Christian Léger, CRM & Univ. de Montréal
Intervalles de confiance basés sur le rééchantillonnage après la sélection de modèle en régression linéaire multiple

February 3, 2000
Jean-François Angers, CRM & Univ. de Montréal
Identificateur d'une densité et les valeurs aberrantes

February 17, 2000
François Bellavance, HEC
Méta-analyse d'une variable dépendante multinomiale à l'aide de modèles linéaires à effets fixes et mixtes

February 24, 2000
M'hamed Mesfioui, Univ. Laval
Nouvelles classes d'ordres stochastiques bivariés, avec applications en actuariat et épidémie

March 9, 2000
Denis Larocque, Univ. du Québec à Trois-Rivières
Un test du signe multidimensionnel affine-invariant pour données corrélées en grappes

March 16, 2000
François Perron, CRM & Univ. de Montréal
Sur l'échantillonnage selon l'algorithme acceptation-rejet en simulation

April 6, 2000
Kjell Doksum, Univ. of California, Berkeley
Partial Regression and Correlation Curves

April 13, 2000
Peter Mueller, Univ. Duke
Hierarchical Meta-Analysis over Related Non-parametric Models

CRM-ISM Colloquium

The CRM, together with the Institut des sciences mathématiques (the Québec university graduate mathematics consortium), runs the Montréal mathematics colloquium, which, during the university year, organises survey talks by distinguished mathematicians on topics of current interest.

Autumn 1999

September 17 ,1999
Andrew Majda, Courant Institute
The Mathematics of Closure for Turbulent Reaction Diffusion Equations

September 24, 1999
Lou Van den Dries, Univ. of Illinois at Urbana-Champaign
Logarithmic-Exponential Series

October 8, 1999
Victor Kac, MIT
Classification of Infinite-Dimensional Groups of Supersymmetries and the Standard Model

October 15, 1999
Niky Kamran, McGill Univ.
Le comportement étrange des solutions classiques de l' opérateur de Dirac au voisinage d'un trou noir

October 22, 1999
Christian Genest, Univ. Laval
Modéliser la dépendance et mesurer ses effets en tthéorie du risque

October 29, 1999
Richard P. Stanley, MIT
The Volume and Ehrhart Polynomial of Convex Polytopes

November 5, 1999
Laurent Lafforgue, CNRS, Univ. d'Orsay
La correspondance de Langlands sur les courbes

November 12, 1999
Peter Kronheimer, Harvard Univ.
Gauge Theory and Topology

November 25, 1999
Harry Kesten, Cornell Univ.
Percolation of Arbitrary Words in {0,1}N

December 3, 1999
Alain Lascoux, Univ. Paris 7
Les polynômes harmoniques

Winter 2000

January 14, 2000
Nicole Tomczak-Jaegermann, Univ. of Alberta
Geometry, Linear Structure and Random Phenomena in Finite-dimensional Normed Spaces

January 21, 2000
Troy Day, Univ. of Toronto
A Generalization of Pontryagin's Maximum Principle for Modeling Dynamic Evolutionary Games Between Relatives

January 28, 2000
Mark Goresky, Institute for Advanced Study (IAS)
Shift Registers, Finite Fields, and Elliptic Curves

February 4, 2000
Pierre Cartier, École Normale Supérieure
Algèbre et combinatoire des graphes (d'Euler à Feynman)

February 11, 2000
Olga Kharlampovich, McGill Univ.
Algebraic Geometry over Groups and the Tarski's Problem

February 18, 2000
Victor Havin, St. Petersburg State Univ.
On Some Non-Local Shift Invariant Operators

March 10, 2000
Jeffrey S. Rosenthal, Univ. of Toronto
Markov Chain Convergence Times and Pseudo-Small Sets

March 24, 2000
Terry Gannon, Univ. of Alberta
The Classification of Conformal Field Theories

March 31, 2000
Jean-Paul Allouche, Univ. Paris-Sud, Centre d'Orsay
Transcendance de nombre réels trop « réguliers »

April 7, 2000
Steven Boyer, UQAM
Linear Representations of the Fundamental Groups of 3-manifolds

April 14, 2000
Helmut Koch, Humboldt-Univ. of Berlin
Cubic Number Fields

April 19, 2000
Klauss Fleischmann, Weierstrass Institute for Applied and Stochastics, Bertin (Germany)
Catalytic, Mutually Catalytic, and Cyclically Catalytic Branching

April 28, 2000
Joel Feldman, Univ. of British Columbia
Fermi Surfaces and Infinite Genus Riemann Surfaces

World Mathematical Year

Sponsored by the International Mathematical Union and UNESCO, the year 2000 was declared the World Mathematical Year. On this occasion, many special activities were held all year long throughout the country. Many of them were organized by CRM members.

Mathematical Posters

Stéphane Durand, a CRM member, was awarded first prize in the international poster contest organized by the European Mathematical Society. His entry consisted of a series of seven posters on the links between mathematics and nature. These posters have been used and adapted in many countries in different ways (posters in the subway, postcards, CD-ROM, etc.):

- Montréal (posters in the subway)
- France (posters and postcards)
- Denmark (postcards)
- Belgium and Holland (posters)
- Italy (Archimède journal)
- UK and Portugal (CD-M)
- Germany (CD-ROM)

Three of the posters were printed in Québec. Besides their use in Montréal's subway, they have also been widely circulated in the schools.

Operation Subway 2000

One of the activities of the World Mathematical Year was a series of exhibits of mathematical posters in the subways of the world's biggest cities. In January 2000, Montréal's subway was the first to display these mathematical posters. The campaign was organized by Christiane Rousseau, a CRM member.

Public Lectures

Les Belles Soirées of the Université de Montréal consist of lectures for a wide audience on a variety of topics. To mark the World Mathematical Year, three lectures on mathematics were given in October 2000. The lecturers were Adrien Douady of Paris-Sud XI University at Orsay (*La dimension fractale*) and Stéphane Durand of CRM (*Structure universelle... vraiment?* and *Les mathématiques dans la nature: du léopard au tournesol...*).

What do a snail and the number $(1+\sqrt{5})/2$ have in common?

Why do sunflower seeds show a pattern of 34 clockwise curves and 21 counterclockwise curves?

The number $(1+\sqrt{5})/2$ is the golden mean which is found in many parts of nature. The spiral shell of the nautilus is an example of a geometric construction based on this number. Even Stradivarius used it when constructing his famous violins.

Why do buttercups have 5 petals? Why do pineapples have 8 diagonals in one direction and 13 in the other? Why do daisies generally have 34, 55, or 89 petals? All these numbers are part of the Fibonacci sequence (1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144,…) related to the golden mean, and where each number is obtained by adding the two previous ones. Only recently have we understood why these numbers are important in nature.

Mathematical Insert

To show the general public the importance and the presence of mathematics in modern life, CRM has prepared a popular document on the mathematical sciences in Québec. Entitled *Math2000*, it was published in the magazine *Québec Science* in May 2000. This document was edited by Stéphane Durand in collaboration with *Québec Science* and 40,000 copies were printed. The document has also been widely distributed in schools, colleges, and university departments of mathematics education.

Another document, entitled *Mathématiques An 2000*, was prepared jointly by the *Institut des sciences mathématiques* and by the *Association mathématique du Québec*. Giving a brief survey of research in mathematics, it was distributed with *Interface*, the magazine of the *Association canadienne-française pour l'avancement des sciences* (ACFAS).

A paper called *Décoder la nature* was also published in the magazine *Quatre-temps* of the Montréal Botanical Garden (vol 24, no 4, december 2000).

Exhibition

An exhibition called ***1, 2, 3 Math.*** was prepared jointly by the Museum of the séminaire de Sherbrooke, the Association mathématique du Québec, and Université de Montréal. It was inaugurated in May 2000 and since then has travelled in Québec and the rest of Canada. This animated and interactive travelling exhibition is intended for the general public and school-children. Some CRM members participated in its development, including Stéphane Durand, Jean-Marc Lina, and Christiane Rousseau. When it came to the Exhibit Centre of Université de Montréal from October 3rd through November 10th 2000, guided tours were offered to schoolchildren. They were led by students from the Department of Mathematics and Statistics.

Mega-Congress of Year 2000

Mathematics educators, from grade school to university, met during a mega-congress sponsored by the Ministry of Education of the Province of Québec. It was held last May at the Université Laval. Seven associations dedicated to the promotion of mathematics in Québec hosted this meeting.

Television Programmes

Hosted by Jean-Marie De Koninck of Université Laval, the television series, *C'est mathématique,* of 16 half-hour programmes was produced by *Productions Téléfiction* and shown on *Canal Z* during Winter 2000. The following CRM members participated: Jacques Bélair, Stéphane Durand, Jean-Marc Lina, Christiane Rousseau, and Yvan Saint-Aubin. Following its release, the series was bought by many schools. A sequel is being planned.

Radio shows

As part of the radio programme *Les nourritures terrestres* of the French CBC Radio 2, a half-hour interview with Stéphane Durand on mathematics was broadcast on October 26, 2000.

Coming Events

Theme Year 2000-2001:
Mathematical Methods in Biology and Medicine

Organizing Committee

Jacques Bélair (Montréal)
Leon Glass (McGill)
Brian Golding (McMaster)
Leah Keshet (UBC)
David Sankoff (Montréal)
Keith Worsley (McGill)

Overview

The year 2000-2001 at the CRM will be devoted to the rapidly developing field of mathematical methods in biology and medicine. The application of mathematics contributes to the understanding of natural processes both through mathematical models and their analysis, and through the development and application of mathematical methods of inference. The year emphasizes both aspects, with workshops covering various applications of nonlinear dynamics in biology and medicine, as well as genomics, and medical imaging.

10th CRM Summer School: *Nonlinear Dynamics in Biology and Medecine*

May 22 - June 2, 2000
Org. : Jacques Bélair (Montréal)

Instructors : L. Glass (McGill), M. Guevara (McGill), A. Longtin (Ottawa), M. C. Mackey (McGill), J. Milton (Chicago), A. Vinet (Montréal), J. Bélair (Montréal).

Offered jointly with the "Centre for Nonlinear Dynamics in Physiology and Medicine", this is an intensive introduction to the applications of nonlinear dynamics to biology and medicine, with computer exercises and an introduction to numerical techniques.

Aisenstadt Chair Lecture Series

- *Vortices in Motionless Media*
  Arthur T. Winfree (Arizona)
  September 2000
- *Mathematics for Reading and Understanding Genetic Sequences*
  Michael S. Waterman (USC)
  March 2001

International Annual Meetings *Combinatorial Pattern Matching (CPM 2000)*

June 21 – 23, 2000
Org. : Raffaele Giancarlo (Univ. of Palermo), David Sankoff (Montréal)

Invited speakers : A. Broder (Altavista), F. Major (Montréal), F. Pereira (AT&T Labs), I. Witten (Waikato, New Zealand).

This meeting has a major computational biology component and includes fields which share a common focus on the formulation, algorithmic recognition, analysis, communication, and storage of patterns in diverse kinds of data.

5th Annual International Conference on Computational Molecular Biology (RECOMB 01)

April 22 – 25, 2001
Org. : David Sankoff (Montréal)

The premier annual meeting in computational molecular biology, featuring a highly competitive selection of the best research papers from cutting edge projects whose subjects are computational and mathematical in nature.

Workshop on *Novel Approaches in RNA Informatics (NARI)*

May 18 – 19, 2000
Org. : François Major (Montréal)

Invited speakers : C. Duarte (Columbia), E. Rivas (Washington), B. Shapiro (NCI), M. Venkantraman (Isis Pharmaceuticals Inc.), C. Wilson (UCSC), M. Zuker (Washington).

The goal of this symposium is to explore the current state of the art in RNA informatics and to look towards the future of the field. The NARI symposium will provide a general forum for disseminating the latest developments, and will bring together scientists from biochemistry, molecular biology, computer science, mathematics, and statistics who will present an overview of novel approaches.

Workshop on Bioinformatics

May 17, 2000
Org. : Nadia El-Mabrouk (Montréal)

Invited speakers: I. Barrette (Montréal), G. Butler (Concordia), G. Drouin (Ottawa), N. El-Mabrouk (Montréal), D. Forsdyke (Queen's), A. Kusalik (Saskatoon), M. Li (Waterloo), A. Nip (Montréal), G. Poisson (Montréal), P. Rouzé (Ghent), D. Sankoff (Montréal).

A workshop on problem areas in bioinformatics was held, as part of the annual meeting of the Association canadienne-française pour l'avancement des sciences (ACFAS).

Workshop on Molecular, Metabolic, and Gene Control Networks

September 9 – 13, 2000
Org. : Michael C. Mackey (McGill)

Invited speakers: D. Bray (Cambridge), G. Church (Harvard), J. Collins (Boston), J. Ferrell (Stanford), L. Glass (McGill), A. Goldbeter (UL Bruxelles), H. Herzel (Berlin), K. Kohn (NIH), R. Larter (Purdue), J. Mahaffy (San Diego State), J. Paulsson (Uppsala), J. Ross (Stanford), M. Roussel (Lethbridge), M. Santillan (Mexico City), P. Smolen (Houston), R. Somogyi (Incyte), D. Thieffry (ULB), J. Tyson (Virginia).

Recently in this field modeling has been done of regulation of progression through the cell cycle as mediated by check points, control in the lactose and tryptophan operons, and the integrated behaviour of large coupled molecular / metabolic / gene networks. This workshop brings together both experimentalists and modelers to examine the current state of the field and the exciting future prospects.

Workshop on Gene Order Dynamics, Comparative Mapping and Multigene Families (DCAF)

September 22 – 25, 2000, Ste-Adèle
Org. : David Sankoff (Montréal), Joseph H. Nadeau (Case Western Reserve University)

Invited speakers: S. Anderson (Uppsala), V. Barriel (Paris) & C. Gallut (Paris), B. Bed'Hom (Paris), J. Boore (Michigan), P. Bork (Heidelberg), D. Bryant (Montpellier), A. Caprara (Bologna) & G. Lancia (Padua), O. Cohen (Grenoble), J. Demongeot (Joseph Fourier de Grenoble), K. Devos (UK), J. Dicks (Norwich Research Park), E. Eichler (Case Western Reserve), N. El-Mabrouk (Montréal), A. Hughes (South Carolina), B. Koop (Victoria), F. Lang (Montréal), D. Liben-Nowell (Cornell), L.A. Lyons (NIH), B. McAllister (Texas), S.R. McCouch (Cornell), A. McLysaght (Dublin), J. Meidanis (Sao Paolo), I. Parkin (Saskatoon Research Centre), A. Paterson (Georgia), P.A. Pevzner (USC), D. Schoen (McGill), R. Shamir & I. Pe'er (Tel Aviv), B. Trask (Seattle), M. Turmel (Laval), D. Waddington (UK), T. Warnow (Austin), J. Womack (Texas A&M).

This meeting will bring together scholars in the biological and mathematical sciences working on genome rearrangement, mapping, and the evolution of gene families in human, animal, plant, other eukaryote, prokaryote, organellar, and viral genomes.

Workshop on Nonlinear Dynamics and Biomathematics

October 3 – 6, 2000
Org.: Pierre Auger (Lyon), Jacques Bélair (Montréal), Jacques Demongeot (Grenoble), Christiane Rousseau (Montréal)

Invited speakers: O. Arino (Pau), P. Auger (Lyon), J. Bélair (Montréal), H. Benali (CHU Pitié Salpêtrière), A. Bourdou (INSERM), R. Bravo de la Parra (Alacala), S.A. Campbell (Waterloo), C. Chevalet (Toulouse), F. Clarke (Lyon), J.-L. Coatrieux (Rennes I), M. Courtemanche (Montréal), J. Demongeot (Grenoble), L. Glass (McGill), A. Goldbeter (UL Bruxelles), B. Goulard (Montréal), J.-M. Lina (Montréal), S. Lessard (Montréal), A. Longtin (Ottawa), N. Raissi (Morocco), D. Salahub (Institut Steacie), P. Tracqui (Grenoble), B. A. Vinet (Hôpital du Sacré-Coeur), G. Wolkowicz (McMaster).

The state of the art in the application of techniques from nonlinear dynamics to diverse fields of biology (biochemistry, physiology, resources management, medical imaging) will be covered. This workshop is part of the Entretiens du Centre Jacques-Cartier.

Workshop on Memory, Delays, and Multistability

October 12 – 15, 2000
Org. : André Longtin (Ottawa)

Invited speakers: K. Aihara (Tokyo), T. Aonishi (RIKEN, Japon), S. Becker (McMaster), J. Bélair (Montréal), F. Buarque de Lima Neto (Imperial College), J.-L. Cabrera (Chicago), S.A. Campbell (Waterloo), C. Canavier (New Orleans), G. Carpenter (Boston), M. Chacron (Ottawa), G. Deco (Siemens), A. Destexhe (Laval), M. Ding (Florida Atlantic), B. Doiron (Ottawa), R. Engbert (Postdam), U. Ernst (Bremen), J. Freund (Humboldt), W. Gerster (Lausanne), L. Glass (McGill), S. Guillouzic (Ottawa), R. Hahnloser (MIT), S.K. Han (Chungbuk Nat. Univ.), A. Herz (Humboldt-Bremen), E. Izhikevich (Neurosciences Inst.), J. Jeong (Yale), R. Kuske (Minnesota), C. Laing (Pittsburgh), J. Lewis (Ottawa), W. Mass (Tech. U. Graz), M. Menzinger (Toronto), J. Milton (Chicago), K. Pakdaman (INSERM), A. Potapov (Lethbridge), M. Titcombe (UQAM), R. Wackerbauer (West Virginia), H. Wilson (York), J. Wu (York).

This workshop will focus on important current issues in the modeling of neural activity in recurrent circuitry, such as recurrent activity thought to lie at the core of sensory information processing. The emphasis will be on the mathematical issues which arise in the modeling of such activity in real biological systems.

Workshop on Mapping and Control of Complex Arrhythmia

October 29– November 1, 2000
Org. : Leon Glass (McGill)

Invited speakers: J. Beaumont (SUNY Syracuse), A. Beuter (UQAM), D. Christini (New York), J. Collins (Boston), F. Fenton (Northeastern), A. Garfinkel (Los Angeles), D. Gauthier (Duke), M. Guevara (McGill), V. Hakim (Laboratoire de physique statistique), H. Hastings (Hofstra), R. Ideker (Alabama), A. Karma (Boston), V. Krinsky (Nice), J. Leon (Montréal), S. Nattel (Montréal), A. Panfilov (Holland), G. Rousseau (Paris 7), Y. Rudy (Cleveland), A. Shrier (McGill), K. Stein (NY Presbyterian Hospital), N. Trayanova (New Orleans), A. Vinet (Montréal).

This workshop will bring together mathematicians, experimentalists, physicians, and industrial representatives to present papers and discuss approaches to mapping and control of complex arrhythmias. There will be a strong focus on novel interdisciplinary approaches to control atrial fibrillation.

Workshop on Fractal and Modeling in Structural and Dynamical Analysis

November 11 – 14, 2000
Org. : Jacques Bélair (Montréal), Fahima Nekka (Montréal)

Invited speakers: A. Arnéodo (C.N.R.S.), Y. Ashkenazy (Boston), D.R. Bickel (Texas), Q. Cheng (York), S. Dubuc (Montréal), A. Einstein (Mt. Sinaï), A. Khalil (Laval), A.P. Kirilyuk (Institute of Metal Physics, Kiev), H. Kitaoka (Osaka), L.S. Liebovitch (Florida Atlantic), S. Lovejoy (McGill), S. Lubkin (North Carolina), B. Sapoval (Polytechnique), C. Tricot (Clermont-Ferrand), M.J. Turner (De Montfort).

Classical problems in material sciences (surface characterization, description of branching networks) have been given new impetus by the introduction of fractal concepts. This workshop will cover the latest theoretical developments, their contributions in the biomedical field and future directions of investigations.

Workshop on Mathematical Methods in Brain Mapping

December 10 – 11, 2000
Org. : Keith Worsley (McGill)

Invited speakers: J. Ashburner (Inst. of Neurology Funct. Imaging Lab.), J. Aston (London), E. Brown (Harvard), M. Chung (McGill), A. Dale (Harvard), K. Friston (Inst. of Neurology Funct. Imaging Lab.), G. Glover (Stanford), N. V. Hartvig (Aarhus), M. Hurdal (Florida Atlantic), S. Kiebel (Inst. of Neurology Funct. Imaging Lab.), J.-F. Mangin (Service Hospitalier Frédéric Joliot, Orsay), T. Ozaki (Tokyo), J.-B. Poline (CEA), J. Polzehl (Weierstrass Inst.), J. Riera (Cuban Neuroscience Center), S. Smith (Oxford), J. Taylor (McGill), P. Valdes (Cuban Neuroscience Center).

Brain mapping is a rapidly growing research field that tries to understand human brain function and anatomy using 3D images from MRI, fMRI, PET, EEG and MEG and applying geometry, topology, statistics, and random fields. This workshop is intended to bring together mathematicians and statisticians interested in brain mapping, and medical researchers interested in mathematical and statistical methods for the analysis of brain mapping data.

Workshop on Population Genetics at the Molecular Level

March 8 – 11, 2001
Org. : Brian Golding (McMaster)

Invited speakers : M. Gouy (Lyon), J. Huelsenbeck (Rochester), S. Kumar (Arizona State), S. Muse (NCSU), R. Nielsen (Cornell), B. Rannala (Stony Brook), A. Rzhetsky (Columbia), D. Schoen (McGill), J. Thorne (NCSU), Z. Yang (U.C.London).

The genes and alleles of classical genetics are abstract notions. Now that these are increasingly understood in terms of particular sequences of DNA and protein, the mathematical foundations of the field must be revisited and expanded, which is the object of this workshop.

Workshop on Mathematical Formalisms for RNA Structure

April 25 – 26, 2001
Org. : François Major (Montréal)

Invited speakers: R. Altman (Stanford), J. Brown (NCSU), J. Burke (Vermont), D. Case (Scripps), D. Gautheret (CNRS-Marseille), S. Harvey (Alabama), P. Legault (Georgia), J.-P. Perreault (Sherbrooke), E. Westhof (CNRS-Strasbourg), M. Zuker (St. Louis).

This symposium will explore the current state of the art in computational RNA structures, and provide a look towards the future of the field.

Courses and Seminars

Combinatorial Pattern Matching

June 19 – 20, 2000
Org. : David Sankoff (Montréal)

Invited speakers: D. Bryant (Montpellier), N. El-Mabrouk (Montréal), R. Giancarlo (Palermo), C. Lam (Concordia), L. Parida (IBM T.J. Watson Research Center), I. Witten (Waikato, New Zealand).

Preceding CPM2000, this is a two-day tutorial on sequence analysis and other topics in computational biology and pattern matching.

Developing the Tools: A Canadian Bioinformatics Workshop

June 26– July 1, 2000
Org. : Christopher Hogue (Toronto), François Major (Montréal)

One of a series of training workshops directed by the Canadian Genetic Diseases Network and the Biotechnology Human Resources Council.

Techniques in Brain Mapping

December 5 - 8, 2000
Org. : Keith Worsley (McGill), Bernard Goulard (Montréal)

Invited speakers: R. Adler (TECHNION), N. Lange (Harvard), P. Valdes (Cuban Neuroscience Center).

In preparation for the workshop on brain mapping, four series of introductory lectures will be given, covering the geometry of random field, methods in functional magnetic resonance imaging and methods for EEG analysis.

Fractals and Wavelets in Medical Imaging

February 23 – 24, 2001
Org. : Jean-Marc Lina (Montréal), Fahima Nekka (Montréal)

Invited speakers: M. Unser (Swiss Federal Institute of Technology, Lausanne)

Preceding the workshop, this tutorial will introduce the subject to non-specialists.

Showcase for Competing Technologies for Phylogenetics (SCOPH)

April 19 – 21, 2001
Org.: David Bryant (Montréal), David Sankoff (Montréal)

Invited speakers: D. Bryant (Montréal), A. Dress (Bielefeld), J. Felsenstein (Seattle), O. Gascuel (Montpellier), T. Hagedorn (College of New Jersey), J. Huelsenbeck (Rochester), K. Nixon (Cornell), D. Sankoff (Montréal), M. Steel (Canterbury), D. Swofford (Cornell), T. Warnow (Texas, Austin)

This seminar is aimed at researchers, teachers and students interested in current developments in phylogenetic analysis. The speakers will each address one or two major areas and there will be ample time for comparison, debate, and discussion. Some of the themes will be: efficient methods for very large phylogenies, model-based versus model-free approaches, tree inference with and without ancestor reconstruction, generalizations of trees. Software packages will be available on-line and there will be facilities for demonstrations and hands-on experimentation.

Visitors

Support is available for short- and long-term visits. Preference will be given to junior investigators.

Those wishing to participate in the above activities are invited to write to:

Louis Pelletier
Centre de recherches mathématiques (CRM)
E-mail: **ACTIVITES@CRM.UMontreal.CA**
World Wide Web:
http://www.CRM.UMontreal.CA/biomath

General Programme 2000-2001

Canadian Journal of Statistics Read Paper Session

June 4, 2000, Ottawa, Ontario
Org. : Christian Genest (Laval)

During the Annual Meeting of the Statistical Society of Canada, a major scientific contribution will be read and discussed publicly. The paper is *The Estimating Function Bootstrap* of John D. Kalbfleisch (Waterloo) and Heifang Hu (Singapore). The paper will be discussed by Jim Zidek (British Columbia), Tom Diccicio (Cornell) and Rob Tibshirani (Stanford), Christian Léger (Montréal), and Angelo Canty (Concordia). This event, inspired by a similar activity of the Royal Statistical Society of the United Kingdom, is a first for the *Canadian Journal of Statistics*.

Québec Math Camp 2000

June 2000, Université du Québec à Trois-Rivières, Trois-Rivières
Org. : Harry White (Université du Québec à Trois-Rivières)

Le camp mathématique est une activité parrainée par l'Association mathématique du Québec (AMQ) dans le but de mettre en contact des étudiants doués pour les mathématiques avec des mathématiciens professionnels. Les campeurs sont sélectionnés parmi ceux qui ont le mieux réussi au concours de l'AMQ (niveau collégial).

Mini-programme: *Asymptotic series, differential algebra and finiteness problems in non-linear dynamical systems*

June 19 - July 7, 2000
Org. : Dana Schlomiuk (Montréal) , Luc Bélair (UQAM)

Invited participants : A. Buium (New Mexico), A. Bolibrukh (Steklov Institute), L. Van den Dries (Illinois), F. Dumortier (Limburgs Universitair Centrum), J.P. Françoise (Paris VI), Y. Ilyashenko (Steklov Institute), V. Kaloshin (Princeton), J. Llibre (Universitat Autonoma de Barcelona), C. Miller (Ohio State), R. Moosa (Illinois at Urbana-Champaign), A. Mourtada (Bourgogne), J.-P. Rolin (Bourgogne), C. Rousseau (Montréal), P. Speissegger (Wisconsin, Madison), S. Yakovenko (Wiezmann Institute of Science), H. Zhu (Waterloo).

While the relationship between asymptotic analysis and differential algebra has long been useful in linear differential equations, the merger of tools and the opening of a wider scope of investigations in both the areas of non-linear dynamics and differential algebraic geometry is more recent. In particular, model theoretical methods have recently come to the fore in the area. These new developments provide ample motivation for organizing a mini-programme in this area of research.

The aim is to get specialists together from these different fields and have them talk. Plenty of time will be reserved for discussion, and the whole event will last three weeks, starting with a week of mini-courses, and followed by an extended two week workshop-working session.

There will be four mini-courses aimed at graduate students and potential researchers:

- Bolibruch *Asymptotic series and differential equations.*
- Buium, *Differential Algebraic Geometry and Diophantine Geometry*.
- L. Van den Dries, *Logarithmic-Exponential Series and o-Minimality.*
- V.Y. Kaloshin, *Finiteness Theorems in Dynamical Systems*.

A workshop built around four themes :

- Algebras of quasi-analytic terms, Weierstrass-type preparation theorems and finiteness results with applications to global problems in analytic vector fields,
- Finiteness theorems in non-linear dynamical systems,
- Ecalle's theory and applications,
- Model theory - finiteness theorems in -o-minimality.

There will also be several colloquium style lectures.

Séminaire de mathématiques supérieures: *Approximation, Complex Analysis, and Potential Theory*

July 3 - 14 , 2000, Université de Montréal, Montréal
Org. : A. Daigneault (Montréal), N. Arakelian (Armenian National Academy of Sciences), P. Gauthier (Montréal), D. Armitage (Queen's University of Belfast), D. Drasin (Purdue), A. Gonchar (Steklov), S. Lessard (Montréal), G. Sabidussi (Montréal)

The 2000 SMS will focus on the interplay between complex analysis and potential theory. Complex analysis relies heavily on potential theory, since the absolute value (as well as the logarithm) of a holomorphic function is a subharmonic function. In the other direction, much research in potential theory has been inspired by the attempt to seek analogues to complex phenomena. This is especially true in

approximation theory, a central theme of this SMS.

The main lectures will be given by A. Ancona (Paris-Sud), *Topics on Martin Boundaries, Positive Harmonic Functions and Green's Functions*; N. Arakelian (Armenian National Academy of Sciences), *Approximation and Value Distribution*; D. Armitage (Queen's University of Belfast), *Uniform and Tangential Harmonic Approximation*; T. Bagby (Indiana), *Sobolev Spaces and Approximation Problems for Differential Operators*; M. Bonk (Michigan), *Negative Curvature in Real and Complex Analysis*; H. Chen (Nanjing Normal University, China) *The Bloch Constant for One and Several Variables, Holomorphic and Harmonic Mappings*; D. Drasin (Purdue), *Approximation Theorem, Normal Families, and Meromorphic Functions*; S. Gardiner (University College, Dublin), *Harmonic Approximation and its Applications*; P. Gauthier (Montréal), *Approximation on Riemann Surfaces and Complex Manifolds*; T. Ransford (Laval), *Jensen Measures*; and A. Stray (Bergen), *Simultaneous Approximation in Various Function Spaces.*

Fête en l'honneur de Walter Hengartner «Hengartnerfest»

July 7 – 8, 2000
Org. : Richard Fournier (CRM), Paul Gauthier (Montréal) , Thomas Ransford (Laval)

Cette conférence vise à honorer la carrière du professeur Walter Hengartner à l'occasion de sa retraite de l'Université Laval. Les conférences porteront sur divers sujets de la théorie des fonctions reliés à ses travaux, notamment sur l'analyse complexe. La fête aura lieu durant le Séminaire de Mathématiques Supérieures dont le sujet est *Approximation, analyse complexe et théorie du potentiel.* Les conférenciers invités sont Daoud Bshouty (Technion-Israel), Ted Suffridge (Kentucky), Peter Duren (Michigan), Walter Hayman (Imperial College), Line Baribeau (Laval), Tom Bagby (Indiana) et Paul Gauthier (Montréal).

Colloque LACIM 2000

September 7 – 10, 2000, UQAM, Montréal
Org.: Pierre Leroux (UQAM), Robert Bédard (UQAM), Srecko Brlek (UQAM) , Manon Blais (UQAM).

Co-sponsors: Université du Québec à Montréal (UQAM), le Ministère de la Recherche, de la Science et de la Technologie (Québec).

Invited speakers: Jean Berstel (Marne-la-Vallée), Richard Ehrenborg (KTH), Nadia El-Mabrouk (Montréal), Dominique Foata (Strasbourg), Adriano Garsia (UCSD), Pierre Lalonde, Christophe Reutenauer (Strasbourg), Richard Stanley (Massacchusetts Institute of Technology), Xavier Viennot (LaBRI, Bordeaux I), Doron Zeilberger (Temple).

L'année 2000, année mondiale des mathématiques sous l'égide de l'UNESCO, marque, parmi tant d'autres anniversaires, les dix ans du Laboratoire de combinatoire et d'informatique mathématique de l'UQAM. Les disciplines couvertes par le LaCIM ont connu des développements remarquables au cours des dix dernières années, que ce soit sur le plan théorique, en combinatoire énumérative ou algébrique, ou au niveau des applications, en analyse classique, en calcul formel, en géométrie algorithmique, en chimie combinatoire, en physique statistique, et, plus récemment, en bio-informatique.

Le but du colloque est de faire le point sur quelques-uns de ces développements en réunissant des experts internationaux de ces domaines. Nous souhaitons également donner la chance aux chercheurs jeunes ou plus expérimentés de faire connaître leurs résultats récents. Le programme comprend dix conférences plénières ainsi que des communications sélectionnées par le comité scientifique. Afin de favoriser une plus grande interaction, ces communications sont regroupées à l'intérieur d'une séance d'affichage. Un numéro spécial de la revue *Discrete Mathematics* sera consacré aux actes du Colloque sous la direction de Gilbert Labelle et Pierre Leroux.

XIIth Meeting on the Representation Theory of Algebras

September 29 – 30, 2000, Bishop's University, Lennoxville
Org. : Ibrahim Assem (Sherbrooke), Andrew Dean (Bishop's), François Huard (Bishop's), Pierre-Yves Leduc (Sherbrooke), Shiping Liu (Sherbrooke)

This is the 12th of a series of annual meetings held each autumn, alternately at the Université de Sherbrooke and at Bishop's University. These meetings are devoted to the Representation Theory of Associative Algebras, an area of mathematics which is presently very well developed, and connected to many other areas (such as, for instance, commutative algebra, algebraic geometry, algebraic topology, singularity theory and Lie theory).

This year's programme includes invited talks of 45-50 minutes given by Luchevar Avramov (Purdue), Vlastimil Dlab (Carleton), Alex Martsinkovsky (Northeastern), Cristian Novoa (Catholic University of Goias, Brazil), Claus Michael Ringel (Bielefeld), Shaobin Tan (Fields), Dan Zacharia (Syracuse), and Rita Zuazua (National Autonomous University of Mexico).

Conférence «Adrien Douady»

October 20 – 21, 2000
Org. : Dana Schlomiuk (Montréal), Norbert Schlomiuk (Montréal).

Invited speakers: Bodil Branner (Tecnical Univ. of Denmark), Welington de Melo (IMPA - Rio de Janeiro), Adrien Douady (Orsay - Paris), Raphael Douady (E.N.S. Paris), John Hubbard (Univ. de Marseille), Mikhael Lyubich (SUNY - Stony Brook), Curtis McMullen (Harvard Univ.), John Milnor (SUNY - Stony Brook), Raghavan Narasimhan (Univ. of Chicago), Mitsuhiro Shishikura (Hiroshima Univ.).

A conference to celebrate the 65 years of Adrien Douady and to highlight his numerous important contributions to mathematics, most notably to dynamical systems and to analytic geometry.

A Series of Conferences by Professor Alexei Miasnikov

March 2 – 30, 2001, McGill Univ. , Montréal
Org. : O. Kharlampovich (McGill)

This is a series of lectures on equations over free groups and free semigroups. In theoretical computer science, this topic is known as the unification problem. Professor Miasnikov will discuss recent developments in this area related to algebraic geometry over groups, Tarski's problems, and complexity of the unification problem. Lectures will be given every Friday in March.

Symplectic and Contact Topology, Quantum Cohomology, Symplectic Field Theory and Higher-Dimensional Gauge Theory

March 26 - April 7, 2001, Fields Institute, Toronto, Ontario, & CRM
Org. : S. Donaldson (London), B. Dubrovin (Trieste), Y. Eliashberg (Stanford), A. Givental (Berkeley), B. Khesin (Toronto), F. Lalonde (Montréal)

This two-week workshop will bring together researchers from symplectic topology, algebraic geometry, and mathematical physicists working in gauge theory and quantum field theory. Its main goal is to discuss recent developments in the construction and computation of invariants of symplectic and contact manifolds and their automorphism groups, using methods of the theory of J-holomorphic curves, as well as those from gauge theory and dynamical Hamiltonian systems. The theory of these invariants is tightly related to enumerative algebraic geometry, quantum cohomology and mirror symmetry. Recent results, of both mathematicians and physicists, show the existence of surprising correspondences between various gauge theories on real and complex manifolds.

The first week, to be held at the Fields Institute in Toronto, will emphasize relations of the theory of holomorphic curves with field theories, mirror symmetries, as well as (higher dimensional) gauge theories. The second week at the CRM in Montréal will concentrate more on the geometric, analytic and dynamical aspects of symplectic topology.

Theme Year 2001-2002: Groups and Geometry

Organizing Committee

A. Broer (Montréal), S. Boyer (UQAM), J. Carrell (UBC), W. Casselman (UBC), H. Darmon (McGill), I. Hambleton (McMaster), J. Hurtubise (CRM), N. Kamran (McGill), B. Khesin (Toronto), F. Knop (Rutgers), R. Lee (Yale), D. Wise (Brandeis and McGill).

Overview

The role of group actions and groups in general is ubiquitous in geometry, and the year's programme will concentrate on some areas in which there has been important recent progress.

The year consists of two segments, the first more differential-geometric in flavour, and the other one concentrating specifically on the links between algebraic geometry, group theory, and representation theory.

Groups, Topology and Differential Geometry

June - December 2001

Groups and Low-Dimensional Topology

June - July 2001
Org.: Steven Boyer (UQAM), Dani Wise (Brandeis & McGill)

Throughout the 20th century there has been a remarkably fruitful interplay between group theory and the geometry and topology of low-dimensional manifolds. The study of 3-manifolds through their fundamental groups and symmetries has turned out to be a particularly rich vein with applications to such topics as the tabulation of knots, geometrization problems, group actions, and surgery theory. Conversely, results of 3-dimensional topology have been fundamental in motivating many exciting developments in geometric group theory: actions on **R**-trees, word-hyperbolic groups, decomposition theorems, quasiconvexity, coherence, etc. Our goal is to bring together students and researchers from these active research areas over a three week period in order to underline and foster the connections between them.

Workshop on Groups and 3-manifolds

June 25 – 29, 2001

This workshop will focus on recent progress on various open topological and geometric classification problems as well as some of the newer research directions. There will be four 50 minute talks per day, leaving plenty of time for informal discussions amongst the participants.

They include: M. Boileau (Université Paul Sabatier), D. Calegari (Harvard), A. Casson (Yale), D. Cooper (California at Santa Barbara), M. Culler (Illinois at Chicago), D. Gabai, (California Institute of Technology), C. McA. Gordon (Texas at Austin), S. Kerchoff (Stanford), M. Lackenby (Oxford), D. Long (California at Santa Barbara), J. Luecke (Texas at Austin), Y. Moriah (Technion), J. Porti (Barcelona), A. Reid (Texas at Austin), H. Rubinstein (Melbourne), P. Shalen (Illinois at Chicago), Y.-Q. Wu (Iowa), X. Zhang (State University of New York at Buffalo).

Mini-courses

July 2 – 6, 2001

Michel Boileau (Paul Sabatier)
Geometrization of 3-dimensional orbifolds

Martin Bridson (Oxford)
Non-positively Curved Spaces and Hyperbolic Groups

Ruth Charney (Ohio State)
The Geometry of Coxeter and Artin Groups

Benson Farb (Chicago)
A Crash Course on the Geometry of Groups

Peter Shalen (Univ. of Illinois at Chicago)
Representations of 3-manifold Groups

Workshop on Geometric Group Theory

July 9 – 13, 2001

The theory of infinite groups was revolutionized by an infusion of ideas from geometry and topology. This has led to the resolution of many old problems and the formulation of new problems and methods which have broadened the scope of the field. This workshop will focus on these new developments in geometric group theory. There will be four 50 minute talks per day, leaving plenty of time for informal discussions amongst the participants.

They include: W. Ballmann (Bonn), M. Bestvina (Utah), B. Bowditch (Southampton), M. Bridson (Oxford), R. Charney (Ohio State), B. Farb (Chicago), M. Feighn (Rutgers), I. Kapovich (University of Illinois at Urbana-Champaign), M. Kapovich (Utah), O. Kharlampovich (McGill), J. McCammond (Texas A & M), A. Myasnikov (CCNY), P. Papazoglou (Paris-Sud), M. Sapir (Vanderbilt), M. Sageev (Technion) , Z. Sela (Hebrew University).

Topology of Manifolds and Group Actions

August 20 – 24, 2001
Org. : Ian Hambleton (McMaster), Ronnie Lee (Yale)

Recently there have been important breakthroughs in the study of the topology of manifolds and related topics on group actions, especially in the area of 3-and 4-dimensional manifolds with new input from the Seiberg-Witten theory and symplectic topology. One of the main objects of this workshop is to describe these new advances on the subject.

In addition, there also have been important developments in other areas. For example, there are the study of discrete group actions on Euclidean space using controlled surgery theory, the generalization of Casson invariants from SU(2) to SU(3), the study of Torelli group actions on the cohomology of moduli spaces, the classification of topological group actions on 4-manifolds, just to name a few. Not concentrated completely on 4-dimensions, our programme will also present these topics for the case of high-dimensional manifolds and related subjects. In fact, it is the design of the conference to bring about formal and informal discussion between different perspectives, to compare questions, methods and applications.

The list of participants includes:
R. Cohen (Stanford), S. Cappell (Courant Institute), J. Davis (Indiana), A. Edmonds (Indiana), T. Farrell (SUNY at Binghamton), P. Feehan (Max-Planck-Institute für Mathematik, Bonn), R. Fintushel (Michigan State) K. Froyshov (Harvard), R. Gompf (Texas at Austin), C. Herald (Nevada at Reno), R. Kirby (UC Berkeley), T. Leness (Florida International), T. Li (Princeton), M. Marcolli (Max-Planck-Institut für Mathematik, Bonn), M. McCooey (McMaster), E. Miller (Polytechnic University of New York), J. Morgan (Columbia), L. Nicolaescu (Notre Dame), P. Ozsvath (Michigan State), E. Pedersen (SUNY at Binghamton), F. Quinn (Virginia Polytech Inst & State University), D. Ruberman (Brandeis), R. Schultz (UCR), D. Wilczynski (Utah State University at Logan), B. Williams (Notre Dame).

Infinite-Dimensional Lie Groups

October - November 2001
Org. : Niky Kamran (McGill), Boris Khesin (Toronto)

From a differential-geometric point-of-view, infinite-dimensional Lie groups arise as automorphism groups of various geometric structures on the manifolds, such as a volume form, a foliation, a contact structure or a symplectic structure. The study of these infinite-dimensional Lie groups becomes a fundamental problem in areas of mathematics as diverse as hydrodynamics and symplectic topology. Another wide class of infinite-dimensional Lie groups is formed by loop groups, Kac-Moody groups, and more generally, by gauge groups on manifolds of arbitrary dimension. The successes in the study of these groups have been immensely fruitful both in low-dimensional geometry and topology and in quantum field theory. Infinite-dimensional Lie groups are also fundamental in the theory of integrable systems and their hierarchies. In this context, their action becomes quite explicit on spaces of pseudo-differential and Fourier integral operators. The purpose of this mini-programme will be to review some of the significant recent developments in the above areas and to explore some of the important open problems.

- ***Introductory Lectures***
  A.A. Kirillov (Pennsylvania)
  October 29– November 1, 2001
- ***Workshop on the Geometry of Infinite-Dimensional Lie Groups***
  November 2 – 6, 2001

Participants will include: P. Deift (Pennsylvania), P. Etingof (MIT), V. Fock (ITEP), V. Guillemin (MIT), L. Jeffrey (Toronto), M. Kapranov (Toronto), A.A. Kirillov (Pennsylvania) , F. Lalonde (Montréal), J. Leslie (Howard), P. Michor (Vienna), E. Meinrenken (Toronto), P. Olver (Minnesota), H. Omori (Tokyo), V. Ovsienko (CNRS-Luminy), T. Ratiu (EPFL Lausanne), T. Robart (Howard), P. Slodowy (Hamburg), I. Zakharevich (Ohio State).

Groups and Algebraic Geometry

January - June 2002

The importance of algebraic geometry in representation theory, has grown enormously during the past decades, with the arrival of such techniques as *D*-modules and perverse sheaves. Geometry intervenes in a crucial fashion in the proof of such results as the Kazhdan-Lusztig conjecture, the construction of canonical bases for representations, and the work of Beilinson-Drinfeld on the Geometric Langlands programme. A number of deep connections have arisen between the algebraic geometry and algebraic combinatorics, whose ramifications extend all the way to mathematical physics and topology. A special emphasis of the programme will be in graduate training, and a variety of short courses will be organized, as well as

graduate courses of a more introductory nature. Funding is available for graduate students wishing to attend.

Aisenstadt Chairs

There will be three series of lectures delivered under the auspices of the Aisenstadt chair, by **E. Frenkel** (Berkeley), **L. Lafforgue** (IHES), and **G. Lusztig** (MIT).

Graduate courses

January - April 2002

Abram Broer (Montréal)
Hilbert Schemes of Points and their Applications

Henri Darmon (McGill)
Automorphic Forms

Eyal Goren (McGill)
Curves, Vector Bundles on Curves and their Moduli

Yvan Saint-Aubin (Montréal)
Kac-Moody Algebras

Winter School on Computations in Coxeter Groups

January 21 – 28, 2002
Org. : W. Casselman (UBC), R. Bédard (UQAM), F. du Cloux (Lyon I)

These short courses are designed to show how techniques from computer algebra can be applied to effective computation in Coxeter groups. The course will be held in the Laurentians, outside Montréal.

Group Actions on Rational Varieties

February 27 - March 3, 2002
Org. : P. Russell (McGill)

The workshop will focus on recent developments in automorphisms of affine spaces and related algebraic varieties with simple topology, in particular exotic affine spaces (algebraic varieties homeomorphic to an affine space).

The list of invited speakers includes: T. Asanuma (Toyama), T. Bandman (Bar-Ilan), D. Daigle (Ottawa), A. Van den Essen (Nijmegen), G. Freudenburg (Southern Indiana), M. Gizatullin (UTFSM), R. Gurjar* (Tata), I. Dolgachev* (Michigan), J. Winkelmann* (Bochum), S. Kaliman (Miami), K. Masuda (Himeji), F. Knop* (Rutgers), M. Koras, H. Kraft (Basel), L. Makar-Limanov (Wayne State), L. Moser-Jauslin* (Bourgogne), M. Miyanishi (Osaka), P. Cassou-Nogues (Bordeaux), V. Popov (MIEM), A. Sathaye (Kentucky), G. Schwarz (Brandeis), D. Wright (Washington University), M. Zaidenberg (Grenoble), D. Zhang (Singapore).

* To be confirmed

Invariant Theory

April 8 – 19, 2002, Queen's University, Kingston, Ontario
Org. : D. Wehlau (Queen's), E. Campbell (Queen's)

The first week will be devoted to introductory lectures aimed at graduate students by Professors P. Fleischmann (Kent), H. Kraft (Basel), G. W. Schwarz (Brandeis), and Harm Dersksen (MIT). The second week will be devoted to a workshop on Invariant Theory.

The list of invited speaker includes: M. Brion*, B. Broer, C. De Concini*, L. Helminck , M. Hunziker, G. Kemper, N. Kechagias, F. Knop, P. Littelmann , L. Moser-Jauslin, V. Popov, Y. Sanderson, R J. Shank, N. Thiery, W. van der Kallen*, E. Vinberg*.

*To be confirmed

Concentration Period on the Langlands Programme for Function Fields

April - May 2002
Org. : H. Darmon (McGill), J. Hurtubise (CRM)

The last few years have seen spectacular new results in the Langlands programme over function fields, both in characteristic zero and in characteristic p. The aim of this period is to provide an overview of some essential techniques in the area, as well as new results.

April 2002

Short courses for graduate students on topics including the classical Hitchin systems, étale and l-adic sheaves, as well as a survey of the number theoretic Langlands programme.

The Langlands Programme for Function Fields

April 30 - May 17, 2002

A three week extended workshop, with the first two weeks devoted to survey lectures for graduate students:

Week 1: Survey lectures on preliminary material: stacks, chtoucas, perverse sheaves and D-modules, opers. Lectures by D. Ben Zvi (Chicago), D. Goss (Ohio State), A. Polischuk (Boston), C. Sorger (Nantes), K. Vilonen (Northwestern).

Week 2: Aisenstadt lectures given by L. Lafforgue (IHES) and E. Frenkel (Berkeley), covering recent results in the Langlands programme over function fields, in both characteristic 0 and characteristic p. During the first two weeks, R. Langlands will also give a series of lectures.

Week 3: The concentration period is to be followed by the 2002 Canadian Number Theory Association conference.

Computational Lie Theory

May 27 - June 10, 2002
Org. : W. Casselman (UBC), F. Knop (Rutgers)

This extended workshop is aimed at researchers interested in explicit computations in Lie theory, in particular Coxeter groups. In addition to the usual talks, there will also be several series of survey lectures, suitable for graduate students, by M. Brion (Grenoble), M. Geck (Lyon), F. Knop (Rutgers), P. Littelmann (Wuppertal), G. Olshanskii (*) (IITP), J. Stembridge (Michigan). Professor G. Lusztig (MIT) will be delivering some of his Aisenstadt lectures during the period of the conference.

Invited participants include: D. L. Alvis (Indiana), A. Anatolievich Klyachko (Bilkent), R. Bédard (UQAM), R. Bezrukavnikov (Chicago), S. Billey (MIT), M. Brion (Joseph Fourier), I. Cherednik (North Carolina), F. du Cloux (Lyon I), M. J. Dyer (Notre Dame), W. Fulton (Michigan) M. Geck (Lyon), M. Goreski (IAS), M. Haiman (California, San Diego), G. J. Heckman (Nijmegen), A. G. Helminck (North Carolina State), R.Kottwitz (Chicago), F. Knop (Rutgers), S. Kumar (North Carolina at Chapel Hill), P. Littelman (Bergische), R. MacPherson (IAS), J. McKay (Concordia), M. Noumi (Kobe), A. Okounkov (Berkeley), M. Olshanetsky (Moscow), G. Olshanski (Moscow), E. M. Opdam (Amsterdam), A. Ram (Wisconsin), Y. B. Sanderson (William Paterson) T. A. Springer (Utrech), J. R. Stembridge (Michigan), B. Sturmfels (Berkeley), P. Trapa (Harvard), J. F. van Diejen (Chile), M. van Leeuwen (Poitiers), D. A. Jr Vogan (MIT), N. R. Wallach (California, San Diego), G. Saunders Warrington (Harvard), A. Zelevinski (Northeastern).

*** To be confirmed**

Algebraic Transformation Groups

June 10 – 15, 2002
Org. : A. Broer (Montréal), J. Carrell (UBC)

The purpose of the meeting is to bring together experts in Algebraic Groups, Algebraic Geometry, Representation Theory and related areas, especially those touching on: geometric methods in representation theory using tools like equivariant cohomology and perverse sheaves; the Hilbert scheme of points on a surface and its connection with the n!-conjecture in algebraic combinatorics; equivariant versions of cohomology and Chow groups related to flag manifolds and Schubert varieties; quantum cohomology and Schubert calculus.

The list of participants includes: A. Bertram (Utah), M. Brion (Grenoble), C. De Concini (Rome), W. Fulton (Michigan), V. Ginzburg (Chicago), M. Haiman (UCSD), M. Kapranov (Toronto), A. Knutson (Berkeley), B. Kostant (MIT), S. Kumar (North Carolina), L. Manivel (Grenoble), E. Meinrenken (Toronto), I. Mirkovic (Massachusetts), H. Nakajima (Kyoto), D. Peterson* (UBC), C. Procesi* (Rome), E. Vasserot* (Cergy-Pontoise), C. Woodward (Rutgers).

* To be confirmed

Those wishing to participate in the above activities are invited to write to:

Louis Pelletier
Centre de recherches mathématiques (CRM)
Université de Montréal
C.P. 6128, Succ. Centre-ville
Montréal (Québec), CANADA H3C3J7

E-mail: **ACTIVITES@CRM.UMontreal.CA**
World Wide Web:
http://www.CRM.UMontreal.CA/geometry

General Programme 2001-2002

Second *Canadian Journal of Statistics* Read Paper Session

June 2001, Simon Fraser University, Burnaby, British Columbia
Org. : Christian Genest (Laval), Richard Lockhart (Simon Fraser)

During the Annual Meeting of the Statistical Society of Canada, a major scientific contribution will be read and discussed publicly. The paper is *Flexible Regression Modeling with Adaptive Logistic Basis Functions of* Peter Hooper (Alberta). The paper will be discussed by many researchers who have until May 15, 2001 to submit their written discussion. The comments of the selected discussants will be published along with the paper in the September 2001 issue of the *Canadian Journal of Statistics* and presented orally during this session.

Eighth Canadian Undergraduate Mathematics Conference

June 12 – 17, 2001, Université Laval, Québec
Org. : Pier-André Bouchard St-Amant (Laval), Jean-Philippe Boulet (Laval), Sylvain Hallé (Laval), Jean-François Plante (Laval)

This annual conference is aimed at Canadian undergraduate students whose programme of study involves mathematics. The participants are encouraged to present a 20 or 50 minute talk on a mathematical subject of their choice. Furthermore, five invited speakers will enrich the participant's knowledge of current mathematical research.

Séminaire de mathématiques supérieures : *Modern Methods in Scientific Computing and Applications*

July 9 – 20, 2001, Université de Montréal
Org. : G. Sabidussi (Montréal), K. Mikula (Slovak Technical University, Brátislává, Slovakia), A. Bourlioux (Montréal), M. Gander (McGill), S. Lessard (Montréal), G. C. Papanicolaou (Stanford), A. Stuart (Warwick)

The scientific computing approach to the solution of differential equations of all types, associated with a variety of applications, is a multi-faceted technique that encompasses not only numerical methods but also more formal analysis of the underlying equations, along with a good understanding of the practical application being modelled. Recent achievements of this multi-disciplinary approach will be presented by expert applied mathematicians, together with applications in finance, stochastic systems, image processing, solid mechanics, electrodynamics, combustion, matrix calculation, etc. In-depth coverage of each theme (including discussion of both numerical, modelling and theoretical issues specific to each application) along with hands-on computer experiments will be offered at this SMS 2001.

The speakers will be Anne Bourlioux and Panagiotis Souganis, *Numerical Combustion : Modelling and Computing Turbulent Flamelets*; Gene H. Golub and C. Bai, *Matrices, Moments, and Quadratures*; Gundolf Haase and Ulrich Langer, *Multigrid Methods: Theory, Algorithms, Implementation, Parallelization*; Laurence Halpern *One-way Operators, Absorbing Boundary Conditions, and Domain Decomposition for Evolution Operators*; Anthony Humphries and Andrew Stuart, *Computational Aspects of Deterministic and Random Dynamical Systems*; Karol Mikula and James A. Sethian, *Level-set and Diffusion Methods in Image Processing*; Frédéric Nataf, *Optimized Domain Decomposition Methods*; George Papanicolaou, *Asymptotic Analysis of Stochastic Differential Equations and Applications*; and Ronnie Sircar, *Stochastic Volatility Modelling.*

Statistics 2001 Canada: *The Fourth Canadian Conference in Applied Statistics*

July 6 – 8, 2001, Université Concordia, Montréal
Org. : Y. Chaubey (Concordia), F. Nebebe (Concordia)

This conference will feature plenary speakers, and contributed and invited papers, with emphasis on applied statistics. Areas covered include Bayesian Methods, Biostatistics, Data Mining, Demography, Econometrics, Multivariate Analysis, Operations Research, Probability, Psychometrics, Sampling, Survival Analysis, and Time Series.

The conference follows a well established tradition. The First Canadian Conference in Applied Statistics was held in 1971 at Concordia University. Since then, the Department of Mathematics and Statistics has organized such a conference every tenth year.
The plenary speakers are David Brillinger (Berkeley), Christian Genest (Laval), John D. Kalbfleisch (Waterloo), Jerry Lawless (Waterloo), Jim Ramsay (McGill), C. R. Rao (Penn State), J. N. K. Rao (Carleton), P. K. Sen (North Carolina).

FUSION 2001: *4th International Conference on Information Fusion*

August 7 – 10, 2001, Montréal
Org. : E. Shahbazian (Lockheed Martin & CRM)

This conference will provide a forum for the presentation of research and technological advances by scientists and engineers working in all aspects of information and data fusion techniques and systems. It will also feature keynote speeches and plenary talks. Topics include various aspects of theoretical and technical advances in information fusion, algorithms and systems, as well as applications.

Second Gilles Fournier Memorial Conference

August 13 – 15, 2001, Université de Sherbrooke
Org. : Marlène Frigon (Montréal), Andrzej Granas (Montréal), Tomasz Kaczynski (Sherbrooke)

Les thèmes principaux de cette seconde conférence dédiée à la mémoire de Gilles Fournier seront la théorie des points fixes et la théorie de points critiques ainsi que leurs applications aux équations différentielles et aux systèmes dynamiques. À cette occasion, des développements récents de ces domaines seront présentés par des experts canadiens et étrangers afin de stimuler les échanges entre eux et les étudiants des cycles supérieurs qui participeront.

La conférence sera composée de conférences principales de 50 minutes, conférences invitées de 40 minutes et quelques exposés de 30 minutes données par de jeunes mathématiciens. La participation d'étudiants de cycles supérieurs sera fortement encouragée.

Les conférenciers principaux seront Massimo Furi (Florence), Kazimierz Geba (Gdansk), Andrez Granas (Montréal), Antonio Marino (Pise), Mario Martelli (Cal St. Fullerton), Jean Mawhin (Université Catholique de Louvain) et Michel Willem (Université Catholique de Louvain). Les conférenciers invités seront A. Abbondandolo (Pise), S. Alama (McMaster), H. Ben-El-Mechaiekh (Brock), P. Deguire (Moncton), M. Lassonde (Université des Antilles et de la Guyane) et H. Steinlein (Munich).

Spectral Statistics and High Energy Eigenstates

August 25 - September 2, 2001, CRM
Org. : Dmitry Jakobson (McGill), John Toth (McGill)

The idea of the workshop is to bring together mathematicians and physicists working on issues related to asymptotic eigenstate properties, especially as they relate to classical limits and chaos. There are various subjects to be investigated. These include the asymptotic behaviour of individual eigenstates, the role and utility of random matrix theory in the prediction of eigenvalue statistics for the Laplace-Beltrami operator and the role of periodic orbits and scars.

The list of invited speakers includes: T. Paul* (Paris Dauphine), S. Zelditch* (Johns Hopkins), V. Jaksic (Ottawa), A. Uribe (Michigan), B. Shiffman* (Johns Hopkins), V. Guillemin* (MIT), S.T. Yau* (Harvard), M. Zworski (Berkeley), M. Min-Oo (McMaster), W. Craig* (McMaster), Y. Colin De Verdière* (Institut Fourier, Grenoble), P. Deift* (UPenn), G. Olshanski* (Institute for Information Transmission Problems, Moscow, Russia), U. Smilansky (Weizman Institute), A. Soshnikov (UC Davis), C. Tracy (UC Davis), H. Widom (UC Santa Cruz), N. Nadirashvili* (Chicago), P. Sarnak (Princeton), A. Borodin* (Penn), D. Heijhal* (Minnesota and Uppsala), A. Its* (IUPUI), P. Bleher* (IUPUI), A. Okounkov* (Berkeley), A. Zaharescu* (UIUC), Z. Rudnick (Tel Aviv), K. Soundararajan* (IAS), K. McLaughlin* (Arizona), X. Zhou* (Duke), A. Eskin* (Chicago), R. Speicher (Queens)

* to be confirmed

Mathematical Statistics 2002: A Conference Honouring Constance van Eeden's 75th Birthday

May 31– June 1, 2002, CRM
Org. : Marc Moore (École Polytechnique), Sorana Froda (UQAM)

This conference will recognize the extraordinary services of Professor Constance van Eeden to the Canadian statistical community, and to the Université de Montréal in particular. Five to eight first-class researchers will be invited to give talks in fields in which she has made important contributions, including nonparametric statistics and decision theory. This conference will precede the Annual Meeting of the Statistical Society of Canada which will be held in Hamilton.

Theme Year 2002-2003 : Mathematical Methods of Computer Science

Organizing Committee

Y. Bengio (Montréal)
A. Borodin (Toronto)
G. Brassard (Montréal)
L. Devroye (McGill)
D. Thérien (McGill)

Overview

The field of computation, formally born only in the last century, now constitutes a science in its own right, with solid theoretical foundations on which its spectacular development is based. The CRM thematic year in the mathematical methods of computer science proposes to explore in depth a significant spectrum of the many sub-areas that are foundational material for modern computer science, that exhibit significant and new mathematical content, and that have indeed influenced the development of mathematics.

Mathematically, the areas with the earliest influence on computer science were logic and discrete mathematics. Since then, the theory of theoretical computer science has blossomed, and ideas from the area (starting with such concepts as the Turing machine) have grown to occupy an ever more important role in mathematics. More recently, a recurrent theme in many of the domains examined is probabilistic methods; these have permeated the whole of computer science, and so particular emphasis will be placed on the use of these techniques, both in theoretical areas and in more applied ones such as simulation and machine learning.

The computer has also allowed mathematical techniques to be developed and used, in areas in which the computations were simply too daunting. One area, of course, where this is true is that of large scale scientific computing. This is not part of the year, as it is being covered elsewhere. However there are other areas, such as discrete mathematics or optimization, in which the availability of computing power has made an enormous difference.

The main fields to be covered during the thematic year are complexity theory and analysis of algorithms, quantum computing, cryptography, stochastic simulation, machine learning, and discrete computational mathematics.

Along with the usual workshops and courses being organized during the thematic year, CRM will host two of the most important international conferences in theoretical Computer Science, namely the ACM *Symposium on Theory of Computing* and the IEEE *Conference on Computational Complexity*.

Research Programmes

Research reports appear in their original language.

Twareque Ali

Square-integrable Group Representations, Wavelets, and Wigner Transforms

Twareque Ali's research during the last couple of years was centred around the theory of square-integrable group representations and the relationship of square-integrability with the Plancherel transform. It has been demonstrated that the Plancherel transform for Type I groups is the unifying link between square-integrability, the wavelet transform, and the generalized Wigner function. This connection has far-reaching consequences, in the sense that it can be used to generate large classes of Wigner functions for Type I groups. From the point of view of physical applications, Wigner functions are quasi-probability distributions on classical phase spaces (coadjoint orbits of the groups in question), corresponding to quantum mechanical states, and hence they can be used to study the physical states of atomic and quantum-optical systems. They can also be interpreted as characteristic signatures of signals in image analyses. In this way, the use of the Plancherel transform in connection with square-integrability unifies the theories of signal analysis, wavelet transforms, and quantum tomography. On the computational side, a large number of generalized Wigner distributions have been computed for a special class of group semidirect products admitting open free orbits under the coadjoint action. These distributions have been used extensively in atomic and quantum optical calculations.

Jean-François Angers

Modélisation avec des densités a priori à queues aplaties et estimation de fonction

En théorie de la décision bayésienne, en plus d'avoir à spécifier un modèle statistique pour les observations, nous devons spécifier un autre modèle, dit *a priori*, pour les paramètres décrivant celui des observations. Le choix du modèle *a priori* est très important particulièrement lorsque notre échantillon contient des valeurs extrêmes. En effet, le comportement des règles de décisions en présence de telles observations dépend principalement de la différence d'aplatissement entre les queues du modèle *a priori* avec celles du modèle des observations. Dans ce projet, il est envisagé de généraliser les travaux déjà entrepris sur les paramètres de position aux paramètres d'échelle. Une théorie plus globale sur les modèles de position-échelle sera ensuite développée.

Un autre problème important en statistique est l'estimation d'une fonction basée sur l'observation, avec erreur, de celle-ci à différents points de son support. En utilisant une approche bayésienne et une base de fonctions appropriée, il est possible d'estimer une fonction définie sur différents domaines. Dans les mois à venir, il est envisagé d'essayer de développer une théorie générale qui aura comme cas particuliers les différents contextes déjà étudiés. Les propriétés statistiques de ces estimateurs seront aussi étudiées.

Paul Arminjon

Numerical Methods in Fluid Dynamics and Electrodynamics

P. Arminjon works in the area of Computational Fluid Dynamics (CFD). With A. Dervieux, he constructs and analyzes high resolution non oscillatory positivity preserving finite volume/finite element methods for hyperbolic systems, with applications to compressible flows.

With M.C. Viallon, he has constructed, for non-linear hyperbolic systems, a 2-dimensional second-order accurate nonoscillatory finite volume method for staggered unstructured triangular grids inspired by the Lax-Friedrichs and Nessyahu-Tadmor 1-dimensional difference schemes; they also proved the convergence of the method for a linear hyperbolic equation.

With D. Stanescu, he extended these schemes to a finite volume method for Cartesian grids, and with A. Madrane he developed and applied the triangular method to many typical flow problems; comparison with other methods (discontinuous finite elements, etc.) showed the high resolution and sharp shock capture capacities of the method, which also requires shorter computing times. With A. Madrane, he has constructed a mixed finite volume/finite element method for the Navier-Stokes equations, where the convective terms are treated with the

Arminjon-Viallon finite volume method and the viscous terms with a finite element method. With A. St-Cyr and A. Madrane, they have also extended the non-linear hyperbolic method to the 3-dimensional case. Results are excellent both for cartesian grids and for unstructured tetrahedric grids. For cartesian grids they have proved positivity and a maximum principle.

Liliane Beaulieu

Bourbaki en son temps

L'objectif central de cette étude est de reconstituer l'histoire de la formation du groupe de mathématiciens N(icolas) Bourbaki, dans les années trente, de sa survie durant les années de guerre et de la restauration de l'équipe à la fin des années quarante. Ce travail d'historien s'appuie sur une documentation solide, inédite à ce jour, qui fait elle-même l'objet d'une publication sous la forme d'une base de données. Au plan mathématique, il s'agit de retracer les changements de cap pris par Bourbaki dans ses choix théoriques et de les situer dans le contexte, plus vaste, des mathématiques qui étaient en train de se développer, notamment en théorie des ensembles, en algèbre et en théorie de l'intégration. D'autres publications du chercheur ont porté sur l'histoire de la topologie, de la stochastique et de l'informatique.

Jacques Bélair

Équations différentielles non linéaires retardées et modélisation physiologique

La dynamique non linéaire fournit une interprétation de changements complexes du rythme physiologique comme bifurcations lorsque les valeurs des paramètres de contrôle sont modifiées. La théorie mène à des prédictions pour les comportements possibles dans un environnement expérimental et permet une explication unifiée des divers régimes. Le travail de Bélair est concentré sur les feed back non linéaires à retard en contrôle et dans les systèmes d'oscillations hormonales et neuromusculaires, en insistant sur le rôle du délai, des boucles multiples de feed back et des délais variables dans la génération de comportements périodiques (oscillatoires) ou irréguliers.

En collaboration avec J. Mahaffy, M. Mackey et M. Santillan, nous avons développé un modèle de thrombopoièse qui inclut un mécanisme de destruction à taux constant. Ce travail incorpore les découvertes les plus récentes sur la thrombopoeitine, et permet de suggérer des mécanismes d'induction d'oscillation dans le niveau des plaquettes sanguines en circulation.

Un projet de collaboration avec des chercheurs en pharmacie a mené à une co-supervision d'étudiant, afin de construire des modèles qui incorporent des régimes transients pour la représentation de mécanismes d'absorption de relaxant neuromusculaires. Un modèle original a été mis au point.

Enfin, dans le cadre du réseau MaTICS, un étudiant a travaillé sur le raffinement d'un modèle ionique de myocyte auriculaire.

Habib Benali

Modélisation en imagerie neurofonctionnelle

Notre projet de recherche consiste à développer une méthodologie de quantification fiable des processus physiologiques cérébraux à partir de séquences d'images médicales multimodalité en IRM fonctionnelle, IRM anatomique, MEG et EEG. Les approches utilisées relèvent des techniques statistiques multidimensionnelles ainsi que l'apport des méthodes hiérarchiques et multi-échelles pour la localisation des activations en IRMf et des sources d'activations en EEG / MEG. Nos applications cognitives et cliniques ont pour objectifs de:

- Caractériser les circuits neuronaux des processus cognitifs correspondant à des ensembles distribués au niveau du cerveau et liés transitoirement pour exécuter une tâche. Les liens dynamiques entre ces ensembles seront examinés à l'aide des modalités d'imagerie IRMf et EEG / MEG.
- Caractériser les invariants anatomiques et fonctionnels de ces ensembles neuronaux. Dans des études longitudinales, ces invariants seront corrélés au processus de réorganisation fonctionnelle de l'activité cérébrale. L'étude de la plasticité cérébrale chez des patients opérés de Gliomes bas grades guidera nos développements méthodologiques.

Yoshua Bengio
Algorithmes d'apprentissage

Les algorithmes d'apprentissage automatique permettent à l'ordinateur d'apprendre à partir d'exemples. Ce champ de recherche est à l'intersection de l'intelligence artificielle, l'inférence statistique, et l'optimisation numérique. Les algorithmes d'apprentissage sont particulièrement utiles dans les situations où nous n'avons pas assez de connaissances sur un problème pour directement énoncer une solution sous la forme d'un programme, mais où nous avons des exemples illustrant la tâche à effectuer. Le problème de l'apprentissage peut s'exprimer comme le choix d'une fonction parmi un ensemble de fonctions selon l'espérance d'un critère (la qualité de la solution choisie par l'ordinateur pour un exemple particulier). Cependant, comme la véritable distribution des exemples est inconnue, cette espérance ne peut pas être calculée, seulement estimée par sa valeur empirique sur les données observées. La véritable difficulté de l'apprentissage est donc de généraliser, ou de pouvoir transférer l'information existante dans les exemples disponibles à de nouveaux exemples. Les recherches de Yoshua Bengio se concentrent sur certains types d'algorithmes d'apprentissage (en particulier les réseaux de neurones artificiels et les modèles de Markov cachés) et leurs applications (en reconnaissance de formes, reconnaissance de la parole, vision par ordinateur, analyse de processus industriels, et la prédiction et prise de décision à partir de séries chronologiques financières). Cette année des résultats très importants ont été obtenus dans le domaine de la modélisation statistique du langage, battant les systèmes qui dominent ce problème depuis vingt ans.

François Bergeron
Décomposition de représentations

Mes recherches concernent divers aspects de l'interaction entre la combinatoire et l'algèbre, plus particulièrement autour d'un problème central de la théorie de la représentation consistant à décomposer une représentation donnée en ses composantes irréductibles. On dit que le nombre d'occurrences d'une représentation irréductible au sein d'une représentation est sa multiplicité. Il appert que le calcul de ces multiplicités est fondamental dans plusieurs domaines de la physique et des mathématiques. Ainsi, pour la physique, cette multiplicité peut correspondre aux niveaux atomiques, pour l'algèbre, elle représente une dimension, et pour la combinatoire, elle répond à un problème d'énumération. Un résultat classique de Frobenius rend accessibles ces calculs (autrement difficiles) dans le contexte de la théorie des fonctions symétriques, au prix du développement de formules donnant l'expression de certains polynômes en termes d'une base fixée. Les fonctions de Schur et les fonctions de Hall-Littlewood ont classiquement joué ce rôle de bases fondamentales, mais, au cours des dernières années, de nouvelles bases ont été introduites pour répondre à de nouvelles problématiques. Ces variantes ont été synthétisées par Macdonald pour donner naissance à une nouvelle famille de fonctions symétriques à deux paramètres contenant toutes les bases précédentes.

En utilisant des techniques de la théorie des représentations, de la combinatoire algébrique et des calculs dans l'algèbre des fonctions symétriques, je cherche à trouver et démontrer des identités et des propriétés de ces polynômes de Macdonald. Ce sujet est particulièrement intéressant en ce qu'il fait interagir combinatoire, théorie de la représentation, analyse harmonique, théorie des fonctions spéciales et géométrie algébrique. Chaque progrès donne lieu à de multiples questions et applications dans tous ces domaines.

Nantel Bergeron
Combinatoire algébrique et application

Nous nous intéressons à l'étude de structures algébriques en utilisant la combinatoire. Deux grandes lignes de recherche se découpent dans nos travaux.

- L'étude d'espaces de polynômes quasi-harmoniques associés à des diagrammes.
- Les algèbres de Hopf associés à des réseaux.

En ce qui concerne le premier point, nous avons émis l'hypothèse que ces espaces sont hautement symétriques et leur étude a suscité beaucoup d'intérêt dans la communauté mathématique et physique. Nous savons maintenant que certains de ces espaces sont liés à des solutions de modèles en physique quantique.

En ce qui concerne le second point, nous avons remarqué que pour plusieurs algèbres, les constantes de structure multiplicative sont liées à l'énumération de chemins dans des réseaux. Nous développons présentement une théorie qui

nous permet de mieux comprendre ce lien et d'unifier les constructions existantes.

Anne Bourlioux
Simulation numérique de flammes turbulentes

Le régime de flammelettes (applicable par exemple dans les moteurs d'automobiles) est caractérisé par une épaisseur de flamme très mince: le défi en combustion numérique turbulente est de représenter de façon adéquate l'effet global sur la propagation de la flamme de phénomènes (combustion, turbulence) se passant à une échelle trop petite pour être représentés de façon précise dans une simulation numérique.

Une stratégie de développement et de validation systématique de modèles mathématiques pour ces effets sous-grille a été mise en place via une équation idéalisée. Les effets des petites échelles sont renormalisés de façon asymptotique rigoureuse.

Cette stratégie a permis d'élucider dans le contexte du modèle idéalisé des questions posées par les ingénieurs qui développent des codes de simulation de moteurs à combustion:

- dans le cas de flammes prémélangées: l'identification de deux régimes distincts dans la paramétrisation de l'augmentation de la flamme en fonction de l'intensité de la turbulence (l'effet de «bending»);
- dans le cas de flammes non-prémélangées (moteurs diesel): la réduction du taux de convergence asymptotique des modèles hybrides utilisés en pratique comparés au taux de convergence idéal des modèles théoriques.

Steven Boyer
Studies in Low-dimensional Topology

The research efforts of Steven Boyer over the last few years focused on the topology of low-dimensional manifolds, particularly knot theory, and the geometric representation theory of 3-manifold groups. His primary interest in the first of these research areas is to study exceptional phenomena which arise from the geometric operation of Dehn surgery on knots. Together with his collaborator Xingru Zhang (SUNY at Buffalo) they were able to prove definitive results in several cases they studied. The methods they employed involve an interplay between the topology of 3-dimensional manifolds and the representation theory of their fundamental groups. In particular they made important theoretical advances in this latter area which led to other applications in surgery theory.

This year he began a collaboration with Dale Rolfsen (UBC) and Bert Wiest (PIms) centred on the orderability of the fundamental groups of 3-manifolds.

Abraham Broer
Les groupes algébriques de transformation et la théorie des invariants.

Présentement, il s'intéresse aux variétés algébriques qui sont liées à la théorie des représentations des groupes de Lie semi-simples. Les liens entre la théorie des représentations et la géométrie algébrique sont profonds et très intéressants.

Quelques exemples typiques de telles variétés sont les variétés nilpotentes dans une algèbre de Lie, les variétés de décompositions et le fibré cotangent d'une variété de drapeaux. Pour l'étude de ces variétés, on a besoin de la géométrie algébrique, de la topologie algébrique et la théorie des invariants.

Ces dernières années, il a étudié en particulier la structure des variétés de décomposition des algèbres de Lie semi-simples, avec des applications dans la théorie des arrangements d'hyperplans associés aux groupes de réflexion.

Francis Clarke
Control and Nonsmooth Analysis

A recent paper [IEEE Transactions on Automatic Control 42 (1997) 1394-1407] written in collaboration with Yu. S. Ledyaev, E. Sontag and A. Subbotin solves a well-known and long-standing question in control theory: we give a constructive proof of the fact that any asymptotically controllable system admits a *retour d'état* which stabilizes it. In general, it is necessary that this *retour d'état* be discontinuous. One can then prove its robustness by some new and apparently very promising techniques, and establish interesting relationships with the regularity of eventual Liapunov functions.

Henri Darmon
Courbes elliptiques et formes modulaires

Mes recherches des dernières années ont visé tout d'abord à démontrer certaines variantes p-adiques de la célèbre conjecture de Birch et Swinnerton-Dyer, projet qui a été mené à bien dans une série d'articles conjoints avec Massimo Bertolini. Plus récemment, mes travaux avec Bertolini m'ont amené à découvrir une généralisation inattendue de la théorie classique de la multiplication complexe; cette généralisation, si elle pouvait être placée sur des bases mathématiques solides, aurait des conséquences importantes pour la théorie des nombres. C'est désormais le développement de cette théorie qui me préoccupe principalement.

Michel Delfour
Modeling, Design, and Control of Physical and Technological Systems with Respect to Shapes

The theme of this programme is the study of the theoretical and numerical aspects of shapes and geometries as variables in the modeling, design, and control of physical and technological systems. This area of research is becoming very broad, rich and fascinating with an extremely important potential for applications in many different areas: optimal design of mechanical parts for the automotive industry, positioning of sensors and actuators, control of the position of the free boundary in material sciences, active control of noise, image processing, free and moving boundary problems, design of biomedical devices, design and control of thin structures, control of the drag by small changes in the shape of the wing of an aircraft, etc... There is an urgent need for theory and directions to understand and interpret the increasing number of computational results and the modeling issues encountered in applications.

The programme concentrates on the following five intertwined projects:

- the mathematical analysis, differential calculus, and optimization for shapes and geometries,
- the development of appropriate intrinsic methods for the differential calculus and functional analysis on submanifolds of the Euclidean space,
- the intrinsic modelling and analysis of thin and asymptotic shells for $C^{1,1}$ midsurfaces or curves,
- the design of solid vibrating gyroscopes (Bryan effect),
- the stabilization and control of partial differential equations on submanifolds when the underlying geometry is an integral part of the control process (non-cylindrical problems, shells).

This work has had an impact on the Canadian Space Programme for the design of thermal diffusers and radiators to condition the thermal environment of satellites and on the positioning of sensors and actuators for satellites of the third generation. The fundamental results of the research are also used on current projects on the design of planned NEV to be built by Bombardier and the design of medical devices (stents for cardiac surgery).

Rachida Dssouli
Ingénierie des logiciels de télécommunication

Nos projets de recherche s'inscrivent dans le cadre de l'ingénierie des logiciels de télécommunication. On s'intéresse tout particulièrement à la modélisation des systèmes complexes réactifs en temps réel. La majorité de nos travaux utilisent des techniques formelles telles que la théorie de contrôle, la théorie des automates, la théorie des graphes et algorithmes de minimisation. Nos projets sont:

- *Server and e-commerce testing* qui traite des tests des applications type commerce électronique et des tests de serveurs.
- *Testing Complex Systems* qui traite des tests des systèmes réactifs temps réel et des systèmes communicants avec ou sans files FIFO.
- *Spécification incrémentale, analyse et simulation de systèmes réactifs fondées sur les langages de scénario* où on s'intéresse à la synthèse et composition de scénarios afin de produire systématiquement des spécifications formelles cohérentes.
- *Formalisation et test des protocoles de la pile IPv6.* La pile de logiciels de communication connue sous le vocable IPv6 est la norme qui va remplacer à long terme la pile IP actuelle. Ce projet, en collaboration avec un groupe européen, va fournir des tests de normalisation dérivés à partir de spécifications formelles.

Stéphane Durand
Fractional Generalization of the KdV Equation

Using supersymmetry it is possible to generalize in a non-trivial way the Korteweg-de-Vries equation (KdV) to an integrable system of two coupled differential equations (Mathieu). Knowing that the supersymmetry can itself be extended (parasupersymmetry and fractional supersymmetry [Durand, Vinet]), it is natural to look for generalizations to integrable systems of several coupled differential equations. The formalism of fractional superspace introduced by Durand allows such a generalization in a natural way. This result is reached using the fractional extension of supersymmetry, the Hamiltonian structure of the fractional pseudo-classical mechanics and the fractional generalization of a superextension of a Virasoro algebra (and / or its *q*-deformations).

Nadia El-Mabrouk
Réarrangements génomiques et recherche de motifs d'ARN

Le programme de recherche s'oriente sur deux aspects différents liés à l'analyse des génomes. Le premier se situe dans le cadre de la phylogénie et de la génomique comparative, et le deuxième se rapporte à la recherche de motifs d'ARN dans le génome.

Le but ultime de la génomique comparative est de construire l'arbre d'évolution des espèces. Cela implique la considération de distances d'évolution particulières. Une méthode consiste à comparer l'ordre des gènes dans les deux génomes étudiés. Cette étude sous-entend que les espèces ont divergé par des mutations globales (suppression, duplication, mouvements de blocs de gènes). Différents problèmes peuvent être abordés, dépendant du type de mutations, du phénomène d'évolution et de la complexité biologique considérée. Ces problèmes donnent lieu à des études combinatoires, algorithmiques et de théorie des graphes variées et complexes. Je me propose de contribuer au développement du domaine en considérant des opérations de réarrangement encore non étudiées, comme la duplication de fragments de chromosomes. Je propose également de développer des algorithmes qui permettent de prendre en compte différentes pondérations pour les opérations de réarrangement en fonction de leur type, leur position et de leur taille.

Le deuxième projet consiste à développer un algorithme, satisfaisant dans un contexte pratique, qui aide le biologiste à identifier dans un génome toutes les parties qui codent pour une famille particulière d'ARN. Cet algorithme doit intégrer différentes méthodes efficaces pour la recherche d'éléments structuraux et de séquences conservées, permettre une définition souple du ou des motifs, permettre toute sorte d'erreurs et d'incertitude. Le but de la recherche est de développer un algorithme qui allie résultats biologiques pertinents et rapidité d'exécution.

Isidore Fleischer
Change of Variables in Multiple Integrals

Change of variables in multiple integrals is very useful both for evaluation of integrals and for theoretical purposes. The basic theorem is usually stated by requiring continuous differentiability and injectivity of the transformation. Recent work has succeeded in lightening these hypotheses, e.g., by removing continuity from the derivative. This study aims to push this cleaning up further.

Richard Fournier
Quelques problèmes d'analyse complexe

Le domaine de recherche de Richard Fournier est l'analyse complexe, en particulier la théorie géométrique des fonctions d'une variable complexe. Ce chercheur s'intéresse plus spécialement à certains problèmes sur les transformations conformes, les classes spéciales de fonctions univalentes et l'extension au plan de certaines inégalités classiques (par exemple l'inégalité entre les moyennes arithmétique et géométrique). L'analyse complexe est un sujet classique qui s'est récemment renouvelé grâce à l'étude des fractals et de la dynamique des fonctions méromorphes ou entières.

Langis Gagnon
Contours actifs sans contraintes topologiques pour la segmentation d'images bruitées

Le projet consiste à mettre en œuvre et étudier une technique moderne de détection de contours dans des images bruitées (e.g., imagerie radar) basée sur une approche de propagation de fronts d'ondes. Cette technique s'apparente à celle des contours actifs (snakes) basée sur une formulation Lagrangienne de l'évolution d'une

courbe élastique dans un plan, mais avec deux avantages importants :

- le contour initial peut être aussi éloigné que l'on veut de l'objet, ce qui implique qu'aucune information a priori sur la position ou la forme de l'objet n'est nécessaire;
- le contour final peut être topologiquement différent du contour initial, e.g., un contour fermé peut évoluer en se scindant en plusieurs sous contours pour capturer différent objets.

La mise en œuvre numérique fait appel à des méthodes d'évolution de courbes de niveaux utilisées dans les simulations de la propagation des flammes.

Martin Gander

Parallel Algorithms for High Performance Computing

Computation is now regarded as an equal and indispensable partner, along with theory and experiment, in the advance of scientific knowledge and engineering practice. Numerical simulation enables the study of complex systems and natural phenomena that would be too expensive or dangerous, or even impossible, to study by direct experimentation. The quest for ever higher levels of detail and realism in such simulations requires enormous computational capacity, and has provided the impetus for dramatic breakthroughs in computer algorithms and architectures. Parallel computers have proved to be the only tools with the necessary capacity to satisfy current demands in research and industry. But the development of parallel algorithms specialized for the underlying problems is lagging behind. This is my current main area of research.

Paul Gauthier

Analyse

Les nombres complexes peuvent être identifiés aux points du plan. Une fonction complexe $w=f(z)$ est donc une fonction qui envoie les points du plan des z sur des points du plan des w. Le problème principal des nombres complexes est d'estimer la grandeur des disques contenus dans l'image de f (constante de Bloch). Le meilleur estimé à ce jour est celui de Gauthier et Chen et ils espèrent pouvoir améliorer cet estimé encore. Encouragés par ce succès avec les transformations du plan, Gauthier et ses collaborateurs et étudiants ont amorcé une étude semblable pour les transformations de l'espace. Ils continuent aussi leurs recherches en approximation.

Bernard Goulard

Méthodes statistiques et imagerie

Le traitement d'une image revient de plus en plus à reconstruire au mieux un objet à partir d'informations incomplètes et souvent bruitées, ce qui amène l'utilisation de connaissances *a priori* et de méthodes statistiques. B. Goulard, J.M. Lina et D. Clonda procèdent à une modélisation statistique des images à traiter basée sur les propriétés des ondelettes de Daubechies complexes. Leur caractérisation des images passe par une modélisation de la distribution des coefficients en ondelettes par le biais d'un modèle en arbre pour un processus de Markov caché. Ce modèle a été perfectionné et appliqué à différents problèmes de traitement du signal. Ces études sont en phase avec les travaux menés dans le cadre d'une collaboration avec le groupe de Pitié-Salpêtrière (Paris) dans l'analyse des mesures de magnétoencéphalographie (cf J. M. Lina).

Par ailleurs, dans un projet subventionné par Bell-Lube, B.Goulard, J.M.Lina et F. Nekka travaillent en collaboration avec B. Johnston (INRS-Télécommunications) à la mise en oeuvre d'un système basé sur la technologie intemet. L'objectif est de faire circuler des images médicales et des logiciels d'analyse entre des lieux (hôpitaux, instituts,..) éloignés géographiquement et ce, dans des conditions maximales de confidentialité, intégrité et disponibilité des données. Ce travail implique notamment une intégration d'analyse des images et de leur circulation sur le réseau.

Michel Grundland

Symétries et solutions des systèmes non-linéaires en physique

Au cours des dernières années, les recherches de Michel Grundland portent sur les méthodes de réduction par symétries (MRS) ainsi que sur la méthode des invariants de Riemann (MRI) et leurs applications aux équations de la théorie des champs non-linéaires, à la physique de la matière condensée ainsi qu'à la dynamique des fluides. Le développement de ces méthodes nous fournit de nouveaux outils pour aborder les phénomènes non-linéaires en physique,

spécialement ceux décrits par des systèmes multidimensionnels d'équations aux dérivées partielles (EDP) et qui n'ont pu être résolus par d'autres méthodes (par exemple la diffusion inverse). Le programme de recherche est constitué des quatre projets suivants:

- Symétries conditionnelles pour les systèmes d'EDP non-linéaires.
- Une comparaison entre les différentes méthodes de groupe de Lie servant à solutionner les EDP.
- Solutions invariantes et partiellement invariantes des équations de la dynamique des fluides.
- Les ondes de Riemann multiples pour les systèmes quasilinéaires d'EDP et les relations avec la méthode de réduction par symétries.

John Harnad

Systèmes intégrables, déformations isomonodromiques et applications

Pendant l'année passée (1999-2000), deux nouveaux projets ont été développés:
Une relation entre deux approches aux systèmes hamiltoniens complètement intégrables a été mise au point. La première approche est fondée sur les flots hamiltoniens isospectraux dans les groupes et les algèbres de lacets générés par les invariants spectraux avec une structure de Poisson qui provient d'une matrice R classique. La seconde approche développée par Magri et ses collaborateurs, est fondée sur la notion de structures multi-hamiltoniennes. On a démontré que, dans le contexte de flots isospectraux dans les algèbres et les groupes de lacets, tous les résultats de la seconde approche, soit l'existence des structures multi-hamiltoniennes, les invariantes commutatives provenant du théorème de Gel'fand-Zakharevich et les coordonnées séparatrices associées aux vecteurs propres du tenseur de Nijenhuis, sont des conséquences de la théorie des matrices R associées aux structures de Poisson holomorphes sur les surfaces complexes.

Un autre projet a été complété pendant un séjour au MSRI à Berkeley. Ceci concerne les déterminants de Fredholm de certains opérateurs intégraux qui figurent comme fonctions de distributions spectrales de matrices aléatoires. On a démontré que ces déterminants étaient des "fonctions tau" des systèmes dynamiques qui déterminent des déformations isomonodromiques d'une famille de dérivées covariantes méromorphes sur la sphère de Riemann, et qu'ils satisfont en conséquence des équations de déformations, équations bilinéaires qui ressemblent à celles de l'hiérarchie KP, mais où ne figurent que des générateurs de l'algèbre de Virasoro dans les paramètres de déformation.

Jacques Hurtubise

Systèmes intégrables

Les travaux de J. Hurtubise pour l'année 99-00 ont porté sur les systèmes intégrables. Un travail conjoint avec E. Markman sur les systèmes de Calogero-Moser, donnant une construction naturelle de l'espace de phase, a été terminé et soumis. Un autre, portant sur la séparation de variables pour les crochets de Sklyanin, a été entrepris. Des travaux sont en cours avec L. Jeffrey pour comprendre les G-fibrés sur une surface de Riemann avec trivialisation parabolique. Finalement, conjointement avec H. Darmon, un séminaire sur la quantification des systèmes de Hitchin et le programme de Langlands géométrique a été organisé, avec une dizaine de rencontres.

Véronique Hussin

Supersymmetry

During the last twenty years, the theory of Lie groups and algebras has been extended in many directions. One of them deals with the supersymmetric theories and the notions of Lie supergroups and superalgebras. Since it is concerned with a unified description of fermionic and bosonic objects, one has to work with commuting and anticommuting variables. The problem of resolving non-linear differential equations with such variables is studied by V. Hussin with students and collaborators such as P. Winternitz at the CRM. New supersolitonic solutions have been obtained by generalizing the method of reduction by symmetries for such equations.

Another aspect of the research of V. Hussin deals with the construction of minimal uncertainty states in terms of the so-called "coherent" or "squeezed" states for supersymmetric systems in quantum mechanics. We make use of new relations between the eigenstates of annihilation operators associated with the harmonic and anharmonic oscillators and the Jaynes-Cummings model important in quantum optics. Students, post-doc, and

collaborators in Mexico and Spain are working on this project.

Anatole Joffe

Probabilités pures et appliquées

Les processus de branchement décrivent l'évolution d'une population d'objets (individus, plantes, particules) qui se reproduisent suivant un mécanisme aléatoire. Lorsque ces objets se déplacent, le modèle est "la promenade aléatoire avec branchement"; ce modèle décrit des choses aussi différentes que le comportement d'un réacteur nucléaire (une population de neutrons se reproduisant par les chocs des neutrons sur les atomes) ou la description de la forme d'une forêt (une population de graines dispersées par le vent et les oiseaux).

Joffe s'intéresse depuis longtemps aux propriétés asymptotiques de ces processus sous des hypothèses minimales.

En collaboration avec A. Fuchs, J.L. Teugels, A. Joffe a obtenu des résultats définitifs sur le comportement asymptotique du rapport de la somme des carrés par le carré de la somme en donnant une formule exacte de son espérance. Il s'agit d'études très techniques dont l'origine se trouve dans le problème précédent mais qui présente un intérêt en soi.

"L'ergodicité forte" dans le domaine des mathématiques pures ne peut être décrite dans un langage simple. A. Joffe et I. Fleischer ont obtenu des résultats dans ce domaine.

L'impact du développement des mathématiques pures est complètement imprévisible... mais presque toujours inéluctable (*it is a tale told by an idiot, full of sound and fury, signifying nothing* - Macbeth).

Niky Kamran

Géométrie des équations aux dérivées partielles/ Groupes de Lie de dimension infinie/ Équations d'onde en relativité générale

Le programme de recherches de Niky Kamran comporte trois axes principaux. D'une part, il vise à étudier les rapports géométriques qui existent entre les diverses propriétés d'intégrabilité géométrique et l'existence de lois de conservation pour les équations aux dérivées partielles en dimensions $m \geq 3$. D'autre part, il porte sur l'étude des structures de groupe de Lie de dimension infinie qui sont adaptées à la théorie des pseudogroupes de Lie analytiques de type infini. Enfin, il a pour but d'étudier le comportement global des solutions d'équations d'onde telles que l'équation de Dirac dans les variétés pseudo-riemanniennes correspondant aux solutions exactes de type trou noir des équations d'Einstein, un des objectifs étant de démontrer la non-existence de fermions en configuration stable au voisinage d'un trou noir en rotation.

Paul Koosis

Amélioration de l'estimation harmonique

Jusqu'à récemment l'estimation harmonique (c.à.d. l'emploi de la formule généralisée de Jensen) a été l'un des procédés les plus puissants pour trouver des bornes pour une fonction analytique dont le comportement précis est inconnu. Il est très important en analyse de pouvoir établir ces bornes, car elles nous permettent d'augmenter notre connaissance de la fonction en question. Mais l'estimation harmonique n'est pas un outil universel et ne s'applique pas dans certaines situations; il serait donc intéressant de trouver une méthode qui va plus loin.

On peut parfois obtenir les bornes qu'on cherche pourvu que les *intégrales* figurant dans l'estimation harmonique puissent être remplacées par des *sommes* de forme semblable, prises sur un ensemble discret de points, et on a vu dernièrement que ce remplacement *est* parfois possible. Pour cela la *plus petite majorante surharmonique* est employée. Le but de ce projet est de comprendre le rôle, encore mystérieux, joué par cet objet dans ce genre de question; on espère pouvoir de cette façon parvenir à une méthode générale. De nouveaux résultats ont été obtenus.

François Lalonde

Topologie symplectique et systèmes hamiltoniens

Les travaux les plus récents se rapportent à la topologie symplectique, à la théorie de jauge et aux systèmes hamiltoniens, sujets qui ont fait l'objet d'un intense développement depuis une quinzaine d'années.

La topologie (ou géométrie) symplectique est l'étude mathématique des espaces courbes, de dimension paire arbitraire, munis d'une forme symplectique, analogue anti-symétrique d'une métrique riemannienne, qui donne à ces espaces la structure qu'il faut pour donner un sens aux

lois de la physique aussi bien qu'aux procédés de quantification (passage du classique au quantique). Ce sujet est le versant mathématique de ce que les physiciens appellent la théorie des super-cordes. Son développement a attiré l'attention des physiciens (Witten, Vafa, Aspinwal, Greene, ...) aussi bien que celle des mathématiciens dont les méthodes ont suivi une évolution rapide depuis vingt ans.

La plupart des travaux portent sur les aspects dits "hard" de la topologie symplectique et des systèmes hamiltoniens, en se servant de techniques topologiques, géométriques et analytiques, en particulier les méthodes d'équations aux dérivées partielles elliptiques et la cohomologie quantique. Ces méthodes sont fondées sur l'étude du comportement des espaces de modules de courbes pseudoholomorphes, qui sont solutions des équations de Cauchy-Riemann généralisées associées à une structure presque complexe. Les résultats que nous avons obtenus au cours des deux dernières années incluent l'application de la cohomologie quantique à l'étude de la dynamique hamiltonienne qui a mis en évidence les propriétés de stabilité et de rigidité des systèmes hamiltoniens. Ils contiennent aussi une forte généralisation des travaux de Kirwan et d'Atiyah-Bott sur les fibations symplectiques ou algébriques, à partir de méthodes tout à fait nouvelles.

Robert Langlands, Marc-André Lewis et Yvan Saint-Aubin

The Ising Model in Domains with Boundary

In order to describe the critical behaviour of the two-dimensional Ising model, this group of researchers has introduced a field similar to that of the free boson whose jump lines delimit the constant spin clusters. The statistical distribution of this field has been studied by Monte-Carlo simulations. It satisfies the two hypotheses of universality and conformal invariance. Crossings on clusters of positive spins have also been investigated and some of their properties are similar to those of crossings in percolation models.

Christian Léger

Resampling Methods and Tuning Parameter Selection

Christian Léger's research is on the use of resampling methods in statistics. These methods use the power of the computer to approximate the distribution of an estimator to construct, for instance, a confidence interval for an unknown parameter. To validate these methods, asymptotic theory as well as computer simulations are used. In the last few years, Léger has constructed confidence intervals which take into account the data driven selection of the model in multiple linear regression when the model is chosen using the data. By using the bootstrap or subsampling to create new data sets and by rechoosing the model on each of them, it is possible to construct confidence intervals which reflect the uncertainty in the model selection step.

Sabin Lessard

Analysis of Population Genetic Models

Sabin Lessard's research interests include a wide variety of population genetic models and the concomitant evolutionary dynamics. His ultimate goals are: a) to explain the maintenance of variability in biological populations, b) to develop mathematical and statistical techniques to analyse population genetic structures, c) to deduce general evolutionary principles, and d) to study populations with complex interactions between individuals.

Jean LeTourneux

q-fonctions spéciales

La plupart des fonctions spéciales de la physique mathématique possèdent des *q*-analogues, c'est-à-dire des déformations faisant intervenir un paramètre *q*. De même que les algèbres de Lie fournissent un cadre unificateur pour l'étude des fonctions spéciales, les *q*-déformations de ces algèbres en fournissent un pour celle des *q*-fonctions spéciales. En collaboration avec Luc Vinet (CRM) et Roberto Floreanini (Trieste), Jean LeTourneux étudie systématiquement l'interprétation algébrique des *q*-polynômes spéciaux contenus dans la hiérarchie des polynômes d'Askey-Wilson.

Jean-Marc Lina

Ondelettes, statistique et processus complexes

En collaboration avec le groupe de recherche PhysNum qu'il codirige avec B. Goulard, Jean-Marc Lina consacre principalement ses activités scientifiques au traitement du signal. Les différents sujets étudiés ont comme dénominateurs communs l'analyse statistique, les techniques d'inférence et, depuis six ans, la théorie des ondelettes, qui a donné lieu à une recherche active dans le contexte des bases en ondelettes de Daubechies complexes. Les propriétés de ces fonctions ont conduit à des travaux plus appliqués, comme l'estimation de signaux dans le domaine de l'industrie nucléaire et, plus récemment, l'imagerie. Ainsi, la modélisation statistique de la représentation multi-échelle complexe des images (par un modèle de Markov caché) et la mise au point d'un algorithme d'optimisation pour des observations complexes ont débouché au cours de la dernière année sur des algorithmes d'estimation robustes et sur une technique originale de classification de textures. La statistique des signaux complexes est également à la base d'une étude d'estimation de phase pour l'imagerie d'interférométrie radar en collaboration avec l'industrie. Dans le contexte de l'imagerie cérébrale fonctionnelle, J.M. Lina collabore actuellement avec deux unités de recherche à Paris (INSERM et CHU-Pitié-Salpêtrière) pour appliquer des techniques statistiques à la détection des sources fonctionnelles à partir de données magnéto-électro-encéphalographiques. Parmi les principaux aspects de ce problème, on citera la prise en compte des informations *a priori* de l'imagerie de résonance magnétique fonctionnelle ainsi que la modélisation multi-échelle de la surface corticale.

John McKay

Moonshine and its Haupt Modules and ADE

We investigate the consequences of the relation between the Monster sporadic finite group, and the Haupt modules which describe its representations. This research was started in 1979 by the author and is known as Monstrous Moonshine. Designated by John Thompson (Fields medalist) as a 'problem for the next century' it has recently been explained by Richard Borchards for which he was awarded a Fields medal in 1998 at Berlin. By using recurrence relations for the Fourier coefficients of the Haupt modules, and the devices of symmetrization and desymmetrization, we believe we have a complete list. A consequence of this is the description of many hundreds of integrable systems attached to the Haupt modules, generalizing the work of Halphen in 1881 on the reduction of self-dual Yang-Mills.
The ADE problem, now called the McKay correspondence, involves the remarkable fact that the fundamental groups of type E_8, E_7, E_6 are related to the Monster, Baby, and F_{24} as Schur multipliers.

Fahima Nekka

Vers une nouvelle méthode de classification et modélisation pharmaco-cinétique des effets spatiaux des médicaments à action rapide.

En géométrie fractale, il est bien connu qu'on peut définir différentes dimensions pour le même objet, ce qui a suscité beaucoup de recherche autour de la définition et du calcul des dimensions fractales. Il est aussi possible d'associer la même dimension fractale, voire le même spectre de dimensions, à différents objets. Ce dernier point est d'importance centrale dans la caractérisation des structures et leur comparaison en vue de classification. C'est dans ce but que nous avons entamé notre recherche sur un des indices les plus popularisés par Mandelbrot, qui néanmoins a bénéficié de peu d'études. Nous avons été menés ainsi à étudier un aspect de l'écart par rapport à l'invariance par translation. On a démontré que la mesure (de Hausdorff) générée par l'intersection des ensembles étudiés avec leurs translatés vérifie une loi de conservation de masse avec les échelles. Nous avons aussi trouvé que le spectre de mesures associé à ces intersections pouvait servir de nouvel outil de classification entre deux structures distinctes mais ayant la même dimension. Nous mettons actuellement au point l'algorithme de calcul de ce spectre de mesure afin de le valider et de l'adapter à des structures réelles.

Les bloqueurs neuromusculaires sont utilisés comme agents anesthésiants à action rapide. Il est donc important de bien modéliser la phase initiale afin de bien évaluer les paramètres pharmacocinétiques et pharmacodynamiques. Les modèles classiques s'avèrent inadéquats pour la description de la circulation non-homogène de ces médicaments. Dans ce deuxième projet, nous avons développé un modèle basé sur l'équation de diffusion qui

incorpore l'hétérogénéité spatiale par une meilleure compréhension physiologique de la circulation et nous l'avons validé sur une variété de données cliniques.

Jiri Patera

Lie Theory, Quasicrystals, and Image Processing

Following is a list of the research interests being pursued by Jiri Patera.
Application of Lie theory. Exploitation of our most recent results, namely the classification of the gradings of classical simple Lie algebras over the real number field. Most important among the applications is the grading preserving deformations of the algebras.
Study of properties and applications of the cut and project point sets ("quasicrystals"). Completion of a small monograph where the properties of the 1-dimensional sets are brought together, proven, and explained.
Specific applications of image processing and data fusion motivated mainly by our collaboration with Lockheed Martin, Canada.
Most intensive efforts will be invested in the application of "quasicrystals" in cryptography, and in the exploration of the many possibilities, evaluation of demonstration models, and the security questions.

François Perron

Inférence statistique, simulations MCMC

Les intérêts de recherche de F. Perron sont liés à la statistique et portent plus particulièrement sur les sujets suivants : théorie de la décision, analyse multidimensionnelle, statistique bayésienne et simulations par MCMC (chaînes de Markov avec Monte-Carlo). Les problèmes liés à la théorie de la décision visent à améliorer les estimateurs existants. L'approche privilégiée consiste à produire de meilleurs estimateurs minimax, l'estimateur minimax étant celui qui performe le mieux dans le pire des cas. Un estimateur est meilleur qu'un autre s'il fait toujours au moins aussi bien que l'autre en faisant parfois mieux. Dans l'article '*On a Conjecture of Krishnamoorthy and Gupta*' on démolit la conjecture qui prétend qu'un certain algorithme améliore plusieurs estimateurs minimax. Dans un autre contexte, celui de l'estimation d'une moyenne pour une distribution de loi normale en plusieurs dimensions, on sait que lorsque la dimension excède deux, on peut améliorer l'estimateur donné par la moyenne échantillonnale. Dans l'article '*Improving on the MLE of a Bounded Normal Mean*' on montre que le même phénomène se produit en dimension 1 et 2 lorsque la moyenne est tronquée. De façon générale, on favorise l'approche bayésienne. On y parvient plus facilement avec l'aide de l'ordinateur en effectuant d'intenses calculs numériques. Ceci nous amène à raffiner les méthodes de simulation existantes. Dans l'article "*Beyond Accept-Reject Sampling*" on perfectionne la méthode d'acceptation-rejet. Un projet en cours est de la rendre encore plus sophistiquée en y incorporant des chaînes de Markov.

Colin Rogers

Deformation of Isothermic Surfaces and K-Nets in Membrane Theory and Nonlinear Elasticity : Application of Solitonic Methods

Solitonic pulses with their novel survival properties following interaction have major technological applications to optimal communication and semi-conducting devices. Materials which allow solitonic propagation are of paramount practical importance in nonlinear optics. This project will provide model constitutive laws for smart materials which admit soliton transmission. In a parallel investigation, solitonic methods will be used in the engineering design of elastic membrane structures.

We also investigate the synthesis of materials science. Here, recent advances in materials design and soliton theory are brought together to synthesize smart solitonic materials.

Ivo Rosenberg

Clones and Relations

Universal algebra. The main topic is the study of clones, on a finite universe A, which are composition closed sets of operations on A. This is a basic problem for finite algebras. Ideals, congruence kernels and discriminator algebras were also studied. Algebraic duality, an extension of Stone's duality for boolean algebras, allows topological representations of algebras. It was shown that dualizability is invariant under nilpotent shifts.

The very complex problem of local completeness and of locally maximal clones on infinite universes was reduced to a few more manageable cases. The completeness problem for uniformly delayed circuits over a finite at-

least-four-letter alphabet was advanced. The simplicity of the lattice of clones and the description of all Mal'tsev clones on a finite at-least-three-element universe was studied.

Hyperalgebras. A hyperalgebra on A is an algebraic structure with values in the set P of nonvoid subsets of A. I. Rosenberg studied them as C-isotone algebras on P which allowed a universal algebra approach to hyperalgebras and lead to interesting problems on C-isotone clones on P. In particular, hypergroups on A can be studied as C-isotone monoids on P.

Christiane Rousseau

Étude qualitative et bifurcations dans les équations différentielles ordinaires

Un premier aspect porte sur les problèmes de finitude des cycles limites (cyclicité finie) dans les bifurcations des champs de vecteurs du plan. Ce problème est important dans l'étude des bifurcations génériques de champs de vecteurs mais aussi pour compléter la partie finitude du 16e problème de Hilbert pour les systèmes quadratiques. Un grand programme commencé par C. Rousseau, conjointement avec F. Dumortier et R. Roussarie en 1991, montre que la solution du problème découle de la cyclicité finie de 121 graphiques du plan. Deux progrès très significatifs ont été accomplis: le premier avec la thèse de H. Zhu (décembre 1999) qui montre la cyclicité finie de graphiques génériques ayant un point nilpotent de type elliptique ou selle, le deuxième avec F. Dumortier et Y. Ilyashenko où un principe de « prolongement analytique » permet de montrer aisément la cyclicité finie de graphiques apparaissant dans des familles continues de graphiques. Des applications de ces théorèmes montrent la cyclicité finie d'environ 35 graphiques parmi les 121 du programme ci-dessus.

Un deuxième aspect porte sur les critères d'intégrabilité et de linéarisabilité d'un champ de vecteurs polynomial au voisinage d'un point de selle. Des travaux préliminaires montrent une organisation remarquable des strates de champs intégrables et linéarisables. Le travail se poursuit pour expliquer ce phénomène. La démarche consiste à regarder l'influence des invariants de Martinet-Ramis pour la classification analytique des points de selle résonants et des col-nœuds lorsqu'on perturbe les valeurs propres. Dans ce projet C. Rousseau collabore avec C. Christopher (Plymouth, UK), P. Mardesic et R. Roussarie (Dijon).

Roch Roy

On Time Series Analysis and Modelling

Roch Roy's main research interest is time series analysis and modelling. Time series analysis continues to be a major field of interest in statistical research as almost scientific discipline is concerned with data collected over time. His recent research was mostly concentrated on the following projects:

- Tests for independence of two possibly nonstationnary multivariate time series and application in economic and finance;
- Goodness of fit tests for multivariate time series models;
- Study of the properties of a class of generalized linear regression models for describing time series of counts and application in epidemiology;
- Modelling of non-linear time series using weak ARMA representations.

During the past year, with the Ph.D. student Pierre Duchesne, he has developed a class of consistent tests for the hypothesis of independent errors against the alternative of serial dependence of an arbitrary form for the multivariate autoregressive models with explanatory variables that are also called dynamic simultaneous equation models in econometrics.

Gert Sabidussi

Graphes eulériens et automorphismes de graphes

Graphes eulériens: Études des graphes 4-réguliers. Inspiré par l'importance de ces graphes pour la théorie des nœuds et par le fait qu'on connaît peu de choses sur leurs propriétés combinatoires, nous avons fait une étude approfondie de deux paramètres combinatoires importants, le nombre chromatique et le nombre de stabilité, pour plusieurs classes de graphes 4-réguliers. Pour les deux paramètres il y a des valeurs « naturelles », et notre recherche porte sur l'existence d'algorithmes efficaces pour décider si un graphe 4-régulier donné (avec ou sans contraintes additionnelles) atteint les valeurs naturelles. Le résultat principal de l'étude est que pour les deux paramètres le problème s'avère NP-complet.

Automorphisme: Pseudo-similarité / similarité. Ici on étudie des questions découlant de la théorie

de reconstruction de graphes. Si en supprimant deux arêtes d'un graphe (une à la fois) on obtient deux graphes isomorphes (pseudo-similarité), les deux arêtes sont-elles dans la même orbite sous l'action du groupe d'automorphismes du graphe (similarité)? En général la réponse est négative, mais elle est affirmative si le nombre d'orbites du graphe est petit. Jusqu'à quel nombre d'orbites les deux types de similarité coïncident-ils? Ce qui est important dans ce genre de questions n'est pas nécessairement une réponse finale mais les méthodes utilisées pour reconnaître la similarité de deux arêtes (ou d'autres éléments) d'un graphe. Plusieurs méthodes puissantes de ce type ont été développées au cours de notre étude.

David Sankoff

Biomathématique et sociolinguistique

David Sankoff's research involves the formulation of mathematical models and the development of analytical methods in the sciences and humanities. This includes the design of algorithms for problems in computational biology, applied probability for phylogenetic analysis of evolution, and statistical methodology for studying grammatical variation and change in speech communities. Recent work has focused on the evolution of genomes as the result of chromosomal rearrangement processes and on formal models for bilingual syntax.

Dana Schlomiuk

Études locales et globales de champs de vecteurs analytiques

Les travaux de Dana Schlomiuk portent sur des problèmes locaux (problème de centre) ainsi que sur la géométrie globale de certaines familles de champs de vecteurs polynomiaux ou analytiques dans le plan. Ces travaux visent en particulier à donner une base conceptuelle nouvelle pour les champs de vecteurs polynomiaux dans le plan, permettant d'en dégager des traits caractéristiques de la dynamique doublement globale (on s'intéresse aux champs dans toute l'étendue du plan et cela pour des familles dépendant de paramètres) afin d'unifier des résultats épars de la littérature et d'en obtenir des nouveaux. Un trait caractéristique de ces travaux est l'usage des méthodes multidisciplinaires : analytiques, algébriques, géométriques (plus particulièrement algébro-géométriques). Un autre volet du projet en cours porte sur la partie finitude du 16^{e} problème de Hilbert concernant les cycles limites.

Elisa Shahbazian

Data Fusion

Elisa Shahbazian's main area of expertise is Data Fusion architectures, and how the data fusion capabilities should be integrated within large systems.

Since 1994, she has been responsible for conception, prioritization, and coordination of all R&D activities at Lockheed Martin Canada. These activities involve development of intelligent decision support technologies for C^4I applications (Data Fusion – levels 1, 2, 3 & 4, Resource Management, Imaging, etc.), and the engineering infrastructure for the establishment of these technologies on board the naval and airborne platforms of Canada, and diversification of these capabilities into commercial applications such as Intelligent Transportation and Remote Sensing.

Ronald Stern

Nonsmooth Analysis: Theory and Applications

R.J. Stern's general area of interest is nonsmooth analysis and control theory. A general goal in control problems is to design a feedback law, which achieves some desired behaviour. Examples include problems of stabilization in a dynamical system, steering a trajectory to a target set in minimal time, or minimizing a cost functional subject to some dynamic constraints. Even in some very simple models of such problems, however, there is generally no classical (e.g., continuous or smooth) feedback synthesis. The root cause of this is the fact that in optimal control, the value function is generally nonsmooth, while in problems of stabilization, one only has a generalized (nonsmooth) Lyapunov function available. Dr. Stern's present research interests involve applying the methods of nonsmooth analysis to such feedback design problems, in order to obtain solutions in a generalized framework.

John Toth

I am interested in questions related to spectral statistics of quantum Hamiltonians and in problems of quantum chaos for integrable systems.

Pierre Valin

Fusion de données par raisonnement évidentiel

Toute application de fusion de données doit contenir 4 fonctions séquentielles :

- l'enregistrement spatio-temporel,
- un mécanisme d'association pour corréler les nouvelles données avec des objets existants,
- l'estimation de l'identification (ID) (ou fusion d'attributs) obtenue par un raisonnement évidentiel de tous les attributs.
- Les attributs peuvent provenir d'images, de capteurs de type radar, de senseurs intelligents, ou d'algorithmes.

La présente recherche se concentre sur la troisième fonction la plus importante, celle de l'estimation de l'identité, à travers classifieurs (Bayes, réseaux de neurones, etc.) et la logique de Dempster-Shafer.

Luc Vinet

Physique théorique et combinatoire algébrique

Les objectifs principaux des projets de recherche de Luc Vinet sont:

- de développer les outils théoriques nécessaires à la résolution des modèles importants de la physique des systèmes quantiques à plusieurs corps;
- d'étendre la théorie algébrique des fonctions spéciales.

Deux résultats dignes de mention ont été obtenus par Luc Vinet et ses collaborateurs en 1999-2000. Il a montré en utilisant les transformations de Darboux qu'une classe importante de polynômes de Koornwinder avec fonction de poids $w(x) = x^a(1-x)^b+M_0\delta(x) + M_1\delta(1-x)$ obéissent à des équations différentielles de rang élevé.

Il a aussi examiné certains aspects des polynômes de Krall-Sheffer. Il s'agit de polynômes à *deux* variables qui généralisent les polynômes orthogonaux classiques à une variable. Luc Vinet a montré avec ses collaborateurs que ces polynômes sont reliés à des modèles superintégrables sur des espaces à courbure constante.

Pavel Winternitz

Group Theoretical Methods in Physics and Non-linear Phenomena in Physics

Field of research: Mathematical physics, symmetries and non-linear phenomena.

Applications of Lie groups to the study of difference equations.

Exact solutions of non-linear differential equations, especially those coming from non-linear optics.

Lie algebra contractions and the separation of variables.

Classification of Lie algebras and their subalgebras.

Keith Worsley

The Geometry of Random Images in Medicine and Astrophysics

The Euler characteristic of the excursion set of a random field is a tool that has been used over the last decade to analyse positron emission tomography (PET) images, functional magnetic resonance images (fMRI), galaxy density maps and the cosmic microwave background, thought to originate from the creation of the universe. These images are modelled as a Gaussian random field, and the excursion set is the set of points where the field exceeds some fixed threshold value. The Euler characteristic, which counts the number of connected components of the excursion set minus the number of "holes", is the basis of a proposed estimator of the number of "signals" in the image. I have extended the theory developed by Adler (1981), The Geometry of Random Fields, to: a) include a boundary correction for the expected Euler characteristic, which leads to a highly accurate *P* -value for the field maximum; b) χ^2, *t* and *F* fields; c) searching over smoothing kernel width as well as location, so we can estimate the extent of the signal (joint work with David Siegmund); d) knots in the excursion set.

Jean-Paul Zolézio

Coques et dérivabilité

Le premier volet de mes recherches consiste en la démonstration de la dérivabilité par rapport au domaine dans l'équation des ondes pour des seconds membres réguliers. On caractérise la dérivée comme solution d'un problème caractéristique au moyen de la dérivée normale de la solution. On établit une condition nécessaire d'optimalité d'un domaine en utilisant la dérivée de forme. Le cas Neumann est également étudié.

Les travaux de L. Lasiecka, J-L. Lions et R. Triggiani sur l'équation des ondes (1986) donnent une régularité de la dérivée normale,

qui ne résulte pas de la régularité de la solution. Cette régularité cachée permet à l'équation caractéristique de « survivre » lorsqu'on baisse la régularité du second membre. On montre que la solution de ce problème est la dérivée par rapport au domaine, également dans le cas où le second membre est peu régulier.

Dans un second volet, je m'intéresse à la vibration d'une coque précontrainte. Une coque est contrainte par un grand déplacement et une petite déformation. On calcule au moyen d'un logiciel calcul formel-calcul numérique les positions d'équilibre statique des coques de type Adèle et logiciel S3CS. On étudie ensuite la vibration de la coque autour de cette position d'équilibre stable. La modélisation est effectuée au moyen de la fonction distance orientée. L'équation obtenue est de type hyperbolique, on souhaite dériver les solutions par rapport au domaine. Pour ce faire, nous utilisons les méthodes développées pour la dérivabilité par rapport au domaine dans l'équation des ondes. Le problème réside dans l'absence de résultat de régularité et l'absence de régularité cachée. On démontre un résultat analogue à la dérivabilité cachée de l'équation des ondes par des méthodes de type extracteur, la régularité intérieure étant obtenue par la théorie des semi-groupes.

Parmi les développements futurs, on envisage le modèle exact $p(d,\infty)$ pour les coques précontraintes. On envisage également de généraliser les résultats de dérivabilité par rapport au domaine à une plus grande classe d'équations hyperboliques en extrayant les hypothèses minimales.

Collaborations

Within its general mandate of promoting mathematical research, the CRM maintains a wide network of collaborations at the local, national, and international levels.

A National Institute

The CRM is strongly committed to its national mission. The CRM takes measures to ensure that the largest possible number of scientists across Canada benefit from its activities and become involved in their planning. For instance, it appoints to its 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 organisers to make efforts to ensure the participation of the Canadian specialists in their activities; it organises 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 programmes. The CRM is the only national institute which operates in the two official languages of Canada and it is highly visible on the international scene. In keeping with its national role, it co-ordinates its activities with the Fields Institute, PIms, the Canadian Mathematical Society (CMS), 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 as with other institutes abroad.

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

Since the early 1990's 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 co-ordinating 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, of which more is described elsewhere in this report.

There are several other initiatives worthy of mention. One of these is the National Programme, described in the next section. Another one is the CRM-FI prize awarded in recognition of outstanding accomplishments in the mathematical sciences in Canada. It was created in 1994. This year's winner is I.M. Sigal of the University of Toronto. The administrative responsibility in this matter alternates each year between the CRM and the FI. Scientific collaboration continues between the FI and the CRM, with a joint workshop in symplectic geometry and topology, during the spring of 2001.

National Programme Committee

The three Canadian Institutes in the Mathematical Sciences, CRM, Fields, and PIms, have initiated a new programme for the support of joint activities of a national stature in the mathematical sciences. This programme, funded to the tune of $100,000 per year, is administered by a National Programme Committee of members from the three institutes which makes recommendations to the three directors. The programme has many mandates, the first being to fund conferences and workshops in the mathematical sciences across Canada. These funds are essentially allocated to activities that fall outside the main purview of the three institutes, or that would benefit from joint institute funding. The programme also aims to support activities that are held at the meetings of the three mathematical science societies: CMS, CAIMS, and SSC, as well as to support the participation of graduate students at these scientific meetings. Finally, it coordinates international programmes and other ventures where it is advantageous for the three institutes to act as a whole.

Here is the list of the activities sponsored by the National Programme in 1999-2000:

Congrès mathématique de l'an 2000
May 5 – 7, 2000, Univ. Laval, Québec
Contact : Frédéric Gourdeau

Western Canada Linear Algebra Meeting
May 26 – 27, 2000, Univ. of Manitoba, Winnipeg, Manitoba
Contact : Pauline van den Driessche

Special Functions 2000
May 29 - June 9 2000, Arizona State Univ., Tempe, Arizona
Contact : Luc Vinet

Annual Meeting 2000 of the Statistical Society of Canada
June 4 – 7, 2000, Ottawa, Ontario
Contact : Duncan Murdoch

Math 2000
(joint meeting SMC-SCMAI)
June 10 – 13, 2000, McMaster Univ, Hamilton, Ontario

Topological and Variational Methods in Non-linear Analysis
June 19 – 23, 2000, Warsaw, Poland
Contact : Wieslaw Krawcewicz

Séminaire de mathématiques supérieures :
Approximation, Complex Analysis and Potential Theory
July 3 – 7, 2000, Univ. de Montréal, Montréal
Contact : Aubert Daigneault

First Prairie Industrial Problem Solving Workshop
August 7 – 11, 2000, Brandon, Manitoba
Contact : Lynn Batten

12th Canadian Conference on Computational Geometry
August 16 – 19, 2000, Fredericton, New Brunswick
Contact : David Bremner

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

CMS Winter Meeting 2000
December 10 – 12, 2000, Vancouver, British Columbia

Canadian 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 advisory committee, and together with the other institutes, the CRM organises special sessions at CMS meetings. The SSC meetings have been funded through the national programme; as well, the CRM gives out a prize each year jointly with the SSC; similarly, together with CAP, it awards a prize each year in mathematical and theoretical physics. There is a section on this year's prize-winners elsewhere in this report.

International Collaboration

The CRM has exchange protocols with Osaka University, with Seoul's Asia-Pacific Center for Theoretical Physics, with the Institute of Mathematical Sciences at Nankai University, with the Technical University of Prague and the University of Rome.

In its publications, the CRM is continuing its partnership with the American Mathematical Society, 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-Verlag, in statistics and in mathematical physics. It has publications exchange agreements with Fields Institute, PIms (Pacific Institute for the Mathematical Sciences), M.S.R.I. (Mathematical Sciences Research Institute), the Institute for Mathematics and its Applications, École Normale Supérieure (France), and Isaac Newton Institute.

A Solid Regional Base

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 indefatigable. The Université de Montréal releases each year five of its faculty members to work at the CRM, and the support of these faculty members is an essential asset for the CRM's scientific activities. There is in addition a regular programme 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 programme, the CRM has also been arranging release of research personnel from nearby universities such as Laval, Sherbrooke, Queen's and Ottawa; some of these arrangements are being put on a more permanent footing. The partnerships of the CRM with the other research institutes in the Montreal area have been very profitable. More will be said about these in the next section.

Institut des sciences mathématiques

One important vehicle for collaboration with the Québec universities is the Institut des sciences mathématiques. This institute, which encompasses most of Québec's universities, is principally concerned with co-ordinating graduate training. The links with research are obvious, and indeed, the CRM and the ISM have a long standing partnership, in particular in offering postdoctoral fellowships, in organising the CRM-ISM colloquium, and in organising special courses for the CRM's thematic programmes.

Industrial Mathematics

The industrial programme of CRM has grown considerably in the last year; many important initiatives were solidified and others were launched.

MITACS

This network of centres of excellence on Mathematics of Information Technology And Complex Systems (MITACS) is one of 18 such networks set up by the federal government. MITACS was put together by the three Canadian mathematical institutes (CRM, Fields, PIms) in 1998, and research began in the spring of 1999. This year the network will grow with new projects such as those of K. Worsley (McGill) and D. Thérien (McGill) located in Montréal. The MITACS network covers the whole country, with the participation of 26 universities, 200 researchers, 150 students, and more than 75 companies. The research areas (essentially in applied mathematics) also cover a large spectrum. The industrial partners of our research projects are: Microcell, National Bank of Canada, NATCAN, Hydro-Québec, Procter & Gamble, Heart & Stroke Foundation, Medtronic Inc., DND-Valcartier, and Ad-Opt Technologies.

The first general annual meeting of the network was held in June 2000 in Toronto. This large scale event brought together most of the researchers in the network, a large number of students (whose travel fees were mostly paid by MITACS), and many of the industrial collaborators. At the conference, results from the research groups were presented, but there were also very interesting presentations from scientists in industry exhibiting their specific needs in the areas of applied mathematics covered by the MITACS researchers, and displaying the links that have been established between MITACS groups and private partners. Students and postdoctoral fellows played a very important role at the conference, with a poster session and a study group on the industrial applications of mathematics held before the main sessions. The best poster presentations were selected by a panel and received honorary and monetary prizes.

The next annual meeting will be held in Montréal in May 2001. These meetings are essential to create new links and maintain cohesion between the different researchers of the network, which work on quite varied aspects of applied mathematics: biomedical research, commercial and industrial applications, information technology, manufacturing, and mathematical finance. Each MITACS project belongs to one of these themes, and theme leaders have organized theme meetings (which will be repeated next year) where technical details of the research can be discussed more easily than in the general meeting.

Finally, each of the institutes has organized special events (workshops, seminars, conferences) linked to the MITACS projects. In the case of the CRM, let us note in particular for 2000 the workshop on Selecting and Combining Models with Machine Learning Algorithms, which has attracted more than 130 participants, including the majority of the world leaders in this research area. This workshop is linked to the MITACS research on data-mining, neural networks, and computational statistics.

On the research side, almost all the groups obtained significant results, which has been recognized by the MITACS Board through the renewal of the projects for 2000-2001. Among the projects linked to the CRM, let us note a few really interesting results. For example the group led by B. Jaumard (Poly) has developed new and more powerful optimization algorithms for communication channels allocation, taking advantage of Montréal's expertise in operations research applied to telecommunications networks. The group led by L. Glass (McGill) has created new atrial fibrillation models, allowing to classify and detect different types of atrial fibrillations. The group led by J. Detemple (McGill) and R. Garcia (UdeM) has produced an impressive number of published results showing progress in the areas of asset allocation, statistical models of financial time-series, and statistical inference on these series. The group led by F. Soumis (Poly) has created a new version of the GENCOL software for mathematical programming based on column generation, and the new system, delivered to AD OPT and GIRO, speeds up the solution (up to a factor of 10) of scheduling problems. The group led by Y. Bengio (UdeM) has created a successful new paradigm for statistical language modeling which beats the performance of models which have dominated this area for almost 20 years, thanks to the computation power delivered by the super-computers of the Réseau Québécois de Calcul de Haute Performance. New learning

algorithms for data-mining of large data sets, which interest Bell Canada, have also been designed. The multi-disciplinary group led by D. Thérien (McGill), just added to MITACS, will work on modeling biological mechanisms such as the response to medications, based on the patterns of genetic expression. The group led by K. Worsley (McGill), also just added to MITACS, will work on the statistical analysis of 3D images of the brain, using new results from the areas of wavelets, functional data analysis, and random fields.

Network for Computing and Mathematical Modelling (ncm_2)

The CRM is one of seven Montreal-based centres which together are the members of the Network for Computing and Mathematical Modelling, ncm_2 (in French: Réseau de calcul et de modélisation mathématique, rcm_2), a unique 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 modelling, mostly around three major themes: (1) risk management, (2) information processing, imaging and parallel computing, and (3) transport and telecommunications.

The ncm_2 is in the third year of a 5-year NSERC grant with an average of $600K per year. The network is managed through the CRM.

The other centres of the network at the time of creation were the Centre for Research on Computation and its Applications (CERCA), the Centre for Interuniversity Research and Analysis on Organizations (CIRANO), the Centre for Research on Transportation (CRT), and the Group for Research in Decision Analysis (GERAD). Since then, two new members joined the network: the Centre de Recherche Informatique de Montréal (CRIM) and the Institut National de la Recherche Scientifique-Télécommunications (INRS-Télécommunications).

The year 1999-2000 has been rather active for the ncm_2. The major undertaking of the year was a process of project renewal. Indeed, many of the initial projects which were associated to the network were coming to fruition, and so a call for proposals was put out. Proposals were received, refereed, and adjudicated by a committee with three network members and three outside members. One constraint imposed was that the projects should involve collaboration between members of different centres. In all, the process was quite successful, with the following new projects being funded:

- *Analyse du risque des flottes de véhicules*
  Georges Dionne, CRT
- *Modèles à noyaux et modèles probabilistes pour l'extraction d'informations utiles de grandes bases de données*
  Yoshua Bengio, CRM
- *Nowcasting and Decision Making for Environmental Problems*
  Charles Lin, CERCA
- *Image Segmentation and Characterization Using Level Set-Based Curve and Surface Evolution, Boundary Detection and Lie Groups.*
  Jiri Patera, CRM
- *Tarification et gestion du revenu en transport aérien.*
  Patrice Marcotte, CRT and Gilles Savard, GERAD
- *Design et contrôle optimal de dispositifs médicaux.*
  Dominique Pelletier, CERCA
- *Algorithme d'optimisation pour les problèmes de tournées et d'horaires.*
  François Soumis, GERAD
- *Quality of Service Mapping as an Optimization Problem*
  Odile Marcotte, GERAD and Brigitte Kerhervé, UQAM
- *Approche hiérarchique et multi-échelles pour la localisation des sources d'activité en MEG/EEG.*
  Bernard Goulard, CRM

There are in addition 9 ongoing projects, of which 3 involve CRM researchers. Overall, the projects have involved the participation of 50 researchers in the network centres, and 60 postdoctoral fellows and graduate students. The total value (cash and in-kind) of the contributions of our partners in 1999-2000 was $1M. The industrial partners of ncm_2's research projects are: Ad Opt, ANIQ R&D Inc., National Bank of Canada, Centre de sécurité civile du Québec, CHUM (Centre hospitalier de l'Université de Montréal), CLSC Côte-des-Neiges, Consultants INRO Inc., Environment Canada, Bombardier, Prévost Car Inc., ADS Groupe Composites Inc., Groupe Québec-Cartier, Hydro-Québec, HydroSoft, Lockheed Martin Electronic Systems Canada, Montreal Jewish General Hospital, Urgences Santé.

The ncm_2 has pursued a variety of networking activities, encouraging integration. In 1999-2000, the ncm_2 organised the following workshops and

conferences: *Conférences sur les techniques d'optimisation pour améliorer la gestion dans le domaine de la santé,* M. Gendreau and B. Jaumard; *Nowcasting Workshop,* Charles Lin (CERCA); *L'économie et la gestion des risques majeurs,* CIRANO / rcm_2 / Columbia University.

Also, a series of workshops called *Autour de midi* were organized by J-M. Lina (CRM). Each workshop was made up of a mini-course and a seminar. The first was given by B. Vidakovic (Duke) on *Wavelets and statistics*, as well as *Functional Data Analysis via Wavelets.* Then Wim Sweldens (Bell Laboratories, Lucent Technologies) talked about *The Lifting Scheme and Second Generation Wavelets,* followed by *Digital Geometry Processing.* Hugh A. Chipman (Waterloo) made two presentations on *The State of the Art in Data Mining,* and *Segmentation via Tree Models.* Finally A. Arnéodo (CNRS, France) gave a mini-course on *Analyses des ondelettes et analyses multifractales (ADN, imagerie).*

Moreover, there were 2 presentations as part of the series *Grandes Conférences*:

- 3 November 1999
  Richard Anthes (University Corporation for Atmospheric Research)
  Global Weather Services in 2025
- 25 May 2000
  Michel Balinski (Laboratoire d'Économétrie de l'École Polytechnique, Paris)
  Axiomatique appliquée : équité et autres applications

Laboratoires Universitaires Bell

The CRM is an active participant in the 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.

The guiding principles of the Bell University Laboratories are: a deep integration with the university environment; a balance between exploratory research, applied research and applications development; a multidisciplinary approach.

These objectives and guiding principles are made possible thanks to a $12M investment over 3 years which will be used to finance research projects, to create an endowment fund in order to recruit elite researchers, and to establish an infrastructure.

The year 1999-2000 saw the LUB move into its new quarters, financed through 539K$ from the laboratory's infrastructure fund, as well as contributions from the Canadian Foundation for Innovation (740K$) and the Québec government (570K$). The laboratories are distributed over two locations, the main one being in downtown Montréal, next to CIRANO. As well as offices, it contains a state-of-the-art simulation laboratory for electronic commerce and experimental economics. The other component is located at the Université de Montréal, and is devoted to multi-media research.

Fifteen research projects are now underway. Of these, 5 are affiliated with the CRM. They are Yoshua Bengio's *Datamining*, Rachida Dssouli's *Service Creation Environment: A Quality Driven Service Engineering Methodology*, Bernard Goulard's *M3Int: Multi-Media Mathematical Imaging on the Net*, and Jiri Patera's *Development of the Aperiodic Encryption Method* and *Evaluation and Demonstration of a New Family of Cryptographic Systems.*

Awards, Distinctions, and Landmarks

Researchers play a key role in a research centre such as ours and we are particularly proud of the group that we have assembled. Their scientific and academic influence is outstanding. Here is a short list of the main prizes and awards that they have received in the last year.

Nantel Bergeron of York University has received a *Premier's Research Excellence Award* (PREA) from the Ontario Government for the years 2000 through 2005. These prizes are awarded to the best young researchers in Ontario.

Michel Delfour of Université de Montréal was the Meeting Director and Scientific Chair of the Canadian Mathematical Society Winter 1999 Meeting. A report on this activity is found elsewhere in this report.

Stéphane Durand of Collège Édouard-Montpetit was awarded the first prize of the World Mathematical Year 2000 Poster Competition of the European Mathematical Society. These posters can be seen at http://www.crm.umontreal.ca/math2000/tableau.html

Martin Gander of McGill University gave two prestigious invited talks: *Optimized Schwarz Methods* during the *12th International Conference on Domain Decomposition Methods* at Chiba University in Japan and *Why are Schwarz Domain Decomposition Methods Slow?*, during the *Householder Symposium XIV* at Whistler in British Columbia. Moreover, Martin has obtained one of the prestigious positions of the Strategic Programme of Professor-Researcher of the Fonds FCAR in Québec.

Thomas Hagedorn of Harvard University has been awarded a Sloan Postdoctoral Fellowship in computational molecular biology for the years 1999-2001. His work at CRM is under the supervision of David Sankoff.

Stéphane Lafortune of Université de Montréal won the Prize for the best thesis with co-supervision of the Québec Ministry of International Relations and the Consulate of France in Québec. This prize is awarded to the best thesis done under the co-supervision of a Director from Québec and one from France. The thesis entitled *Symétries et intégrabilités des équations aux différences finies* was written under the co-supervision of Pavel Winternitz of CRM and Jean-Pierre Gazeau of Université de Paris VII.

François Lalonde of Université du Québec à Montréal is a Killam Research Fellow of the Canada Council for the Arts for the years 2000-2002. These fellowships are among the most distinguished reseach awards in Canada. In 1999, he has also delivered a plenary one-hour talk at the first Canada-China Math Congress in Peking.

Christian Léger of Université de Montréal has been awarded the 2000 Excellence in Teaching Award for the Science Sector of the Faculty of Arts and Sciences of Université de Montréal.

Colin Rogers of New South Wales University in Australia has been elected Fellow of the Australian Science Academy in 1999.

Christiane Rousseau of Université de Montréal received the Abel-Gauthier Prize of the *Association mathématique du Québec* (AMQ) as the 1999 Personality of the year. The citation mentions that "AMQ wishes to recognize your exceptional contribution to the mathematical community of Québec by your research, your teaching, as well as your significant implication in extra-academic activities such as the organization of the AMQ math camps and your active participation in many projects for the World mathematical year in Québec." Christiane also received the Prize for the best co-supervision of a thesis of the Québec Ministry of International Relations and the Consulate of France in Québec. This prize, awarded jointly to Robert Roussarie in May 2000, recognizes their work in the co-supervision of Louis-Sébastien Guimond's thesis.

Dana Schlomiuk of Université de Montréal is a member of the Council of NSERC (1998-2001). In 1999, she has presided over the Selection Committee for the Gold Medal in Science and Engineering. She is also Chair of the Canadian

Mathematical Society's Selection Committee for the best doctoral thesis (1998-2000).

John Toth of McGill University has been awarded a Sloan Research Fellowship. Only two of the one hundred recipients come from Canadian universities.

Keith Worsley of McGill University is a Killam Research Fellow of the Canada Council for the Arts for the years 2000-2002.

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 many titles in both English and French. The CRM also has publishing agreements with the American Mathematical Society (AMS), Springer-Verlag and International Press. 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-Verlag publishes the CRM Series in Mathematical Physics and the CRM Subseries of the Springer Lecture Notes in Statistics. During the year 1999-2000, the first three volumes of the series in Physics appeared and the first two volumes of the Lecture Notes in Statistics were delivered to the publisher. The following list of "Recent Titles" contains books that have appeared during the year 1999-2000 or that will be published soon.

Recent Titles

AMS: CRM Monograph Series

- Spencer J. Bloch, *Higher Regulators, Algebraic K-Theory, and Zeta Functions of Elliptic Curves*, vol. 11, (to appear).
- Masayoshi Miyanishi, *Open Algebraic Surfaces*, vol. 12, (to appear).
- Michael Baake & Robert V. Moody (eds.), *Directions in Mathematical Quasicrystals*, vol. 13, (to appear).
- Joel Feldman, Horst Knörrer & Eugene Trubowitz, *Fermionic Functional Integrals and the Renormalization Group* (to appear).
- Eyal Z. Goren, *Lectures on Hilbert Modular Varieties and Modular Forms* (to appear).
- Jose I. Burgos, *The Regulators of Beilinson and Borel* (to appear).

AMS: CRM Proceedings & Lecture Notes

- Pierre Hansen & Odile Marcotte (eds.), *Graph Colouring and Applications*, vol. 23, 1999.
- B. Brent Gordon, James D. Lewis, Stefan Müller-Stach, Shuji Saito & Noriko Yui (eds.), *The Arithmetic and Geometry of Algebraic Cycles*, vol. 24, 2000.
- Decio Levi & Orlando Ragnisco (eds.), *SIDE III - Symmetry and Integrability of Difference Equations*, vol. 25, 2000.
- John Harnad, Gert Sabidussi & Pavel Winternitz (eds.), *Integrable Systems: From Classical to Quantum*, vol. 26 (to appear).
- Israel M. Sigal & Catherine Sulem, *Nonlinear Dynamics and Renormalization Group*, vol. 27, (to appear).
- J.C. Taylor (ed.), *Topics in Probability and Lie Groups : Boundary Theory*, vol. 28, (to appear).
- Alan Coley, Decio Levi, Robert Milson, Colin Rogers & Pavel Winternitz (eds.), *Bäcklund and Darboux Transformations: The Geometry of Soliton Theory*, (to appear).
- John McKay & Abdellah Sebbar (eds.), *The Moonshine Workshop*, (to appear).

Springer-Verlag: CRM Series in Mathematical Physics

- Jan Felipe van Diejen & Luc Vinet (eds.), *Calogero-Moser-Sutherland Models*, 1999.
- Yvan Saint-Aubin & Luc Vinet (eds.), *Algebraic Methods in Physics - A Symposium for the 60th Birthday of Jíri Patera and Pavel Winternitz*, 2000.
- Yvan Saint-Aubin & Luc Vinet (eds.), *Theoretical Physics at the End of the XXth Century*. Lecture Notes of the CRM Summer School, June 27-July 10, 1999, Banff, Alberta, Canada, (to appear).
- Roman Jackiw, *(A Particle Field Theorist's) Lecture on (Supersymmetric, Non-Abelian) Fluid Mechanics (and d-Branes)*, (to appear).

CRM Subseries of the Springer-Verlag Series: Lecture Notes in Statistics

- S.Ejaz Ahmed & Nancy Reid (eds.), *Empirical Bayes and Likelihood Inference*, (to appear).
- Marc Moore (ed.), Spatial Statistics, (to appear).

Les Publications CRM

- James G. Huard & Kenneth S. Williams (eds.), *The Collected Papers of Sarvadaman Chowla, I, II, III, 2000.*

Previous Titles

AMS: CRM Monograph Series

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

- 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* (Banff, 1996), vol. 17, 1998.
- Alain Vincent (ed.), *Numerical Methods in Fluid Mechanics* (Montréal, 1995), vol. 16, 1998.
- François Lalonde (ed.), *Geometry, Topology and Dynamics*, (Montréal, 1995), vol. 15, 1998.
- John Harnad & Alex Kasman (eds.), *The Bispectral Problem* (Montréal, 1997), vol. 14, 1998.
- Michel Delfour (ed.), *Boundaries, Interfaces and Transitions* (Banff, 1995), vol. 13, 1998.
- Peter G. Greiner, Victor Ivrii, Luis A. Seco & Catherine Sulem (eds.), *Partial Differential Equations and their Applications* (Toronto, 1995), vol. 12, 1997.
- Luc Vinet (ed.), *Advances in Mathematical Sciences: CRM's 25 Years* (Montréal, 1994), vol. 11, 1997.
- Donald E. Knuth, *Stable Marriage and its Relation to Other Combinatorial Problems. An Introduction to the Mathematical Analysis of Algorithms*, vol. 10, 1996.
- Decio Levi, Luc Vinet, & Pavel Winternitz (eds.), *Symmetries and Integrability of Difference Equations* (Estérel, 1994), vol. 9, 1995.
- Joel S. Feldman, Richard Froese, & Lon M. Rosen (eds.), *Mathematical Quantum Theory II : Schrödinger Operator* (Vancouver, 1993), vol. 8, 1995.
- Joel S. Feldman, Richard Froese, & Lon M. Rosen (eds.), *Mathematical Quantum Theory I: Many-Body Theory and Group Theory* (Vancouver, 1993), vol. 7, 1994.
- Guido Mislin (ed.), *The Hilton Symposium 1993 : Topics in Topology and Group Theory* (Montréal, 1993), vol. 6, 1994.
- Donald A. Dawson (ed.), *Measure-valued Processes, Stochastic Partial Differential Equations and Interacting Systems* (Montréal, 1992), vol. 5, 1994.
- Hershy Kisilevsky & M. Ram Murty (eds.), *Elliptic Curves and Related Topics* (Sainte-Adèle, 1992), 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. From the Classical to the Modern*, vol. 1, 1993.

Springer-Verlag: CRM Series in Mathematical Physics

- Robert Conte (ed.), *The Painlevé Property: One Century Later*, 1999
- Richard MacKenzie, Manu B. Paranjape & Wojciech J. M. Zakrzewski (eds.), *Soliton: Properties, Dynamics, Interactions, Applications*, 1999
- Luc Vinet & Gordon Semenoff (eds.), *Particles and Fields* (Banff, 1994), CRM Series

in Mathematical Physics, Springer, New York, 1998.

Les Publications CRM

- 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: Concordance Software for the Macintosh*, Montréal, 1996 (software and user guide).
- Decio Levi, Curtis R. Menyuk, & Pavel Winternitz, *Self-Similarity in Stimulated Raman Scattering* (Montréal, 1993), Montréal, 1994.
- Jacques Gauvin, *Theory of Nonconvex Programming*, Montréal, 1994.
- Rémi Vaillancourt, *Compléments de mathématiques pour ingénieurs*, Montréal, 1993.
- Robert P. Langlands & Dinakar Ramakrishnan (eds.), *The Zeta Functions of Picard Modular Surfaces* (Montréal, 1988), Montréal, 1992.
- Florin N. Diacu, *Singularities of the N-Body Problem*, Montréal, 1992.
- Jacques Gauvin, *Théorie de la programmation mathématique non convexe*, Montréal, 1992.
- Pierre Ferland, Claude Tricot, & Axel van de Walle, *Analyse fractale: Application W indows ™ 3.x d'initiation aux ensembles fractals*, Montréal, 1992 (software and user guide).
- Stéphane Baldo, *Introduction à la topologie des ensembles fractals*, 1991.
- Robert Bédard, *Groupes linéaires algébriques*, Montréal, 1991.
- Rudolf Beran & Gilles R. Ducharme, *Asymptotic Theory for Bootstrap Methods in Statistics*, Montréal, 1991.
- James D. Lewis, *A Survey of the Hodge Conjecture*, Montréal, 1991.
- David W. Rand & Tatiana Patera, *Concorder: Concordance Software for the Macintosh*, Montréal, 1991 (software and user guide).
- David W. Rand & Tatiana Patera, *Le Concordeur: un logiciel de concordances pour le Macintosh*, Montréal, 1991 (software and user guide).
- Véronique Hussin (ed.), *Lie Theory, Differential Equations and Representation Theory* (Montréal, 1989), Montréal, 1990.
- John Harnad & Jerrold E. Marsden (eds.), *Hamiltonian Systems, Transformation Groups and Spectral Transform Methods* (Montréal, 1989), Montréal, 1990.
- M. Ram Murty (ed.) *Automorphic Forms and Analytic Number Theory* (Montréal, 1989), Montréal, 1990.
- Wendy G. McKay, Jirí Patera & David W. Rand, *Tables of Representations of Simple Lie Algebras. I. Ex-ceptional Simple Lie Algebras*, Montréal, 1990.
- Anthony W. Knapp, *Representations of Real Reduc-tive Groups*, Montréal, 1990.
- Wendy G. McKay, Jirí Patera & David W. Rand, *SimpLie User's Manual–Macintosh Software for Representations of Simple Lie Algebras*, Montréal, 1990 (software and user guide).
- Francis H. Clarke, *Optimization and Nonsmooth Analysis*, Montréal, 1989.
- Hedy Attouch, Jean-Pierre Aubin, Francis Clarke & Ivar Ekeland (eds.), *Analyse non linéaire* (Perpignan, 1987), Montréal & Gauthiers-Villars, Paris, 1989.
- Samuel Zaidman, *Une introduction à la théorie des équations aux dérivées partielles*, Montréal, 1989.
- Lucien Le Cam, *Notes on Asymptotic Methods in Statistical Decision Theory*, Montréal, 1974.

AMS/International Press

- Duong H. Phong, Luc Vinet & Shing-Tung Yau (eds.), *Mirror Manifolds and Geometry*, AMS/IP Studies in Advanced Mathematics, Amer. Math. Soc., Providence, RI, Internat. Press, Cambridge, MA, & CRM, Montréal, 1998(vol.10).

Collection de la Chair Aisenstadt

- Yuri I. Manin, *Quantum Groups and Noncommutative Geometry*, Les Publications CRM, 1988.
- Laurent Schwartz, *Semimartingales and Their Stochastic Calculus on Manifolds*, Presses de l'Université de Montréal, 1984.

- Yuval Ne'eman, *Symétries, jauges et variétés de groupe*, Presses de l'Université de Montréal, 1979.
- R. Tyrrell Rockafellar, *La théorie des sous-gradients et ses applications à l'optimisation, fonctions convexes et non convexes*, Presses de l'Université de Montréal, 1979.
- Jacques-Louis Lions, *Sur quelques questions d'analyse, de mécanique et de contrôle optimal*, Presses de l'Université de Montréal, 1976.
- Donald E. Knuth, *Mariage stables et leurs relations avec d'autres problèmes combinatoires*, Presses de l'Université de Montréal, 1976.
- Robert Hermann, *Physical Aspects of Lie Group Theory*, Presses de l'Université de Montréal, 1974.
- Mark Kac, *Quelques problèmes mathématiques en physique statistique*, Presses de l'Université de Montréal, 1974.
- Sybreen de Groot, *La transformation de Weyl et la fonction de Wigner: une forme alternative de la mécanique quantique*, Presses de l'Université de Montréal, 1974.

Miscellaneous

- Pierre Ferland, Claude Tricot, & Axel van de Walle, *Fractal analysis user's guide. Introduction to fractal sets using Windows ™ 3.x*., Amer. Math. Soc., Providence, RI & Centre de recherches mathématiques, Montréal, 1994.

Research Reports

[CRM-2566] Stéphane Lafortune, Pavel Winternitz & Luis Martina, *Point Symmetries of Generalized Toda Field Theories*, January 2000.

[CRM-2615] Luc Vinet, Oksana Yermolayeva & Alexei Zhedanov, *A New Family of Krall Polynomials*, June 1999.

[CRM-2616] Luc Vinet & Alexei Zhedanov, *Spectral Transformations of the Laurent Biorthogonal Polynomials*, June 1999.

[CRM-2617] Luc Vinet & Alexei Zhedanov, *Spectral Transformations of the Laurent Biorthogonal Polynomials. II. Pastro polynomials*, June 1999.

[CRM-2618] Vyacheslav Spirodonov & Alexei Zhedanov, *Classical Biorthogonal Rational Functions on Elliptic Grids*, June 1999.

[CRM-2620] Paul Bracken, *Renormalization of Scalar ϕ^4 Theory to Second Order in the Coupling Constant*, July 1999.

[CRM-2621] Paul Bracken, *Analysis of a Renormalization Group Equation by the Prolongation Method*, July 1999.

[CRM-2622] Eric McSweenn & Pavel Winternitz, *Integrable and Superintegrable Hamiltonian Systems in Magnetic Fields*, August 1999.

[CRM-2623] Miloslav Havlícek, Jirí Patera & Edita Pelantovà, *On Lie Gradings. III. Gradings of the Real Forms of Classical Lie Algebras*, August 1999.

[CRM-2624] Louis-Sébastien Guimond, Jirí Patera, Zuzana Masáková & Edita Pelantová, *Deterministically Broken Periodicity of Linear Congruential Generators Using Quasi-Crystals*, August 1999.

[CRM-2625] Paul Bracken & A. Michel Grundland, *Multi-Soliton Solutions of the Generalized Weierstrass System*, September 1999.

[CRM-2626] Hubert de Guise & Marc de Montigny, *Grading Preserving Contractions of Semi-Simple Lie Algebras and Central Extensions*, September 1999.

[CRM-2627] Richard Fournier & Stephan Ruscheweyh, *A Generalization of the Schwarz-Carathéodory Reflection Principle and Spaces of Pseudo-Metrics*, September 1999.

[CRM-2628] Éric Marchand & François Perron, *Improving on the MLE of a Bounded Normal Mean*, September 1999.

[CRM-2629] Bourama Toni, *Bifurcations of Limit Cycles from Hamiltonian Isochrones: A Darboux Linearization Approach*, September 1999.

[CRM-2630] Aimé Fuchs, Anatole Joffe & Jozef L. Teugels, *Expectation of the Ratio of a Sum of Squares to the Square of the Sum: Exact and Asymptotic Results*, October 1999.

[CRM-2631] Paul Bracken & A. Michel Grundland, *On the Bäcklund Transformation and the Theorem of Permutability for the Generalized Weierstrass System*, October 1999.

[CRM-2632] Louis-Sébastien Guimond & Jirí Patera, *Proving the Deterministic Period Breaking of Linear Congruential Generators Using Two Tile Quasicrystals, October* 1999.

[CRM-2633] Paul Koosis, *Hartree's Theorem on Existence of the Quantum Defect*, October 1999.

[CRM-2634] Vladimir Dorodnitsyn, Roman Kozlov & Pavel Winternitz, *Lie Group Classification of Second-Order Ordinary Difference Equations*, October 1999.

[CRM-2635] Stéphane Lafortune, Basile Grammaticos, Alfred Ramani & Pavel Winternitz, *Discrete Systems Related to Equations of the Painlevé-Gambier Classification*, November 1999.

[CRM-2636] Lubomir T. Dechevsky, *Atomic Decomposition of Function Spaces and Fractional Integral and Differential Operators*, November 1999.

[CRM-2637] Lubomir T. Dechevsky, *Near-Degenerate Finite Element and Lacunary Multiresolution Methods of Approximation*, November 1999.

[CRM-2638] Zuzana Masáková, Jirí Patera & Edita Pelantová, *Lattice-like Properties of Quasicrystal Models with Quadratic Irrationalities*, November 1999.

[CRM-2639] Zuzana Masáková, Jirí Patera & Edita Pelantová, *S-convexity, Model Sets and Their Relation*, November 1999.

[CRM-2640] Zuzana Masáková, Jirí Patera & Edita Pelantová, *Substitution Rules for Cut-and-Project Sequences*, November 1999.

[CRM-2641] Jean-François Angers, *Credence and Robustness Behavior*, November 1999.

[CRM-2642] Jean-François Angers, *Bayesian Inference for the Location Parameter of a Student-t Density*, November 1999.

[CRM-2643] Marc Fredette & Jean-François Angers, *A New Approximation of the Posterior Distribution of the log-odds Ratio*, November 1999.

[CRM-2644] Paul Bracken, *A Differential Geometric Approach to Helmholtz Equations: An Application to a Space With a Nontrivial Riemannian Metric*, December 1999.

[CRM-2645] Zora Thomova & Pavel Winternitz, *Separation of Variables and Darboux Transformations*, January 2000.
[CRM-2646] Jean-François Angers & Atanu Biswas, *Estimation of Monotone Function for Data on Records*, January 2000.
[CRM-2647] Andrei A. Kolyshkin & Rémi Vaillancourt, *Series Solution of an Eddy Current Problem for a Sphere With Varying Conductivity and Permeability Profiles*, December 1999.
[CRM-2648] Huaiping Zhu & Christiane Rousseau, *Finite cyclicity of Graphics With a Nilpotent Singularity of Saddle or Elliptic Type*, December 1999.
[CRM-2649] Dinh Tuan Pham, Roch Roy & Lyne Cédras, *Tests for Non-Correlation of Two Cointegrated ARMA Time Series*, January 2000.
[CRM-2650] Ryuichi Ashino, Christopher Heil, Michihiro Nagase & Rémi Vaillancourt, *Microlocal Filtering With Multiwavelets*, January 2000.
[CRM-2651] Ryuichi Ashino, Michihiro Nagase & Rémi Vaillancourt, *A Survey of the MATLAB ODE Suite*, February 2000.
[CRM-2652] Jean-François Angers, *Bayesian Inference for the Location Parameter of a Student-t Density*, February 2000.
[CRM-2653] Marc-André Lewis & Yvan Saint-Aubin, *Boundary States for a Free Boson Defined on Finite Geometries*, February 2000.
[CRM-2654] Jean-Marc Lina, Diego Clonda & Bernard Goulard, *Statistical Modeling With Complex Dyadic Wavelets*, February 2000.
[CRM-2655] Philippe St-Jean & Jean-Marc Lina, *Exceedence Statistics of Irregular Random Field Using Wavelets and Euler Characteristics*, February 2000.
[CRM-2656] A. Michel Grundland, M. B. Sheftel & Pavel Winternitz, *Invariant Solutions of Equations of the Hydrodynamic Type*, March 2000.
[CRM-2670] Marco Bertola, Jacques Bros, Vittorio Gorini, Ugo Moschella & Richard Schaeffer, *Decomposing Quantum Fields on Branes*, March 2000.
[CRM-2671] Thomas R. Hagedorn, *A Combinatorial Approach for Determining Phylogenetic Invariants for the General Model*, March 2000.
[CRM-2672] Paul Bracken, *An Arithmetic-Geometric Mean Inequality*, March 2000.
[CRM-2673] Paul Bracken & A. Michel Grundland, *Symmetry Properties and Explicit Solution of the Generalized Weierstrass System*, March 2000.
[CRM-2674] L. Martina, Stéphane Lafortune & Pavel Winternitz, *Point Symmetries of Generalized Toda Field Theories. II. Applications of the Symmetries*, March 2000.
[CRM-2675] Paul Arminjon & Amik St-Cyr, *New 2 and 3-dimensional non-oscillatory central finite volume methods on staggered Cartesian grids* March 2000.
[CRM-2676] Ervig Lapalme & Yvan Saint-Aubin, *Crossing Probabilities on Same-Spin Clusters in the Two-Dimensional Ising Model*, May 2000.
[CRM-2677] Paul Bracken, *The Cartan Form and its Relation to the Inverse Problem of the Calculus of Variations and the Helmotz Equations*, May 2000.
[CRM-2716] Yoshua Bengio & C. Dugas, *Learning Simple Non-Stationarities With Hyper-Parameters*
[CRM-2717] Yoshua Bengio, *Continuous Optimization of Hyper-Parameters* 1999
[CRM-2718] C. Nadeau & Yoshua Bengio, *Inference and the Generalization Error*, 1999
[CRM-2719] Yoshua Bengio & R. Ducharme, *A Neural Probabilistic Language Model*, 2000
[CRM-2720] Steven Boyer & X. Zhang, *A Proof of the Finite Filling Conjecture*, 1999
[CRM-2721] Steven Boyer, On the Local Structure of $SL_2(C)$-character varieties at reducible characters, 1999
[CRM-2722] Steven Boyer, M. Culler, P. Shalem & X. Zhang, *Small Dehn Fillings*, 2000
[CRM-2723] Steven Boyer, C. Gordon & X. Zhang, *Dehn Fillings of Large Hyperbolic 3-Manifolds*, 2000
[CRM-2724] Steven Boyer, D. Rolfsen & B. Wiest, *On the Orderability of 3-Manifold Groups*
[CRM-2725] Isidore Fleischer & John E. Porter, *Convergence of Metric Space-Valued BV Functions*, May 2000
[CRM-2726] Langis Gagnon & M. Lalonde, *Vision artificielle et traitement d'images*, November 1999
[CRM-2727] A. Michel Grundland & Decio Levi, *On a New Integrable Equation of Toda Type*, 2000
[CRM-2728] Paul Bracken & A. Michel Grundland, *Links Between the Weierstrass Representation, the Complex Sine-Gordon Equation and Multivortex Solutions*, 2000
[CRM-2729] Paul Bracken & A. Michel Grundland, *Conditional Symmetries for the Generalized Weierstrass System*, 2000
[CRM-2730] Jacques Hurtubise & Lisa Jeffreys, *Representations With Weighted Frames and Framed Parabolic Bundles*, June 1999
[CRM-2731] Jacques Hurtubise & E,. Markman, *Calogero-Moser Systems and Hitchin Systems*, 2000

[CRM-2732] Paul Koosis, *Use of Logarithmic Sums to Estimate Polynomials*, 1999

[CRM-2733] Paul Koosis, *On Perturbed Coulomb Solutions of the Schrödinger Equation*, February 2000

[CRM-2734] François Lalonde & D. McDuff, *Symplectic Structures on Fibered Manifolds*, 2000

[CRM-2735] François Lalonde & D. McDuff, *Cohomological Properties of Ruled Symplectic Manifolds*, March 2000

[CRM-2736] C. Ibrahim & F. Nekka, *Amélioration du traitement des images, applications aux réseaux vasculaires de la rétine*, October 1999

[CRM-2737] F. Nekka & J. Li, *Intersection of Cantor Sets With Their Translates. I. Fundamental Properties*, 2000

[CRM-2738] Z. Masáková, Jíri Patera, & E. Pelantová, *Exceptional Algebraic Properties of the Three Quadratic Irrationalities*, 2000

[CRM-2739] C. Rogers & W. K. Schief, *On the Heisenberg Spin Equation in Hydrodynamic*, 2000.

Financial Report

The CRM benefits from numerous sources of funding to sustain its various sectors of activity. This report distinguishes the amounts awarded to *the CRM* from those awarded to the Centre's *researchers*.

The Centre's Funding

The various sources of funding are presented in Table 1. In 1999-2000, the CRM received $874,650 for the first year of a four-year NSERC institutes grant. This grant enables the Centre to fulfil its national mandate centred on the organization of scientific activities each year (postdoctoral fellowships, student scholarships, visiting researchers, thematic scientific activities as well as a general program of scientific activities, research support personnel). (See the section titled "Financial statements" for more details.)

The Comité d'étude et d'administration de la recherche (CÉDAR) of the Université de Montréal provided an operating grant of $722,000 in 1999-2000. This budget is principally allocated for the remuneration of the scientific personnel of the Centre. The budget also covers the release time of the mathematicians who direct the CRM and a part of the salary of administrative staff and operating expenses.

The Fonds FCAR supports the CRM with two grants. The Centre's three-year operating grant was renewed in 1999. This grant of $210,000 per year covers a part of the salary expenditures for the research support personnel, the publications personnel, the administrative personnel and operating costs. An annual amount of $14,000 from this grant is set aside for the research activities of two college (CEGEP) researchers on release time to the CRM. In 1999-2000, the FCAR also awarded the CRM a three-year grant of $50,000 for computer equipment.

The CRM manages the common scientific activities and the general administration of the Network for Computing and Mathematical Modeling (ncm_2). A budget of $83,000 was allocated for these tasks in 1999-2000. In addition, the CRM received $81,444 from the Network for the four research projects of the Centre's members. These amounts come from the Network's annual NSERC grant of $648,894. The balance of this amount goes to the research projects of the four other founding centres of ncm_2: the Centre de recherche en calcul appliqué (CERCA); the Centre interuniversitaire de recherche en analyse des organisations (CIRANO); the Centre de recherche sur les transports (CRT); and the Groupe d'études et de recherche en analyse des décisions (GERAD).

As one of the three mathematics institutes in Canada that established the Mathematics of Information Technology and Complex Systems Network of Centres of Excellence (MITACS), the CRM supervises the activities of five of the Network's research projects. It also promotes networking activities. The CRM received $75,000 in 1999-2000 for these tasks from the overall NCE funding provided to MITACS. In addition, the five research projects just mentioned received $686,667 in NCE funding in 1999-2000 (see the footnote below Table 3). The CRM is not responsible for the financial management of this last amount.

Other contributions to the CRM's funding, totaling $407,429, come from the Institut des sciences mathématiques (ISM) for joint CRM-ISM postdoctoral fellowships and for the joint CRM-ISM colloquium series; from researchers of the Montréal universities for joint postdoctoral fellowships and student scholarships; from the André Aisenstadt endowment; from the Canadian Institute for Advanced Research (CIAR); from various contributions and sponsorships for the "Mathématiques et société" insert published in the magazine *Québec Science* in May 2000 (in addition, $10,000 were provided by the Québec Ministry of Culture and Communications in 1998-1999). Furthermore, the CRM received funding from several contributors, donators and sponsors supporting a promotional campaign held in January-February 2000 in the Montréal public transit system for the World Mathematical Year 2000. Finally, contributions were also provided by the PIMS and the Canadian Institute of Theoretical Astrophysics for workshops held during the Mathematical Physics thematic year.

The CRM generated revenues of $64,481 from its publishing programs (sales and royalties from the American Mathematical Society, Springer Verlag and the CRM's in-house collection) and $24,459 from registrations to the summer school and thematic year activities. Other funds came

from compensation for services rendered and operating costs incurred for the Bell University Laboratories (the CRM housed this division of ncm_2 during several months after its establishment, and the Centre also provided IT expertise to the Bell University Laboratories when they moved into new quarters). MITACS also compensated services delivered by the CRM before NCE funding was confirmed. Finally, the sale of coffee cups and posters generated a small income.

Table 1
Main sources of funding of the CRM, 1999-2000

	$ Amount
NSERC (Institutes and Initiatives Program)	874,650
CÉDAR-Université de Montréal	722,000
FCAR (Research Centres Program)	260,000
NSERC (Research Network Program for ncm_2)	164,444
National Centres of Excellence (MITACS)	75,000
Contributions from Universities & Partners	407,429
Sales, Registrations & Other Revenues	199,077
Total	**2,702,600**

Funding for Research

In addition to the CRM's grants, its researchers obtained $1,717,435 in research funding during the 1999-2000 fiscal year. The two following tables provide details on funding awarded by granting agencies and by categories of research partnerships. The last column in each table indicates the amount of funding that is managed directly by the CRM in its accounts at the Université de Montréal.

Table 2
Research grants, individual and team, CRM researchers, 1999-2000

Granting agency	Number	$ Amount	$ Account at CRM
NSERC	32	812,910	230,895
NSERC-Equipment	3	84,918	0
FCAR	7	243,230	117,000
FCAR-Equipment	1	33,777	0
NCE-MITACS*	3	108,750	10,000
NCE-IRIS	1	60,000	0
AOSQ	1	10,000	0
Total	**48**	**1,353,585357 895**	

Table 3
Research partnerships: contracts and grants from industry, foundations, etc., CRM researchers, 1999-2000

Partner	Number	$Amount	$Account at CRM
Bell University Laboratories	2	110,000	110,000
ncm_2 (ANIQ, Lockheed Martin, industry partners of GIREF)	6	62,850	62,850
MITACS* (Microcell, Bell University Laboratories)	2	70,000	0
Lockheed Martin	1	11,000	11,000
Others (Merck Frosst, US Air Force)	2	110,000	0
Total	**13**	**363,850**	**183,850**

*The total amount of the MITACS NCE funding awarded to the five projects supervised by the CRM is $686,667 (of which $108,750 was awarded to researchers of the CRM). The industrial partners of these five MITACS projects contributed $325,300 (of which $70,000 was obtained by researchers of the CRM).

Furthermore, the CRM, for the benefit of ncm_2, prepared and obtained a grant of $740,000 from the Canadian Foundation for Innovation (CFI). This grant served to establish the research installations of the Bell University Laboratories. The Government of Québec ($570,000), Bell Canada ($500,000) and other enterprises ($40,000) also contributed to the establishment of the laboratories. As for other CFI grants, the Université de Montréal Office of Research managed these funds.

Financial Statements

The following financial statements present, on a cash accounting basis, the revenues and expenditures of the CRM for the fiscal year that ended on May 31, 2000. The financial statements do not include the research funding of individual researchers.

Expenditures are divided in three broad categories: Scientific Activities, Publications and Administration. The main line items under *Scientific Activities* are:

- *scientific personnel* (that is, remuneration of professors at the Université de Montréal who undertake research on a full-time basis at the CRM; expenses associated with the release of professors and researchers from other institutions for prolonged periods so that they may work as invited researchers or as members of the CRM (this includes the André Aisenstadt Chair and the visiting

researchers taking part in the scientific activities of the Centre); and postdoctoral fellowships and student scholarships);

- *scientific programmes* (that is, the annual thematic programme; the 1999 Banff summer school and advance payment for the 2000 summer school; the general scientific programme made up of contributions to off-site scientific activities and events, mini-programmes on particular topics, colloquia organized jointly with the ISM, and to cover expenses associated with the four prizes of excellence in the mathematical sciences (the André Aisenstadt Prize, the CAP-CRM Prize in Theoretical and Mathematical Physics, the CRM-Fields Institute Prize and the CRM-SSC Prize), and finally, the programmes of activities (workshops, seminars, lectures, conferences) of the two networks, MITACS and ncm_2);
- the *personnel* involved directly in the management and organization of the scientific programs; and
- the *research support personnel* delivering computer services and electronic-publishing services for the preparation of research reports.

The rubric *Publications* includes all production costs associated with the CRM's publishing programmes (remuneration of personnel preparing publications as well as direct costs such as printing). Finally, the rubric *Administration* includes remuneration of the executive and the administrative personnel, the computer systems analyst, and expenses related to executive and advisory business meetings, current operating costs (including computer equipment and maintenance).

The year end surplus is explained in great part by two exceptional factors: the FCAR equipment grant, which appears in full as revenue but is to be spent over three years, and the reimbursement for services from the Bell University Laboratories.